PROCEEDINGS

OF THE

Iowa Academy of Sciences

FOR 1899.

VOLUME VII.

EDITED BY THE SECRETARY.

PUBLISHED BY THE STATE.

DES MOINES:
F. R. CONAWAY, STATE PRINTER.
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LETTER OF TRANSMITTAL.

AMES, Iowa, December 31, 1899.

To His Excellency, Leslie M. Shaw, Governor of Iowa:

SIR—In accordance with the provision of title 2, chapter 5, section 136, code 1897, I have the honor to transmit herewith the proceedings of the fourteenth annual session of the Iowa Academy of Sciences.

Respectfully submitted, your obedient servant,

SAMUEL W. BEYER,

Secretary Iowa Academy of Sciences.

OFFICERS OF THE ACADEMY.

1899.

President.—W. S. HENDRIXSON.
First Vice-President.—M. F. AREY.
Second Vice-President.—F. M. WITTER.
Secretary-Treasurer.—H. FOSTER BAIN.

EXECUTIVE COMMITTEE.

Ex-Officio.—W. S. HENDRIXSON, M. F. AREY, F. M. WITTER, H. F. BAIN.
Elective.—S. W. BEYER, A. C. PAGE, W. H NORTON.

1900.

President.—W. H. NORTON.
First Vice-President.—B. FINK.
Second Vice-President.—A. A. VEBLEN.
Treasurer.—J. B. WEEMS.
Secretary.—S. W. BEYER.

EXECUTIVE COMMITTEE.

Ex-Officio.—W. H. NORTON, B. FINK, A. A. VEBLEN, S. W. BEYER.
Elective.—A. MARSTON, J. R. SAGE, B. SHIMEK.

PAST PRESIDENTS.

OSBORN, HERBERT	1887–88
TODD, J. E.	1888–89
WITTER, F. M	1889–90
NUTTING, C. C	1890–92
PAMMEL, L. H	1893
ANDREWS, L. W	1894
NORRIS, H. W	1895
HALL, T. P	1896
FRANKLIN, W. S	1897
MACBRIDE, T. H	1897–98
HENDRIXSON, W. S	1899

MEMBERSHIP OF THE ACADEMY.

FELLOWS.

ALMY, F. F.	Iowa College, Grinnell
AREY, M. F	State Normal School, Cedar Falls
BAIN, H. F.	Geological Survey, Des Moines
BARRIS, W. H.	Griswold College, Davenport
BATES, C. O	Coe College, Cedar Rapids
BEARDSHEAR, W. M.	State College, Ames
BENNETT, A. A.	State College, Ames
BEYER, S. W.	State College, Ames
BLAKESLEE, T. M.	Des Moines College, Des Moines
CALVIN, S.	State University, Iowa City
CHAPPEL, GEORGE M.	State Weather Service, Des Moines
CLARK, DR. J. FRED	Fairfield
CRAIG, JOHN	State College, Ames
CRATTY, R. I.	Armstrong
CURTISS, C. F.	State College, Ames
DAVIS, FLOYD	Des Moines
DENNISON, O. T	Mason City
ENDE, C. L.	Burlington
FINK, B.	Upper Iowa University, Fayette
FITZPATRICK, T. J.	Lamoni
FULTZ, F. M.	Burlington
HADDEN, DAVID E.	Alta
HENDRIXSON, W. S.	Iowa College, Grinnell
HOLWAY, E. W. D	Decorah
HOUSER, G. L.	State University, Iowa City
KELLY, H. M.	Mt. Vernon
KEPPEL, J. T.	Upper Iowa University, Fayette
KEYES, C. R.	Des Moines
KUNTZE, DR. OTTO	Iowa City
LEVERETT, FRANK	U. S. Geological Survey, Denmark
MARSTON, A.	State College, Ames
MACBRIDE, T. H.	State University, Iowa City
METCALF, HAVEN	Tabor
MILLER, B. L.	Penn College, Oskaloosa
NEWTON, G. W.	Cedar Falls
NORRIS, W. H	Iowa College, Grinnell
NORTON, W. H.	Cornell College, Mt. Vernon
NUTTING, C. C.	State University, Iowa City
O'DONOGHUE, J. H.	Storm Lake

Page, A. C. .... State Normal, Cedar Falls
Pammel, L. H. .... State College, Ames
Ricker, Maurice .... Burlington
Ross, L. S. .... Drake University, Des Moines
Sage, J. R. .... State Weather Service, Des Moines
Savage, T. E. .... Iowa City
Shimek, B. .... State University, Iowa City
Stanton, E. W. .... State College, Ames
Stookey, Stephen W. .... Coe College, Cedar Rapids
Summers, H. E. .... State College, Ames
Tilton, J. L. .... Simpson College, Indianola
Veblen, A. A. .... State University, Iowa City
Walker, Percy H. .... State University, Iowa City
Weems, J. B. .... State College, Ames
Wickham, H. F. .... State University, Iowa City
Witter, F. M. .... Muscatine
Youtz, L. A. .... Simpson College, Indianola

ASSOCIATE MEMBERS.

Adams, P. E. .... Durham
Allen, J. R. .... State College, Ames
Baldwin, F. H. .... Tabor
Barnes, William D. .... Blue Grass
Beatty, Esther .... State College, Ames
Biering, Dr. Walter .... Iowa City
Bond, D. K. .... Rockwell City
Bouska, F. W. .... Ames
Brainard, J. M. .... Boone
Brown, Eugene .... Mason City
Brown, J. C. .... State College, Ames
Brawnlie, I. C. .... Ames
Cameron, J. E. .... Cedar Rapids
Carter, Charles .... Corydon
Coburn, Gertrude .... State College, Ames
Crawford, Dr. G. E. .... Cedar Rapids
Deyoe, A. M. .... Britt
Eckles, C. H. .... State College, Ames
Finch, G. E. .... West Union
Gifford, E. H. .... Oskaloosa
Gow, James E. .... Greenfield
Grettenburg, H. N. .... State College, Ames
Hess, Alice .... State College, Ames
Hill, Dr Gershom H. .... Independence
Hodson, E. R. .... State College, Ames
Jenkins, P. W. .... Simpson College, Indianola
Johnson, F. W. .... Grinnell
King, Charotte M. .... State College, Ames
Lenocher, F. E. .... Panora
Little, E. E. .... State College, Ames
Livingston, Dr. H. .... Hopkinton

LUMMIS, DR. W. D. . . . . Des Moines
MAIN, J. H. T. . . . . Iowa College, Grinnell
MILLER, A. A. . . . . Davenport
MORTLAND, J. A. . . . . Cedar Falls
MUELLER, HERMAN . . . . . Webster City
MYERS, P. C. . . . . Iowa City
OSBORN, B. F. . . . . Rippey
PADDOCK, A. ESTELLA . . . . . State College, Ames
PECK, MORTON E. . . . . Iowa Falls
RADEBAUGH, J. W. . . . . Simpson College, Indianola
REPP, J. J. . . . . State College, Ames
RIGGS, C. B. . . . . Rockwell City
SAMPLE, A. F. . . . . Lebanon
SKINNER, A. S. . . . . Upper Iowa University, Fayette
STEWART, HELEN W. . . . . Des Moines
VANDIVERT, HARRIET . . . . . State College, Ames
VOLDENG, DR. N. M . . . . . Des Moines
WALKER, L. R. . . . . Oelwein
WALTERS, C. W. . . . . Cedar Falls
WEAVER, C. B. . . . . Denver, Colorado
WILDER, F. A. . . . . Geological Survey, Des Moines
WILLIAMS, I. A. . . . . State College, Ames

CORRESPONDING MEMBERS.

ARTHUR, J. C. . . . . Purdue University, Lafayette, Indiana
BALL, C. R. . . . . Department of Agriculture, Washington, D. C.
BALL, E. D. . . . . Agricultural College, Ft. Collins, Colorado
BARBOUR, E. H. . . . . State University, Lincoln, Nebraska
BARTSCH, PAUL . . . . . Smithsonian Institution, Washington, D. C.
BEACH, S. A . . . . . Geneva, New York
BEACH, ALICE M . . . . . University of Illinois, Urbana, Illinois
BESSEY, C. E. . . . . State University, Lincoln, Nebraska
BRUNER, H. L . . . . . Irvington, Indiana
CALL, R. E. . . . .
CARVER, G. W. . . . . Tuskegee, Alabama
COLTON, G. H. . . . . Virginia City, Montana
CONRAD, A. H. . . . . 1621 Briar Place, Chicago
DREW, GILMAN C. . . . . Johns Hopkins University, Baltimore, Maryland
FRANKLIN, W. S. . . . . South Bethlehem, Pennsylvania
GILLETTE, C. P. . . . . Agricultural College, Ft. Collins, Colorado
GOSSARD, H. A . . . . . Lake City, Florida
HALL, T. P. . . . . Kansas City University, Kansas City, Missouri
HALSTED, B. D. . . . . New Brunswick, New Jersey
HANSEN, N. E. . . . . Brookings, South Dakota
HANSEN, MRS. N. E. . . . . Brookings, South Dakota
HAWORTH, ERASMUS . . . . . State University, Lawrence, Kansas
HEILEMAN, W. H. . . . . Pullman, Washington
HITCHCOCK, A. S. . . . . Agricultural College, Manhattan, Kansas
HUME, H. H. . . . . Lake City, Florida
JAMESON, C. D. . . . .

LEONARD, A. G..Oberlin, Ohio
MALLY, C. W..Wooster, Ohio
MALLY, F. W..Hulen, Texas
McGEE, W. J.... ....Bureau of Ethnology, Washington, D. C.
MEEK, S. E....................Field Columbian Museum, Chicago, Illinois
MILLS, S. J..Denver Colorado
NEWELL, WILMER..............Ohio Experiment Station, Wooster, Ohio
OSBORN, HERBERT........................State University, Columbus, Ohio
OWENS, ELIZA..Bozeman, Montana
PARKER, H. W................................New York City, New York
PATRICK, G. E........ ......Department Agriculture, Washington, D. C.
READ, C. D......................Weather Bureau, Vicksburg, Mississippi
ROLFS, P. H..Lake City, Florida
SIRRINE. F. A ....Jamaica, New York
SIRRINE, EMMA..Woodstock, Illinois
SPENCER, A. C................U. S. Geological Survey, Washington, D. C.
STEWART, F. C..Ithaca, New York
TODD, J. E....................State University, Vermillion, South Dakota
WINSLOW, ARTHUR................................Kansas City, Missouri

PROCEEDINGS

OF THE

FOURTEENTH ANNUAL SESSION

OF THE

IOWA ACADEMY OF SCIENCES

The fourteenth annual session of the Iowa Acadamy of Sciences was held in the state horticultural rooms at the capitol building in Des Moines, December 26, 27 and 28, 1899. In business sessions the following matters of general interest were passed upon.

REPORT OF THE SECRETARY-TREASURER.

To the members of the Iowa Academy of Science:

I have the pleasure of presenting the following report upon the work of the Academy for the year 1899. Within that period the sixth volume of the proceedings has been printed and published as usual. Most of the labor incident to this in the way of proof reading was performed by Mr. S. W. Beyer in my absence. The secretary and the Academy are under obligations to Mr. Beyer for his work in this connection and the excellent appearance of the volume. Seven additions have been made to the list of fellows, three by election of members to that position and four by the election of men outside the Academy. Ten new members have been elected and have qualified. One fellow and two members have resigned and one fellow, Mr. Robert Combs, one member, Mr. Carl Schlabach, and one corresponding member, Prof. A. A. Crozier, have been lost by death. I would recommend that a committee be appointed to prepare suitable memorials. One fellow, Prof. A. H. Conrad, and three members, Messrs. Hume and Read and Miss Stewart, having removed from the state, I would recommend that they be made corresponding members.

The following have failed to keep the secretary informed of their address, with the result that letters and packages addressed to them are returned to this office:

Eliza Owens, corresponding member.
H. W. Parker, corresponding member.
Emma Sirrine, corresponding member.
C. B. Weaver, member.
F. H Baldwin, member.
J. A. Mortland, member.
E. H. Gifford, member.
A. Estella Paddock, member.
W. D. Barnes, member.

I refer these names to the Academy for action.

Early this year the books and papers coming to the Academy were transferred to the State Library and an arrangement made whereby they will hereafter be catalogued with the remainder of the books of that library. A separate list will, however, be kept, so that it will always be possible to learn just what books have been obtained through the efforts of the Academy. All this material will be suitably bound and cared for. It will at all times be accessible to the members of the Academy, either for use in the building or elsewhere, and in addition a large number of scientific books not previously classified so as to be subject to withdrawal can be borrowed by members of the Academy under very simple restrictions. By this arrangement the Academy is freed from all expense in connection with its library and the members receive important borrowing privileges. The State Library is in return freed from the expense of keeping up several important and expensive sets. The Academy is under obligations to the librarian, Mr. Johnson Brigham, and the trustees of the State Library for the liberality of these terms of exchange.

In publishing the proceedings of the last meeting a special edition printed on enameled paper and suitably bound in cloth was printed for members of the Academy and for the principal exchanges. The extra expense involved was small and it is hoped that the move will meet with the approval of the members.

After correspondence with the members of the executive committee, and such other members of the Academy as could be readily reached, the secretary has arranged for an evening lecture in connection with the meeting of this year. It is hoped that this lecture may become an annual affair and be one of the attractions of the winter meetings.

The expenses of the year have been somewhat heavier than heretofore, both as a result of the extra printing and binding and the bill for illustrations which was held over from the last year. To offset this a considerable amount of back dues has been collected. There are now $22 still outstanding in dues, and of this amount $5 is due from those whose address is lost and will probably not be collectible. A number of members who ordered extra reprints have not yet settled for them, and if they fail to do so the Academy will, I presume, be held responsible for the amounts.

FINANCIAL STATEMENT.

RECEIPTS.

Dues	$	76 00
Back dues		29 00
Fellowship fees		12.00
Membership fees		9 00
Sale of proceedings		6 70
Illustrations		10.45
Balance		69 52
Total	$	212.67

DISBURSEMENTS.

Illustrations	$	85.60
Printing and binding		50.03
Postage		10.00
Express charges		9 63
Wrapping books		3.25
Typewriting		3.50
Receipt books		.20
Total	$	162 21
Net balance		50.46

Very respectfully,

H. FOSTER BAIN,
Secretary-Treasurer.

Des Moines, December 23, 1899.

The following fellows and members were elected:

FELLOWS.

John Craig, of Ames, professor of horticulture at the Iowa State college; O. T. Dennison, of Mason City, president Mason City Brick and Tile company; J. T. Keppel, of Fayette, professor of physics in the Upper Iowa university; Dr. Otto Kuntze, of Iowa City; Haven Metcalf, of Tabor, professor of biology; Benjamin L. Miller, of Oskaloosa, professor of geology in Penn college.

ASSOCIATE MEMBERS.

J. R. Allen, Ames; Esther Beatty, Ames; J. C. Brown, Ames: Dr. I. C. Brownlie, Ames; F. S. Butler, Des Moines; H. N. Grettenburg, Ames; Dr. W. E. Harriman, Ames; Alice Hess, Ames; E. R. Hodson, Ames; Charlotte M. King, Ames; E. E. Little, Ames; Dr. W. D. Lummis, Des Moines; Prof. J. H. T. Main, Grinnell; J W Radebaugh, Indianola; Dr. J. J. Repp, Ames; Prof. A. S. Skinner, Fayette; Grace Troutner, Des Moines; Harriet Vandivert, Ames; Frank A. Wilder, Des Moines.

CORRESPONDING MEMBERS.

R. D. Salisbury, of Chicago, professor of geology in the University of Chicago. By transfer, Mr. Wilmon Newell, of Wooster, Ohio, assistant entomologist in the Ohio experiment station.

Mr. Wesley Greene, secretary of the state horticultural society, was elected a member with dues remitted in recognition of his courtesy in furnishing a hall for the meeting.

The nominating committee reported the following officers for the ensuing year:

President.—W. H. Norton.
First Vice-President.—Bruce Fink.
Second Vice-President.—A. A. Veblen.
Secretary.—S. W. Beyer.
Treasurer.—J. B. Weems.
Elective Members of the Executive Committee.—A. Marston, J. R. Sage and B. Shimek.

Messrs. A. Marston, M. Ricker and L. S. Ross were elected to fill the vacancies in the Council.

The resignation of Prof. L. W. Andrews was received and accepted.

A vote of thanks was extended to Mr. F. A. Wilder for his services in connection with Professor Salisbury's lecture.

It was ordered that the president, president-elect and secretary constitute a sifting committee to determine what papers should be printed in the next volume of the proceedings.

The following amendment to the constitution was adopted:

> Section iv to be amended by the substitution of the word "treasurer" where the word "secretary-treasurer" is used.
>
> Section v, (a) to be amended by the substitution of the words "a secretary and a treasurer," where the words "a secretary-treasurer" are used.
>
> Section viii to be amended by the substitution of the word "secretary" for the word "secretary-treasurer," as there used.
>
> Section ix to be amended by the substitution of the word "secretary" for the word "secretary-treasurer," as there used.

The auditing committee offered the following report, which was received and adopted:

To the Members of the Iowa Academy of Sciences:

Your auditing committee would present the following report:

1. The books of the secretary-treasurer have been examined, and found correct.

2. Regarding the report of the secretary-treasurer for the year, we would suggest as follows:

a. Regarding deceased members, we recommend that a special committe be appointed to draft resolutions or secure brief sketches on their lives, or both, as may seem best.

b. Concerning members failing to pay dues, we suggest that section iv of the constitution be applied.

c. Regarding the deposition of the books of the Academy library in the state library, and the facilities therewith offered to members of the Academy for drawing books from the library for use, we recommend the appointment of a special committe to formulate suitable resolutions embodying the thanks of the Academy.

d. We also approve the recommendations of the secretary-treasurer that volumes of proceedings for members and principal exchanges be printed on enamel paper, and bound in cloth, and that the evening lecture be made a permanent feature of our meetings.

Respectfully submitted,

A. C. PAGE,
C. C. NUTTING,
B. FINK,
Committee.

The committee on necrology was instructed to prepare sketches of deceased members of the Academy for publication in the proceedings. Upon motion the committee was made permanent and the secretary made *ex-officio* chairman.

The chairman appointed Messrs. Bain, Pammel and Page on the legislative committee.

By an unanimous vote it was ordered that bills for reprints remaining unpaid shall, if necessary, be settled by the Academy, and that persons owing for reprints be notified that if they do not pay this and any other delinquent dues promptly their names will be dropped from the Academy roster.

Votes of thanks were extended to Prof. R. D. Salisbury for for his instructive and entertaining lecture and to the retiring secretary-treasurer for the zeal and ability shown in discharging the arduous duties of his office.

The following memorial was addressed to the State Librarian:

The Iowa Academy of Sciences would hereby express its high appreciation of the valuable services to the Academy which have been rendered by the State Librarian in providing alcove room for the books and pamphlets belonging to the Academy, and also for the liberal terms on which scientific books may be obtained from the State Library for the personal use of the members.

J. L. TILTON,
SAMUEL CALVIN,
M. F. AREY,
Committee

At the literary session the following papers were presented:

"A Chemical Study of Butter Increasers," by J. B. Weems and F. W. Bouska.

*"A Study of the Chemical Composition of Some of the Native Grasses of the State," by J. B. Weems.

**"Determination of Alcohol in Weak Liquors," by J. P. O'Donoghue.

Other products, sugar, tartaric acid, etc. Adulterants, bi-carbonate of soda. Disposal of carbonic acid gas. Distillation, precautions to fix acetic acid and other volatile acids. Determination of sp. gr. of distillate. Determination of percentage by weight.

"Klebs-Loefsler Diphtheritic Bacillus," by Gershom Hill.

*"Notes on the Acocephali (Hemoptera, Jassidae)," by E. D. Ball.

*"The Scydmænidas and Pselaphidæ Occurring near Iowa City," by H. F. Wickham.

"Eleodes in Iowa," by H. F. Wickham.

*"Forest Trees and Shrubs of Hamilton County," by H. A. Mueller.

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*Read by title and published in the Proceedings. **Read by title but paper withdrawn.

*"Addition to Lichen Distribution in the Mississippi Valley," by Bruce Fink.

*"The Orchidaceæ of Iowa," by T. J. and M. L. F. Fitzpatrick.

*"The Genus Viburnum of Iowa," by T. J. and M. L. F. Fitzpatrick.

*"Saprophytic Basidionycetæ of Ames," by Alice Ward Hess and Harriet Vandivert.

*"Quince Fruit with an Unusual Number of Seeds," by L. H. Pammel.

*"The Occurrence of Sphærotheca Mali in Iowa," by L. H. Pammel.

*"Preliminary Notes on Some Bacteria of the Ames Flora," by L. H. Pammel.

*"Some Cercospora of Macon County, Alabama," by George Carver.

*"The Genus Salix in Iowa," by Carleton R. Ball.

*"The Distributon of Trees in Iowa," by B. Shimek.

"An Abnormal Fermentation of Bread," by C. H. Eckles.

"A Notable Ride; from Driftless Area to Iowan Drift," by Samuel Calvin.

*"Formational Synonomy of the Coal Measures of the Western Interior Province," by Charles R. Keyes.

*"Terraces of the Nile Valley," by Charles R. Keyes.

*"Genesis of Normal Compound and Normal Horizontal Faulting," by Charles R Keyes.

"Observations in the Vicinity of Wall Lake," by Frank A. Wilder. (Introduced by H. F. Bain).

"Sand Ridges of Marion County," by B. L. Miller. (Introduced by H. F. Bain).

A study of the distribution, movement and origin of certain sand ridges.

Prof. R. D. Salisbury of the University of Chicago, guest of the Academy, attended the afternoon session on Tuesday, and upon motion was invited to address the Academy upon such subject as he might choose. He spoke briefly upon the features of the edge of a drift sheet and significance of certain extra morainic gravels found in the "Driftless Area."

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* Read by title and published in Proceedings. ** Read by title but paper withdrawn.

Very Truly
A. A. Crozier

Necrology.

ARTHUR A. CROZIER.

BY L. H PAMMEL.

It was the writer's good fortune soon after his arrival in Iowa in 1889 to have become acquainted with Mr. A. A. Crozier, who was then station botanist of the Iowa Agricultural Experiment station. Because of the similar lines of work we were engaged in I was frequently thrown in his company, and it is needless for me to say that I found Mr. Crozier a faithful and most conscientious worker in every line of work in which he was engaged. I found him ever helpful and ready to give me suggestions as to how certain lines of work should be done. He was a most careful and painstaking worker. Nothing was done by halves. Whatever he undertook to do was carried out in the most careful manner. I never knew him to shirk any of his work. He was not content to merely plan his experiments, and let others do the work, but a great deal of the work done at the Iowa Agricultural Experiment station was planned and executed by himself. Mr. Crozier was connected with the station a little over a year, and left because of a disagreement with the director as to how the scientific work should be done. It was evident to all that an injustice was done and that he should have remained to complete the work so well begun. It was during his stay here that he was elected fellow of this body in 1888. During the years 1886 and 1887 he was assistant botanist in the division of botany, U. S. Department of Agriculture. While connected with the Iowa Agricultural Experiment station he was made secretary of the American Pomological society, a position worthily filled for two years. After leaving the Iowa Agricultural Experiment station, he became assistant agriculturist at the Michigan Agricultural Experiment station. He continued to hold this position, till by reason of failing health, he resigned. He sought the dry climate of Arizona, but, as he seemed to grow worse, a sea voyage to Honolulu was taken, but the pulmonary trouble was so deep rooted that the change of climate offered little relief, and he returned to his home in Ann Arbor on the 20th of May. After a noble fight for life he died on the 28th of January, 1899. He was born in Georgetown, Ottawa county, Mich., on September 22, 1856. Most of his youth was spent on a farm in Jamestown of the same state, where his parents settled, cleared the land of forest trees, and made a farm. He early became interested in the planting of trees, and did much, as his mother says, to beautify the home by setting native trees. His preparation for college was mostly done at home. He graduated from the Michigan Agricultural college in 1879 and from the University of

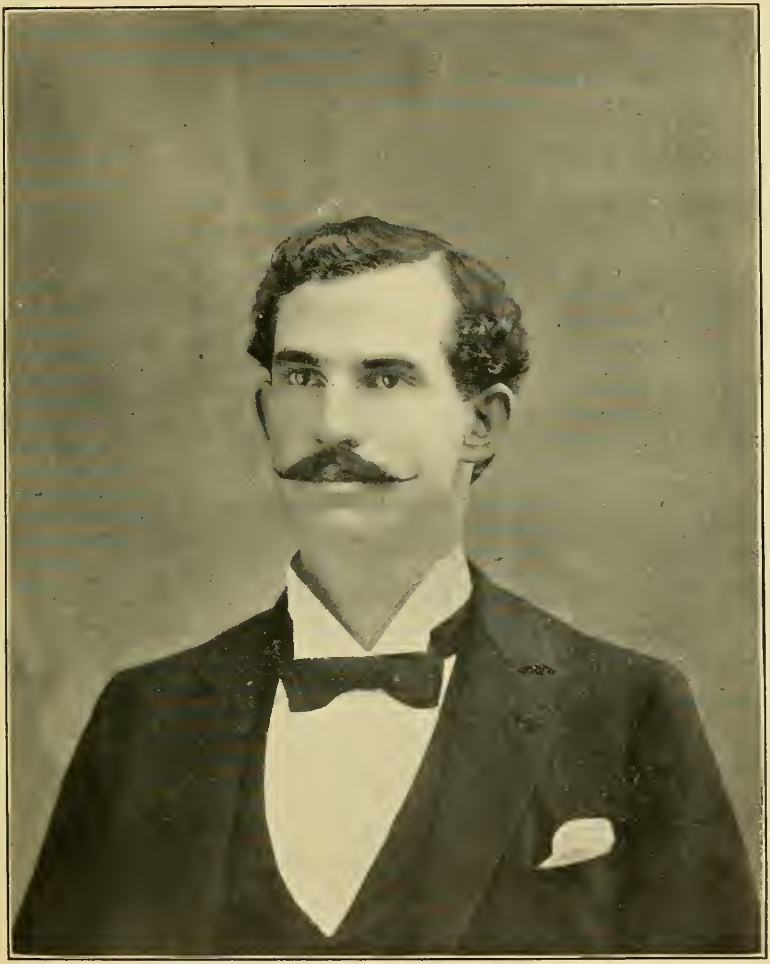
Michigan in 1885, receiving therefrom the degree of A. M., his thesis being the modification of plants by climate. This paper showed wonderful familiarity with the literature, and a broad conception of the subject. His interest in this line of work continued throughout his life, and he left many unpublished notes which were turned over to the writer. He was a prolific writer, and published much that is of a high grade. In addition to the work of acclimitization he was much interested along the line of cross fertilization of plants, especially the secondary effects, and much of this kind of work was done with corn.

Several papers on this subject were published by him. He outlined some of this work for the division of botany more than ten years ago. The U. S. department of agriculture, within the last few years, is taking up this line of investiga'ion which he regarded so important. His paper on millets is frequently quoted in scientific and agricultural papers. This work was started while in Iowa, and continued in Michigan, and the results of experiments were finally published as a bulletin by the Michigan Agricultural Experiment station. He was much interested in the weeds of agriculture, and during his connection with the U. S. department of agriculture prepared several papers on the subject. He gave special attention to grasses, and many of his specimens are preserved in the herbarium of the Iowa State college. A collection of grasses was made for the Paris exposition. Other papers of his were on "Crimson Clover," and "Influence of Scion on Stock." He published two books along economic lines "The Cauliflower," and "Popular Errors of Plants." He also published a "Dictionary of Botanical Terms," and was editor of pomological terms for the Standard dictionary. All of his works show his unmistakable bent along the lines of economic botany. In all of his papers scientific methods are shown. In careful collecting of literature, and the weighing of evidence pro and con, Mr. Crozier has shown that the socalled agricultural and horticultural topics can be treated from a scientific standpoint without losing their value for the practical farmer and horticulturist.

ROBERT COMBS, B. S., M. S.

BY L. H. PAMMEL.

Robert Combs, who was a member of this Academy since 1894, died in Phœnix, Ariz., on the 11th of April, 1899, from tuberculosis. He was born in Lyon county, Kan., on the 12th day of February, 1872. At the age of 4 years he moved with his parents to Cambridge, Cowley county, of the same state. At an early age he showed tastes for natural history and his parents gave him every opportunity to acquire knowledge. His early instruction was obtained in the public schools of Cambridge, and from a private tutor who gave him instruction in algebra and geometry. In 1892 he graduated from the course in pharmacy of Kansas State university and soon found employment during the sugar season as chemist for a large sugar company at McCall and Burnside, La. In February, 1894, he entered Iowa State col-



Very respectfully
Rob Combs

lege with the hope of completing his college course, which he did, in 1896. He received the M. S. degree in 1898. He became an assistant in the department of botany and continued in this capacity till July, 1898. During this time he acted as instructor in botany in the college, assistant botanist of the Iowa Agricultural Experiment station, and botanical collector in Cuba. Mr. Combs was largely interested along economic lines. He published several papers of much merit, one on the anatomy of corn leaves in the proceedings of the Iowa Academy, another on the alfalfa leaf spot in the biennial report of the Iowa State College of Agriculture and Mechanic Arts for 1897 and 1898. During the early days of the Cuban insurrection, 1895, he was on the Island of Cuba. Here Mr. Combs was sugar chemist for a large concern near Cienfuegos, and after the sugar season was over he began to make a large collection of Cuban plants. These were distributed to leading institutions. The results of his labors were embodied in a paper of considerable length on the plants of Santa Clara province published in transactions of the St. Louis Academy of Science, Vol. VII, p. 393. In this paper are described a number of new species and one species, the *Rondeletia Combsii*, was dedicated to our young, enthusiastic naturalist by Mr. Greenman. No one was more worthy of such rocognition than Mr. Combs who imperiled his life both by fever and the insurgents, with whom he had several unpleasant experiences. While collecting on the island he had occasion to meet many of the country folk and soon learned that they were much interested in the plants of the island for medicinal purposes. He found that the native Cubans made extensive use of many native plants to cure diseases of various kinds. The results of his observations were embodied in a paper on the medicinal plants of Cuba published in the *Pharmaceutical Review*. It is the only English account we have of the medical plants of the island. The only other published paper of his on corn appeared in Bulletin No. 36 of the Iowa Agricultural Experiment station. In July, 1898, he accepted a position as field agent for the division of agrostology, U. S. department of agriculture, and at the time of his death had ready for publication a paper on the forage conditions and forage plants of Florida. Prof. F. Lamson-Scribner in a letter to the writer says of him, "I had come to admire the sterling qualities of manhood and marked abilities of Mr. Combs, and felt assured that he had a brilliant future in store. It is with more than ordinary feelings of sorrow the news of his death brings me, for I not only held a deep personal regard for him, but science has lost an earnest and most promising student." Mr. Combs, though never of a rugged constitution, was endowed with a will that overcame any obstacles on account of physcial weakness. He was prompt and punctual in all his work. He never undertook anything except that it was done well. As an illustration, when he returned from Cuba he entered the senior year when the term was nearly half gone. His trigonometry, a sophomore study, was nearly half completed, but with the energy characteristic of him he was able to complete all of his work with credit to himself. It is such enthusiasm that makes naturalists, and this was given him in an unusual degree. During the siege of his illness his letters were always hopeful of doing something for the cause of science to which he was so devoted. Just a week before his death he wrote to the writer about his return to his home in Kansas to do some work in a limited way, but that he would have to give up his work with the department of agriculture, because he felt that he ought not to receive pay when he was doing so little. Thus ended the life of a noble and faithful Christian, at the very beginning of his career.

CARL EDWARD SCHLABACH.

BY L. H. PAMMEL.

It was the good fortune of the writer of this sketch to have made the acquaintance of Mr. Schlabach during the fall of 1881, when he entered the University of Wisconsin. I was thrown in his company, more or less, for two years while he was pursuing special work at the university. I did not meet him again until at the meeting of the State Teachers' association in Cedar Rapids. At this time he also became a member of the Iowa Academy. Although he never presented papers, his interest in science never left him. As a teacher of science in the public schools of Clinton, he had to keep his zeal and energy towards improving the instruction in science, frequently so poorly done. According to his view, only the best science should be taught. Carl Edward Schlabach was born in De Witt, August 3, 1862. His parents came to this state in the early fifties, and occupied a prominent place in the affairs of De Witt for many years. It was in De Witt where young Schlabach received his early education, graduating from the high school in 1878, and later attended the high school in Madison to prepare himself for entrance to the University of Wisconsin. He was a successful teacher at Chatsworth, Ill., holding the principalship of the schools at that place from 1887 to 1889. In the fall of 1889 he accepted the position of superintendent of the De Witt schools, remaining here till a call came from Dwight, Ill., to accept the same kind of a position at a much better salary. He remained here till the fall of 1892, when once more he returned to his county to accept the position of science teacher in the public schools of Clinton. It offered him superior advantages, and was work more suited to his scientific tastes. On January 1, 1894, he resigned to take up his new duties as county superintendent. He was popular with the people of his county, being elected on a republican ticket in a democratic county. He held this office two years and retired from active school work on the 1st of January, 1896. For three years he battled with a bronchial trouble, which finally culminated in tuberculosis, from which he died on April 4th, leaving a large circle of friends and relatives to mourn his loss. The Rev. T. Robert Elwell said at the funeral, "I know that this county, and our town particularly, has lost one whom we could ill afford to lose: I know that we each feel that a personal friend has left us. Such, indeed, is my own personal thought and feeling that a worthy and highly esteemed friend has passed away; a young man whom all could honor and sincerely respect." He took a deep interest in higher education, and worked steadfastly for the masses and the enlarging of university and college work. During the last year of his illness he was

Yours Truly
S. E. Schlabach

planning a university extension course. While at Clinton he helped organize a university extension course there, and I remember well, when in conversation with him, how he expounded on the kind of work to educate the people. He was also interested in furthering public libraries, and did much for the De Witt public library. He was generous to a fault. In society, school and class room he was always kind. It was my good fortune to hear him in debate during his college days. In society or in friendly class strife, Carl was always on the right side. Though circumstances did not permit him to become an active scientific worker, yet he has left an impression for the bettering of science in our high schools on the many students who worked in his laboratories where he was an instructor. His work was well done, and science has lost one of its humble workers whose work must be measured by the influence he exerted on the community, rather than his written scientific communications.

PRESIDENTIAL ADDRESS.

SOME FEATURES OF THE SCIENCE OF A HUNDRED YEARS AGO.

BY W. S. HENDRIXSON.

In the past three or four years the popular magazines have contained numerous articles on the progress of science in the nineteenth century. These papers were written for popular information and they deal with only a few great discoveries with which all men of science are familiar. It occurred to the writer that for the entertainment and information of the man of science, who is acquainted with the main facts and theories of every science as it is to-day, and who, though not acquainted with its minute details, is at least aware of its great mass of facts, its intricate theory, and ponderous and ever increasing literature, it would be more to the point to define the conditions of science as it was at the beginning of the century, and let him arrive at a conception of its progress by subtraction.

Upon actual trial I found the process fascinating in more ways than one, and it occurred to me that it might be interesting to us to-day to look back 100 years, or about the extreme limit of a human life, pay our respects to some of the worthies of that day, take a view of their science and contrast it with our own.

It seems wise to restrict our attention to the universally recognized natural sciences, and indeed to those that furnish topics for discussion in this body: Chemistry, physics, biology and geology.

It will be necessary, and we hope interesting, to trace each of these sciences from its birth, so nearly as that date can be determined, down to the even date 1800, or 100 years ago, giving dates of important discoveries both in fact and theory. There must always be uncertainty regarding the dates of many discoveries. To cite examples, we may trace an atomic theory and a theory of evolution back to the time of the early Greek philosophers, yet neither assumed a scientific form until about the beginning of this century. In these and all similar cases the speculations of philosophers, suggestive though they have been, will be passed over and the origin of theories placed at the times when they arose as the results of true scientific research.

It is assumed that there is no occasion in this presence to explain any prominent fact or theory of science farther than to mention it by name.

CHEMISTRY.

The phenomena of Chemistry that appeal to ordinary observation are not many, and the factors of chemical reactions lie beyond the reach of the senses. This may account for the fact that scientific chemistry is a matter of recent origin. Its beginning as an empirical art probably antedates authentic history, but as a science it is difficult for one of the present time to conceive of its existence prior to the discovery of oxygen by Priestley in 1774, and the explanation of the relation of this most important element to combustion and calcination by Lavoisier from about 1777–1783.

The history of Chemistry down to Lavoisier is, as regards theory, a long night with only here and there small gleams of light due to the illumination of the torch of a Boyle in the seventeenth, and a Black in the eighteenth century. The former clearly distinguished elements and compounds, and gave the beginnings of a theory of chemical reaction; but his good work was lost sight of, and completely disappeared with the rise of the theory of phlogiston by Stahl, in the seventeenth century. This theory has such an important relation to the material theories of light and heat that a word of explanation is necessary. It assumed a fire principle which escaped in the combustion and calcination of bodies. A calx, or oxide in our language, was, therefore, an element, while a metal was due to the union of a calx with phlogiston. The more violently a body burned the richer it was in phlogiston, the gaseous products of combustion seeming to be ignored. Later in the history of the theory, carbon, sulphur and hydrogen were successively identified with phlogiston. At first no account was taken of the increase of weight when a metal changed to a calx. Later when hard pressed upon this point phlogistonists did not hesitate to ascribe to phlogiston the property of negative gravity or levity. During this period of theory gone utterly wrong, facts were accumulated by the investigation of many able men, and these were soon to serve a purpose in the establishment of a new theory by which they also were to be co-ordinated and explained.

The work of Lavoisier marks an epoch in chemical history, and paves the way for a general theory. He first employed the balance systematically, and clearly showed that calcination and combustion were processes of union of oxygen with other substances, and his work marks the overthrow of phlogiston. There arose again with his work true ideas of element, compound and chemical reaction.

Probably most chemists accustomed to use the atomic theory with as much confidence as the carpenter uses his square and pencil in marking out his work, would place the origin of *scientific* chemistry at the announcement of the rudiments of the atomic theory by John Dalton, in 1803. This theory was the outgrowth of the law of definite proportions demonstrated by Proust, 1799–1807, against the determined opposition of Berthellot and his school, who argued that the constitution of one and the same compound is variable, and the law of multiple proportions discovered by Dalton himself. The theory accounts for these laws; it is, therefore, the result of legitimate scientific work, and is not to be confused with the speculative theory of atoms of the Greeks. That Chemistry passed the date 1800 without an atomic theory of any kind, sufficiently indicates its condition. No further comment is necessary.

To this period belongs the discovery of nitrogen, phosphorus, chlorine, hydrogen, oxygen, manganese, cobalt, nickel, platinum, though they were not regarded as elements, and many of their compounds were made; the distinction between caustic and mild alkalies, and the relations of acids, bases and salts, were pointed out; many new gases were studied and the foundations of analysis were laid. To this period belongs a long array of illustrious names—Black, Cavendish, Priestley, Galen, Scheele, Hales, Mayow, Bergman and Hoffmann, who paved the way for Lavoisier and Dalton. The theory of phlogiston, though wrong, served to explain and group certain related phenomena, and to that extent there was science of chemistry.

PHYSICS.

So many physical phenomena are met in daily life that it is no matter of surprise that many elementary principles of Physics have been understood for centuries. It is probable, however, that most physicists would place the beginning of scientific physics at about the time of Galileo. He has justly been called the Father of Physics. It is surprising how many great discoveries were made by this many-sided man. It was he who discovered the law of falling bodies, the path of projectiles, the laws of the pendulum, the parallelogram of forces, the satellites of Jupiter, sun-spots and the rotation of the sun upon its axis. He was the first to demonstrate that the air has weight. He greatly improved if he did not invent the telescope and seems to be the first who used it to observe the heavenly bodies. He invented in 1593 the thermoscope consisting of a bulb and stem, the latter partly filled with water and ending in water. It was his pupil Torricelli who devised the barometer and used it to measure the fluctuations in the pressure of the air. About the same time, or about the middle of the seventeenth century, Von Guericke invented the air pump, and a few years later Boyle discovered the important law that the volume of a gas varies inversely as the pressure.

It will be necessary to trace very briefly the progress of discovery in at least three branches of Physics: Light, heat, Electricity and Magnetism.

LIGHT.

The law of reflection of light could scarcely escape the earliest observers and was known to the Greeks. But one must come down to the early part of the seventeenth century for any further advance in the knowledge of light. It is here we meet the invention of the telescope and the microscope in crude forms. It may seem strange that they were invented without a knowledge of the law of refraction, which was experimentally discovered by Snell about 1620, and was given its present form by Descartes in 1637. It was in 1676 that Roemer determined approximately the velocity of light, which before that time was believed to be infinite, from the eclipse of one of the moons of Jupiter, and in 1728 his theory was confirmed by Bradly, who made a nearer approximation in the determination of its velocity; for any advance in this direction we must come down to the middle of the nineteenth century.

In 1665 Robert Hooke suggested a wave theory of light, and such a theory was elaborated by Huygens in a paper before the French Academy in 1678. He assumed the existence of an all pervading ether. He described the double refraction in Iceland spar and observed that both rays were polarized. But polarization received little further attention until the time of Young and Fresnel in our century. The wave theory met the determined opposition of Newton, whose great and increasing authority caused it to sink out of sight for more than 100 years, when it was again brought into prominence by Young in 1801, and was finally established by the experiments of Foucault and Fizeau on the velocity of light in 1850. Though a supporter of the corpuscular theory of light chiefly because it explained the propagation of light in straight lines, Newton made several important additions to our knowledge of light, and probably failed to discover the spectroscope only because the beam of light that fell upon his prism came through a round hole instead of a slot parallel to the edge of his prism. He was the first to explain dispersion upon difference of refrangibility of the rays. He believed that it was not possible to make an achromatic lens and, therefore turned his attention to a reflecting telescope which he invented in 1668.

The phenomenon of diffraction was discovered by Grimaldi in 1666 and experimented upon by Newton, but like polarization it had to wait for its explanation until 1815, when Fresnel r discovered the phenomenon. The eighteenth century witnessed little progress in light beyond the construction of achromatic lenses by Dolland in 1758, and their application to the telescope and microscope.

HEAT.

The first thermometer was invented by Jean Rey, in 1632, by inverting the thermoscope of Galileo and filling the bulb and part of the stem with water. Twenty-five years later the end of the bulb was sealed, and alcohol replaced the water. Mercury was first used in 1659. The thermometer was perfected and the present fixed points adopted by Fahrenheit in 1724, and Celsius in 1742. The discovery that liquids have definite boiling points is apparently due to the former.

The ideas of specific heat and latent heat, apparently originated with Joseph Black in 1756, and he determined the latent heat of vaporization of water and liquifaction of ice. The ideas of Black soon bore fruit in the improvement of the steam engine by Watt, in 1783. Lavoisier determined the specific heat of a number of substances.

The mechanical theory of heat was not known to the philosophers and scientists before the eighteenth century. From a speculative point of view, Descartes, Boyle, Bacon, Hooke and Newton all looked upon heat as possibly a mode of motion. Boyle actually experimented upon the mechanical production of heat, but the theory never attained a scientific basis until the nineteenth century, and, in fact, was not established beyond controversy until about the middle of our century.

The material theory of heat can be traced to the Greeks. In the early part of the seventeenth century it was advocated by Gassendi; the phlogiston theory of combustion seemed to lend it support. In 1783 the French Academy offered a prize for the best paper on the theory of heat. It was won by Euler, who supported the material view, though he is apparently the only man of the century seriously to advocate the wave theory of light.

The material theory was not seriously questioned until Count Rumford observed the enormous amount of heat caused by friction, in boring cannon at Munich, in 1798. He surrounded a piece of brass, in a cavity of which worked a blunt drill, with a box in which he placed eighteen and one-half pounds of water. The drill was started in rotation and at the end of two and one-half hours the water actually boiled. He expresses his delight, and the astonishment of the bystanders, that so much water should be made to boil without any fire. He remarks that the source of heat generated by friction seems inexhaustible. In 1804 he wrote to Pictet, of Geneva, "I am persuaded that I shall live a sufficiently long time to have the satisfaction of seeing caloric interred with phlogiston in the same tomb." But Rumford underestimated the strength of conservatism. The war over the nature of heat was to be a long one, and the establishment of the mechanical theory required fifty years, and all the genius of Young, Meyer, Joule, Thompson, Carnot, Clausius and Rankine.

ELECTRICITY AND MAGNETISM.

Electricity and Magnetism may be considered together though their relation was discovered by accident by Oersted in 1819. The facts of the existence of magnetism and electricity have been known for ages. The founding of magnetism as a branch of science may be placed in 1600, when Gilbert published his "De Magnete." He was the first to use the terms magnetic force, pole. He first studied the declination of the magnetic needle, and first asserted that the earth is itself a great magnet. Magnetic charts were made about the end of the century. There is probably no branch of science that made such progress in the eighteenth century as electrostatics. It is very largely a product of that century. The frictional electric machine of Von Guericke of the seventeenth century consisting of a revolving ball of sulphur rubbed by the hands, was gradually improved by the substitution of a glass globe, then a glass cylinder, and finally a glass plate for the sulphur ball, and fixed pads with amalgam finally took the place of the hands.

Stephen Gray electrified the human body in 1730. Du Fay repeated Gray's experiment and finally arrived at the conclusion that all bodies may be electrified, and he discovered that there are two kinds of electricity. The Leyden jar came in 1745-46 and created no end of interest. There followed soon the ideas of insulation, induction, and potential. The influence of points in dissipating the electric charge was dwelt upon by Franklin, who studied atmospheric electricity, arriving at the identity of electricity and lightning, and suggested the protection of buildings by pointed rods.

In 1747 Franklin advocated a one fluid theory. A body having a certain charge was neutral; less than this amount gave the effects called negative; more gave the effects associated with p sitive electricity.

The latter half of the century saw great advances in electric measurements. Cavendish, the recluse, studied electrical measurement and before 1771 arrived at clear conceptions of inductive capacity and constructed a set of condensers, and determined the capacity of several substances. He proved that static charges are on the outside of hollow bodies, that electric force varies inversely as the square of the distance, but his writings were not made public for a century.

Coulomb invented the torsion balance, and proved that the force of electric attraction or repulsion varies inversely as the square of the distance, and as the product of the quantities of the electricities. He showed that electric charges reside on the surface of bodies, and revived the two fluid theory of Du Fay.

On November 6, 1780, was made the famous discovery by Galvani of the influence of electricity upon a recently killed frog, leading to the production of the electric current by the contact of dissimilar metals, which, in turn, led to the invention of the electric pile and the crown of cups by Volta in 1800. The beginning of dynamic electricity is to be placed here, and this branch of electricity, which has made such unparalleled advancement in our century and has been so profoundly influential in both the thoughts and the material affairs of men, is, therefore, a product of the last 100 years. The change in the condition of electrical science during the last 100 years is typical of that of the whole science of physics, and I might even say of all science, and our conception of the world. The change is one of statics to dynamics. Up to 1800 there was no wave theory of light, no polarization, no spectroscope. There was no mechanical theory of heat or thermo-dynamics, no transformation of energy, and no dynamic electricity.

Physics is regarded to-day as essentially a quantitative science, and yet 100 years ago very few measurements of any sort had been made, and in the huge mass of our present constants I find none that have come down to us from the last century.

BIOLOGY.

Historically the development of Botany and Zoology show such close parallelism that for present purposes they may be considered together under the name Biology, which was really coined in our own century.

Though good beginnings in the anatomy and physiology of both plants and animals were made before 1800, the attention of botanists and zoologists was mainly directed to the work of systematizing, and here the most marked advancement was made. As a systematizer in the animal, vegetable and mineral kingdoms, Linnaeus stands preëminent. He invented a new vocabulary of descriptive terms, and gave us our binomial system for the designation of species. In his systems the accumulated facts of Natural History found a convenient, simple, orderly and exact arrangement, and there followed a great impetus in the discovery and description of new forms, probably to the neglect of other and, as we now regard them, more important branches of the science. The systems of Linnaeus were confessedly artificial. Holding as he did the idea of the fixity of species which was a prime article of faith of most biologists, even down to nearly the middle of our century, he could not conceive of a natural system as we understand it in the light of evolution. To him a natural system was a thing of the future, and it would represent the plan of the Creator. His systems were predominent to about the end of the century, when they were succeeded by others, framed in the attempt to form a natural system, and to provide place for the enormously increasing numbers of known plants and animals of the lower orders. Most of the elements of our present biology had a vigorous beginning in the seventeenth century, but little advance was made during the eighteenth century, and this was mainly due to two causes: the influence of Linnaeus that turned the attention of men to classification, and the tendency toward excessive speculation in the eighteenth century, observable in the history of all sciences, and having its foundation in the general belief that a System of Nature was something to be thought out by *a priori* reasoning.

The first man to observe vegetable cells was probably Robert Hooke, in 1667, not as a botanist, but as one interested in showing the power of the microscope. The first to study in a broad way the minute anatomy of plants, and to describe the structure of plant and animal tissues, were Malphigi and Grew, 1670–82. They did not, however, regard the cell as the unit of plant and animal structure, or from a cell theory. Beyond some work by Wolff, in 1759, who attempted to found a cell theory, little was added to the work of Malphigi and Grew until 1801, when the subject was taken up by Mirbel. The first cell theory wo thy of the name was proposed by Schleiden, according to which the cell is the unit of all plant tissue; and in 1838 the theory was applied to animals, by Schwann. The physiology of the cell, in essentially its present form, was given by Nägeli, only after protoplasm was investigated by Von Mohl, in 1846, and Schultze and De Barry recognized it as the essential part of the cell. The essentials of our theory of the origin of tissues and their classification were worked out between 1820 and 1860.

The history in time of the theory of reproduction is long and interesting, both from the scientific and the psychological point of view. Strange as it may seem the fact of sexuality in plants was first definitely asserted and scientifically maintained by Comerarius about 1694, but his work was lost sight of until republished 100 years later. Despite the seemingly decisive experiments on close and cross fertilization by Gleditsch about the middle of the century, and the thorough and wide reaching experiments of Koelreuter, from 1761–1766, who produced hybrids by cross fertilization, the question of the sexuality of plants continued a matter of dispute until finally settled by Gärtner, who collected the evidence from the work of his predecessors, added it to his own results of experiments extending over twenty-five years and combined all in a volume published in 1849.

The study of the fact of sexuality necessarily involved the study of the functions of the pollen and ovule in fertilization, and here again there was much controversy among those who accepted sexuality, which ended so far as flowering plants are concerned with the discovery of the descent of the pollen tube and its influence upon the egg-cell, by Amici in 1846. The reproduction of the cryptogams was generally thought to be a sexual.

In 1657 Harvey, the discoverer of the circulation of the blood, declared that all living things come from an ovum by differentiation, and that the ovum might proceed from parents or arise spontaneously. Twenty years later, Hamen discovered the spermatazoa, which he regarded as the young, which required only to be nourished by the ovum. Here we have two theories of reproduction that were at war for more than a century and a half.

Wolff, who first studied the development of the chick under the microscope, described the blastoderm in 1759, and its differentiation into organs, contrary to the general opinion held by Grew, Buffon and Haller that the embryo was a complete being like the bud of a tree, whose growth was merely an unfolding. It was in 1827 that Von Baer discovered the ovum of mammals, traced its development and laid the foundation of Embryology.

The seventeenth century saw good beginnings in histology and Comparative Anatomy of animals. Malphigi studied the anatomy of insects; Leuwenhoek discovered striated muscle-fiber and epidermal cells. Swammerdam studied the anatomy of insects, molluscs and the metamorphosis of insects. It may be said, however, that in the eighteenth century such studies were largely superseded as in Botany by classification, and were not again seriously taken up until the rise of Comparative Anatomy with Lamarck, St. Hilaire, Meckel and Cuvier.

Of the nutrition of plants and animals the previous centuries have little to say. Malphigi inferred that the food of plants was elaborated in the green parts. Mariotte showed that plants form chemical combinations from food material taken from the earth and air. Little more could be done before the discovery of oxygen in 1774, and the explanation of the movement of sap had to wait for the discovery of Osmosis in 1822. Relying upon the work of Lavoisier, who himself experimented upon the respiration of plants and animals. Ingen-Houss proved in 1796 that all parts of the plant absorb oxygen and form carbon dioxide, but that the green parts under the influence of sunlight absorb carbon dioxide and exhale oxygen. De Saussaure and Liebig have both been regarded as the founders of this branch of physiology, but they both belong in a later period. It need hardly be stated that animal nutrition was a subject far too difficult for the time.

Probably the greatest doctrine of all science after that of gravitation is Evolution. The idea in some form may be traced to the early Greeks, and it has a place in the discussions of most modern philosophers. It was prominently brought forward, but as a speculation by at least two men of science of the eighteenth century, Buffon and Erasmus Darwin. With neither, however, did the idea advance beyond conjecture or suggestion, and neither seems to have attempted to establish it either by *a priori* reasoning, or by the marshalling of facts; and the great majority of biologists, therefore, place the origin of the idea as a scientific doctrine at the time of the publication of Lamarck's Scientific Zoology in 1809.

To sum up, therefore, we have previously to 1800, a biology of classification, chiefly in the higher orders of plants and animals. We have the beginnings of minute anatomy, the beginnings of theories of reproduction, nutrition and evolution, and the idea of homology as a speculation by Goethe. There was yet no evolution so far as regards its factors, variation, external influences, heredity; no variation or origin of species in time; no movement and, therefore, properly speaking, no scientifically founded Philosophy of Biology.

GEOLOGY.

Geology is a composite of many sciences, and the history of its development is exceedingly complex. Its principles do not admit of ready demonstration by formal syllogisms and Q. E.

D's. Its present conceptions are due to careful balancing of ever accumulating evidence. In probably no other science has there been so much shifting of opinion, and none can vie with it in the amount of wreckage of abandoned theory.

In the short five minutes at command, no more can be done than to state the condition of the science one hundred years ago as regards the cardinal features, the recognition of a geological succession in time, the origin of stratified and unstratified rocks, the significance of fossils, and the development of stratigraphy. We shall have to omit the theories of the natural philosophers, the foremost of whom were Leibnitz and Buffon, regarding the origin of the earth and its inhabitants, suggestive as they were, and proceed at once to the results of scientific research.

According to Geikie, the distinct idea of a geological succession arose with Lehmann, in 1756, as the result of his observations in the Harz mountains and in the Erzgebirge. He classified mountains according to age, and drew sections showing the order of the strata upon their sides, and distinguished between the center of older origin and the fossil-bearing strata. Similar observations were made by Pallas, in Siberia, in 1772–1776, and they were carried further by Fuchsel in his history of the mountains of Thüringen in 1762. He believed that strata had originally been laid down in the bed of the ocean as sediment, and were subsequently displaced or tilted by earthquakes or oscillations of unknown origin. He recognized that different strata have their characteristic fossils, which he regarded as the remains of plants and animals, an opinion by no means general at that time. He inferred that the land was above the sea level during the growth of the plants whose remains he studied. None of these three men seems to have distinguished between the essentially different rocks of the mountains they studied, or to have formed a theory of their origin beyond that they were deposited as sediment from water.

About 1787 there arose to prominence Abraham Gottlob Werner, who, though wrong in his theory and a despot in his opinions, yet by a personality of unusual power, by his systematic arrangement of data and his enthusiasm, gathered about him a large following of devoted students, and ruled the world of geological opinion until near the time of his death in 1817.

Werner went back for part of his theory to Leibnitz and Buffon. The two foundation principles of his doctrine were, first, that originally the ocean was as deep as the tallest mountains are high, and that all rock we call igneous or primary, including granites, gneiss and basalt, were due to chemical precipitation from water. Later rocks, including some shales and limestone, were due chiefly to precipitation, but partly to sediment; and lastly, rocks formed chiefly of sediment, including upper limestone, sandstone, coal, clays, loam, etc. During this time the universal ocean continually subsided, but where the water went to was never explained. He seems to have had no conception of subsidence or elevation of the land. Secondly, he held that there were universal formations represented by those of Saxony, extending over the whole earth. When he announced his theory he had never been out of Saxony. It was, according to him, the province of Geology, or "Geognosy" in his nomenclature, to recognize these formations, and hence to predict the location of minerals in other lands. Werner regarded volcanoes as local phenomena of recent origin, and caused by the combustion of coal. According to him, veins of whatever kind were due to deposits from the quiescent water in cavities or cracks in the rock.

Such was the system that remained predominant until the early years of this century. Its overthrow was due to several causes, among which were the influence of Hutton in England, the impossibility of compressing the formations of other lands, when studied by Werner's pupils, within the "universal formations," and the demonstration of the volcanic origin of basalt. The last was due chiefly to Desmorest, as the result of thirty years' work with the region of extinct volcanoes at Auvergne, France, as a center. His complete account of this region was not published until after the beginning of the century. His conclusions were confirmed by two of Werner's most eminent pupils, Von Buch and D'Aubuisson, who investigated the same region between 1802 and 1804 and publicly announced their change of view.

James Hutton, in 1783–1795, deserves to be called the founder of dynamic geology, though his theory had little influence until explained by Playfair and Hall in 1802. Hutton insisted upon accounting for geological conditions upon the basis of known causes. He studied erosion and advanced the idea that our present world is built up from the fragments of an older world, and perhaps that from one still more ancient. He said, "In the economy of nature I can find no trace of a beginning and no prospect of an end," a conception of the immensity of time that reminds one of Lyell and Darwin. The older continents crumbled away and their fragments were scattered over the floor of the sea. There were periods of convulsion when the land rose and the water receded, but he takes no account of subsidence of the land. Hutton suspected the igneous origin of granite on the theory that the granite had risen in the molten state from the molten interior of the earth. He explored the mountainous regions of Scotland and found numerous instances where granite had intruded the limestone and shale from below.

On the theory of a molten interior he explained foldings, faults, and fractures of strata and accounted for volcanoes. Forty years later his theory, remodeled almost out of recognition and elaborated in the light of accumulated evidence, appeared in Lyell's Principles of Geology.

Though fossils must have attracted the attention of the earliest observers of nature, strange as it may seem to us they were generally regarded as freaks of nature or as forms cast up in the deluge of Noah, until about the middle of the last century. At this time Güttard figured and described some hundreds of them, argued at length that they were the remains of living beings and pointed out their analogy to existing forms.

Fossils were used as an aid in the recognition of strata by Lehmann, Fuchsel, Werner and others, but they were not recognized as the key to stratigraphy until about 1800, and this recognition was due chiefly to William Smith, Cuvier and Brongniart, who are regarded as the founders of stratigraphy.

Smith, who most nearly resembles the modern geologist as we understand the species, began his observations in 1794 while a canal engineer. His first card of the English strata was privately circulated in 1801, and his great map covering the whole of England appeared in 1815. The joint paper of Cuvier and Brongniart appeared in 1808, a year after the founding of the Geological Society of London.

Such are a few of the facts. Before 1800 Geology had no name or habitation, or recognition as a distinct science, but was regarded as a branch of physical geography or mineralogy.

To the layman the Geology of 100 years ago appears as a fragment or a collection of fragments. Magnificent as some of its theories were, they were in the early stages of hypotheses. To make a science more facts were needed, and they would have to be harmonized by a judiciously critical and co-ordinating mind. Few formations had been studied and none with thoroughness. There was no arrangement of historical periods, no glacial theory, no scientific petrography, no conception of the vastness of geological time.

Such, in brief, was the history of the great features of our sciences, and such their condition so far as they existed up to one hundred years ago, regarded only as a body of fact and theory. As regards the dissemination of scientific truth, the conditions were even more primitive. A hundred years ago Chemistry had not emerged from the cave or cellar, and the naturalist was looked upon as an uncanny individual of questionable position in the community. Scientific knowledge in those days was mainly confined to savants, and there was little scientific literature outside the proceedings of a few learned scientists. Books for popular instruction, text-books and popular scientific lectures were practically unknown. Systematic instruction in science was given only in a few of the universities, and in this instruction the laboratory played no part. The first laboratory for students in chemistry was that of Liebig, founded in 1824; and the first physical laboratory was founded about 1845. There is no need, in this place, to compare or rather contrast such conditions with those of the present.

It might be interesting, if time permitted, to turn our attention to the influence of science. Omitting its influence in material ways which is as wide as industry itself, let us for a few moments turn our attention to its influence upon thought.

It is chiefly to science that we owe our present democracy of thought. As late as the seventeenth century, men went with profound faith to Aristotle for their science, and his authority was absolute. It was, therefore, a momentous occasion for science when Galileo, one fine morning about the middle of the seventeenth century, before the assembled university, dropped, at the same time, two shot, of one and one hundred pounds weight, from the top of the tower at Pisa, showing that they struck the ground at the same time, and declared that Aristotle was wrong. He went to prison for his rashness. By the authority of Newton, the corpuscular theory of light was fastened upon physics for a century. Since those times men of science have learned to disregard mere opinion. The determined fight of Priestley for phlogiston could not save it, and the opposition of Cuvier and Agassiz to the theory of evolution could not stay its progress. Opinions are liable to be wrong, and they are, at best, things of a day. They must be changed in accordance with later developments. If there is one lesson that science has had occasion to learn, it is that of the dynamics of thought, and the evolution of all science. The lesson of tolerance and hospitality toward new ideas is a difficult one, but it has been largely mastered by men of science, and the influence has gone over to the realms of thought. Men are gradually learning the lesson of science and history, and are regarding their own platforms as only stages in the great on-march of opinion.

Another great contribution that science has made to thought, lies in the prominence it has given to the inductive method. It would be a serious error to suppose that *a priori* methods have not played an important part in the advancement of science. Many great conceptions of science of to-day had their origin as speculations, but science has refused to stop with speculations. Using speculations only as suggestive hypotheses, it has passed on to the firm establishment of its doctrines by the accumulation and orderly arrangement of facts of observation and experiment. It took long for science to extricate itself from the Nature Philosophy of the eighteenth century. To the philosophers of that day, the system and methods of nature were things to be explained, *a priori*, on the basis of certain postulates; to the poets they were to be discovered by a sort of divination It is safe to say there will be no more systems of Nature Philosophy proposed by sane men. Its problems have been relegated to the rigid methods of science. There is no question that the fruitfulness of the scientific method has reacted upon almost every branch of learning. We have but to point to the laboratory Psychology and to the statistical methods of Political Science and Sociology as illustrations.

The greatest influence that science has contributed to thought since the time of Copernicus and Newton is that of evolution. Of evolution in itself there is no occasion to speak in this place. The idea of evolution is revolutionizing the thought of the world. We are not here to deny the rise of the historical spirit in many departments of thought near the beginning of this century, but there is no doubt that the spirit has had its support and encouragment in the solid achievements of the evolutionary idea in natural science. No other idea has attracted such universal attention, and has found such wide application and exerted such profound influence in altering the point of view in all departments of thought. It is the greatest discovery of this and perhaps of any century.

How insignificant the world of 100 years ago as compared with that of the present time. The world of the eighteenth century was of recent origin and was stationary. It was inhabited by races of beings that had remained as they were created in the beginning. There was no movement, no progress, only stagnation relieved by the endless repetition of the same unalterably fixed forms. How great the change and how immeasurably extended was the sweep of thought when evolution came and gradually men saw that Nature moves and that our world is the product of changes extending through immeasurably long æons of time; when they saw that incessant change in time and space is the only universal law; that whatever the changes have been in time beyond our ken, the movement has certainly been from the simple to the complex, from the lower to the higher during the periods of time that have left a record.

Man is no exception. He is the offspring of the ages, and his powers and institutions are the result of age-long experience in suffering, labor, struggle and conquest. For such a being, old conceptions and old standards no longer sufficed, and man must be studied anew in his proper setting as a part of nature. His mental powers and ethical perceptions, no less than his physical organization, were seen to be products of evolution and for their right comprehension they must be traced through the lower races of men and the lower animals to their beginnings. There came the conception of the evolution of Society, of the State and Religion, and History was invested with a new meaning and a philosophy, whose teachings must be worked out if we were to have a sound doctrine regarding our present relations, their obligations, and have a vision of the future. The idea has taken firm hold upon learning, and to-day men speak as of commonplaces, about the evolution of language, of the state, of religion; evolution of mind-perceptions, reason, will, conscience and many other things that formerly were regarded as having only an oscillatory movement since the creation of the world.

The restatement of philosophic thought is yet in progress, and it is too early to predict the final result of the influence of sciences, but it is already very great. To take a concrete example, we, who first studied Philosophy as a system about twenty years ago, are surprised to find in the most influential text-book of the day, written by an idealist, Psychology introduced by long discussions of the anatomy and functions of the brain, and the physical basis of habit, and the mind-stuff theory, and to find everywhere physiology insisted upon as the foundation of psychology, and the mental powers discussed on the basis of evolution.

We are surprised to find the terms "Innate Ideas," "Intuitions," "Instincts," omitted entirely, or shorn of their original meanings, and the things they represent referred to purely natural origins. We are surprised to find that right is a relative thing, and conscience is the result of evolution in experience. We find the old problem of egoism versus altruism neatly solved, by making society the unit in ethics, as the species is in biology. The individual is nothing apart from society, its highest interests are his highest interests, and, therefore, the most refined egoism finds itself in the most perfect altruism.

But the glory of science lies no more in its past achievement than in its promise for the future. However difficult the conception, and however impossible it may be to predict the developments of the future, the legitimate inference from the past is, that the developments of the next century will be quite as great as those of the present one. We know that much remains to be done, and we have a right to expect that scientific thought will continue to broaden and deepen, leading ever toward a fuller knowledge of the physical universe and a truer Philosophy.

THE NEW SCHOOL OF ANIMAL PSYCHOLOGY.

C. C. NUTTING.

The title of this paper is in one sense a misnomer, from the fact that the prophets of the new school are inclined to deny any real psychology to animals. According to Morgan, mind is the wave of consciousness in its continuity.* Thorndyke says that "The mental stream is not continuous in animals."† If this is true, animals can not be said to have minds, and hence animal psychology can not exist.

However this may be, a discussion of those activities which have heretofore been regarded as psychical in animals forms the theme of a work embodying the views of the most radical of recent writers on comparative psychology.

This work is from the pen of Dr. Edward L. Thorndyke, fellow in psychology in Columbia University, and appeared in the form of a Monograph supplement in the *Psychological Review* of June, 1898. The views advanced therein are so iconoclastic that one rubs his eyes before realizing that these views are quite seriously advanced as the outcome of a great number of ingenious experiments reduced to the form of diagrams, time curves, etc.

The animals experimented with were cats, dogs and chicks, and they were taught to get out of variously contrived boxes under the stimulus of hunger, food being the invariable reward for success, and continued hunger the result of failure.

These boxes were contrived with undeniable ingenuity and were so constructed that the animal experimented with could escape by its own activity. The act of opening the box was of various degrees of complexity from a simple pressure to three separate movements, such as clawing, pushing and biting.

The hungry animal was placed in one of these boxes and the time in which it accomplished its exit was noted. As soon as escape was effected the animal was fed. This process

*Introduction to Comparative Psychology, p. 26.
†Animal Intelligence, p. 99.

was repeated many times with the same animal, the time being always noted, until the appropriate act was thoroughly learned, and performed as soon as the animal found itself in the box. Then the progress of the education was platted in the form of a time curve for future study.

The following are the main conclusions drawn by Dr. Thorndyke from these experiments:

First.—The animals never thought about their situation at all, but out of a multitude of what might be called instinctive activities, such as clawing, pushing, etc., happened to hit upon the act that opened the door.

This successful act resulted in pleasure (*i. e.* food) and by repetition these pleasurable acts are "stamped in" and the proper association is formed through experience, while the unsuccessful acts are "stamped out" by the absence of pleasure.

It may be objected that the conclusion that the animal does not think about its situation at all is entirely gratuitous. It would not, in my opinion, be at all unreasonable to claim that the animal was doing a deal of thinking and that his thoughts might take some such shape as this. "This is unpleasant and I want to get out. I will try all sorts of ways, such as scratching, clawing and pushing until I find a way to escape." Shut a hungry small boy in a tight box and he would have numerous thoughts although he would probably act very much as the cat did, except that he would pound and kick and push instead of scratching and clawing and pushing.

Dr. Thorndyke is so impressed with the importance of his own conclusion that he says, "Surely every one must agree that no man now has a right to advance theories about what is in an animal's mind, or to deny previous theories unless he supports his theories by systematic and extended experiments." (Page 31.)

In other words the naturalist who may have spent the better part of a lifetime in carefully observing animals in a state of nature, must forever hold his peace in the presence of one who has put numerous cats in boxes, thus subjecting them to utterly unnatural conditions, conditions that would be more likely to inhibit than to encourage normal psychic acts.

Second.—Animals do not draw inferences, neither do they reason.

This conclusion is drawn from the fact that the animals give no evidence of observation of their surroundings, or of deliberation.

The author can hardly find words for his contempt for those who believe that animals reason. He says: "So, although it is in a way superfluous to give the *coup de grace* to the despised theory that animals reason, I think it is worth while to settle this question once for all." (Page 39.) Again he says: "I should claim that this quarrel ought now to be dropped for good and all * * * I should claim that the psychologist who studies dogs and cats in order to defend this 'reason' theory is on a level with the zoologist who should study fishes with a view to supporting the thesis that they possessed clawed digits." (Page 46.)

Third.—Animals do not imitate.—Finding that birds do imitate, he, very wisely, leaves them out of this discussion. The cases of imitation are "regarded as a specialization removed from the general course of mental development, just as the feathers or aortic arch of birds are particular specializations of no consequence for the physical development of mammals." (Page 47.)

The kind of specialization investigated by our author is illustrated by the man who, seeing another turn a faucet, turns a faucet himself to get a drink. In other words, "from an act witnessed he learns to do the act."

The experiments bearing on this question may be illustrated by the following:

A pen was so constructed that a chick could get out either by crawling under a wire screen or walking up an inclined plane. A chick who had learned to crawl under the screen was placed in this pen with an inexperienced chick. In nine minutes and twenty seconds the first chick crawled under nine times, and at the end of that time the other walked up the inclined plane and got out. "It was impossible to judge how many times the inexperienced chick actually saw the performance of the other."

Another inexperienced chick was tried in the same way and crawled under the wire in four minutes and twenty seconds, his companion having in the meantime crawled under four times. Now this would appear to be imitation, but no! The author says that probably he went under "not by imitation but by accident."

Here we have a clear case of "Heads I win, tails you lose." In the first experiment the inexperienced chick did not go under the screen, and in the second it did go under. It would have been manifestly impossible for that chick to give evidence of imitation.

Dr. Thorndyke admits that he can not insist upon these experiments as evidence against imitation.

Similar experiments with cats usually gave negative results. Every case in which imitation appeared to be present is explained away, ingeniously it is true, but not by any means in a manner convincing to the unbiased reader.

Dogs were experimented with, the results being always negative.

Dr. Thorndyke sums up the evidence regarding imitation as follows: "It seems sure from these experiments that the animals were unable to form an association leading to an act from having seen another animal or animals perform the act in a certain situation." "Not only do animals not have associations accompanied, more or less permeated and altered, by inference and judgment; they do not have associations of the sort which may be acquired from other animals by imitation." "But in any case the burden of proof would now seem to rest upon the adherents of imitation." (Page 62.)

Now it so happens that the present writer is in possession of such proof, and it is perfectly logical to claim that one positive case of imitation will justly outweigh any number of experiments with purely negative results. It happens, moreover, that the animal observed was a kitten.

This kitten was as wild as any that lives in the forest, and had the misfortune to fall into the brick flue through which cold air reaches the furnace in my house. The flue is about seven feet high, three feet wide and eighteen inches deep. From the bottom a double series of large tiles leads to a chamber beneath the furnace, in which there was at that time no fire.

Various attempts to capture the kitten resulted in its darting into the tiles. Efforts were made to prevent this by dropping a wire window screen in front of the openings to the tiles. These efforts failing, the screen was left leaning against the opposite wall of the flue. The mother of the kitten was then placed in the flue in the hope that she would carry her offspring, or induce it to follow her, through the tiles and out of an opening from the chamber under the furnace to the cellar. This failed, probably because the kitten was unable to make a jump of about eighteen inches from the chamber to the opening into the cellar.

This latter opening was then closed so that the old cat would be forced to remain, and possibly nurse the kitten, which she refused to do, but jumped to the top of the screen and then out. The kitten attempted to follow her, climbed to the top of the screen, but could not jump the rest of the way.

Another screen was now placed on top of the first one so that the two together reached the top of the flue. The kitten very soon climbed nearly to the top, but was frightened and dropped down. She tried again and again and finally succeeded inmaking her escape. Now, although a careful watch had been kept she had not been seen to attempt to climb the first screen during the day and a half that it was in the flue before the mother was put in.

It might be thought that the kitten followed the mother by scent. But the mother *had not climbed the upper screen at all!* Neither did the kitten follow by sight, as it was several minutes after the escape of the mother that the second screen was introduced.

This appears to me to be as clear a case of imitation as could be conceived of, and I believe that anyone who has not prejudged the case will so regard it.

That Dr. Thorndyke has taken the position of an attorney for the prosecution of animals on the charge of being without mentality, is demonstrated by his treatment of the answers to a set of questions propounded to a number of professional animal trainers, five of whom, trainers of acknowledged reputation, responded. Four of the five believed that animals would learn through imitation, and one did not. This evidence not being to the liking of our author, was put out of court in the following language: "I cannot find that trainers make any practical use of imitation in teaching animals tricks*, and on the whole I think these replies leave the matter just where it was before. They are mere opinions—not records of observed facts." (Page 64.)

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* See "The Nature of Animal Intelligence and the Methods of Investing it." Psychological Review, May, 1899, pp. 268-9, for Prof. Wesley Mills' discussion of this point.

I think that no injustice is done Dr. Thorndyke when I state candidly that his position, throughout the entire discussion, is not a judicial one. That he starts out to prove the thesis that the mentality of animals is much lower than heretofore supposed, and that this attitude constantly impairs the reliability of his conclusions.

After having denied the power of inference and of imitation, the author still further demolishes the work of his predecessors by the statement that "the ground-work of animal associations is not the association of ideas, but the association of idea or sense impression with impulse." (Page 71.)

Impulse is defined as "the consciousness a muscular innervation apart from that feeling of the act which comes from seeing one's self move, from feeling one's body in a different position, etc." Dr. Thorndyke does not believe that an animal can supply that impulse when it thinks of that act. For instance a cat can not go into a box by virtue of the thought of going in. It can not say to itself, "I will!" There must be the muscular innervation, accompanied by the consciousness that makes up the impulse. This matter, however, involves too elaborate a discussion to be followed here, interesting as it might be so to do.

Finally we come to the most astounding statement of all, which is the following:

"The possibility is that animals may have no images or memories at all, no ideas to associate. Perhaps the entire fact of association in animals is the presence of sense impressions with which are associated, by result and pleasure, certain impulses, and that therefore, and therefore only, a certain situation brings forth a certain act." (Page 73.)

The author believes that *acts* of recognition, for instance, may not be accompanied by any *feeling* of recognition at all.

We here arrive at as bald an automatism as could well be imagined. The following sentence will best convey Dr. Thorndyke's meaning: "A sense impression of me gets associated in my dog's mind with the impulses to jump on me, lick my hand and wag his tail, though he has not and never had any representation of me." (Page 74.)

Now it may be claimed that I have not done justice to the author under discussion because I have not given the arguments whereby he supports his theories. This course would, however, be impossible in the scope of this paper. I have tried to give merely an idea of his methods and his conclusions. His monograph should be read by all who are interested in the subject of comparative psychology.

He is fairly entitled to much credit for his patience in devising and conducting experiments. In my opinion, however, this kind of experimentation is not the best method of solving the problems connected with the mentality of the lower animals, because it is certainly impaired by the unnaturalness of the whole procedure. Continuous handling, repeated confinement in boxes, and the pangs of hunger would surely and profundly affect the mental machinery of any person or animal.

The true method, it seems to me, is neither the piling up of anecdotes on the one hand, nor the cat and box method on the other, but careful, unbiased observation of animals that are not under pressure of excitement or hunger and are free to act on their own initiative. I would add, moreover, that they should, so far as possible, be ignorant of the fact that they are being watched.

To my mind the most serious criticism that can be made of the monograph under discussion is in reference to the attitude of its author toward previous writers and also toward his own work. It is not likely that the present generation of working naturalists, aside from the immediate friends of Dr. Thorndyke, will readily forgive his unconcealed contempt for such a man as Romanes, a man honored and loved by practically all his contemporaries and a naturalist who, in the minds of many, deserves to be classed among the foremost thinkers of his time.

Before quoting from Romanes, Dr. Thorndyke says: "These passages give an admirable illustration of an attitude of investigation which this research* will, I hope, render impossible for any scientist of the future." (Page 40.)

He sharply criticises the attitude of previous writers in the following words: "How can scientists who act like lawyers defending animals against the charge of having no power of rationality, be at the same time impartial judges on the bench?" (Page 4.)

Now I feel confident that no one, not a partisan of Dr. Thorndyke, can read his work without concluding that he clearly occupies the position of prosecuting attorney in this same case, and is, therefore, equally disqualified from acting

*Dr. Thorndyke here refers to his own work.

as judge. He rigidly excludes or at least minimizes every particle of evidence in favor of the accused.

In proof of this statement, witness his treatment of cats that do not come up, or rather down, to his expectations, and his naive brushing aside of the testimony of the animal trainers whose evidence is most damaging to his theories. For my own part, I still adhere to the belief that the argument submitted to this body in a former paper*, based on the multitude of homologies between man and the higher mammalia is a sound one, and that if this argument is to be overthrown it must be through careful observations of animals that are not psychologically disabled by starvation and imprisonment in boxes, however ingeniously contrived. And I further protest that the men who have gained their knowledge of animals by direct observation of animals in the field, have still their right to be heard on this question; that their observations demand consideration, and their opinions respect. In short, the old style field naturalist refuses to be ruled out of court by the experimental psychogolist of the new school. He emphatically denies jurisdiction, and appeals to the unbiased verdict of thoughtful men.

THE DISTRIBUTION OF FOREST TREES IN IOWA.

BY B. SHIMEK.

The discussion of the origin of our prairies, and of the distribution of our native forest trees, is as old as our knowledge of the central northwest. The earlier discussions were based on a knowledge of conditions as they existed when the white man first appeared in this section, and, though some of them are crude, and based upon insufficient observation, they fortunately give us at least a partial record of those conditions.

Later observers have the advantage of the results of a vast number of attempts at tree-planting, which have subjected existing conditions to a practical test, and which throw considerable light upon the causes which perpetuated the treeless prairies. From the very nature of the case, however, it is quite as difficult now to exactly distinguish in some cases

* "Do the Lower Animals Reason?" Proceedings Iowa Academy of Sciences, 1897

between cause and effect, or to avoid the substitution of a mere coincidence for a cause, as it was in the days of the earliest observers—in fact, while we now have knowledge of a greater number of possible causes, we are by that very fact exposed to the danger of a greater number of possible misinterpretations of effects. It is, therefore, well for the student of our forest and prairie problems to approach his subject with his mind in a position of receptive neutrality toward the various theories of the origin of prairies which have been advanced, but committed to none of them. For it seems that the chief weakness of the majority of the discussions which have been published thus far, is the fact that they are based, for the most part, upon single causes. It is well to bear in mind that the growth of trees may be prevented or influenced by a variety of causes, and that, therefore, there is at least a strong probability that a combination of these causes produced our prairies. For the prairies are not uniform in topography, nor in character of soil, nor in humidity. We have here in Iowa, prairies upon the flat, comparatively wet, north-central Wisconsin drift plain, and upon the adjacent dry, loess hills of the western part of of the state. In fact, so far as their physical features are concerned, these areas agree only in being treeless. And even in more restricted areas differences may be observed. We find one side of a hill treeless, the other clothed with forest. One shore of a lake or stream is skirted with trees, while the other is unobstructed by tree or shrub. Sometimes it is the lowland, and sometimes the adjacent hill, which forms the promising nucleus or the last remnant of a forest. It is, therefore, not wise to assume that one cause alone is responsible for this condition, nor that in every restricted locality the predominating cause, or combination of causes, was the same. It is the purpose of this paper to present a discussion chiefly of a neglected agency which operates against the development of forest trees. In order, however, that it may not seem like another attempt to introduce a single cause explanation, a brief résumé of the causes which have been prominently discussed is here presented.

1. *Fire.*—This stands foremost in prominence among the discussions of the past.* It has no doubt been effective in reducing or checking forests, yet it alone could scarcely have been entirely responsible for our prairies. In the first place we have no proof that fires were sufficiently widespread before the advent of the white man to alone account for the extent of the prairies. Moreover fire-swept groves are by no means always reduced to prairie, but are often soon restored, if indeed they do not remain practically uninjured, the destruction of the underbrush often probably being of advantage to the trees. Nay, groves, even when exposed and of limited extent, have been able to persistently check the advances of prairie fires.† Higher, dry places have frequently suffered less from fires than comparatively wet lowlands, but this may be in part explained by the more scanty vegetation of the former.‡ There are no remains of charred wood, such as we might expect in case of widespread destruction of trees by this means.§

The unequal and interrupted distribution of trees along streams is scarcely consistent with the view that the streams exerted any considerable influence in checking vast conflagrations, and can in fact, be better explained in another manner. However, that fire exerted some influence in the formation of prairies, goes without question. It destroyed seedlings, and in some cases large trees. The location of many groves in the state suggests protection against fires. Such are Coon grove, in Winnebago county, which is nearly surrounded by swamps; an ash grove on an island in Iowa lake, in Osceola county,‖ where all else is prairie, and numerous groves in protected, damp places, especially along streams, in various parts of the state. True, the distribution of many of these groves may be

*See: Am. Jour. Sci. and Arts, Series I, Vol. I, pp. 332-3, 1818; Vol. II, p. 36, 1820; Vol. XXIII, pp. 40-45, 1833; Series II, Vol. XLI, pp. 154 et seq., 1866; C. A. White in Am. Nat., Vol. II, p. 152, 1868; Dr. G. M. Sternberg in Am. Nat., Vol. III, p. 162, 1869; J. A. Allen in Am. Nat., Vol. III, p. 577, 1869; C. A. White, Geol. of Iowa, Vol. I, pp. 131-3, 1870; C. A. White in Am. Nat., Vol. V, p. 68, 1871; T. H. Macbride in the following: Iowa Geol. Sur., Vol. IV, p. 115, 1894; Proc. Iowa Acad. Sci., Vol. III, pp. 96-101, 1896; Iowa Geol. Sur., Vol. IX, pp. 148-9, 1898; Iowa Geol. Sur., Vol. X, advance sheets, p. 4, 1899.

†See: A. Fendler in Am. Jour. of Sci. and Arts, Series II, Vol. XLI, pp. 154, et seq., 1866; T. H. Macbride in Proc. Iowa Acad. Sci., Vol. III, p. 97, 1896.

‡R. W. Wells in Am. Jour. of Sci. and Arts, Series I, Vol. I, p. 333; T. H. Macbride in Proc. Iowa Acad. Sci., l. c., and Iowa Geol. Sur., Vol. IX, pp. 148-9, 1898.

§T. H. Macbride, ibid.

‖ Reported by T. H. Macbride.

accounted for in the manner suggested by a succeeding portion of this paper, but nevertheless it is not wholly wanting in value as testimony in support of the fire theory.

2. *Excess of Moisture.*—That excess of moisture is destructive to trees has long ago been established, and Lesquereaux, White and others, contended that such excess was primarily responsible for our prairies.*

They argued in substance, that the regions now occupied by prairies were formerly, after the recession of the glaciers, large lakes which gradually became swamps, and then dried, forming prairie which remained comparatively damp, the soil becoming "sour," because of poor drainage. Trees do not prosper in such soils, and this theory may be of value in explaining the absence of trees from portions of the drift plains of north-central Iowa, and from local low tracts, but it is not tenable for the loess hills of western Iowa, nor indeed for the rougher treeless parts of the drift area, such as those in western Lyon county. Excessively wet seasons may also be considered among the conditions unfavorable to the extension of forest areas, while in the same connection the effect of such seasons upon the fungus and insect enemies of trees, should receive consideration.

3. *Insufficient Moisture.*—That the amount of rainfall in Iowa diminishes as we go northwestward is a well-known fact. That the amount of forest varies in somewhat the same manner has also been pointed out,† and may be readily observed by reference to the appended map. The diminution in rainfall naturally produces conditions unfavorable to the growth of trees, and this variation in amount may account for some of the differences between the forest conditions of the northwestern and other portions of the state. It does not, however, account for the differences which we may observe in either of these sections. It does not explain why we have prairie tracts in the eastern part of the state, and groves in the western part, though the fact that the northern and eastern slopes in all parts of the state are more likely to produce groves, because they are more

*Caleb Atwater, in Am. Jour. Sci. and Arts, 1st series, Vol. I, p. 120, 1818; A. Bourne, in same, Vol. II, p. 36, 1820; W. W. McGuire, in same, Vol. XXVI, pp. 93-8; reprint in same, Vol. XXXIII, p. 1839; Henry Engleman, in Am. Jour. Sci. and Arts, 2d series, Vol. XXXVI, p. 384, 1863; Alex. Winchell, in same, Vol. XXXVIII, p. 332, 1864; Leo Lesquereaux, in same, Vol. XXXIX, p. 317, and Vol. XL, p. 23, 1865; Jas. D. Dana, in same, Vol. XL, pp. 293 et seq., 1865; C. A. White, in Am. Nat., Vol. II, pp. 143-155, 1868; J. D. Whitney, in Am. Nat., Vol X, pp. 656 et seq., 1876.

†First Annual Rep. of Iowa Weather Station, p. 50.

moist, the southern and western slopes being drier and hence more subject to fires, together with the fact that trees are more common along streams where evaporation and heavy dews are more abundant, have been urged with some reason in support of the claim that the prairies are due to insufficient moisture. During the growing season a lack of moisture means a lack of food, and should prolonged winters, and long hot summers alternate, the growing period becomes short, and during the dry season the vitality of the tree is further diminished by excessive transpiration. Deciduous trees have an advantage over evergreens in the latter case because their transpiring apparatus may be thrown off with the leaves during a dry season.

That dry, cold winters destroy trees has also been shown*, and was amply demonstrated in Iowa last year. But all this does not explain the alternation of prairie and forest in some parts of eastern Iowa where the differences in humidity are slight, or where greater local differences are not accompanied by a corresponding variation in tree-growth, nor does it explain why the bluffs on the Nebraska side of the Missouri river are clothed with forests, while those on the Iowa side are mostly treeless.†

4. *Temperature.*—Of course no general differences in this respect are noticeable in Iowa, but extremes of heat and cold during different seasons, and especially rapid changes during any one season, may do much injury to trees. For example, in sheltered localities which have a southerly exposure trees bud earlier and are often injured by frosts. This cause is sufficient to prevent the cultivation of trees in many such localities, and the same cause no doubt operated against the development of native groves.

That temperature alone is not sufficient to explain the peculiar distribution of forest and prairie is, however, evident.

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*Thos. Meehan in Am. Nat., Vol. VII, p. 234, 1873; Aven Nelson, Bulletin 15, Wyo. Exp. Sta., 1893.

†This is true at least south of Omaha and Council Bluffs. The Nebraska side, north of Omaha, was not examined.

5. *Geological formations and soils.*—To the superficial geological formations and soils have been attributed various influences upon the development of forests and prairies.*

Some of the earlier observers reported that the loess was unfit for the growth of trees, but McGee showed, and now everyone recognizes, that in northeastern Iowa it is the tree-producing formation, while the drift is almost treeless. But the loess of the western part of the state is largely treeless, while groves are found on the drift in Worth, Winnebago, Dickinson, and other counties of the state. In the latter, however, there is always a thin veneer of fine loess-like soil.†

Moreover, alluvium everywhere may or may not produce native trees. It is, therefore, evident that while the fineness and quality of the soil no doubt influence the growth of trees, the particular geological formation or soil does not uniformly determine such growth. It may, however, produce some effect by developing upon different soils unequal quantities of fuel for destructive fires.‡

The foregoing are the most common causes and conditions which have been cited in explanation of the prairie phenomena. There remains one more which has thus far received rather scant notice,§ but which deserves a high rank, namely: wind. The effect of wind upon trees may be twofold—mechanical and physiological. The first is produced by breaking branches or even trunks of trees; by stripping or injuring foliage, by driving sand and dust against the more delicate tissues, into the stomata, etc., and by spreading fires. It was evidently this that Whitney had in mind when he wrote:‖ "If the force of the wind were essentially inimical to the growth of trees, we should find them thriving, if anywhere, in the sheltered nooks, and to the leeward of the northwesters, that being the

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*See: J. D. Whitney in Hall's Geology of Iowa, Vol. I, pt. I, p. 24, 1858; in Am. Nat., Vol. X, pp. 577-656, 1876; W. J. McGee in Proc. Am. A. Ad. Sci, Series I, Vol. XXVII, p. 198, 1878; in Pop. Sci. Mo., Vol. XLIX, p. 115, 1883; Thos. J. Howell in Pop. Sci. Mo., Vol. XXIII, pp. 521-2, 1883; W. J. McGee in Eleventh Annual Rep. U. S. Geol. Sur., pp. 296-8, 1891; L. H. Pammel in Iowa Geol. Sur., Vol. V, p. 233, 1895; Thos. H. Macbride in Proc. Iowa Acad. Sci., Vol. III, p. 96, 1896.

†See author's discussion of surface deposits, in Proc. Iowa Acad. Sci., Vol. IV, pp. 69 et. seq., 1897.

‡See: R. W. Wells in Am. Jour. Sci. and Arts, Series I, Vol. I, p. 333, 1818; and for more complete discussion, Thos. H. Macbride in Iowa Geol. Sur., Vol. IX, pp. 148-9, 1898.

§ See Dr. Rush Nutt in Am. Jour. Sci. and Arts, series I, Vol. XXIII, pp. 40-45, 1833; paper read by Prof. H. H. McAfee, before the Am. For. Ass'n at Philadelphia, Sept., 1876; Rep. of U. S. Dep't Agri. for 1889, p. 276; Rep. of Chief of Div. of For. for 1891, p. 207; Bull. Div. of For., 1893, p. 119.

‖ Am. Nat., Vol. X, p. 582, 1876.

quarter from which the heaviest blasts come.'' However, there is little doubt that the physiological consequences far surpass any merely physical effect. Baranetzky* established the fact that shaking a plant increases the amount of transpiration for a short time, but that this soon falls below the normal, the diminution being due to the closing of the stomata. This means that the process of respiration and assimilation are checked, evidently by the temporary shock which the plant has received. If this shaking should be violent and long continued, as in a succession of strong winds, the plant would be weakened, and in the end probably destroyed. The most exposed trees would, of course, be in the greatest danger—hence those upon exposed hilltops, or upon the windward side of a hill, or upon open flat country.

The winds which would produce the greatest effect are naturally those which prevail during the spring and summer, when the leaves are in full vigor. Winter winds could have almost no effect of this kind, as the trees are then inactive. The prevailing summer winds in practically all of Iowa are southwesterly, and they increase in vigor and in frequency as we go westward in the state. It, therefore, follows that trees on flat areas or on southerly and westerly slopes are most exposed to these winds, and that danger to trees from them increases as we go westward. It is further true that these winds are frequent during the growing period in later spring when transpiration is greatest and most essential, and that in summer, especially westward, they are commonly hot blasts which weaken or destroy the guard cells, thus producing excessive evaporation and leaving the plant in a weakened condition with less energy for the initial growth of the following season. Moreover, such winds modify the humidity and temperature of the air and soil in a marked degree, and thus produce a direct

Viewed in the light of these facts the distribution of forests in Iowa becomes more intelligible. The accompanying map shows that the region south and east of the Wisconsin lobe is most heavily timbered, while the flat drift basin and the region west of it are almost treeless. Most of the streams in the eastern part of the state have a southeasterly course, and run for the most part in rather deep or at least distinct valleys. The effect on the physiological activity of the plant.

* Bot. Zeiting for 1872, p. 82.

southwesterly summer winds, therefore, sweep over this part of the state almost at right angles to the river valleys. Hence the valleys are protected, and this, coupled with a greater rainfall, gives to this part of the state a decided advantage as a tree producer.

In the Wisconsin drift area most of the streams also flow in a southeasterly direction, and where they have cut deeper valleys they are freely bordered with timber,* but where no valleys have been cut the shores and the adjacent plains are almost without exception entirely treeless.†

In the western part of the state the streams flow in a southwesterly direction, and the southwest summer winds, here more violent than eastward, sweep them with full force, and pass unhindered to the flat Wisconsin drift area beyond, which offers practically no obstacles to their progress. And in both these latter regions there are comparatively few trees, and these are mostly stunted, except where a bend in the valley, or a deep lateral ravine affords protection. In this western part of the state the groves are not on the hilltops, but nestle in ravines or on slopes which are on the leeward, north and east side. Even where there are larger tracts of timber, as for example above Hamburg, in Fremont county, and in and near Fairmount park, in Council Bluffs, they are not along the bluffs which face the Missouri river on the Iowa side, but are in the ravines and valleys or on the slopes which lie east of the ridges which form the river bluffs. The Missouri river flows nearly south, and its valley is so broad that the windward, or Iowa, bluffs are fully exposed to the southwest winds and are treeless, while the opposite protected leeward bluffs of the Nebraska side are for the most part quite heavily timbered. The bur oak which frequently forms the greater part of these western groves, also gives interesting testimony. As generally found in that part of the state it is small and stunted, not more than a foot or two in height, at or near the tops of the ridges, but commonly gradually increases in size down the leeward slopes, the better sheltered trees being much larger.‡ It is claimed by some that the small, stunted oaks near the tops of the ridges owe their small size to the fires which annually burned the

*As along the Des Moines river in Boone county and northward.

†As along the upper courses of the forks of the Des Moines river, and along most of the smaller streams in the Wisconsin drift area.

‡Examples are common in Crawford and Carroll counties, and in most of the Missouri river and Big Sioux river counties to the northwestern corner of the state.

stems, leaving only the bench-roots, but in many places, for example in Crawford and other counties, these little oaks have now been unmolested by fires for quite a number of years, yet they have not grown appreciably in exposed situations. The stunted condition of the plants is probably due chiefly to the action of winds. In their efforts to resist the strong, and often hot and dry winds, the plants fortify themselves by producing thicker walled cells, and stronger layers of cutin, thus turning some of their energy aside for this purpose, with the result that their general vigor is diminished, and if they survive they remain dwarfed.

All this suggests, too, that trees are found along our eastern streams largely because they are protected against summer winds, and not so much because there is more moisture in such situations.

The isolated groves of the state are almost invariably, at least in part, upon some knoll or ridge where they were able to gain a foothold and to maintain themselves because sheltered from the southwest winds,* wherever there are elevations which offer such protection, whether upon the otherwise flat drift areas, or in the regions covered by loess, there groves are likely to appear.

In further corroborative testimony it may be noted that the efforts at tree planting in the western part of the state are not always successful. Groves do not flourish except where protected. Walnut, ash, etc., do well in sheltered places or in thickets, but if grown in rows or singly in exposed places they soon die.†

That fruit trees and smaller plants are benefited by a protecting wind-break, has long been known to the farmers of the prairies. That our forest trees are equally benefited by such protection is undoubtedly true. It has been noted "that a tree will die, where a forest will live."‡

Numerous instances might be cited from the author's own observations in northwestern Iowa, in which trees planted in single rows have failed, while upon the same tract, with the same soil, the same species have flourished when grouped in

*Such are Coon Grove in Winnebago county, small prairie groves in most of the northwestern counties, the vicinity of Pilot Mound in Winnebago county, the groves along the Des Moines river in Emmet county, etc.

† The cottonwood is an exception, as it grows better when not in groves, and is therefore, superior in some places for wind-breaks.

‡ Report of the U. S. Dep't of Agri., for 1889, p. 276.

larger groves in which the trees furnish mutual protection. In the latter cases the border trees, especially on the west, are frequently stunted and generally lacking in vigor; cottonwoods, however, usually being an exception. In many localities in that section of the state, rows or narrow bands of trees of some extent, which cross elevations and depressions, well illustrate the effect of winds. On the windward slopes, and the tops of the ridges, the lines and bands are interrupted, the trees being smaller or entirely extinct, while the most vigorous trees are found in the lee of the southwesters. Yet a larger number of trees planted to form a grove will often thrive, even on the hilltops. It is also a well known fact that individual trees, or small parts of groves, which are mere remnants of larger groves upon higher or more exposed grounds, soon perish after isolation by the destruction of their companions.

To summarize briefly, wind must be regarded as one of the most of the important agencies which are concerned in Iowa in checking tree growth, for the following reasons:

1. Winds, especially when violent, or frequent, or hot and dry, affect trees unfavorably, both mechanically and physiologically.

2. During the season of the year when the physiological effect would be most keenly felt, the prevailing winds in Iowa are southwesterly, and being commonly both hot and dry, they are especially injurious to trees.

3. The distribution of our native forests is in harmony with the character and direction of the winds, taken in conjunction with the topography and direction of the river valleys.

4. The experiences of those who have planted trees, especially in the western part of the state, testify to the power of wind as a restraining factor of tree growth.

5. Wind is one of the most general of the agencies which are held to account for the development of prairies, both in frequency of occurrence and in the extent of the area over which it may operate, and hence, would produce substantially the same effect in kind, though not necessarily in degree, over large areas.

It must not be assumed, however, that individual localities may not furnish seeming contradictions, for the various agencies which have been discussed will affect the problem, more or less, locally. The differences between the eastern and western parts of the state are, however, more general. The greater scarcity of timber in the west is in all probability due chiefly to the stronger, hotter and drier winds, to the southwest course of the river valleys, whose bluffs, therefore, offer but little shelter to trees, and to lesser rainfall. That wind, however, is primarily responsible is shown by the difference between the Iowa and Nebraska bluffs along the Missouri river. These bluffs have substantially the same amount of rainfall, etc., but differ in exposure to the southwest winds.

That artificial groves often survive, and even thrive, on the prairies is due to the care which they receive. Cultivation, replanting, general care, and massing in groves often improve the conditions to such a degree that the unfavorable influence of wind is counterbalanced. But neglected groves, when exposed, soon deteriorate, and finally perish.

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Incidentally, an application of this view of wind action may be made to another question of interest. It has already been noted that in eastern Iowa the forests are chiefly on loess which here mantles the hills with nearly uniform thickness. It was, therefore, assumed, that trees found loess especially suitable to their growth. However, in western Iowa the loess hills, covered more irregularly with a much thicker deposit, are in large part devoid of trees, while on the other hand drift ridges often have more or less timber.*

It is noticeable, however, that in the drift area where groves have gained a foothold a thin veneer of loess-like material, varying from one to two feet in thickness, is found. This is true even of the scrub oak groves on the northeast slopes of the drift hills in western Lyon county,—a fine soil occurring in the groves, while on the south and west the ridges are gravelly at the surface and treeless.†

It would seem then that the mere presence of loess does not insure abundant native timber, and that trees may gain a foothold upon drift. In fact the drift-covered area is often capable of sustaining a remarkable growth of trees, the artificial groves near Sibley being a fine example. Some years ago the author suggested‡ that the loess instead of causing or favoring growth of timber, is rather a wind deposit collected

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* As near Forest City, at Clear Lake, etc.

†See the author's discussion of surface deposits already noted.

‡Proc. Iowa Acad. Sci., Vol. III, pp. 82-89, 1895.

in the protecting shelter of forests, the forest preceding the deposition of loess. Subsequent observations have only strengthened this belief, with some modifications.

It must be borne in mind that whatever work of this kind can be done by forests may also be done by smaller vegetation, but perhaps in different degree. If forests could collect and retain dust, prairie grasses and shrubs could do the same, and if the supply of material was greater, might even accomplish more. It is therefore not necessary to assume that all the region now covered by the loess was at one time a forest area, though evidences suggesting this for one locality at least, may be found in the vicinity of Council Bluffs.*

The thickets of *Symphoricarpos* and other shrubs, now common in many prairie sections, and, indeed grasses and other herbaceous plants, could to some extent operate in the same manner, though the deposit would probably be subject to greater variation in amount and distribution. The difference between the loess of eastern and western Iowa suggest something of the kind. It is a well-known fact that the loess of eastern Iowa is finer and more nearly uniform in thickness, which is less, than in the west. The eastern part of the state was (and is) farther removed from the source of dust supply,† its greater forest area insured a more uniform deposition of only the finest material, and its shorter dry seasons and less violent winds resulted in a deposit of lesser thickness. That the differences in conditions during the deposition of the loess as indicated by the fossils were essentially the same as those which exist between the two sections of the state to-day, has already been emphasized by the author.‡

The greatest amount of the material carried by winds would be deposited where there are obstructions, such as ridges or hills,§ and would generally be expected on the leeward side of the hills,‖ though the shifting of winds during different seasons,

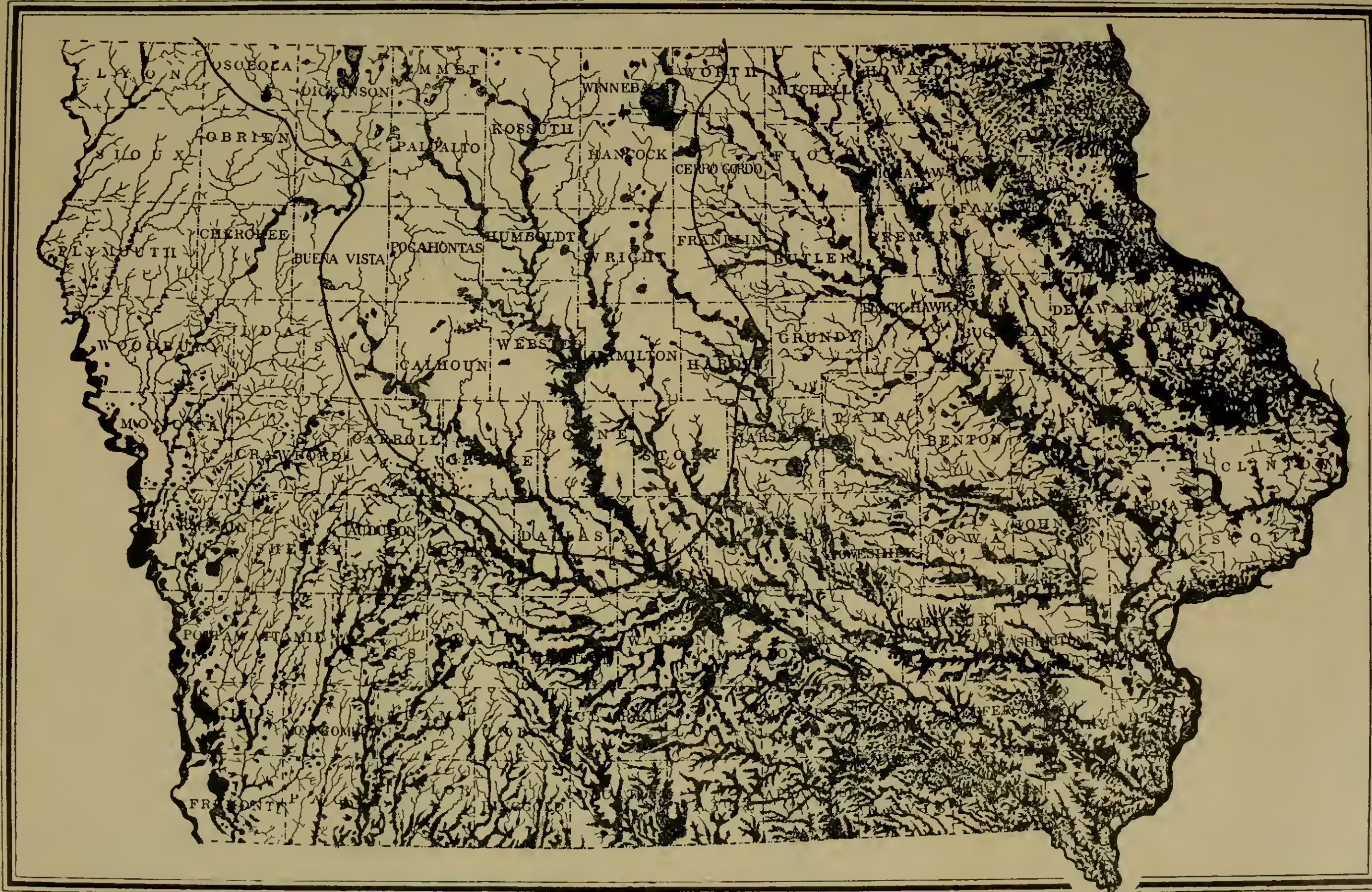
*Discussed by the author in Proc. Iowa Acad. Sci., Vol. VI, pp. 98-113; also in the Jour. of Geol., Vol. VII, pp. 122-140.

†The western part of the state is drier, and moreover lies in the path of the stronger southwest winds which sweep over the dry prairies in summer while there is still a considerable amount of vegetation which may serve as an anchorage for the dust. Incidentally it may be noted that in summer the exposure of bare tracts by the partial or complete drying up of ponds and streams, the work of burrowing worms, insects and mammals and scratching birds, and the decay of vegetable matter all tend to increase the supply of material which may be transported or deposited.

‡Proc. Iowa Acad. Sci., Vol. III, p. 84; Vol. V, p. 15; Vol. VI, p. 110.

§Compare with drifting snow.

‖On the drift hills of western Lyon county the fine soils do commonly appear only on the leeward sides, *i. e.*, north and east, as has been noted.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BUENA VISTA
POCAHONTAS
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WRIGHT
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BLACK HAWK
GRUNDY
CALHOUN
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or because of local topography and changes in temperature, and the comparative abundance of vegetation, especially of trees, would locally very much modify any effect which might result from general causes.

The finer sub-soils in the groves of the drift area are indistinguishable from loess, though quite thin, and the amount of such deposits especially in the northern part of the most recent Wisconsin drift area will be greater as the region becomes drier, or as the number of groves increases,—though cultivation will no doubt affect the distribution and amount of the deposit.

It, therefor, appears that the facts herein presented are consistent with the theory of the æolian origin of the loess. How ever, the author desires that these facts and their relation to prairie formation stand upon their own merits, the application being a purely incidental after-thought.

ELEODES IN IOWA.

H. F. WICKHAM.

The genus Eleodes contains certain species of beetles belonging to the family Tenebrionidæ. They are terrestrial and cursorial, rarely being found on plants of any size, though a few are known to ascend the stems of shrubs. All are of large or medium size, and devoid of functional wings, the elytra being connate, forming a perfect shield which clasps the sides of the body. The integument is very thick, and forms, in connection with this elytral structure, an efficient protection from desiccation. Repugnatorial glands are present, secreting a powerful caustic fluid which is discharged through the anus when the insect is irritated. In order to protect themselves more efficiently they elevate the posterior portions of the body when alarmed, and run off in that position. Probably it is this habit which has suggested the name "circus bugs," often applied to them in the west.

From their abundance, both in species and individuals, they form a most characteristic feature of the arid regions of the west, their recognized range extending from the Missouri river to the Pacific ocean.

In view of their known habits and distribution, I was much interested in finding a number of specimens among the beetles recently brought back from northern Iowa by Prof. B. Shimek. Adding to the records thus established, a few others gathered from various sources, I present the following note, showing the distribution of the genus within the state as far as ascertained:

Eleodes suturalis Say. Taken in Lyon Co. (June) by Professor Shimek. Western Iowa (Professor Macbride).

Eleodes tricostata Say. This has been taken at Ames, by Professor Osborn, while Professor Shimek has given me specimens from Lyon Co. (June); eastern Emmet Co. (August); southern Dickinson Co. (August), and eastern Woodbury Co. (September). It extends as far east as Independence, Buchanan Co., where I found it in September, on a broad, dry sand-flat, along the Wapsipinicon bottom.

Eleodes opaca Say. From Lyon Co., June, Professor Shimek.

As far as my information goes it indicates that the habits of the Iowa specimens do not differ from those of western forms. The beetles are to be seen walking about on roads or other open spots in the cool of morning, and again towards evening. The heat of day drives them to shelter.

THE SCYDMÆNIDÆ AND PSELAPHIDÆ OCCURRING NEAR IOWA CITY, IOWA.

BY H. F. WICKHAM.

The minute beetles belonging to the above families have been much neglected by collectors, although their many peculiarities of habit and structure make them well worthy of attention. For three years past my wife and I have collected them systematically in this vicinity, with the result of very largely increasing the list of species known to occur here.

They seem to be most numerous in the spring, though some may be found during the summer months and many in the autumn, or even throughout the winter. Remarks on the situations most favored by them will be found in the proper places. The classification is that used by Capt. Thos. L. Casey, in his recent papers on the subject. Great assistance in their study has been rendered me by Captain Casey and by the Rev. P. Jerome Schmitt.

FAMILY SCYDMÆNIDÆ.

Euconnus bicolor Lec. Our most abundant species, at times swarming in swampy spots along streams where debris has been piled up by freshets. Occasional under stones and pieces of wood in grassy places. March, April, May.

E. occultus Cas. May 8th. Sifted from rotten oak stump in high woodland.

E. affinis Cas. Found with *E. occultus.*

E. gratus Cas. This or a very closely allied form has been taken here rarely in April and May.

E. salinator Lec. Sifted from debris on damp bottom lands. May 15th–22d.

Pycnophus rasus Lec. Not common here. It has been taken under boards with the ant *Cremastogaster lineolata* Say. May 5th–31st.

Connophron longipenne Cas. March and April, under shelter in open grassy spots.

C. formale Cas. In ants' nests. No date preserved.

C. ludificans Cas. April to June in grassy places, under stones or pieces of wood.

C. nigripenne Cas. April and May.

C. fossiger Lec. April 10th.

C. femorale Cas. April and May. Damp spots near small creeks.

C. clavicorne Cas. April. Seen chiefly under small stones in grassy places.

C. pallidum Cas. May 29th–31st. From nest of the ant *Lasius aphidicola.*

C. integrum Cas. May 1st–29th. Habits of *E. clavicorne.*

C. decorum Cas. April 15th. This and the three following species seem to prefer grassy open ground.

C. testaceipes Cas. April.

C. castaneum Cas. April.

C. triviale Cas. March and April.

C. trifidum Cas. No date.

C. fulvum Lec. May 1st–9th.

C. capillosulum Lec. March, May and June.

C. illustre Cas. No date.

C. lacunosum Cas. March and April.

C. pumilum Cas. April 14th. This and the preceding species have the habits of *decorum.*

Smicrophus leviceps Cas. No date.

Scydmœnus conjux Cas. No date.

Ascydmus tener Cas. May 9th. Sifted from an old rotten oak stump in high woodland.

Eumicrus ochreatus Cas. May 5th. This and the next species live under bark, in the nests of *Lasius americanus.*

E. saginatus Cas. No date.

FAMILY PSELAPHIDÆ.

Rhexius insculptus Lec. Rare. Only three specimens have been found here, one under a stone, the others under pieces of wood in grassy spots. May 1st–15th.

Rhexidius canaliculatus Lec. Sifted from rotten oak wood. May 8th–9th.

Euplectus interruptus Lec. May 28th.

E. confluens Lec. No date.

E. elongatus Brendel. This and the next species were sifted from a rotten oak stump. May 8th.

E. pertenuis Cas. May 8th.

Thesiastes fossulatus Brendel. June 11th.

Melba sulcatula Cas. April 28th, June 12th. Rare. The first mentioned specimen was taken from an oak stump with *Lasius americanus.* The other was sifted from a pile of dead grass in damp bottom land.

Batrisus scabriceps Lec. Two specimens thus named by Dr. Brendel are in my cabinet without date.

B. fossicauda Cas. Common in nests of *Formica subsericea* and *F. exsectoides.* April and May.

B. frontalis Lec. Under bark, with *Lasius americanus;* also found beneath leaves in woodland without the ants. March, April and May.

B. globosus Lec. An abundant species, usually frequenting damp grassy spots where it may be trapped by laying out pieces of board and turning them over occasionally. Sometimes found with *Lasius americanus.* March, April and May.

B. foveicornis Cas. One specimen, April 13th, in nest of *Lasius,* doubtfully *L. aphidicola.*

B. furcatus Brendel. No date.

B. denticollis Cas. April 14th.

B. striatus Lec. Probably our commonest species of the genus. It has about the same habits as *globosus* and has been taken from March to June.

Decarthron abnorme Lec. Rather common under stones and pieces of wood or grassy spots. April, May and June.

D. exsectum Brendel. No date.

Rybaxis truncaticornis Brendel. Not uncommon in the same situations as *D. abnorme.* March to June.

Bryaxis arguta Cas. Common with the preceding. Found in April, May and June.

Reichenbachia divergens Lec. March to June, common, with other species. My experience has been that the species of *Reichenbachia* differ little in habits. They frequent open grassy spots and may be found under stones and pieces of wood.

R. facilis Cas. April and June.

R. subsimilis Cas. May 22d. Determination uncertain.

R. congener Brendel. March to June.

R. cribricollis Brendel. April and May.

R. rubicunda Aube. April 15th.

R. bicolor Brendel. No date.

R. puncticollis Lec. May 15th–22d.

R. sodalis Cas. March, April and May.

R. peregrinator Cas. May 22d.

Anchylarthron cornutum Brendel. No date.

Cylindrarctus longipalpis Lec. No date.

C. crinifer Cas. May 22d. Sifted from piles of dead grass.

Tychus minor Lec. April 15th.

Pselephus erichsonu Lec. Many specimens have been taken about the end of November, nearly all in one very circumscribed locality. They hide under small stones which lie upon turf.

Pilopius lacustris Cas. This species is rather common in exposed places, under pieces of stone or wood, late in the autumn and early in the spring.

P. consobrinus Lec. No date.

P. zimmermanni Lec. No date.

Ceophyllus monilis Lec. April, May, June, in nests of *Lasius aphidicola* (and *Lasius interjectionis?*). Not uncommon.

Tmesiphorus costalis Lec. May 29th. One specimen sifted from dead leaves covering a nest of *Lasius americanus.*

T. carinatus Say. April 27th.

Adranes lecontei Brendel. Found in nests of *Lasius aphidicola* in May and June; also in the autumn in nests of some yellow *Lasius.*

NOTES ON THE ACOCEPHALINA (Homoptera-Jassidæ).

E. D. BALL.

Strongylocephalus agrestis FALL.

Tettigonia mixta Say.

This widely distributed European species has been found in New York, Michigan and Iowa; and this season it was found abundantly in Colorado, as far west as the foot-hills, indicating a very general distribution east of the Rockies, at least.

It occurs only in low places, where the vegetation is rank, and is found down underneath the grass and weeds crawling through the rubbish at the roots of the various plants. The larvæ appear in the fall, pass the winter about half grown, from which adults emerge the next summer. It is apparantly only single brooded, but the adult females often live over winter and are found nearly the whole year around, while on the other hand the male is rarely seen.

Say's description of *T. mixta*, agrees very well with the dark females, the length "less than three-tenths inch," and "the white stripe on the lateral margin of the pronotum" agreeing especially well, while the females of the genus *Acocephalus* which have been called *mixta* are less than two-tenths of an inch, and the males much smaller.

ACOCEPHALUS GERM.

In this genus the sexes differ widely in size and color, the females are all very much alike—dirty, straw-yellow, heavily irrorate with fuscous, and are difficult of determination, except as they are found in company with the males. The males are much smaller than the females, and are strongly and variously colored. The genitalia are of little value, and accurate determinations are based on the color pattern of the males.

Three species, all widely distributed in Europe, are now known for the eastern United States. The males may be separated as follows:

A. Elytra with longitudinal stripes between the white nervures................................*flavostriatus* Donov.
AA. Elytra maculate or transversely banded.
B. Elytra with three definite dark bands, posterior half of pronotum light......*brunneo-bifasciatus* Geoff.
BB. Elytra variously maculate or banded, when banded the bands testaceous brown, posterior half of pronotum dark.............................*albifrons* Linn.

A. flavostriatus Donov.

A. rivularis Germ (of Melichar.)—Female dull, obscure yellow, heavily mottled with fuscous, elytra brownish fuscous with light nervures; male pale yellow, a broad transverse band at the apex of vertex, a bi- or tri-lobed one at base, and a narrower one across the pronotum, fuscous or black, the face pale yellow with a heavy fuscous spot in the center, a pale spot either side the apex of the vertex; elytra dark fuscous with the nervures and margins pale yellow. Length ♀ 4mm; ♂ 3mm.

Specimens taken at Woodstock, Vt., August 6, 1898, by Prof. A. P. Morse.

A. brunneo-bifasciatus Geoff.

A. serratulae Fab. (of Melichar.)—Male, vertex and face mostly fuscous brown or black, pronotum with the posterior half mostly light; elytra, white with three broad, nearly equal, bands, black, the anterior one broken, the posterior just before the apex.

A male from Madison, N. J., June 29, 1897, was sent by Professor Osborn.

A. albifrons Linn.

A. mixtus Say (of Van D. Cat.)—This is the species commonly found in collections under the name of *mixtus*. The females almost always show alternate dark and light maculations along the costal and apical margins of the elytra and sometimes the bands are indicated clear across the elytra. The male is very variable and has been described under a dozen different names in Europe, where it occurs abundantly. It is always maculate or banded, but the general color and bands are much lighter than in the preceding species and the face is always light.

It has been found in Lower Canada, New York, New Hampshire, District of Columbia and Michigan.

A. maculatus G. & B.—This is the only western species known and that only by the two original specimens, both females.

Of the other species credited to the United States *striatus* Linn. is probably an error of determination for *S. agrestis*, as it has not been found in any collection. *A. solidaginis* Walk is an unknown *Phlepsius*, and *circumflexus* Prov. is still unknown in nature.

MEMNONIA N. G.

General form of *Acocephalus*, vertex convex, sloping, nearly right angled, about half as long as width across the eyes, the anterior margin thick, ocelli on the margin above the frontal sutures, distant from the eyes; face convex, forming an acute angle with the vertex, front above broad, narrowing below and abruptly rounding to the parallel margined clypeus; pronotum as long or longer than vertex, strongly, transversely wrinkled, the lateral margins less than half the middle length, anterior and posterior margins nearly parallel; elytra *macropterous*, covering the abdomen in the male and all but the ovipositor in the female, with long apical cells and a narrow appendix, or *brachypterous*, covering about two-thirds of the abdomen, the apical cells very small; under wings rudimentary; venation, the inner branch of the first sector tied to the second sector near its origin, again forking near the middle, its outer fork tied to the outer branch beyond its middle, anteapical cells of very different lengths.

Type of the genus *M. consobrina.*

Memnonia consobrina N. SP. Plate v Figs. 6–10.

Macropterous female, form of a small *Acocephalus* with a longer vertex and ovipositor, vertex nearly twice wider between eyes than length on middle, twice longer on middle than against eyes; pronotum twice wider than long, elytra covering the abdomen. Color, vertex, pronotum and scutellum green or yellowish green, elytra brownish drab, overcast with a heavy whitish bloom, nervures brown, the cross nervures, the apical margin and adjacent nervures, especially the two to the costal margin, fuscous; below, upper part of face green, antennal pits, lower part of front, and the clypeus, black, genæ light brown, legs and abdomen mostly black.

Brachypterous female; resembling the above, except that the elytra are abbreviated, exposing part of the abdomen, the apical cells being small or wanting, under wings rudimentary.

Male; smaller, narrower than the female, vertex more pointed, elytra covering the abdomen, flaring behind; color, shining black, the eyes yellowish, three or four round, white spots in a row across the anteapical cells.

Genitalia; female, ultimate ventral segment twice longer than penultimate, shallowly emarginate with an obtuse median tooth; male valve only just visible beyond the ultimate segment, plates about half as wide as the ultimate segment; the outer margins rounding to before the middle, then regularly narrowing to the acute tips, three times as long as their basal width, pygofers long, narrow, thickly set with coarse spines.

Length ♀ 4–4.25 mm., ♂ 3 mm.; width ♀ 1.25 mm., ♂ 1 mm. Described from numerous specimens collected at Fort Collins, Antonito and Wray, Colo., and Stratton Neb. The larvæ and adults seem to be strictly confined to two species of grass that form mat-like clumps, *Schedonnardus texanus* and *Muhlenbergia gracillima*, where they may be found abundantly, crawling around under the margins of the clumps, in May and June.

Memnonia fraterna N. SP.

Form of *consobrina* nearly, smaller, ovipositor shorter, scarcely exserted; color buff, the vertex lighter; male similar to the female in size and color. Length 3–3.5 mm; width 1 mm.

Brachypterous form, males and females, vertex as long as the pronotum, two-thirds as long as the width between eyes, convex, the margin rounding, front twice wider at base than at apex, a little longer than its greatest width, forming an acute angle with the vertex; clypeus slightly longer than wide; about half the length of the front; elytra exposing the last abdominal segment and the pygofers, their posterior margins broadly rounding, apical cells minute; color, varying from a light, straw color on the vertex, to a creamy buff, with traces of a white bloom on the elytra; eyes reddish brown, apical nervures and a narrow margin on the abdominal segments fuscous; below, pale buff.

Genitalia; female, similar to *consobrina*, except the ultimate segment, less than twice the width of the penultimate, and the ovipositor much shorter, scarcely exceeding the pygofers; male, ultimate segment longer than in *consobrina*, valve longer and narrower, plates shorter than the pygofers, not over twice longer than wide.

Described from numerous specimens taken from the same grasses as the former species. They appear about a month later in the season.

DORYCEPHALUS KUSCH.

This genus, founded on a species from northern Europe, has two representatives in this country, now known from the Mississippi to the Rockies, but probably much more widely distributed, as, unless definitely searched for they are rarely seen, even where abundant.

A. Head broadly foliaceous, front transversely convex, elytra more than half the length of the abdomen in both sexes .... *platyrhynchus* Osb.

AA. Head narrowly foliaceous, front strongly concave its whole length, elytra less than half the length of the abdomen in both sexes .... *vanduzei* O. & B.

D. platyrhynchus Osb.—This unique form, before known from Iowa and Nebraska, has been taken on the plains and well up into the foot hills of Colorado. The larvæ have been found in *Aristida* clumps on plains which gives it a new food plant. In the foot hills it was taken where both Elymus, its known food plant, and Stipa were abundant, but as no larvæ were found it was impossible to locate it as on either grass.

D. vanduzei Osb. and Ball.—This species was described from northwestern Iowa and thought to be from *Sporobolus*, but this season the larvæ and adults have been found quite commonly in clumps of *Aristida purpurea* in western Kansas and Nebraska and as far west as Greeley, Colo. This is the first capture of the male, which is strikingly different from that of *platyrhynchus* and is described as follows:

> Male—slightly smaller and narrower than the female, head similar in shape, slightly shorter, elytra as long as the head and pronotum very narrow, appendix present, abdomen long and narrow, the last two segments visible beyond the elytra, beyond which the remarkably elongated style-like pygofers extend for about four millimeters, as long as the rest of the abdomen. Color—darker than the female, the tip of the vertex broadly fuscous, elytra and abdomen dirty brown.

Hecatus lineatus UHL.

H. fennestratus Uhl.

This species is now known from New Jersey, New York, Iowa, Kansas, Nebraska and Colorado, always found in low places where the "Slough grass," *Spartina cynosuroides*, on which it feeds, is found.

Spanbergiella vulnerata UHL.

S. lynchei Berg.

S. mexicana Baker.

This species ranges from the southern United States through the West Indies and Mexico to Argentine, S. A. It is somewhat variable in the shape of the head, as are all the species with foliaceous vertices, which has led Mr. Baker to resurrect one synonym and create another. He quotes Signoret as saying "this might well be the S. vulnerata" and goes on to say that Berg took this "suggestion" as final. If Mr. Baker had been able to read Signoret himself instead of depending on a translator, he would have found this, also, "Having received the type from the author we confirm this synonomy" a "suggestion" which Berg could hardly refuse to accept as final after submitting his type for inspection. As to *mexicana*, it was founded on a single specimen from Mexico with a slightly more angular vertex than the typical form, a not infrequent variation. I have specimens from the West Indes, Mexico and the United States, collected along with the typical forms, which present all possible gradations in that line and preclude the possibility of being able to define a "species" on that ground.

DICYPHONIA N. G.

General form of *Hecalus*, head shorter and more angulate. Vertex narrower than in *Parabolocratus*, shorter than width across eyes, longer than pronotum, regularly narrowing to the obtusely rounding vertex, where it is about two-thirds the width between the eyes in the female, or narrowing almost to a point in the male, disc-concave, margins sharp, slightly foliaceous; ocelli on the margin close to the eyes. Front longer than its greatest width; wedge-shaped, narrowing below, lateral sutures extending to the margin of the vertex at some distance in front of the ocelli. Pronotum broadly rounding in front, emarginate behind, as wide as the eyes, the lateral margins half of the middle length. Elytra, macropterous, covering the abdomen, with well developed apical cells and appendix, or brachypterous (female) covering little more than half the abdomen, the apical cells minute; venation irregular on the corium, the first sector once forked, the inner branch with one cross nervure to the second sector, obscured by racemose brown lines, except in the apical cells. Ovipositor, in the female, as long or longer than the rest of the abdomen.

Type of the genus *D. ramentosa*.

Dicyphonia pamentosa N. SP. Plate v Figs. 1–5.

Macropterous female; slightly smaller than *Parabolocratus viridis*, with longer, narrower vertex and more flaring elytra, anterior margin of vertex elevated, the disc concave, half longer than width between eyes, pronotum two and one-half times wider than long, transversely convex, elytra covering the abdomen; color, pale, creamy yellow with irregular brownish fuscous markings; elytra, ivory white, heavily, irregular irrorate with brownish fuscous except in the apical cells and a creamy stripe along the costa; below, creamy or greenish yellow with five or six fuscous arcs on the upper half of the front.

Brachypterous female; as above except that the elytra cover only half the abdomen, the apical cells minute or wanting, and the wings abortive, the exposed part of the abdomen striped with brownish, the ovipositor reddish.

Male; vertex little longer than width between eyes, obtusely pointed, the disc nearly flat, elytra covering the abdomen, strongly flaring at apex. Color, black, with more or less light maculations corresponding to the light markings of the female, some irregular white spots on the costal margin and in the apical cells; below, lower half of face and the anterior coxæ creamy yellow, upper part of face and the abdomen, except the margins of the segments, black. A variety of the male is colored like the female.

Genitalia; ultimate ventral segment of the female twice longer than penultimate, posterior margin slightly produced in the middle, pygofers twice longer than wide, much exceeded by the ovipositor, which is as long as the rest of the abdomen; male, valve wanting, plates together, about half as wide as the ultimate segment, nearly half longer than wide, roundingly narrowing to the middle, then nearly parallel margined to the rounding points.

Length ♀ 7mm., ♂ 4 mm.; width ♀ 2–2.25mm., ♂ 1.5mm.

Described from eleven specimens from Fort Collins, Colo., and two from Stratton, Neb.

This is a very interesting polymorphic species, exhibiting two forms in the female, differing in wing length, and two in the male, in color. It has been found only on a single grass, *Soporobolus cryptandrus*, to which the larvæ and adults seem to be strictly confined. The larvæ appear the last of April, and the adults about the 1st of June.

The short-winged females are large, sluggish and clumsy, and either remain quiet on the stems or simply drop to the ground; in either case the grayish-brown spots imitate the rust on a dead leaf so well that they are difficult of detection; the long-winged ones are narrower, more active, and readily fly, their agility, combined with their scarcity, making them a highly desirable capture. The males are all long-winged, small and active; the majority of them are nearly black, while a few mimic the females in color; in either case they rely on their activity and their harmony with the ground on which they light for protection.

PARABOLOCRATUS FIEB.

Three species of this genus are now known from the U. S.; they all occur in long and short-winged forms, in the females, and only long-winged forms in the males. They may be separated as follows:

A. Male vertex with the margin foliaceous, lined with black beneath. Elytral nervures not distinctly fuscous........ ....*viridis* Uhler.

AA. Male vertex with the margins sometimes acute, but not foliaceous, elytral nervures more or less fuscous.

  B. Vertex with the margins acute in the female, slightly so in the male, male elytra yellowish-green, nervures slightly fuscous; males over 5mm. in length.......... ....*flavidus* Sign.

BB. Margins of vertex obtuse in both sexes, male elytra brownish-green, nervures fuscous; male, less than 4mm...................................*brunneus* n. sp.

P. viridis Uhl., this is a common species throughout the northern half of the U. S., west to Colorado. It has been found abundantly in the mountains of Colorado, up to 10,000 feet. The mountain specimens are somewhat larger and of a deeper green than those from the plains. The males usually have the clypeus and margins of the genæ, tergum and venter except the margins, and all the legs deep fuscous. With these, and dark green females, occurred the following variety:

Var. montanus n. var., structurally as in the typical form, slightly larger, pale, straw-yellow, pronotum and elytra narrowly margined with white; an oblique stripe occupying the basal half of the clavus, except the margin, a stripe just inside the costal margin, obsolete at the base, broadening towards the apex, and a stripe on the tergum on either side just inside the margin, deep or fuscous black.

Described from four females from the headwaters of the Little Beaver—altitude, 9,500 feet.

P. flavidus Sign., this is a slightly narrower species than *viridis* and the male vertex is acutely angulate instead of rounding as in that species. It ranges from Florida to Texas, and north to Kansas and southern Iowa, where it overlaps the range of *viridis*.

P. brunneus n. sp., smaller than either of the other species, with a shorter head, margins of the vertex blunt and rounding in both sexes. Pale green, with the elytral nervures brownish fuscous. Length ♀ 6 mm., ♂ 3.5-4 mm.; width ♀ scarcely 2 mm., ♂ 1.25 mm.

Female; vertex convex and slightly sloping, scarcely as long as the pronotum, anterior margin obtusely rounding; front, convex faintly ribbed, clypeus broadest at the apex; pronotum slightly more than twice wider than long, posterior margin roundingly, or slightly angularly, emarginate, an arcuated, impressed line across the disc, behind which it is usually transversely striated. Elytra, in *brachypterous* forms, covering about two-thirds of the abdomen. The apical cells minute; *macropterous*, in which the apical cells are long, wedge-shaped, and reach the apex of the last abdominal segment.

Male; smaller, narrower, with a shorter and still more bluntly rounding vertex; the elytra are always long, covering the abdomen.

Color; female, pale green, the vertex and face shading to white, elytral nervures, greenish fuscous, distinct; apical cells hyaline, the nervures fuscous margined, ovipositor tipped with reddish orange. Male, pale green, the posterior part of pronotum and the elytra washed with testaceous brown, the elytral nervures fuscous brown.

Genitalia; ultimate ventral segment of the female twice longer than the penultimate, posteriorly truncate, with a slight median tooth; ovipositor attenuate, as long as the rest of the abdomen, half longer than in *viridis*; male, valve concealed; plates broad at base, rapidly, roundingly narrowing to the middle, beyond which they extend as finger-like plates; a fuscous crescent inside the margin on either side at the base, spines on the pygofers fuscous.

Described from numerous specimens collected at Fort Collins and Wray, Colo., and Stratton Neb., from "salt grass," *Distichilis maritima*, growing on alkali flats and in pastures. The larvæ appeared the middle of April, the adults about the 1st of June.

EXPLANATION OF PLATE V.

Figure 1 *Dicyphonia ramentosa*, Brachypterous female; 2 Elytra, Macropterous female; 3 Elytra, male; 4 Face, female; 5 Genitalia, male; 6 *Memnonia consobrina*, Brachypterous female; 7 Elytra, Macropterous female; 8 Elytra, male; 9 Genitalia, female; 10 Genitalia, male.

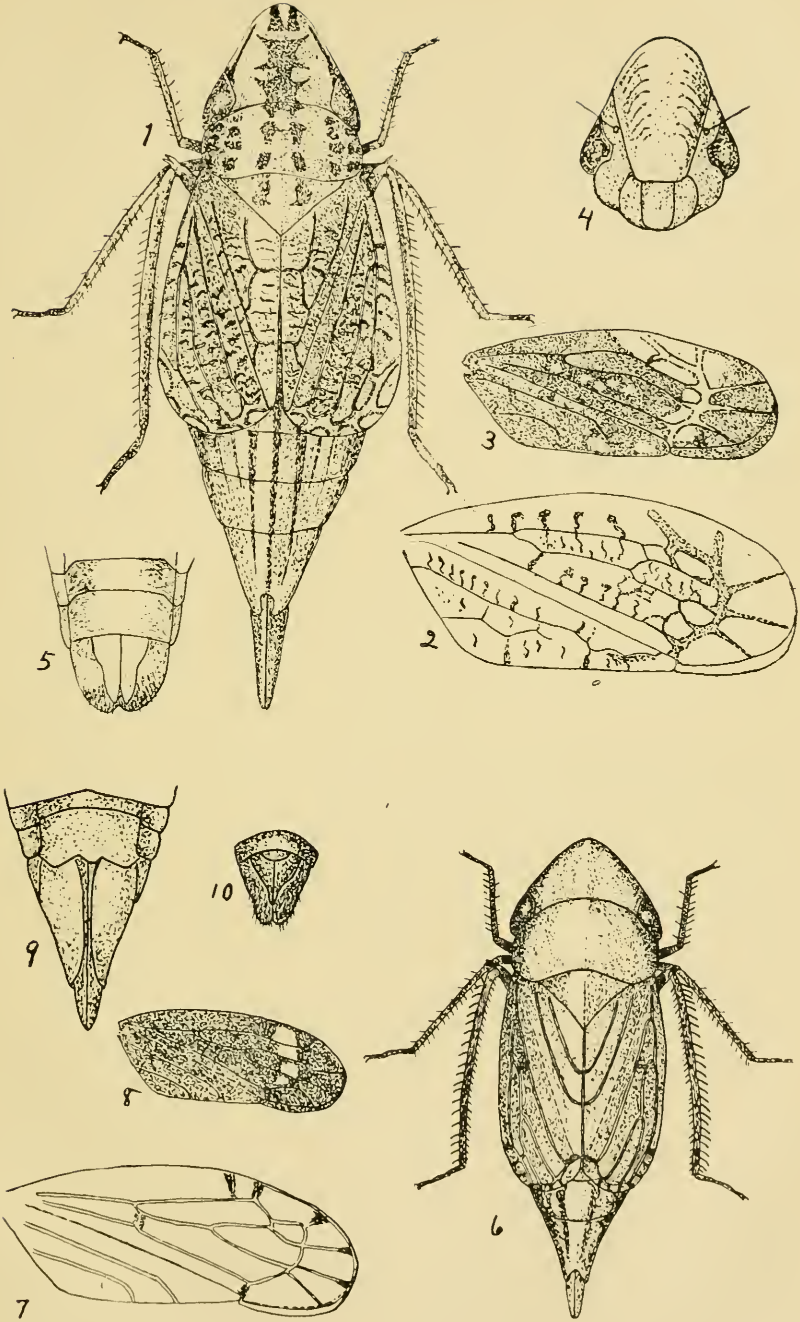
A NOTABLE RIDE.

FROM DRIFTLESS AREA TO IOWAN DRIFT.

BY SAMUEL CALVIN.

There is in eastern Iowa one short journey which shows a more interesting variety of land forms in small space than can be seen almost anywhere else. It shows too, in a typical way, the different surface aspects of areas belonging respectively to the driftless area and to the plains of Kansan and Iowan drift. For these reasons the journey referred to should become famous, and might well become a standard in certain particulars, among students of Pleistocene deposits and topographic forms. The journey is over the Illinois Central railroad; it begins at Dubuque, and it may end at Dyersville. The whole distance does not exceed thirty miles.

At Dubuque the topography is that of the driftless area, and the topographic forms are determined by the effects of erosion on the massive, dolomitic cliff-forming Galena limestone. In and around the city the Galena has been sculptured by atmospheric and other agencies into numerous picturesque towers and castles and mural precipices ranging from fifty to two hundred feet in height. There are bold salients standing out prominently, like jutting headlands, between the lateral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gorges cut in the Mississippi bluffs, and residences perched airily on their summits, seem, at first sight, to be altogether inaccessible. Deep, lateral valleys and ravines afford the only practicable routes for highways of every sort, leading to the higher levels west of the city; and all of these, for some distance, follow tortuous courses, and ascend at very steep grades. The railway uses the valley of Catfish creek as the sinuous pathway whereby it is enabled to make the four hundred feet of ascent necessary to reach the upland plain at Peosta. From Dubuque almost to Julien, the fantastically weathered crags and castles of Galena limestone, and the steep-sided hills, littered with loose fragments of the dolomite partially embedded in the thin, residual soil, are prominent features of the landscape, and at the same time are easily understood characteristics of the driftless area topography. The "Three Towers," massive columns of dolomite, forty to fifty feet in height, rising from the comparatively level bottom of the stream valley, are seen a short distance west of Rockdale; and in the same neighborhood are many picturesque escarpments and buttressed walls and bastioned fortresses, carved by natural processes from the living rock, and lending charm and variety to this unique, driftless landscape so strangely set in the midst of the great prairie plains of the middle west.

Before reaching Julien the surface inequalities become toned down to a marked extent. The relief is very much less. The outlines of the hills are more flowing, the curves more gentle. The weather-beaten crags disappear. The surface is yet rolling and irregular, as compared with the ordinary prairie; but the land is susceptible of cultivation to a greater or less extent, and most of it has been brought under the plow. The ascending grade of the small valley followed by the railway brings the surface here above the upper limit of the Galena limestone, up to the softer Maquoketa shales, and it is this shale formation that expresses itself in the cliffless, cragless, softened landscape. The billowy surface bears little resemblance, however, to even an eroded drift plain. There is a certain tumultuousness and confusion manifest in the swells which mark the surface. There is no common level to which their summits rise, but a knob here and a ridge there may stand conspicuously above all the rest, and it is altogether impossible to pick out any set or series anywhere, which can be referred to a common plane. The valleys of the larger streams are cut well below the general level of the region, the process of peneplanation is yet far from being complete, and the confused appearance of the land swells is due to the fact that the various parts of the surface are not being degraded at the same rate.

A few miles west of Julien, and sweeping around in a long, prominent ridge a mile or two south of the railway line, are the abrupt slopes and cliffs of the Niagara limestone which overlies the Maquoketa shales. The Niagara, like the Galena, is dolomitic. It resists weathering and forms mural cliffs only slightly less pronounced than those of the older and more perfectly crystalline dolomite already noticed. The total thickness of the Maquoketa formation is something more than two hundred feet, but the area within which the shales are superficial—the area between the outcrops of the upper beds of the Galena and the base of the Niagara cliffs—is comparatively narrow, rarely exceeding three miles in this part of Dubuque county. All around the foot of the Niagara escarpment the surface of the Maquoketa area presents a series of long, rain-sculptured, cultivated slopes, rather steep, but gradually blending into the more level area encountered after passing from the rugged topography of the Galena limestone to the more softened forms of the Maquoketa, near Julien.

A mile or two east of Peosta the deep trenches and steep scarps characteristic of the margin of the Niagara limestone are encountered. Erosion has produced picturesque effects, not so pronounced maybe, but yet in a measure comparable with those seen in the region occupied by the Galena limestone. The base of the Niagara is somewhat softer than the Galena. Not far above the base are rapidly weathering beds containing a large amount of chert. As a result of differences in structure there are fewer vertical precipices in the Niagara than in the Galena area, and this is particularly true when the cliffs are formed by erosion of trenches in the basal portions of the Niagara formation. Talus material accumulates at the foot of the scarps, and the upper part of the cliff faces recedes as an effect of weathering. While the resulting slopes, as a rule, are not vertical, they yet stand at high angles; and so the transition from the area of Maquoketa shales to that of the Niagara is marked by an abrupt and steep ascent of sixty to one hundred feet. This sharply defined offset is one of the most striking topographic features in this part of the driftless area.

On the line followed by the Illinois Central railroad the edge of the Niagara does not extend far beyond the margin of the Kansan drift; but south of the valley of Catfish creek, and conspicuous even from the car window, the Niagara gives character to a high ridge, noted above, which extends two or three miles into the driftless area; and at Sherrill's Mound, in the northern part of the county, the Niagara escarpment is nearly ten miles east of the edge of the drift. The drift-covered area is entered by the railway line less than a mile east of Peosta. A cut, thirty to forty feet in depth, is made in the thickened margin of the Kansan till one-half mile east of the village named; and at the station the traveler has at last an uninterrupted view to the western horizon. He has reached the upland plain, a plain which varies but little in altitude all the rest of the way across the state. He has passed from the driftless area where the topographic forms are the resultant of erosion acting on indurated rocks of varying degrees of hardness, to an area of comparatively inconspicuous topographic forms developed by erosion of a body of drift which was originally left by the retreating ice fields, with a surface approximating a plane. It was not a true plane, however, but a drift plain diversified by numerous undulations which were due to two facts—the ice deposited more material in some places than in others, and the mantle of glacial detritus was not in all cases sufficient completely to disguise the high ridges and the deep valleys of the preglacial topography. The thickening of the Kansan drift along its ultimate border has given rise to a well marked ridge which curves so as to trend northeast and southeast from Peosta. The drift plain is inclined very gently to the west, and all the drainage streams, for some miles back from the drift border, take a westerly or southwesterly course. A new type of topography now engages the attention of the observer. The landscape stretches away in an unbroken plain to the far horizon, but the surface of the plain, as in all the Kansan drift areas of Iowa, is carved into a dendritic system of miniature hills and valleys. Compared with the driftless area which was traversed only a mile or two east of Peosta, the visible effects of erosion are very small. Except along the permanent streams the rain sculpture has affected only the drift; it has not exposed any of the indurated rocks. Making allowance for the original undulations of the plain, it may be said that the symmetrically rounded swells of the surface, in striking contrast with the tumultuous and disorderly arrangement seen in the area of eroded Maquoketa shales, all rise approximately to the same level. The Kansan drift is everywhere in this region overlain by loess. Mature erosional topography, on a small scale, was developed on the Kansan surface before the loess was laid down upon it. Subsequent erosion of the friable loess has modified the curves of the original profile lines to some extent, and so the surface features which present themselves between Peosta and Epworth, the next station west, have been classified under the name of loess-Kansan topography. The region affords as typical examples of this kind of surface carving as can be found scores, or even hundreds, of miles back from the terminal margin of the Kansan ice.

The normal loess-Kansan surface, as seen between Peosta and Epworth, is modified by a number of pahoid ridges between Epworth and Farley, but west of the station at Farley the railway enters immediately upon a new type of topography, upon a plain of Iowan drift. The Iowan is much younger than the Kansan. Its surface is nearly level; it is absolutely uneroded; it is not covered with loess; and large granite bowlders, projecting conspicuously above the surface, catch the attention and awaken the interest of even the unscientific traveler. It is a narrow lobe of Iowan drift which is traversed by the railway between Farley and Dyersville. The lobe occupies a low plain as if the Iowan ice had flowed out in a long tongue between ridges of eroded Kansan. These rain-sculptured ridges, now covered with loess, are recognizable on either hand from the platform of the coach. The level, uneroded Iowan surface afforded the engineer in charge of the location of the railway line an opportunity of which he was quick to take advantage. This narrow Iowan lobe between Farley and Dyersville is as typically Iowan as any area in the state; but west of Dyersville, if the observer wishes to pursue the subject further, he may enter upon the great Iowan plain, and all the way across the counties of Delaware, Buchanan, Black Hawk, and westward to the Wisconsin moraine in Hardin, he will find his whole horizon occupied by a surface showing only the gentle undulations left by the melting Iowan ice. Erosion has played no part in producing the land forms which characterize ninety-nine per cent of the Iowan area. Except in the immediate neighborhood of the streams the topography is constructional.

Twice in the short journey from Dubuque to Dyersville, the land forms change with almost surprising suddenness; three distinct topographic areas are included between the eastern and western borders of a single county.

OBSERVATIONS IN THE VICINITY OF WALL LAKE.

BY FRANK A. WILDER.

The Wall lake in question is a picturesque sheet of water three miles long and a mile wide, in southeastern Sac county. The only published observations in regard to this lake that I have found are those of Mr. Charles A. White, who wrote in regard to it in connection with other walled lakes of Iowa, in the American Naturalist, Vol. II, and in the annual reports of the Geological Survey of Iowa, Vols. I and II.

During the past summer while tracing the course of the Altamont moraine the writer very properly arrived at Wall lake, for it was previously known that the lake lies in the moraine and owes its existence to morainic conditions. The purpose of this paper is to record certain observations that make more definite the history of the lake. Most of these points have been observed before, but the locating of the outer edge of the moraine near Wall lake makes it possible to attempt certain new deductions in regard to its origin.

A topographic map would show that Wall lake fills but part of an extensive hollow, which at points is lower than the lake itself. The lake is in the form of a letter L, the long bar lying east and west while the short bar extends to the south. Morainic hills of very moderate elevation are found all about it except at its eastern end and along its southwestern shore. At the southwestern extremity the shore line is uncertain, consisting of marshes and low land with barely elevation enough to keep the water from flowing to the south. This low trough extends to the south for two miles, then swings to the west and continues as far as the Boyer river, four miles away. In width it varies from a mile to a mile and a half. It is very level, has no natural drainage, and when visited in June, 1899, water stood abundantly on the surface. For these reasons, and perhaps also on account of the nature of the soil, no attempt is made to cultivate this strip of low land, and it is devoted solely to pasture. Wells show that the floor of this valley is made up of sand and gravel. The water supply for the town of Wall Lake is obtained from a well fourteen feet deep, in this hollow. The supply is abundant, the well filling as fast as the water is pumped out. The Lake View gravel pit extends for a mile along the west side of this hollow. It is operated by the Chicago & North-Western railroad, and yields great quantities of excellent ballast. The area already excavated, added to that which has been prospected and stripped, shows that the width of the deposit is at least a fourth of a mile. It probably extends along the hollow till it swings to the west. The material is a uniform grade of sand and gravel, at least 15 feet thick. Everywhere the deposit shows oblique lamination. In the finer material quartz abounds, while in the coarse limestone predominates. All of the rock fragments are water worn and rounded. A section 10 feet in height shows that the material is evenly sorted from top to bottom. The railroad is operating the pit on an extensive scale.

At present Wall lake is drained by the 'Coon river. The little stream connecting them has no valley, nor can it be said to have made a course of its own. It is connected with the east end of the lake, and the region just east of the lake through which it flows is lower than the lake itself. Thus is brought about the curious condition that White describes, of a lake lying in a valley which it only partly fills with a wall at each end across the valley, which permits the water in the lake to rise above the level of the land which is only a few rods, or at some points only a few yards away at each end. The stream draining the lake winds around among the morainic knobs that are conspicuous at the east end of the lake, seeking the lowest levels, doubling on itself till it apparently stumbles into the Coon river. The hollow excavated by the stream is seldom more than 30 feet wide and 6 feet deep. Beyond this the stream has no effect on the topography, except at points where a slightly deeper excavation was necessary to connect hollows somewhat separated. Evidently the water rose in the lake till it found an outlet at the east end, then filled the hollow at that point till an elevation was reached sufficient to permit it to flow into the hollow just beyond and so on till the 'Coon river was reached, two miles away. Then the slight task of cutting down the insignificant barriers between the hollows was begun. The nature of the stream's course shows the whole process was very recent, and that unless the lake is very young indeed, it must have had an outlet elsewhere. The depth of the lake is only twenty feet, and recent erosion in the little stream and at the point where it leaves the lake shows that had the lake used this outlet long it would now be dry. Within ten years piling has been put in to protect the exit, and if this were removed the level of the lake would to-day fall three feet.

The Boyer river lies four miles west of Wall lake. Following the Chicago & North-Western track westward, frequent cuttings show that the region as far as the Boyer river is covered with a drift having the characteristics of the Wisconsin, while the surface features are morainic. An excellent exposure in a railroad cutting on the west bank shows twenty feet of loess over sand, and the fields which at the time were freshly cultivated, revealed characteristic loess soil. The Boyer river, then, at this point, marks the western limit of the moraine. A study of the map would also suggest that at this point some new factor enters to determine the nature of the stream. From Wall lake to its mouth its course is southwest, in accordance with the general drainage scheme of tributaries of the Missouri in Iowa. From its source to the vicinity of Wall lake, however, its course is south and southeast. Below Wall lake the railroad commissioners' map traces seven tributary creeks that come from the east, while there is not one for an equal distance to the north.

Below the point where the extensive hollow described in this paper meets the Boyer river, I am told by Mr. Bain, that there is an unusually strong gravel train following the Boyer river, while above this point on the Boyer river, the train, while perhaps present, is relatively insignificant.

The logical inferences from these conditions, I think, are as follows: While the Wisconsin ice lasted a glacial river of considerable size flowed through the valley now represented by Wall lake and the hollow connected with it to the southwest, and emptied into the Boyer river. With the retreat of the ice the river disappeared, leaving a channel nearly level. Slight inequalities gave rise to a very shallow pond at the upper end of the hollow, the beginning of Wall lake. For the subsequent development of Wall lake I would accept White's explanation.

The water in the lakelets is usually very low in the late autumn and when winter comes they are frozen nearly to the bottom in their deepest parts, so that occasionally all the fish are killed by this means. The ice, of course, freezes fast to the boulders as well as to whatever else may be within its reach, and the expansive power of from one to five miles of freezing water is exerted on them in a direction from a center towards the shore—a force much more than sufficient to move the largest boulders on these gentle slopes.

The embankments are from 2 to 6 feet high and from 2 to 20 feet across from the top, and always separate a low piece of ground from the lake; because where the original shore was a little abrupt and higher than the high-water level, no embankment was formed, but the boulders were merely thrust against the shore with such force as to render it steep and often thickly studded with them.

Meeting no such obstruction on a marshy side, the material thrust out accumulates just where the expansive force of the ice is spent. This process, repeated year after year and age after age, has cleared the bottoms of the lakelets of their boulders and other material and piled them up in circular ridges upon their shores; and these are the walls that have excited so much wonder. It has been observed that the embankments are heaviest on the sides opposite the prevailing winds. This may be accounted for, at least in part, by the fact that the ice being burdened with the material to which it has frozen fast, would thus be floated against those shores when the spring floods had raised the water of the lakes, and in part, also, by the fact that the dashing of the waves would be almost constant against these shores.

It will thus be seen that whatever was originally upon the bottom, whether boulders, sand, gravel or mud, has been carried to the shores and we find the embankment composed of all these materials, arranged in perfectly natural disorder. If boulders were numerous we find the embankment largely composed of them. If sand prevailed, a broadly rounded embankment was formed, just such as we would expect from such material; and where a peat marsh extends out into the land, an embankment of turf is thrown up at the water's edge, which, being supported by living rootlets, is frequently high and very narrow.

I found nothing in my observations to contradict these conclusions of White. The accompanying photo, by Professor Calvin, taken at Clear lake, illustrates nicely White's explanation.

It is probable that formerly the lake was drained into the Boyer river. A very slight increase in the elevation of the east shore or depression of the shore at the southwest would again turn its waters to this course. White has indicated that ice and ice pressure are shifting material constantly, and building up walls where shores are low and the slopes gradual. It is easy to believe that at these two rather distant points on this lake, the building up would not be perfectly uniform, and

FIG. 1. Effect of Expansion of Ice at Clear Lake (After Calvin.)

that where so slight a change in elevation of the shore would change the outlet, the change might be brought about by the ice action described.

FIG. 2. Natural Rip-rapping on the Shore of Spirit Lake. (After Macbride.)

There are traditions to the effect that since the arrival of the white man, Wall lake was tributary to the Boyer river, but for them there seems to be no basis other than the fact that every one noting the conditions, even casually, must see that it would require but a slight change in existing conditions to so deflect the water.

Other considerations which further study might remove from the realm of mere speculation to that of reasonable certainty, would be as to whether this glacial river valley does not represent the pre-Wisconsin course of the Boyer river. The slight study given the question seems to show that north of the Wall lake region the valley of Boyer river is younger than the valley of the same stream farther south. The valley of the 'Coon northeast of Wall lake suggests maturity, and a study of the map forces the thought that the 'Coon river from this point on represents the pre-Wisconsin Boyer river, which was diverted and thrown over into a branch of the 'Coon, or into the upper course of the 'Coon itself, by the Wisconsin moraine. These points can be determined only by a more careful study of the valleys of the streams, and the glacial deposits of the vicinity.

FORMATIONAL SYNONOMY OF THE COAL MEASURES OF THE WESTERN INTERIOR BASIN.

BY CHARLES R. KEYES.

Of late years the Carboniferous terranes, or formations of the Mississippi basin west of the great river have been widely studied. They are now capable of being classified in detail.

For a long time much confusion existed in regard to the relations that the schemes of various investigators, and especially those of the pioneers, bore to one another, and to the more modern widely correlated arrangement. The adjustment of the results of all workers, extending over a period of fifty years, in a field embracing the greater part of six states, was fraught with many difficulties.

With the modern method of giving geographic names to the terranes there has arisen a strong tendency to ignore the work of the earlier investigators, and to inordinately multiply titles.

As a result, a number of different titles has often been given to the same formation as it appears in different localities, and synonomy has increased amazingly.

In considering the nomenclature it has been the aim to pass over technicalities, and to adhere to the original idea and intent of the author, so far as possible, even when definitions have not been expressed according to present standards. Personal examinations of nearly all the original localities have enabled interpretations to be made that cannot always be gathered from the published descriptions.

Most of the many names for the Kansas beds, appearing in the *Kansas University Quarterly*, were first used incidentally, with no attempt at exact definition. They have no valid grounds for recognition or notice, and were it not for the fact that their authors have claimed priority in naming formations they would not be noted herein. They are, however, given for what they are worth.

The most satisfactory classification of the terranes comprising what has been generally called the coal measures of the region appears to be as follows:

SYSTEM.	SERIES.	TERRANES.	THICKNESS.
	Oklahoman.		
	Missourian.	Cottonwood limestone.	10
		Atchison shales.	500
		Forbes limestone.	30
		Platte shales.	150
		Plattsmouth limestones.	30
Carboniferous.		Lawrence shales.	300
		Stanton limestones.	35
		Parkville shales.	100
		Iola limestone.	50
		Thayer shales.	75
		Bethany limestones	100
	Des Moines.	Marais des Cygnes shales.	200
		Henrietta limestones.	100
		Cherokee shales.	275
	Mississippian.		

The questions of synonomy are numerous and complex. All important names involved in determining priority of usage are believed to be included in the subjoined list. Their equivalents as now known are enumerated in each case.

NOMINAL HISTORY OF THE TERRANES RECOGNIZED.

As use of the names adopted for the general section here given may not be fully gathered from the synonomic list appended it may not be out of place to give a brief account of the nominal history of each.

Cherokee Shales.—Little attempt has been made to designate, by geographical names, the basal portion of the lower coal measures. Recently Haworth and Kirk* have proposed the name Cherokee. While it was not formally nor properly defined at first as a formation name, subsequent description† leaves practically no doubt as to its extension. The name had been previously used by Jenny‡ for the lead-bearing formations of the Mississippian series of southwest Missouri, but only incidentally. Before this author proposed formally to use the title in this way, the term had been appropriated in another sense. Moreover, Cherokee, as applied to the lead-bearing rocks, covers an indefinite sequence of beds, for which specific titles that are well defined had been already widely adopted; so that even if the term in Jenny's sense had been formally suggested it could scarcely be considered as having priority. In this sense also, the term has nowhere been accepted as a geological name, while it has been practically refused recognition by all who have had occasion to refer to it, either directly or indirectly.

Henrietta Limestones.—The name Henrietta was used by Marbut§ for a subdivision of the coal measures which gives rise, in southwest Missouri, to a prominent relief feature called the Henrietta escarpment. It consists of several limestone beds of great persistency, separated by shales, but presenting a sharp contrast to the immediately underlying and overlying formations, which consist of shale and sandstones.

In southeastern Kansas it embraces of Swallow's section‖ essentially numbers 203 to 217, or from the top of the Pawnee limestone down to the cement rock under the Fort Scott limestone. In the more recent references¶ to the sebeds the same limestones are recognized, but the lower bed is termed the Oswego limestone.

In southern Iowa the limestone in the lower part of Bain's Appanoose formation which contains the great Mystic coal seam, appears to be the real northern extension of the Henrietta.

Marais des Cygnes Shales.—There is considerable difficulty in determining just what term should be applied to the shales

* Kansas Univ. Quart., Vol. II, p. 105, 1894.
†Univ. Geol. Sur. Kansas, Vol. I, p. 150, 1896.
‡ Trans. Am. Inst. Min. Eng., Vol. XXII, p. 171, 1894.
§ Missouri Geol. Sur., Vol. X, p. 44, 1896.
‖ Kansas Geol. Sur., Prelim. Rept., pp. 24-25, 1866.
¶ University Geol. Sur. Kansas, Vol. I, p. 151, 1896.

lying between the Pawnee limestone of the Henrietta and the Bethany limestone of the Missourian series. Haworth* has recently called the shales in question the Pleasanton, from a town in southeastern Kansas. Swallow,† thirty years before, appears to have had essentially the same idea when he defined the "Marais des Cygnes Coal Series." For both, the type localities are practically the same. The recognized basal limit of the one is identical with the other. With very slight change of idea the upper limitations of the Marais des Cygnes could be considered as coinciding with the base of the Bethany, the same as in the case of the Pleasanton. The great thickness ascribed to the Marais des Cygnes is manifestly due to repetition of the upper part of the section. But Swallow himself recognized the probability of this fact when he stated that "some of the strata may be duplicated in this series, as they are very much disturbed where the sections were made." He also said of certain localities that it was almost impossible to make correct sections.

It is also not improbable that, owing to the lack of good outcrops in this level country, Swallow mistook, in his correlations, a part of the Thayer shales for the beds underneath the Bethany, just as he did in the case of what are known to be the Lawrence shales. The correlations of Swallow are in a notable degree faulty, as we now well know. The typical localities of his Marais des Cygnes are all east of the Bethany escarpment, confirming clearly that there was actually a duplication of beds in this part of his section, as he suspected.

For the strata lying between the Pawnee, the upper mem ber of the Henrietta, and Bethany limestones, Haworth and Kirk‡ first suggested the name Laneville shales. This term was not defined in any way. Subsequently Haworth,§ without the slightest reference to this title, and without a very much better definition for the new name, changed it to Pleasanton shales. In a still later publication‖ the latter term was more clearly limited. Laneville was then used in a new sense. Again, within a few months, Haworth relegates Pleasanton to a subordinate taxonomic position, placing it and the Henrietta

* Kansas Univ. Quart., Vol. III, p. 274, 1895.
† Kansas Geol. Sur., Prelim. Rept., p. 22, 1866.
‡ Kansas Univ. Quart., Vol. II, p. 108, 1894.
§ Kansas Univ. Quart., Vol. III, p. 274, 1895.
‖ Univ. Geol. Sur. Kansas, Vol. I, p. 153, 1896.

in the Marmaton formation.* Unfortunately, Marmaton, in this connection is almost exactly equivalent to the Appanoose of Bain. Besides, the term Marmaton had already been used for the median shale member of the Henrietta.†

Eliminating Swallow's correlations as not essential, matters seem vastly simplified by retaining his title of Marais des Cygnes for the upper number of the Des Moines series, or that part lying between the Pawnee and Bethany limestones, especially in Missouri and Kansas.

Bethany Limestone.—The most important limestone of the coal measures is the basal member of the Missourian series, now generally called the Bethany formation. While no special designation was applied to it before Broadhead's, in 1862, this limestone was clearly recognized by a number of scientific travelers. As early as 1840, King‡ called particular attention to these limestones near the Osage river at the western boundary of Missouri. He recognized their three-fold character and pointed out their importance as a stratigraphic horizon.

Owen,§ in 1852, gave a vertical section of the limestone beds under consideration, and their associated strata, as they occur on the Missouri river a few miles below the mouth of the Kaw (Kansas City), near Wayne City. He makes the observation that the beds which are at the water level at the first mentioned place, gradually rise to the eastward. Hawn‖ observed the Bethany limestone in making his section along the line of Hannibal & St. Joseph railroad, but he afterwards confounded with it the Iola, Iatan and Stanton limestones. Swallow¶ also noted these beds at Kansas City and Liberty landing on the Missouri river, but he also correlated with them the Stanton (Plattsburg) beds as shown at Leavenworth.

According to the canons of nomenclature and appropriateness of application, the term Bethany appears best suited to the basal member of the Missourian series. Various other titles for these limestones have been proposed. The subject has been recently reviewed.** The great Winterset limestones

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* University Geol. Sur. Kansas, Vol. III, p. 94, 1898.

† Proc. Iowa Acad. Sci., Vol. IV, p. 24, 1897.

‡ Geol. Sur. Osage River, Eleventh Gen. Assem. Missouri, 1st Sess., Sen. Jour., App p. 518, 1840.

§ Geol. Sur. Wisconsin, Iowa and Minnesota, p. 137, 1852.

‖ Geol. Sur. Missouri, 1st and 2d. Ann. Repts., p. 125, 1855.

¶ Geol. Sur. Missouri, 1st and 2d Ann. Repts., p. 81, 1855.

** American Jour. Sci., (4), Vol. II, p. 222, 1896.

of Iowa, and the Erie limestones of Kansas are now known to be merely the extensions of the Bethany of Missouri.

In addition to the terrane being identical with the Bethany, the name Erie has been preoccupied many times in geology.

Thayer Shales.—The first special mention of these shales in geology was by Broadhead* in 1884, in his account of the "Carboniferous Rocks of Eastern Kansas." He described the formation in practically the same extension as now understood, gave a good detailed section of them near Thayer, in the western part of Neosho county, Kansas, and repeatedly referred to them as the coal, sandstone or shales of Thayer. Attention was also called to them at Chanute.

The accounts of the work of the University geological survey of Kansas contain numerous references to these shales. In the description of the Neosho River section, Haworth and Kirk† call them the Chanute shales, and without definition allude to their position between the Bethany and Iola limestones. In a subsequent article Haworth‡ describes the shales rather fully at Chanute and Thayer but does not give them a specific name, except incidentally in another connection. The first official publication of the survey§ gives them the name Thayer without any allusion to the former name Chanute that was applied. Although proposed independently by the Kansas authors, the name and first description of the formation should be properly credited to Broadhead.

Iola Limestones.—The first application of a distinctive geographical name to this terrane is by Haworth‖ in 1894. It was not, however, defined in any sense of the word, and the name was an extension of a rather widely known commercial name of the chief quarry rock of the bed—the "Iola Marble." A year later, Haworth¶ gave a somewhat fuller account, and at a subsequent date the same writer** gave a more complete description, on account of which the name can really lay claim to recognition.

Parkville Shales.—For the shales lying between the Iola and Stanton (Plattsburg) limestones, along the Missouri river, the title Parkville has been recently suggested.†† The peculiar

* Trans. St. Louis Acad. Sci., Vol. IV. p. 481, 1884.
† Kansas Univ. Quart., Vol. II, p. 109, 1894.
‡ Kansas Univ. Quart., Vol. III, p. 276, 1895.
§ University Geol. Sur. Kansas, Vol. I, p. 157, 1896.
‖ Kansas Univ. Quart., Vol. II, p. 109, 1894.
¶ Ibid., Vol. III, p. 276, 1895.
** University Geol. Sur. Kansas, Vol. I, p. 132, 1896.
†† American Geologist, Vol. XXIII, p. 305, 1899.

relations that the various parts of this terrane bear to one another have occasioned some marked complications in terminology.

At the typical locality, in Platte county, Missouri, a few miles north of Kansas City, the shales are about eighty feet thick. In the Missouri river section no important limestone bands occur. In southeastern Kansas a limestone is soon intercalated, reaching a thickness of twenty feet, or more, and subdividing the formation into parts that have been thought prominent enough to secure special names. The shales thus become separated into two parts by the intervening limestone, the upper one being called by Haworth and Kirk* the Le Roy shale, the calcareous member of Carlyle limestone, by the same writers, and the lower one by the senior author, the Iola shale.† The first named portion was subsequently changed,‡ without explanation, from Le Roy to Lane, the latter name being used also in later descriptions.§

According to deep-well records the Parkville and Thayer shales merge northward beyond St. Joseph, the Iola limestone failing.

Stanton Limestones.—Of late years the Kansas geologists have used the term Garnett for the third important limestone formation of the Missourian series.

There are, however, two older names which have to be considered in this connection, both of which were applied to the main body of limestone.

As early as 1866 Swallow‖ appears clearly to have had the principal calcareous member in mind when he applied the name Stanton limestone. The name is derived from a town of that title situated in Miami county on the eastern border of Kansas.

The lower shaly portion of his Stanton Limestone series, corresponds to the Parkville shales, and has ascribed to it about the same thickness as shown farther to the north on the Missouri river. The correlations made by Swallow, of the Stanton limestone, as developed in the original locality on the Marais des Cygnes, in Miami county, with the section west of Topeka are, of course, erroneous; for it is now known that there is a stratigraphical interval between the two locations of

* Kansas Univ. Quart., Vol. II, p. 110, 1894.

† Ibid., Vol. II, p. 124, 1894.

‡ Ibid., Vol. III, p. 277, 1895.

§ Univ. Geol. Sur. Kansas, Vol. I, p. 159. 1896.

‖ Kansas Geol. Sur., Prelim. Rept., p. 20, 1866.

more than 500 feet, occupied by the Lawrence shales, Plattsmouth limestones, Platte shales, and certain other limestones.

For the time the Stanton limestone was very well defined, and is now easily recognized at the type locality. It is questionable whether the limits of this term should not be extended slightly, and the name adopted, in place of Plattsburg and Garnett.

In 1873 Broadhead* called the lower and most important beds of the limestones, which have since been called Garnett, the "Plattsburg group," giving as typical localities Plattsburg, Parksville and Waldron, Missouri. He also called attention to a limestone, upwards of six feet thick, which existed a few feet above the main bed and which was usually exposed with it. A detailed descriptive section is given.

Nearly twenty years before, Hawn† recognized the limestone at Plattsburg but gave it no specific designation, and moreover he confounded it with the Bethany limestone exposed thirty-five miles east of Plattsburg, and with the limestone known locally as the Iatan, which outcrops about the same distance west in the bluffs of the Missouri river.

In 1884 Broadhead‡ gave a more complete description of his "Plattsburg group," adding also that it was well exposed at Eudora, Kansas, and was easily recognized in Johnson and Wyandotte counties in the same state.

In Kansas the limestone appears to be considered under a variety of different names. Haworth and Kirk§ in the Neosho River section called it the Burlington limestone, and also the Garnett, and referred to doubtful correlations with certain limestones on the Kansas river. Haworth and Piatt‖ call it the Toronto limestone. The Ottawa limestone of Haworth¶ probably is the same formation. In the following year the same author** describes the Garnett or Burlington limestone as a "system" composed of two main members separated by eight to twelve feet of shale, and further says that according to Bennett the heavy limestone at Plattsburg, Mo., is equivalent to the upper Oread. The Garnett limestone is the title by which the formation is known in the notes

* Missouri Geol. Sur., Iron Ores and Coal Fields, pt. ii, pp. 94 and 111, 1873.

† Missouri Geol. Sur., 1st and 2d Ann. Repts., p. 128, 1855.

‡ Trans. St. Louis Acad. Sci., Vol. IV, p. 482, 1884.

§ Kansas Univ. Quart., Vol. II, p. 110, 1894.

‖ Ibid., p. 117.

¶ Ibid., p. 121.

** Ibid., Vol. III, p. 227, 1895.

published in the first volume of the Kansas university survey.*

The upper limestone is gray and is especially characterized by the fossil *Syntrialasma hemiplicata*; it is widely known as the "Syntrialasma Zone."

Lawrence Shales.—The name was suggested by Haworth† for the greater part of the shales lying between the Stanton (Plattsburg or Garnett) and Plattsmouth (Oread) limestones. Afterwards the term was extended‡ to include all of the shales occurring between the two limestones mentioned, and the maximum thickness placed at 300 feet. It was fully described§ the year following. A thin limestone layer, forty to seventy-five feet from the base, which is found in southeastern Kansas, has received the special name of Strawn limestone and Ottawa limestone. In the Missouri River section the limestone near the middle of the Lawrence formation becomes an important member, but its exact relations to the similarly situated limestones in southeastern Kansas is not known. Along the Missouri river the median calcareous member is called the Iatan limestone; the argillaceous member beneath, the Weston shales and the one above the Andrew shales.‖

Plattsmouth Limestone.—The typical section of the Plattsmouth limestone early attracted attention. Owen visited the locality more than fifty years ago. From the same limestone at Belleview, a few miles away, he collected a number of characteristic fossils.¶ He, however, thought that the rocks exposed along this part of the Missouri river belonged to the Carboniferous limestone series (Mississippian), and they were so colored on his map. The marked dip to the southward, which he perceived below the mouth of the Platte river, probably lead him to believe that the coal measures were deposited in a shallow, saucer-shaped basin, of which the opposite rim was near the Mississippi river.

Swallow,** though he mistook the limestone as exposed at Belleview to be the same as that at Parkville and Weston (Stanton limestone), referred the formation to the upper coal series or upper coal measures. During the same year there appeared a geological map of the United States, by Marcou,††

* University Geol. Sur. Kansas, Vol. 1, p. 159, 1896.
†Kansas Univ. Quart., Vol. II, p. 122, 1894.
‡Ibid., Vol. III, p. 277, 1895.
§ University Geol. Sur. Kansas, Vol. I, p. 160, 1896.
‖ American Geologist, Vol. XXIII, p. 306, 1899.
¶ Geol. Sur. Wisconsin, Iowa and Minnesota, p. 134, 1852.
** Missouri Geol. Sur., 1st and 2d Ann. Repts., p. 79, 1855.
†† Bull. Soc. Géol. de France, Tome XII, 1855.

in which the formations of the Missouri river were colored as New Red sandstone, or Triassic. The English edition of the map, which accompanies his "Geology of North America," has the same coloration.

Two years later, Hayden* gave out the results of his observations along the Missouri river, and refers the rocks south of the Platte to the Carboniferous or coal measures.

From observations made during a brief visit to the Missouri river region in Nebraska, by Marcou† and Capellini, the Plattsmouth beds were placed in the lower Dyas or Permian. A year afterwards, Meek‡ pointed out, in a special paper, the fact that the rocks in question belonged to the coal measures, and not to any younger formations. Geinitz,§ who described the fossils collected by Marcou in Nebraska, only incidentally mentions the limestone at Plattsmouth, remarking that it was probably below the Nebraska City sections, and belonged to the "Oberen Kolenkalk," or the upper part of the lower Carboniferous series.

Up to this time, although many references had been made to the formation, no specific designation had been given to the limestone. Meek appears to be the first to attempt to call it by a geographic name. He refers‖ about 200 feet of strata below the first heavy limestone above the Plattsmouth to the "Platte division." This included all of the shales now known to be not more than 100 feet thick in the vicinity of the Platte river, the limestone now called the Plattsmouth, and the few feet of shales beneath exposed at the landing. As the major part of "division" is a well defined formation comprised almost entirely of shales, the term Platte has been reserved for that subdivision. Meek,¶ however, in the same memoir referred to, terms the fossiliferous limestones which comprise most of his section as the "Plattsmouth beds." By this name they have since become widely known. For this reason it is believed that the limestone should be continued to be known by the name of a locality which has become classical in American geology.

* Proc. Philadelphia Acad. Nat. Sci., Vol. IX, p. 110, 1857.
† Bull. Soc. Géol. France, 2e série, t. XXI, p. 137, 1864.
‡ Am. Jour. Sci., (2), Vol. XXXIX, p. 165, 1865.
§ Memoirs, d. d. Leop. Carol. Akad. Nat., 1866, 91 pp.
‖ U. S. Geol. Sur. Nebraska, p. 85, 1872.
¶ Ibid., p. 94.

From the town of Plattsmouth the shales dip southward and those exposed at that place are soon lost from view below the river bed. No attempt appears ever to have been made to carefully correlate the formation with any exposed further south, and consequently the beds shown along the Missouri river between St. Joseph and Kansas City have always been considered independently of those of the region to the north. There is, however, one exception. Swallow* says, incidentally, that a certain limestone of his upper coal series is exposed at Belleview, at the mouth of the Platte, near St. Joseph, and elsewhere southward. This statement is manifestly little more than a happy guess. It was only very recently demonstrated beyond much doubt that the limestone so well exposed at the first named locality and the one in the top of the bluffs near St. Joseph are the same. But as Swallow in the same sentence just referred to made three other different limestones continuous with this one, it is safe to conclude that he had merely surmised the connection between the limestones of all four localities.

In the recent geological work done in Kansas there has come to be widely recognized through the eastern part of the state a conspicuous limestone which has been named after the hill on which the State University stands, the Oread limestone. There is now but little doubt that it is identical with the Plattsmouth limestone of Nebraska and Iowa. The term Oread was first used by Haworth† in 1894. At a subsequent date,‡ the name was extended so as to include two limestones separated at the typical locality by twenty feet of shale. Its wide extent in Kansas was recognized, and it was correlated with the Stanton (or Plattsburg) limestone of Missouri. Bennett§ traced the Oread north from Leavenworth nearly to Iowa Point and regarded it as probably equivalent to Broadhead's No. 150.

Platte Shales.—In the Nebraska sections there appear above the Plattsmouth limestone over 100 feet of shales, to which the term Platte may be appropriately applied. The name was first used by Meek,‖ who called the rocks exposed from Omaha to Nebraska City the "Platte division" from its

* Missouri Geol. Sur., 1st and 2d Ann. Repts., p. 79, 1855.
† Kansas Univ. Quart., Vol. II, p. 123, 1894.
‡ Ibid., Vol. III, p. 278, 1895.
§ Univ. Geol. Sur. Kansas, Vol. I, p. 62, et seq., 1896.
‖ U. S. Geol. Sur. Nebraska, p. 85, 1872.

development in the vicinity of the mouth of the Platte river where the various outcrops seem to exhibit a thickness of between 200 and 300 feet. This embraced all of the shales from the first important limestone (Forbes-Bed B of Meek's section) above the Plattsmouth, the latter, and some twenty-five feet of shales below. The Plattsmouth forming a well defined member by itself, the name Platte is retained for the major part of the "division," or the shales.

The advisability of recognizing this subdivision was further advocated recently.*

The fact that the exact equivalency of the Forbes limestones on the Missouri river, with the principal limestones on the Kansas river near Topeka is not yet determined, makes little difference so far as understanding the general stratigraphy is concerned. The Forbes may be the continuation of either the Topeka or the Burlingame limestones. At any rate the Platte is very nearly, if not exactly, the equivalent of Haworth's Shawnee formation.† It thus embraces the Lecompton shales, the Lecompton limestone, the Tecumseh shales, the Deer Creek limestone, the Calhoun shales, and possibly also the Topeka limestone and Osage shales.

Forbes Limestone.—In the Missourian series there is one important limestone member between the Plattsmouth and Cottonwood limestones. This is called the Forbes formation from its best outcrops in northwestern Missouri, along the Missouri river. In Kansas it appears to be the Burlingame.

This stratum has been referred to many times in the literature of the region, but it has never received special designation. Marcou‡ assigned it and other beds, as exhibited at Belleview and Omaha, to the Mountain limestone series (Mississippian), and the Plattsmouth limestone farther down the river to the Permian.

Whenever it is with certainty correlated with Burlingame limestones of the Kansas river section, the title will probably have to take the place of one or the other of these. It might be inferred that this could be easily determined from the correlations of the geologists who have been in northeastern Kansas. There are, however, in their work, marked discrepancies. No account is taken of the remarkable syncline in the extreme northeastern corner of the state. Along the Mis-

*American Geologist, Vol. XXIII, p. 380, 1899.
†Univ. Geol. Sur. Kansas, Vol III, p. 94, 1898.
‡Bull Soc Géol. France, 2e serie, t. XXI, p. 132, 1864.

souri river the Forbes limestone is carried down beneath the water level. This trough is more than 250 feet deep, and permits the Cottonwood limestone, for example, to extend eastward in a broad tongue more than forty miles farther than would be ordinarily expected. This being the case, the extension of the Burlingame limestone, as put down in the maps of the Kansas geologists, meets in Nebraska the Cottonwood limestone which is nearly 500 feet above.

Atchison Shales.—In the most recent papers the name Wabaunsee has been used in connection with the formation under consideration. The latter name is derived from one of the counties in central Kansas where the formation is well exposed. The designation is that of Prosser,* for a sequence of shales that occupy the interval between the Cottonwood limestone and the Osage coals. It was subsequently made to include a few more feet of shale below the last named horizon, and to extend to the Burlingame (Forbes?) limestone.

There seems to have been another name that has been used in nearly the same sense as Prosser originally used Wabaunsee. This will probably have to be substituted. As early as 1873, Broadhead designated the uppermost beds of the upper coal measures as exposed in northwest Missouri, as the "Atchison County Group." Subsequently he refers often to them in this way. His descriptions of the lithological and faunal characters, though widely scattered, are very complete. Regarding the stratigraphic position of the formation, it reached from the summit of the Missouri section—now known to be about 75 feet below the Cottonwood limestone—almost to the Nodaway coal, which is nearly on the same horizon with the Osage coal of central Kansas. The Atchison beds thus have practically the same limits assigned to them as a quarter of a century later Prosser proposed for the Wabaunsee. They occupy over four-fifths of the interval that the Wabaunsee occupies in the northwest corner of Missouri. For this reason Atchison appears to be the only name that can be legitimately used for the shales between the Forbes and Cottonwood limestones.

The Atchison shales are 500 feet thick on the Missouri river. Near the base is at least one seam of coal of sufficient thickness to profitably mine. This is the Nodaway coal, which has a very considerable extent in northwestern Missouri and southwestern

* Journal Geology, Vol. III, p. 690, 1895.

Iowa. The Aspinwall coal seam in southeastern Nebraska and northeastern Kansas is probably a part of the same stratum.

These extensive shales impart certain peculiarities to the topography of the area occupied by the Nodaway coal that are not noted elsewhere in the Missouri region. The soft rocks have permitted a moderately uniform plain to be worn out. In Missouri, Marbut has designated the plain Maryville lowland, thus recognizing it as one of the important relief features of that state. The shales, moreover, occupy the bottom of what is known as the Brownville syncline. Owing to the attitude of the strata, their softness, and the peculiarities of the drainage of this region, by which the lowland plain has been formed and the contrasts of relief reduced, little information has been heretofore obtained regarding the shales. They have been scarcely noted, though they are two and one-half times as thick as the whole upper coal measures were once thought to be. Since their extent has been recognized the Atchison shales have come to assume more and more importance, until it has come to be suspected that eventually they may possibly have equal taxonomic rank with the Des Moines series.

Prosser's name Wabaunsee is admirably defined, according to modern standards, and to its author represents far more than a term applied in a district in which he has not worked. To an unprejudiced observer, however, and to one who has been over both fields, Broadhead's group cannot fail to be regarded as equally well portrayed.

Cottonwood Limestone.—The name Cottonwood limestone has been adopted for the uppermost member of the Missourian series. The rock was widely known as a quarry stone, long before its importance as a geological formation was recognized, it being called the "Cotton-rock," or "Cottonwood Falls rock" or "Cottonwood stone" Thus, the last two names have crept into geological literature and it seems advisable to adopt the title, especially since other geographic names that have been applied to it have been found to be preoccupied. Cottonwood Falls and Manhattan, Kansas, may therefore be considered as typical localities. The formation was called many years ago by Swallow the "Fusulina limestone," from its most characteristic fossil feature, it being composed in certain layers almost entirely of rhizopodous shells, resembling grains of wheat. The stone is widely used for construction purposes, and is shipped into many states. The stratum has been traced from southeastern Nebraska, where it passes beneath the Cretaceous, entirely across Kansas, into Oklahoma. It often forms a noticeable topographic feature.

SYNONYMIC LIST.

Alma stone, Prosser. (Bull. Geol. Soc. America, Vol. VI, p. 44, 1894.) A local quarry name used in Wabaunsee county, Kansas, for the Cottonwood limestone.

Altamont limestone, Adams. (Univ. Geol. Sur. Kansas, Vol. I, p. 22, 1896.) Applied to a thin stratum, in southern Kansas, lying in the Marais des Cygnes shales.

Altoona limestone, Haworth and Hiatt. (Kansas Univ. Quart., Vol. II, p. 117, 1894.) Not defined; but name used for a part of Bethany.

Americus limestone, Kirk. (Univ. Geol. Sur. Kansas, Vol. I, p. 80, 1896.) One of the thin, unimportant, double limestone bands, apparently lying in the lower part of the Atchison (Wabaunsee) formation, in east-central Kansas.

Andrew shale, Keyes. (American Geologist, Vol. XXIII, p. 306, 1899.) Incidentally introduced to designate the upper shale member of the Lawrence, along the Missouri river, in Andrew county, Missouri.

Appanoose beds, Bain. (Iowa Geol. Sur., Vol. V, p. 378, 1896.) Proposed for shales, in Appanoose county, in southeastern Iowa. It includes the Henrietta and the major part, if not all, of the Marais des Cygnes.

Atchison county group, Broadhead. (Geol. Sur. Missouri, Iron Ores and Coal Fields, pt. ii, p. 28, and section p. 379, 1873.) Corresponds almost exactly to the Wabaunsee of Kansas. Applied to the highest beds of the coal measures in the northwest corner of Missouri. The top and base were not clearly defined originally with reference to other sections. It is now known to represent practically the shales lying between the Forbes and Cottonwood limestones.

Atchison shales, Keyes. (American Geologist, Vol. XXIII, p. 309, 1899.) Title derived from Broadhead's Atchison county group, which includes essentially what was called recently the Wabaunsee formation. It refers to the uppermost shale terrane of the Missourian series.

Auburn shale, Beede. (Trans. Kansas Acad. Sci., Vol. XV, p. 30, 1898.) A term given to a thin fossiliferous bed in the middle Wabaunsee (Atchison), in Shawnee county, Kansas.

Benedict limestone, Haworth and Piatt. (Kansas Univ. Quart., Vol. II, p. 116, 1894.) Not defined, but term used for Iola—"the Benedict-Iola system."

Bethany Falls limestone, Broadhead. (Trans. St. Louis Acad. Sci., Vol. II, p. 311, 1862.) Applied to the main body of limestones forming the basal terrane of the Missourian series.

Bethany limestone, Keyes. (American Jour. Sci., (3), Vol. L, p. 243, 1895.) Proposed for the basal limestone terrane of the Missourian series. A slight modification in meaning of Broadhead's term Bethany Falls limestone.

Burlingame limestone, Hall. (Univ. Geol. Sur. Kansas, Vol. I, p. 105, 1896.) Corresponds probably to the Forbes limestone of the Missouri river section.

Burlingame shale, Haworth. (Kansas Univ. Quart., Vol. III, p. 278, 1895) A name given to one of the minor beds in the lower part of the Atchison (Wabaunsee) formation in central Kansas.

Burlington limestone, Haworth and Kirk. (Kansas Univ. Quart., Vol. II, p. 110, 1894.) Temporarily proposed for the Garnett, now known as the Stanton (Plattsburg).

Calhoun limestone, Beede. (Trans. Kansas Acad. Sci., Vol. XV, p. 28, 1898) A term suggested for a locally developed layer in Shawnee county, Kansas, in the upper portion of the Platte shales.

Calhoun sandstone and shale, Beede. (Trans. Kansas Acad. Sci., Vol. XV, p. 29, 1898.) Suggested for the upper part of the Platte shales, in Shawnee county, Kansas.

Carlyle limestone, Haworth and Kirk. (Kansas Univ. Quart., Vol. II, p. 110, 1894.) A term given to one of the limestones occurring seventy-five feet above the base of the Parkville shales in eastern Kansas.

Cave limestone, Swallow. (Kansas Geol. Sur., Prelim Rept., p. 20, 1866.) In eastern Kansas this is now known as the Iola limestone

Cave Rock series, Swallow. (Kansas Geol. Sur., Prelim. Rept., p. 20, 1866.) A term applied to what is known as the Iola limestone, and the upper sandstone of the Thayer, in eastern Kansas.

Chaetetes limestone, Swallow (Kansas Geol. Sur., Prelim. Rept., p. 19, 1866.) The bed to which this term was applied appears to be really near the base of the Atchison shales, as occurring in Wabaunsee county, Kansas.

Chanute shales, Haworth and Kirk. (Kansas Univ. Quart., Vol. II, p. 109, 1894.) Proposed for the Thayer shales.

Chariton conglomerate, Bain. (Iowa Geol. Sur., Vol. V, p. 394, 1896) Formation of doubtful age, but is placed in the Des Moines series. Occurs in southeastern Iowa, and overlies Henrietta beds.

Chautauqua sandstone, Adams. (Univ. Geol. Sur. Kansas, Vol. III, p. 59, 1898.) In central Kansas a local development in the Lawrence shales.

Cherokee shales, Haworth and Kirk. (Kansas Univ. Quart., Vol. II, p. 105, 1895.) The basal member of the triple Des Moines series. The first references are very indefinite as to limits, but the term was later defined.

Cherryvale shales, Haworth. (Univ. Geol. Sur, Kansas, Vol. III, p. 47, 1898.) In southern Kansas the shales separating the middle and upper main limestones of the Bethany are unusually well developed and are given this title.

Chocolate limestone, Swallow. (Kansas Geol. Sur., Prelim. Rep., p. 19, 1866.) Title of one of the thin limestones on the Kansas river, west of Topeka, lying in the lower part of the Atchison (Wabaunsee) shales.

Chocolate limestone series, Swallow. (Kansas Geol. Sur., Prelim. Rep., p. 19, 1866.) Applied to the beds in the lower part of the Atchison (Wabaunsee) shales as exposed on the Kansas river, west of Topeka.

Clear Fork group, Broadhead. (Missouri Geol. Sur., Iron Ores and Coal Fields, pt. ii, p. 170, 1873.) Proposed for the lower seventy feet of the Cherokee shales in Pettis and Johnson counties, Mo.

Columbus sandstone, Haworth and Kirk. (Kansas Univ. Quart., Vol. II, p. 106, 1894.) Title given to one of the heavy sandstones occurring in the Cherokee shales of southwest Missouri and southeast Kansas. It is not formally defined.

Cotton rock, Swallow. (Kansas Geol. Sur., Prelim. Rept., p. 16, 1866.) Term applied to one of the thin limestones near the top of the Atchison (Wabaunsee) shales near Manhattan, Kan.

Cottonwood Falls limestone, Haworth and Kirk. (Kansas Univ. Quart., Vol. II, p. 112, 1894.) Name merely incidentally mentioned at this time, though afterwards defined. The terrane is the superior member of the Missourian series.

Deer Creek limestones, Bennett. (Univ. Geol. Sur. Kansas, Vol. I, p. 117, 1896.) Applied to a number of thin limestone bands in the Platte shales, east of Topeka.

DeKalb limestone, Bain. (Iowa Geol Sur., Vol. VIII, p. 276, 1898.) In south-central Iowa applied to one of the upper limestones of the Bethany.

Douglass formation, Haworth. (Univ. Geol. Sur. Kansas, Vol. III, p. 93, 1898.) Proposed to embrace the Lawrence shales and the Plattsmouth limestones.

Dover limestone, Beede. (Trans. Kansas Acad. Sci., Vol. XV, p. 31, 1898.) A name given to a thin stratum in the median part of the Atchison (Wabaunsee) shale, in Shawnee county, Kansas.

Dover shale and sandstone, Beede. (Trans. Kansas Acad. Sci., Vol. XV, p. 31, 1898.) A local name for a part of the middle portion of the Atchison (Wabaunsee) shale, in Shawnee county, Kansas.

Dry Bone limestone, Swallow. (Kansas Geol. Sur. Prelim. Rept., p. 16, 1866.) Near Manhattan, Kansas, applied to a bed near top of the Atchison (Wabaunsee) shales.

Earlham limestone, Bain. (Iowa Geol. Sur., Vol. VII, p. 448, 1897.) The term is used in connection with one of the lower principal limestone beds of the Bethany, in central Iowa.

Earlton limestone, Adams. (Univ. Geol. Sur. Kansas, Vol. III, p. 51, 1898.) Proposed for a limited lenticular bed near the top of the Thayer shales, in southern Kansas.

Eastern and lower coal-bearing division, Winslow. (Arkansas Geol. Sur., Ann. Rept. 1888, Vol. III, p. 22, 1888.) Applied to a part of the coal measures probably lying below the Cherokee, in west-central Arkansas.

Einstein sandstone, Swallow. (Kansas Geol. Sur., Prelim. Rept., p. 21, 1866.) A name given, in eastern Kansas, to the uppermost bed of the Thayer shales.

Elgin sandstone, Adams. (Univ. Geol. Sur. Kansas, Vol. III, p. 64, 1898.) In southern Kansas, applied to beds lying in the Platte shales.

Elk Falls limestone, Adams. (Univ. Geol. Sur. Kansas, Vol. III, p. 65, 1898.) In southern Kansas the term refers to a thin limestone in the lower part of the Platte shales. It probably corresponds to the Lecompton and Deer Creek limestones of the central portion of the state.

Elmont limestone, Beede. (Trans. Kansas Acad. Sci., Vol. XV, p. 30, 1898.) Designation of a thin stratum in the median part of the Atchison (Wabaunsee) shales, in Shawnee county, Kansas.

Emporia limestone, Kirk. (Univ. Geol. Sur. Kansas, Vol. I, p. 80, 1896.) Apparently applied to one of the strata near the base of the Atchison (Wabaunsee) shales.

Erie limestone, Haworth and Kirk. (Kansas Univ. Quart., Vol. II, p. 108, 1894.) Designation of the triple limestone in Kansas, now known to be the Bethany limestone, of Missouri. The title is preoccupied.

Eudora limestone, Haworth. (Univ. Geol. Sur. Kansas, Vol. I, p. 136, 1896.) Applied to one of the Stanton (Plattsburg) layers.

Eureka limestone, Adams. (Univ. Geol. Sur. Kansas, Vol. III, p. 67, 1898.) According to Haworth, the bed thus named is the Burlingame limestone.

Forbes limestone, Keyes. (American Geologist, Vol. XXI, p. 349, 1898.) Applied, in the Missouri river section, to the fifth great limestone terrane of the Missourian series. It is probably equivalent to either the Topeka or the Burlingame limestone of central Kansas.

Fort Scott cement rock, Swallow. (Geol. Sur. Kansas, Prelim. Rept., p. 24, 1866.) Applied to what is now regarded as the lowermost limestone member of the Henrietta.

Fort Scott coal series, Swallow. (Geol. Sur. Kansas, Prelim. Rept., p. 25, 1866.) A name given locally, in southeastern Kansas, to the uppermost shales of what is now known as the Cherokee, including also the lower limestone of the Henrietta.

Fort Scott limestone, Swallow. (Geol. Sur. Kansas, Prelim. Rept., p. 25, 1866.) Name applied to the basal member of what is now called the Henrietta.

Fort Scott marble, Swallow. (Geol. Sur. Kansas, Prelim. Rept., p. 26, 1866.) Term given to a locally developed bituminous limerock lying in the upper part of the Cherokee shales.

Fort Scott marble series, Swallow. (Geol. Sur. Kansas, Prelim. Rept., p. 26, 1866.) Applied to beds, chiefly shales, near the top of what is now called the Cherokee shales.

Fragmental limestone, Bain. (Iowa Geol. Sur., Vol. VII, p. 448, 1897.) Designates the lowermost layer of the Bethany, in central Iowa.

Fusulina limestone, Swallow. (Kansas Geol. Sur., Prelim. Rept., p. 16, 1866.) The Cottonwood limestone of later reports.

Fusulina limestone, Bennett. (Univ. Geol. Sur. Kansas, Vol. I, p. 116, 1896.) Applied to the Lecompton limestone, as exposed along the Kansas river.

Fusulina limestone, Bain. (Iowa Geol. Sur., Vol. VII, p. 448, 1897.) In central Iowa refers to the third heavy limestone of the Bethany.

Fusulina shales, Swallow. (Kansas Geol. Sur., Prelim. Rept., p. 17, 1866.) East of Manhattan, Kansas, the upper part of what is now called the Atchison (Wabaunsee) is so designated.

Hartfort limestone, Kirk. (Univ. Geol. Sur. Kansas, Vol. I, p. 80, 1896.) Alludes to a thin stratum near the top of the Lawrence shale.

Henrietta limestone, Marbut. (Missouri Geol. Sur., Vol. X, p. 44, 1896,) Incidentally suggested for the middle member of the Des Moines series. Subsequently more fully defined.

Holden group, Broadhead. (Missouri Geol. Sur., Iron Ores and Coal Fields, pt. ii, p. 194, 1873.) Includes about sixty feet of the Marais des Cygnes shales, in Johnson and Cass counties, Missouri.

Howard limestone, Adams. (Univ. Geol. Sur. Kansas, Vol. III, p. 67, 1898.) Apparently corresponds to the Topeka (Forbes?) limestone.

Garnett limestone, Haworth and Kirk. (Kansas Univ. Quart., Vol. II, p. 110, 1894.) A later Kansas name for the Stanton (Plattsburg) limestone.

Iatan limestone, Keyes, 1899. (American Geologist, Vol. XXIII, p. 306, 1899.) A quarry name incidentally used, in the description of the Missouri river section, to designate the median limestone of the Lawrence shales.

Independence limestone, Haworth and Piatt. (Kansas Univ. Quart., Vol. II, p. 115, 1894.) Proposed for the upper of the three heavy limestones of the Bethany, in southern Kansas.

Intermediate barren division, Winslow. (Arkansas Geol. Sur., Ann. Rept. 1888, Vol. III, map, 1888.) Applied to a part of the lower portion of the Cherokee in western Arkansas.

Iola gas rock, Orton. (Bull. Geol. Soc. America, Vol. X, p, 104, 1899.) A sandstone in southeastern Kansas, 75 feet above the base of the Cherokee shales.

Iola limestone, Haworth and Kirk. (Kansas Univ. Quart., Vol. II, p. 109, 1894.) The first geographic designation of the second great limestone terrane of the Missourian series.

Iola shale, Haworth. (Kansas Univ. Quart., Vol. II, p. 124, 1894.) An undefined name for the lower part of the Parkville shales.

Knob Noster group, Broadhead. (Missouri Geol. Sur , Iron Ores and Coal Fields, pt. ii, p. 176, 1873.) Applied to about 100 feet of the middle Cherokee, in Johnson county, Mo.

Labette shales, Adams. (Univ. Geol. Sur. Kansas, Vol. III, p. 36, 1899.) A term given to the median member of the Henrietta limestone in southeastern Kansas.

Lane limestone, Haworth. (Univ. Geol. Sur. Kansas, p. 136, 1896.) Title of the upper member of the Stanton (Plattsburg) formation, in Franklin county, Kansas.

Lane shales, Haworth. (Univ. Geol. Sur. Kansas, Vol. I, p. 48, 1896.) Name used for part of the shales lying immediately above the Iola limestone, in eastern Kansas.

Lane shales, Haworth. (Univ. Geol. Sur. Kansas, Vol III, p. 54, 1898.) Title applied in the general Kansas section, to all of the shales between the Iola and the Stanton (Plattsburg). In this sense it is synonymous with Parkville.

Laneville shales, Haworth and Kirk. (Kansas Univ. Quart., Vol. II, p. 108, 1894) Provisionally proposed, without definition, for the Marais des Cygnes or Pleasanton in eastern Kansas.

Lawrence shales, Haworth. (Kansas Univ. Quart., Vol. II, p. 122, 1894.) As used in this connection the name only applied to a part of the formation as now understood. It was subsequently extended and limited.

Lecompton limestone, Haworth. (Kansas Univ. Quart., Vol. III, p. 278, 1895.) Applied to the first limestone above the Plattsmouth, in central Kansas, lying in the Platte shales.

LeRoy shales, Haworth and Kirk. (Kansas Univ. Quart., Vol. II, p. 110, 1894.) Proposed for the upper part of the Parkville.

Lexington group, Broadhead. (Missouri Geol. Sur., Iron Ores and Coal Fields, pt. ii, p. 187, 1873.) Proposed for a part of the Henrietta formation as developed in west-central Missouri immediately south of the Missouri river.

Lower coal series, Swallow, 1866. (Geol. Sur. Kansas, Prelim. Rept., p. 26, 1866.) Corresponds very nearly to the Cherokee shales in southeastern Kansas.

Lower Pleasanton shales, Haworth. (Univ. Geol. Sur. Kansas, Vol. III, p. 40, 1898.) Applied to the lower half of the upper member of the Des Moines series.

Manhattan stone, Prosser. (Bull. Geol. Soc. America, Vol. VI, p. 37, 1894.) A local name of quarrymen, near Manhattan, Kansas, applied to the Cottonwood limestone. The name is preoccupied.

Marais des Cygnes coal series, Swallow. (Kansas Geol. Sur., Prelim. Rept., p. 22, 1866.) Although duplicated in part, the Marais des Cygnes corresponds essentially to the Pleasanton shales of the later Kansas geologists. The formation is typically exposed in Miami county, Kansas.

Marmaton formation, Haworth. (Univ. Geol. Sur. Kansas, Vol. III, p. 92, 1898.) Proposed for the upper two members of the Des Moines series, the Henrietta and Marais des Cygnes (Pleasanton). Bain's Appanoose has essentially the same delimitation.

Marmaton shale, Keyes. (Proc. Iowa Acad. Sci., Vol. IV, p. 24, 1898.) Suggested for the median shale member of the Henrietta.

Mound group, Broadhead. (Missouri Geol. Sur., Iron Ores and Coal Fields, pt. ii, p. 196, 1873.) The upper part of the Marais des Cygnes (Pleasanton) in Cass county, Mo.

Mound Valley limestone, Adams. (Univ. Geol. Sur. Kansas, Vol. I, p. 23, 1896.) Applied to the median heavy limestone of the Bethany as it occurs in southern Kansas.

Mound Valley shales, Haworth. (Univ. Geol. Sur. Kansas, Vol. III, p. 47, 1898.) In southern Kansas, applied to the shales separating the lower and middle main limestones of the Bethany.

Muscotah series of limestones, Knerr. (Univ. Geol. Sur. Kansas, Vol. I, p. 144, 1896.) Title of some thin limestone beds occurring west of Atchison, and about 150 feet above the Plattsmouth limestone. Perhaps equivalent to the Forbes.

Neodesha sandstone, Haworth. (Univ. Geol. Sur. Kansas, Vol. I, p. 131, 1896.) Applied to the massive sandstone occurring in the upper part of the Thayer shales, especially at Neodesha and Thayer, Kansas.

Oread limestone, Haworth. (Kansas Univ. Quart., Vol. II, p. 123, 1894.) Here applied, without definition, to the lower part of what appears to be the Plattsmouth. It was subsequently defined.

Osage shales, Haworth. (Univ. Geol. Sur. Kansas, Vol. III, p. 67, 1898.) Title of the lower part of the Atchison (Wabaunsee).

Osage City shale, Haworth. (Kansas Univ. Quart., Vol. III, p. 278, 1895.) Name given to the lower portion of the Atchison (Wabaunsee).

Oswego limestone, Haworth and Kirk. (Kansas Univ. Quart., Vol. II, p. 106, 1894.) A term for the lower member of the Henrietta formation.

Ottawa limestone, Haworth. (Kansas Univ. Quart., Vol. II, p. 121, 1894.) Name incidentally used for the Stanton (Plattsburg) limestone in Franklin county, Kansas. Not defined.

Parkville shales, Keyes. (American Geologist, Vol. XXI, p. 345, 1898.) A designation for shales exposed on the Missouri river, and included between the lola and Stanton (Plattsburg) limestone.

Pawnee limestone, Swallow. (Kansas Geol. Sur., Prelim. Rept., p. 24, 1866.) The top member of the Henrietta as now known was thus designated.

Pawnee limestone series, Swallow. (Kansas Geol. Sur., Prelim. Rept., p. 24, 1866.) In southeastern Kansas, the title covered all of the Henrietta, except the basal limestone.

Pennsylvanian series, Williams. (U. S. Geol. Sur., Bull. 80, p. 108, 1891.) Proposed for the Coal Measures of the United States.

Pennsylvanian series, Beyer. (Iowa Geol. Sur., Vol. IX, p. 190, 1899.) In Story county, Iowa, the name is used for the lower coal measures.

Platte division, Meek. (U. S. Geol. Sur. Nebraska, p. 85, 1872.) Applied to shales below limestone bed B (Forbes limestone) down to and including the limestone at Plattsmouth and a few feet of shales beneath.

Platte shales, Keyes. (American Geologist, Vol. XXIII, p. 308, 1899.) An adaptation of Meek's earlier title of Platte division.

Plattsburg group, Broadhead. (Missouri Geol. Sur., Iron Ores and Coal Fields, pt. ii, p. 94, 1873.) Applied to a number of limestone beds exposed on the Missouri river above Kansas City, that are essentially equivalent to Swallow's typical Stanton limestone, and Haworth's Garnett as originally used.

Plattsburg limestone, Keyes. (American Geologist, Vol. XXIII, p. 305, 1899.) An adaptation of Broadhead's earlier term of Plattsburg group, for the third great limestone terrane of the Missourian series. It now embraces a few feet more than was intended to be covered by Broadhead, which properly belong to it. As Swallow's typical Stanton is an exact equivalent to Broadhead's the former term is adopted.

Plattsmouth beds, Meek. (U. S. Geol. Sur. Nebraska, p. 94, 1872.) Refers to the section exposed at Plattsmouth, which is chiefly the limestone.

Plattsmouth limestone, Keyes. (American Geologist, Vol. XXIII, p. 305, 1899.) An adaptation of Meek's term for one of the upper limestone terranes of the Missourian series.

Pleasanton shales, Haworth. (Kansas Univ. Quart., Vol. III, p. 274, 1895.) The upper member of the Des Moines series was designated by this title. The formation corresponds almost exactly to Swallow's Marais des Cygnes.

Pottawattamie formation, Haworth. (Univ. Geol. Sur. Kansas, Vol. III, p. 93, 1898.) Proposed to include the Bethany limestone, the Thayer shales, the Iola limestone, the Parkville shales and the Stanton (Plattsburg) limestone.

Quenemo limestone, Hall. (Univ. Geol. Sur. Kansas, Vol. I, p. 104, 1896.) Name of a thin layer, five feet thick, seventy-five feet above the base of the Platte shales, in Osage county, Kansas.

Raven Cliff sandstone, Bain. (Iowa Geol. Sur., Vol. IV, p. 341, 1895.) Name applied to one of the thick massive sandstone deposits, in the lower part of the Cherokee, in Mahaska county, Iowa.

Redrock sandstone, Keyes. (Am. Jour. Sci., (3), Vol. XLI, p. 273, 1891.) Proposed for a conspicuous and important deposit of massive sandstone in Marion county, Iowa, in the lower part of the Cherokee.

Robinett flags, Haworth and Kirk. (Kansas Univ. Quart., Vol. II, p. 108, 1894.) Not defined; but applied to certain sandstones, on the Neosho river in Kansas, occurring in the Marais des Cygnes (Pleasanton).

Rossville shales and sandstone, Beede. (Trans. Kansas Acad. Sci., Vol. XV, p. 31, 1898.) Proposed for the upper part of the Atchison (Wabaunsee) shales, as exposed in Shawnee county, Kansas.

Severy shales, Adams. (Univ. Geol. Sur. Kansas, Vol. III, p. 66, 1898.) Apparently applied to median part of Platte shales in southern Kansas.

Sharpsburg sandstone, Hawn. (Missouri Geol. Sur., 1st and 2d Ann. Repts., p. 127, 1855.) Name of a basal sandstone of the coal measures in Monroe county, Mo. This author also correlated with it a sandstone immediately underneath the Bethany in Calwell county, Mo. It belongs to the Cherokee shale.

Shawnee limestone, Haworth. (Univ. Geol. Sur. Kansas, Vol. III, p. 93, 1898.) Proposed to embrace the Platte shales, the Topeka (Forbès?) and the lower part of the Atchison (Wabaunsee) shales.

Shunganunga shale, Beede. (Trans. Kansas Acad. Sci., Vol. XV, p. 29, 1898.) Lower part of the Atchison (Wabaunsee) shales in Shawnee county, Kansas, is thus designated.

Silver Lake shale, Beede. (Trans. Kansas Acad. Sci., Vol. XV, p. 30, 1898.) A local name given in Shawnee county, Kansas, to a part of the Atchison (Wabaunsee) shales.

Soldier Creek shales, Beede. (Trans. Kansas Acad. Sci., Vol. XV, p. 30, 1898.) Applied in Shawnee county Kansas, to a portion of the lower part of the Atchison (Wabaunsee) shales.

Spring rock, Swallow. (Kansas Geol. Sur., Prelim. Rept., p. 21, 1866.) Name applied to a thin limestone layer which, in Miami county, Kansas, belongs to what is now called the Thayer shales.

Spring rock limestone, Swallow. (Geol. Sur. Kansas, Prelim. Rept., p. 21, 1868.) Name given to a local development in central Kansas, occupying a position in the lower part of the Atchison (Wabaunsee) shales.

Spring rock series, Swallow. (Kansas Geol. Sur,, Prelim. Rept., p. 21, 1866.) Name originally intended to cover all beds, except uppermost local sandstone, now known as the Thayer shales.

Stanton limestone, Swallow. (Kansas Geol. Sur., Prelim. Rept., p. 20, 1866.) In eastern Kansas applied to the main body of what was later known as the lower limestone of the Garnett, or the Plattsburg of Missouri.

Stanton limestone, Swallow. (Geol. Sur. Kansas, Prelim. Rept., p. 20, 1868.) In central Kansas, it refers to a local development in the lower Atchison (Wabaunsee) shales.

Stanton limestone series, Swallow. (Kansas Geol. Sur., Prelim. Rept., p. 20, 1899.) Includes the lower Stanton (Plattsburg) limestone and the Parkville shales.

Strawn limestone, Haworth and Kirk. (Kansas Univ. Quart., Vol. II, p. 110, 1894.) Not defined. Applied to a limestone exposed on the Neosho river that lies in the Lawrence shales.

Swallow limestone, Haworth and Kirk. (Kansas Univ. Quart., Vol. II, p. 105, 1894.) Applied to a thin limestone in the Cherokee shales, in southeastern Kansas, but not defined.

Syntrialasma limestone, Bennett. (Univ. Geol. Sur. Kansas, Vol. I, p. 111, 1896.) The lower limestone of the Stanton (Plattsburg) formation was thus designated.

Tecumseh shales, Beede. (Trans. Kansas Acad. Sci., Vol. XV, p. 28, 1898.) In Shawnee county, Kansas, applied to middle part of the Platte shales.

Thayer shales, Broadhead. (Trans. St. Louis Acad. Sci., Vol. IV, p. 481, 1884.) The "Shales of Thayer" was a title used in referring to a well-described section at Thayer, Kansas.

Thayer shales, Haworth. (Kansas Univ. Quart., Vol. III, p. 276, 1895.) A term given to the shale member of the Missourian series immediately overlying the Bethany limestone, and extending to the Iola.

Toronto limestone, Haworth and Kirk. (Kansas Univ. Quart., Vol. II, p. 117, 1894.) In southeastern Kansas, applied apparently to the Stanton (Plattsbürg).

Topeka limestone, Haworth. (Kansas Univ. Quart., Vol. III, p. 278, 1895.) In this place merely mentioned as "Limestone near Topeka." Defined afterwards. Forbes limestone of the Missouri river section is the probable equivalent.

Triple limestone, Haworth and Kirk. (Kansas Univ. Quart., Vol. II, p. 122, 1894.) Name applied to the Bethany formation in eastern Kansas.

Upper coal series, Swallow. (Kansas Geol. Sur., Prelim. Rept., p. 16, 1866.) This term covers very nearly all of the Atchison (Wabaunsee) shales, except a few feet at the top and bottom, on the Kansas river, east of Manhattan. It appears to have included also a part of the Osage shales below the Burlingame limestone.

Upper Oswego limestone, Haworth. (Univ. Geol. Sur. Kansas, Vol. III, p. 34, 1899.) Name given to a part of the lower limestone member of the Henrietta.

Upper Pleasanton shales, Haworth. (Univ. Geol. Sur. Kansas, Vol. III, p. 41, 1898.) The uppermost part of the Des Moines series is so called. In southern Kansas a thin limestone called the Altamont is said to be its base.

Vilas shales, Adams. (Univ. Geol. Sur. Kansas, Vol. III, p. 51, 1898.) A thin shale immediately beneath the Iola limestone in southern Kansas has thus been termed. It refers to the upper part of the Thayer.

Wakarusa limestone, Beede. (Trans. Kansas Acad. Sci., Vol. XV, p. 30, 1898.) Title of a thin bed in the lower part of the Atchison (Wabaunsee) shales, in Shawnee county, Kansas.

Warrensburg group, Broadhead. (Missouri Geol. Sur., Iron Ores and Coal Fields, pt. ii, p. 182, 1873.) Applied to the beds associated with the coal at Warrensburg, Johnson county, Mo. It forms the upper part of the Cherokee.

Weeping Water limestone, Prosser. (Jour. Geol., Vol. V, p. 159, 1897.) The stratum is probably equivalent to the Forbes limestone, the upper limestone at Rock Bluff, Nebraska.

Well rock, Swallow. (Kansas Geol. Sur., Prelim. Rept., p. 22, 1866.) Applied to what is no doubt the middle main limestone of the Bethany, as shown in Miami county, Kansas.

Well rock series, Swallow. (Kansas Geol. Sur., Prelim. Rept., p. 21, 1866.) Term is essentially co-extensive with the Bethany along the eastern border of Kansas. The formation includes also a part of the duplicated section of the Marais des Cygnes underlying.

Western and upper coal-bearing division, Winslow. (Arkansas Geol. Sur., Ann. Rept. 1888, Vol. III, p. 11, 1888.) Applied to a part of the Cherokee in western Arkansas.

Westerville limestone, Bain. (Iowa Geol. Sur., Vol. VIII, p. 276, 1898.) A title designating a stratum in the lower part of the Missourian, possibly in the Bethany, in Decatur county, Iowa.

Weston shales, Keyes. (Amer. Geologist, Vol. XXIII, p. 306, 1899.) A term used locally on the Missouri river for the lower part of the Lawrence.

Willard shale, Beede. (Trans. Kansas Acad. Sci., Vol. XV, p. 31, 1898.) Part of the middle portion of the Atchison (Wabaunsee) shales, in Shawnee county, Kansas.

Winterset limestone, White. (Geol. Iowa, Vol. I, p. 246, 1870.) A designation given to the limestones exposed in Madison county, Iowa, that are now regarded as essentially an equivalent of the Bethany.

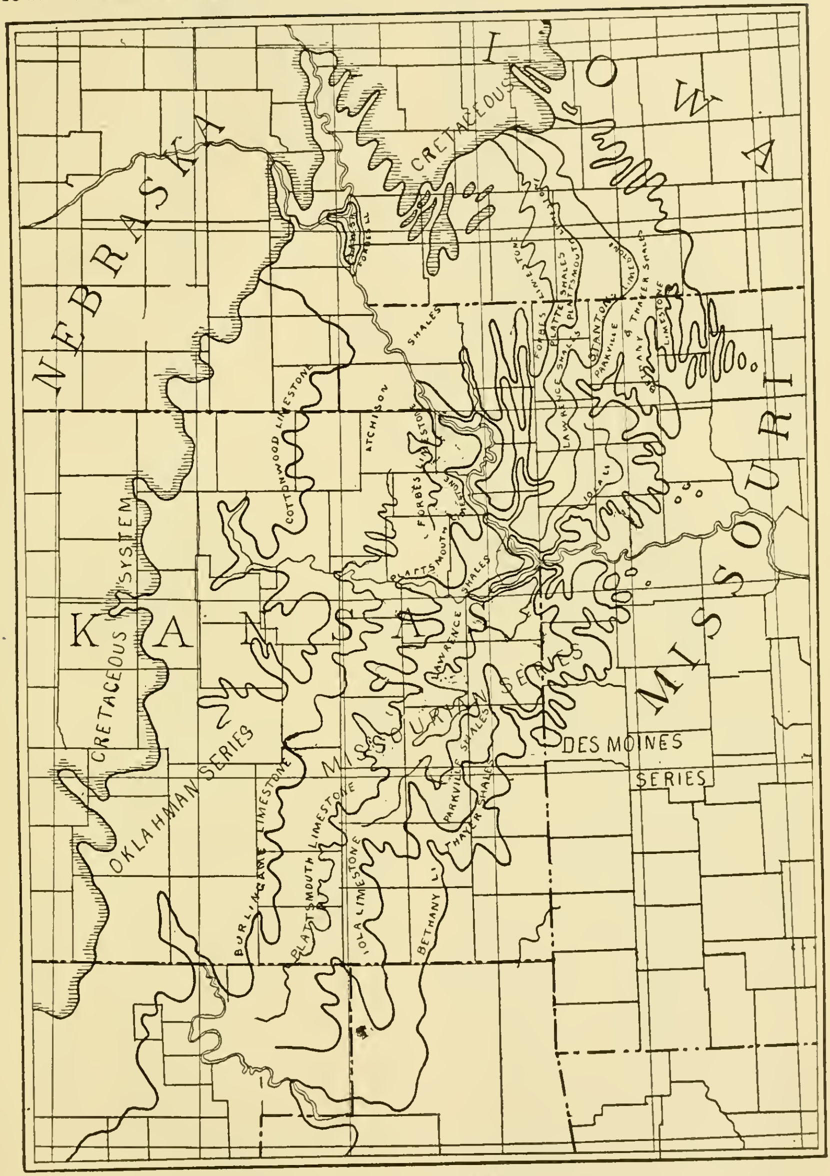
Winterset limestone, Bain and Tilton. (Iowa Geol. Sur., Vol. VII, p. 512, 1897.) Restricted to the uppermost of the three thin, heavy limestones of the Bethany formation, in central Iowa.

Wyckoff limestone, Haworth and Kirk. (Kansas Univ. Quart., Vol. II, p. 111, 1894.) A name used in connection with what is probably a part of the Oread or Plattsmouth limestones. Not defined.

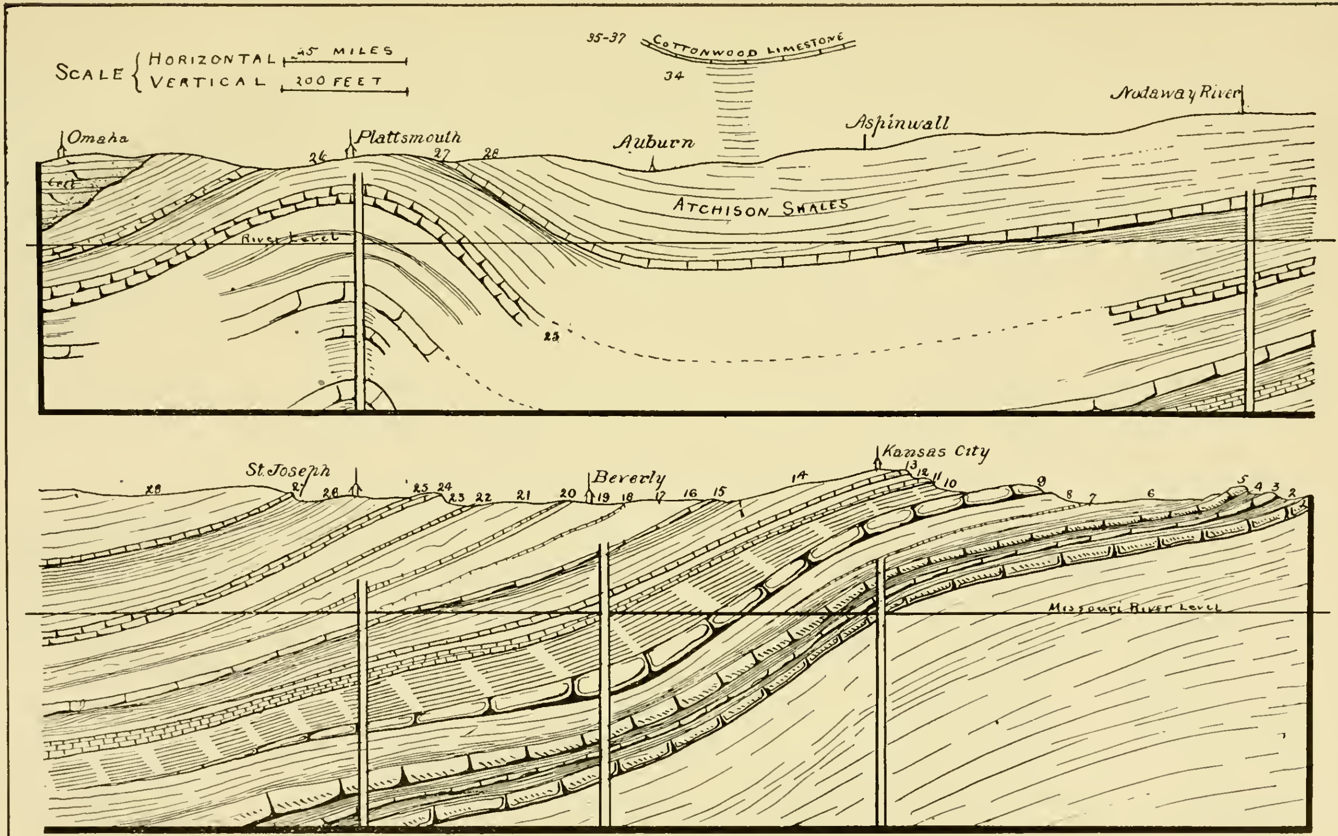
EXPLANATION OF PLATES.

PLATE VI.—*Terranes of the coal measures.* The approximate boundaries of the terranes of the coal measures in Iowa, Nebraska, Missouri and Kansas are indicated by the limestone margins. The courses in Kansas were traced chiefly by the geologists of that state. In Iowa and Missouri the geologists of those states have located the boundaries.

PLATE VII.—*General section of coal measures along the Missouri river.* Bethany limestone is represented by numbers 1 to 5; the Thayer shales by 6 to 8; Iola limestone by 9; Parkville shales, 10; Stanton limestone, 11 to 13; Lawrence shales, 14 to 23; Plattsmouth limestone, 24 to 25; Platte shales, 26; Forbes (Burlingame) limestone, 27; Atchison shales, 28 to 34; Cottonwood limestone, 35 to 37.



Terranes of the Coal Measures.



THE PRINCIPAL MISSOURIAN SECTION

TERRACES OF THE NILE VALLEY.

BY CHARLES R. KEYES.

(Abstract.)

Erosion forms in regions of very dry climates are always of great interest. The characteristic relief outlines are not only preserved much longer than in regions of abundant rainfall, but the types of different cycles or parts of cycles are not merged with one another. In other words, the sequence of events is read at a glance in the one district, while in the second it is made out only partially after long and laborious effort. The Great Basin is the best example in this country.

In the Nile valley, in lower Egypt, there is a similar group of conditions presented that we find in the Great Basin. The annual amount of rainfall is so scant (only about one inch) that the older European geologists who have visited the great delta and the valley opening out to the south have been unable to ascribe any of the hill terraces to the action of water. They have been pretty well agreed in considering the terraces as the result of faulting, though admitting that the terrace courses are remarkably sinuous and angular.

In some places the faces of the terraces do resemble fault-scarps. The appearance of some of these are shown in the accompanying photographs which represent the approach to the Mokattam hills, which form the high ground on the east side of the Nile, near Cairo. The photographs were obtained a few months ago while on a visit to the Nile country in company with Mr. Alexis Fry, of Boston, and Dr. Woodrow, of Columbia.

In the waddies, or deep ravines, running back from the main Nile escarpment the terraces are found to follow all the windings for several miles at least. Those of the several different levels are easily traced. Their concidence with the terraces of the main escarpment bordering the Nile precludes the idea of faulting as a satisfactory explanation of the terrace forms.

It is manifest in the waddies that torrent action is vigorous, though of course at irregular and long intervals. Moreover,

the presence of broad terraces at various elevations and other topographic forms indicate plainly the region has been one of recent oscillation and that the terraces mark stages in the cycles when for a considerable period little movement took place.

GENESIS OF NORMAL COMPOUND, AND NORMAL HORIZONTAL FAULTING.

BY CHARLES R. KEYES.

(Abstract)

In the mining districts of mountainous regions the ore-bearing belts are quite often coincident with fault planes. These planes are not usually clean-cut, single slipping surfaces, but consist of a number of gliding faces distinct from one another, sometimes branching, sometimes crossing at low angles, and contain in their immediate neighborhood more or less brecciated material. This compound character of what we are prone to pass over as single, simple dislocation, is found, after a little careful examination, to prevail in the majority of cases.

As the slipping commonly occurs in districts in which folding of strata has been more or less intense, it is not frequently taken for granted that the dislocation is of the nature of reverse faulting. This conclusion is apt to be reached when the detailed proofs are obscure, or not clearly made out.

In many cases, in regions in which the strata have been folded, normal faulting is known to be of frequent occurrence. The illustrations are numerous. The beautiful examples depicted by Spurr in his recent work on the Aspen mining district of Colorado are especially noteworthy as typical developments of the normal compound, or normal horizontal faults. Although not clearly shown in his diagrams, in other localities it is known that the origin of the phenomena is due to a comparatively sudden relaxation of the pressure, allowing the crest of a fold to settle somewhat. When the strata are gradually bowed upward, they do not fracture but flow, as it were, into position; but when the compressing forces are relieved suddenly the layers cannot respond in the same way. They are broken.

In the case of a strongly curved fold the pressure may be relieved locally by sliding along the bedding plains. In others the fault plane, instead of being almost vertical, may be nearly horizontal, which, in the near proximity to vertical faults, is apparently anomalous.

Both the normal compound and normal horizontal faults are readily reproduced experimentally. Two or three hundred sheets of paper are bent in the form of a pronounced fold, and clamped. The end of the fold is then covered with a colored paste, that becomes somewhat brittle when dry. When the clamps are slowly relieved the sheet of paste on the end indicates at once the movements of the strata of paper, and the directions and locations of the sudden movements and the production of the phenomena corresponding to the dislocations. On this transverse plate of paste the compound normal faulting and normal horizontal faulting is beautifully portrayed in miniature.

A STUDY OF THE CHEMICAL COMPOSITION OF SOME OF THE GRASSES OF THE STATE.

BY J. B. WEEMS.

One of the problems in connection with the work of the experiment station for the past two or three years has been an investigation of the native grasses of the state. The work has been carried on by the botanical and chemical sections of the station and the results which are presented here may be regarded as a part of this work. The analyses presented are of those grasses which have been most thoroughly investigated and are as follows: (1), Dactylis glomerata (orchard grass); (2), Muhlenbergia Mexicana (Mexican wood-grass); (3), Spartina cynosuroides (fresh water cord grass); (4), Poa pratensis (Kentucky blue grass).

The first of these to be considered is Dactylis glomerata or orchard grass. In the eastern states and the older settled countries this grass has been known for a long time and is considered one of the most valuable pasture grasses. The good properties of the grass consist in being an early and rapid grower and with strong resisting powers against drouth. If allowed to grow to extreme height it is said to become coarse and hard. The grass is widely distributed in the state but is grown very little for forage purposes.

The following analyses of orchard grass were made in the laboratory of this station:

Sample 1. April 24, 1896, 7 to 16 inches high.
Sample 2. May 4, 1896, 14 to 18 inches high.
Sample 3. May 18, 1896, sample very wet
Sample 4. May 26, 1896, 38 to 42 inches high.
Sample 5 June 5, 1896, 28 to 30 inches high.
Sample 6. June 17, 1896, 40 to 45 inches high.

NATURAL CONDITION.

	Water.	Fat.	Protein.	Albumenoids.	Crude fiber.	Ash.	Nitrogen free extract.
Sample 1	85.52	.77	4.38	(3.39)	3.38	2.23	3.77
Sample 2	84.54	1.02	3.15	(2 14)	4.15	1.93	5.21
Sample 3	83.25	.86	2.51	(2.31)	5.80	1.77	5.81
Sample 4	78.18	1.35	2.95	(2.42)	7.17	2.36	7.99
Sample 5	78.74	1.00	3.38	(2.33)	8.63	2.68	5.57
Sample 6	69 78	1 22	2.75	(2.55)	11.71	2.58	11 96

WATE FREE SUBSTANCE.

	Fat.	Protein.	Albumenoids.	Crude fiber.	Ash.	Nitrogen free extract.
Sample 1	5.36	30.25	(23.45)	23.01	15.38	26.00
Sample 2	6.62	20.37	(13.83)	26 88	12 46	33.67
Sample 3	5.09	15.01	(13.80)	34 59	10.59	34.72
Sample 4	6.20	13.50	(11.09)	32.85	10.84	36.61
Sample 5	4.72	15.91	(10.98)	40.60	12.62	26.15
Sample 6	4.04	9 11	(8.44)	38.76	8.54	39 55

From these results it is readily seen that there is a decrease in the amount of water present in the samples as the growth increases. In the water free substance we find that the fat varies in the sample from 6.62 per cent to 4.04 per cent. There is not a regular decrease in this constituent, but it is somewhat irregular. Regarding the amount of protein we might say that there is a regular decrease with one exception from 30.25 per cent to 9.11 per cent. With the crude fiber there is a tendency for the amount to increase as the plant grows older as we have in the first sample 23.01 per cent and in samples five and six 40.60 per cent and 38.76 per cent respectively, and the same may be said regarding the amount of nitrogen free extract, ncreasing from 26 per cent to 39.55 per cent, with one exception.

The following analyses of other states are added for comparison:

SAMPLE FROM—	Water.	Fat.	Protein.	Albumenoids.	Crude fiber.	Ash.	Nitrogen free extract.
U. S. Exp. Sta. Handbook (1)—Green fodder—in bloom	73.00	.90	2.60	.. ..	8.20	2.00	13.30
Iowa (2)—Cut June 9, just out of bloom	70.07	.71	2.31	......	10.15	3.00	13.76
Cut April 29	*78.14	6.27	21.46	. ....	16.92	13.22	42.13
Cut May 10	*75.58	6 36	18.50	......	19 76	12.27	43.11
Cut May 20	*72.43	4.62	12.34	......	21.75	10.23	51.06
Cut May 30	*71.90	2.65	9.19	......	29.48	10.00	48.68
Cut June 9	*70.07	2 36	7.71	......	33.90	10.02	46 01
Louisiana (3)	*12.82	3.70	7.82	....	28.35	10.75	36.56
North Carolina (4)	5.25	2.60	6.69	.. ..	38.43	5.90	41.43
North Dakota (5)	15.35	3.53	8.12	. ....	31.14	6.13	35.73
Oregon (6)	11.80	2 26	8.17	......	38.33	5.90	33.54
Storrs (Conn.) (7), 16 analyses	68.60	1.30	3.00	......	10.70	2.80	13.60
Utah (8), average of 3 analyses	14.82	2.62	3.52	......	30.01	7.93	50.66

1. U. S. Dept. of Agriculture, Handbook Experiment Sta. Work, p. 386, 1893.
2. Bull. Iowa Agricultural Experiment Station 11. pp. 453, 476.
3. Bull. La. Agricultural Experiment Station 19, 2d series.
4. Bull. N. C. Agricultural Experiment Station 900.
5. Bull. N. D. Experiment Station 15.
6. Bull. Oregon Agricultural Exp. Sta. 39, 1895.
7. Ann. Report Storrs Agrl. Exp. Sta., Conn. 9, p. 280, 1896.
8. Rept Experiment Station Utah, pp. 254-255, 1893.

Muhlenbergia Mexicana (Mexican wood-grass) is a grass which is said to be common in the state.

Seven samples of Muhlenbergia Mexicana were analyzed in the laboratory and the results are given below:

Sample 1. Collected April 29, 1896, height 4 to 12 inches.
Sample 2. Collected May 14, 1896, height 20 to 23 inches.
Sample 3. Collected May 28, 1896, height 26 to 29 inches.
Sample 4. Collected June 8, 1896, height 36 to 38 inches.
Sample 5. Collected June 18, 1896, height 38 to 39 inches.
Sample 6. Collected June 29, 1896, height 39 to 40 inches.
Sample 7. Collected July 20, 1896, height 48 to 49 inches.

NATURAL CONDITION.

	Water.	Fat.	Protein.	Albuminoid.	Fiber.	Ash.	Nitrogen free extract.
Sample 1	84 82	.88	3 51	(2.73)	3.70	2.04	5.05
Sample 2	73.28	1.21	5.12	(3.78)	7.72	2.77	9.90
Sample 3	82.95	.54	2.86	(1.96)	6 43	1.95	5.27
Sample 4	77.46	.79	2.41	(2.14)	8.10	2.08	9.16
Sample 5	73.37	.81	3.13	(2.10)	9.01	2.57	12.11
Sample 6	58.77	1.49	3.22	(2.60)	13.32	2.64	20.56
Sample 7	81.98	.53	1.48	(1.09)	5.82	1.10	9.09

*Per cents given are all for air-dry material except per cent of water.

WATER FREE SUBSTANCE.

Sample 1	5.81	23.16	(17.99)	24.36	13.41	33.26
Sample 2	4.52	19.17	(14.17)	28.90	10.38	37.03
Sample 3	3.14	16 77	(11.46)	37.72	11.43	30.94
Sample 4	3.49	10.70	(9.52)	35.94	9.27	40.60
Sample 5	3.03	8.00	(7.88)	33.83	9.67	45.47
Sample 6	3.62	7.81	(6.30)	32.31	6.40	49.86
Sample 7	2.95	8.26	(6 11)	32.48	6.16	50.15

In the above results we find that the amount of water present varies from 84.82 per cent to 58.77 per cent, while it might be said that the amount tends to become less as the plant matures, yet there are exceptions, as it will be seen that the first sample collected in April having a height of four to twelve inches has only 2.84 per cent more of water than the sample taken on July 20th and having a height of forty-eight to forty-nine inches.

In considering the water free substance we find that the fat present varies from 5.81 per cent to 2.95 per cent, and that the change is not a constant one. The change in the amount of protein is constant for the first six samples and changes from 23.16 per cent to 7.81 per cent and in the seventh sample having this substance to the amount of 8.26 per cent; however, in the results for albuminoids we find that the decrease of this substance is constant, changing from 17.99 per cent to 6.11 per cent. The amount of fiber varies irregularly from 24.36 per cent in the youngest sample to 37.72 per cent in the third sample of May 28th. The ash constituent decreases with a regular change, while the nitrogen free extract increases constantly with one exception from 33.26 per cent to 50.15 per cent, the exception being the third sample with 30.94 per cent. The following analyses are added for comparison:

AIR DRY SUBSTANCE.

	Water.	Ash.	Fat.	Fiber.	Protein.	Nitrogen free extract.	Albuminoids.
South Dakota* Col. September 1, 1892	7 31	9.67	2.49	27.96	13.05	39.52	8.44
Tennessee† not yet in bloom	‡10.65	7.04	2 32	29.61	8.00	42.38	.....

WATER FREE SUBSTANCE.

South Dakota Col. September 1, 1892	10.43	2.69	30.17	14.08	42.64	9.06
Tennessee not yet in bloom	7.87	2.59	33 14	8.96	47.44	.....

* S. D. Bull. Agricultural Experiment Station 40, p. 64.

† Bull. Tenn. Agricultural Experiment Station, Vol. IX, No. 3, p. 90.

‡ Hay of grass.

Spartina cynosuroides, fresh water cord grass, grows from two to nine feet high and in this state is known by the name of slough grass, on account of occurring in low grounds. It is cut for hay along the Missouri and Mississippi rivers and is regarded very highly by many on account of the large growth produced by the grass, although it is not as valuable as some of the wild grasses.

The chemical composition of Spartina cynosuroides may be shown by the following analyses made in the laboratory:

Sample 1. Collected April 23, 1896, 6 inches to 1 foot high.
Sample 2. Collected May 7, 1896, 16 to 24 inches high.
Sample 3. Collected May 20, 1896, 36 to 38 inches high.
Sample 4. Collected June 1, 1896, 46 to 48 inches high.
Sample 5. Collected June 10, 1896, 50 to 56 inches high.
Sample 6. Collected June 20, 1896, 53 to 55 inches high.
Sample 7. Collected July 20, 1896, 62 to 63 inches high.

NATURAL CONDITION.

	Water.	Fat.	Protein.	Albuminoid.	Fiber.	Ash.	Nitrogen free extract.
Sample 1	71.81	1.49	4.33	(2.66)	9.19	1.89	11 29
Sample 2	69.84	.70	3.90	(3.07)	10.06	2.20	13.80
Sample 3	67.84	.70	3.74	(2.52)	11.66	2.06	14.00
Sample 4	63.32	.54	4.13	(2.90)	14.03	2.46	15.52
Sample 5	59.13	1.14	3.05	(2.10)	16.02	2.00	18.66
Sample 6	61.02	.89	2.15	(1.81)	15.44	2.07	18.43
Sample 7	56.74	1.21	3.15	(2.35)	17.19	2.87	18.84

WATER FREE SUBSTANCE.

	Fat.	Protein.	Albuminoid.	Fiber.	Ash.	Nitrogen free extract.
Sample 1	5.30	15.34	(9.42)	32.61	6 71	40.02
Sample 2	2.32	12.92	(10.17)	33.38	7.29	44.09
Sample 3	2.18	11.61	(7.84)	36.24	6 40	43.54
Sample 4	1.46	11.27	(7.92)	38.24	6.70	42.33
Sample 5	2.79	7.57	(4.24)	39.21	4.90	45.53
Sample 6	2.27	5.52	(4.66)	39.62	5.32	47.17
Sample 7	2.79	7.29	(5 44)	39.73	6.62	43.57

It will be noticed that the above results show that the water content decreases gradually, with one exception, as the grass matures. The fat in the water free substance is largest in the youngest sample and varies in the others. The percentage of protein gradually decreases from 15.34 per cent to 5.52 per cent in the first six samples and then we find 7.29 per cent in the last sample. In the albuminoids we find that the amounts are not constant in their changes, the second sample having 10.17 per cent and the fifth sample 4.24 per cent. In the fiber there is a constant increase as the plant becomes matured. The nitrogen free extract increases from 40.02 per cent in the young grass from six inches to one foot high, and increases to 47.17 per cent in the grass fifty-three to fifty-five inches high. The amount of ash varies from 6.71 per cent to 4.90 per cent and the changes are very irregular. The following analyses are added for comparison.

NATURAL CONDITION.

	Water.	Fat.	Protein.	Albuminoid.	Fiber.	Ash.	Nitrogen free extract.
Iowa,* cut Aug. 27th in full bloom, height sixty inches	53.53	.63	2.57	(2.27)	16.39	2.17	24.71
Cut June 1st, no head, sixty inches	‡65.36	1.63	8.41	(6.75)	38.32	6.75	44.89
Cut August 27th	‡53.53	1.35	5.53	(4.89)	35.27	4.66	53.19
South Dakota†, July 10, 1891	§6.45	1.21	5.29	....	38.51	4.07	50.91

The other grass selected for presentation is Poa pratensis, or Kentucky blue grass. This grass is considered one of the best pasture grasses in the state, and it is said that the excellence of the Iowa stock is due largely to the pastures of this grass.

The samples analyzed in this station are given in the following table:

Sample 1. April 14, 1896, young, 1 to 4 inches high.
Sample 2. April 29, 1896, 3 to 10 inches high.
Sample 3. May 6, 1896, beginning to head out, 14 to 15 inches high.
Sample 4. May 18, 1896, very wet, headed, 14 to 15 inches high.
Sample 5. June 1, 1896, 31 to 32 inches high.

NATURAL CONDITION.

	Water.	Fat.	Protein.	Albuminoids.	Crude fiber.	Ash.	Nitrogen free extract.
Sample 1	77.78	1.36	8 66	(6.00)	3.61	2.91	5.68
Sample 2	78.96	1.03	4.42	(3.78)	5.22	3.06	7.31
Sample 3	76.18	1.04	4.79	(3.59)	5.49	2.65	9.85
Sample 4	78.50	.97	3.26	(3.14)	6.66	2.54	8 07
Sample 5	73.46	2.10	3.84	(2.35)	8.74	3.05	8 81

* Bull. Iowa Agricultural Experiment Station 11, pp. 456, 478.

† Bull. S. D. Agricultural Experiment Station 40, p. 94, 1894.

‡ These give the water which is found in the natural condition while the other percentages of these analyses are for the water free substance.

§ The amount of water is for the air dried substance while the other results are for water free substance.

WATER FREE SUBSTANCE.

Sample 1	6.13	38.98	(26.99)	16.23	13.10	25.56
Sample 2	4.90	21.02	(17.95)	24.71	14.53	34.84
Sample 3	4.25	20.11	(15.07)	23.06	11.11	41.47
Sample 4	4.51	15.18	(14.58)	30 96	11.80	37.55
Sample 5	7.91	14.46	(8.83)	32 92	11.48	33.23

In the above results we find that the amount of water present in the grass as received in the laboratory is very constant, the highest being 78.96 per cent and the lowest 73.46 per cent, a difference of only 5.5 per cent for a period of six weeks. In the comparison of the results of the analyses based on the water free substance in the fat content we find that the amount decreases comparatively little as the grass matures. However, with the amount of protein present there is a marked decrease from 38.98 per cent to 14.46 per cent and in the albuminoids from 26.99 per cent to 8.83 per cent. The crude fiber increases on the contrary from 16.23 per cent to 32.92 per cent. The amount of nitrogen free extract present varies greatly. There is no constant increase but it varies from 25.56 per cent to 41.47 per cent.

The constituents of an inorganic nature of ash remain quite constant. The following analyses have been selected for comparison with the work of this laboratory:

	Water.	Fat.	Protein.	Crude fiber.	Ash.	Nitrogen free extract
U. S. Exp. Sta. Rec. (1)—						
Aug. of 4 samples	....	4.38	13.07	30.05	8.48	42.02
Northern grown	... ...	3.60	10.50	26.10	7.90	51.90
Iowa (2)—						
Cut April 28th (3-6 in. high)	....	5.55	18.03	22.19	11.49	42.74
Cut May 8th (8 in. high)	... ...	4.14	13.58	22.74	10.67	48 87
Cut May 18th (panicle spreading)	....	3 89	11.11	24.36	8.75	51.89
Cut May 28th (early bloom)	....	2.25	9 67	29.11	8.47	50.50
Cut June 7th (after bloom)	....	2.75	7.88	29.92	8.66	51.79
Cut July 5th, in seed; brown	....	3.05	7.89	30.55	9.98	48.53
Aug. of 3 analyses before blooming	. .	4.53	14.24	23.09	10.30	47.83
Louisiana (3)	*12.15	3.35	8.00	23.56	10.16	42.78
Mississippi (4)—						
Gathered March	....	4.38	21.79	24.75	12.00	37.08
Gathered April	....	4.13	9.04	34.64	5 34	46.85
Gathered May, just headed	....	4.90	13.25	30.71	9.12	42.02
Gathered June, over-ripe	... .	4.13	8.21	30.12	7.45	50 09
North Dakota (5)	*15.35	3.03	6.53	27.29	4.16	43.64
Oregon (6)	*65 10	1.30	4.10	9.10	2 80	17.60

1. U. S. Dept. Agricultural Experiment Station Record VI, No. 2, p. 102, 1894.
2. Bull. Iowa Experiment Station 11, pp. 432, 434.
3. Bull. La. Agricultural Experiment Station 19, 2d series, pp. 536, 562.
4. Ann. Report Agricultural Experiment Station Miss. 8, p. 92, 1895.
5. Bull. Agricultural Experiment Station North Dakota, 15, 1894.
6. Bull. Oregon Agricultural Experiment Station 39, 1895.

* Analyses are for natural or air-dry condition; others are for water free substances

The results from the study of the grasses presented readily show that the chemical composition of a grass varies within wide limits, and that a knowledge of the composition of any grass can be made of great value in determining the time which is best adapted for cutting, for making hay, or for general feeding purposes.

A CHEMICAL STUDY OF BUTTER INCREASERS.

BY J. B. WEEMS AND F. W. BOUSKA.

In connection with the investigations in the chemical laboratory of the experiment station of problems connected with the amount of water present in butter, analyses were made of two samples of butter which appeared to contain a very large amount of water. The water present was apparently in large proportions and this condition gave a reason for the request for the analyses. In the attempt to mix the product in order to get an average sample it was found that the water readily separated from the other constitutents, and on analysis of the product the following results were obtained:

SAMPLE 1.	PER CENT.
Water	59.61
Fat	21.31
Casein	11.72
Ash	*7.36

SAMPLE 2.	PER CENT.
Water	42.76
Fat	44.92
Casein	5.10
Ash	†7.22

The above results were from samples of a product which has been sent to a commission firm with the object of selling it as butter. The large amount of water present with casein, etc., would naturally cause one to conclude that use was made of the so-called butter increasers in producing this product. It was a matter of interest in this connection to investigate some of these methods advertised in the past few years for the purpose of producing an abnormal amount of butter from cream and milk. In this relation it may be of interest to

* In sample one there was 6.48 per cent of salt in the ash.

† In sample two there was 6.60 per cent of salt in the ash.

present the following claims and representations made by the individuals who pose as benefactors of the butter-maker and dairyman.

In answer to a letter of inquiry regarding the process as advertised, the following circular was received:

DEAR SIR—In reply to your favor of the 14th inst. I would say this butter-making process of mine is the result of twenty-five years' experience in the dairy business, and is genuine, simple and a fact. It is a process in which no chemicals or any foreign substances are used. The process produces pure, sweet butter, that keeps sweet and pure longer than butter made by any other process. This process requires less labor than the old fashioned way of butter-making. Now to show the money profit over the old way of butter-making, I will illustrate. You take a gallon of cream and churn a few pounds of butter. I will take a gallon of the same cream and by this process produce over 100 per cent more butter than you do, and at no more cost. I save by the process what you throw away. It is a wonderful process; yet very simple. Now, if you have a large quantity of cream to be churned you can use a nice clean tub, instead of a churn, and use a paddle to stir it with instead of a churn dasher. Butter made by this process will stand most rigid inspection by an expert and brings the highest market price. I have made the price low and reasonable because it is a very valuable receipt to know, and worth many times the price to any butter-maker, and you will say so if you buy it. There is no extra machinery, no extra cost—less labor and over 100 per cent profit over any other process known to man. The instructions are simple and complete, and can not fail if followed faithfully.

TERMS.—Price $5. Sent by postoffice or express money order.

The process for making the product which is called butter in the above circular is as follows:

Skim half the cream to be churned off of milk that is sour just before it clabbers, the other half sweet cream, *i. e.*, half sour and half sweet cream. Mix well in churn. Now add one pound of nice sweet butter to each pint of cream to be churned and have the butter put in cream broken into pieces. Mix well together. Have cream and butter heated to 70° temperature. Take off the churn lid, add one tablespoonful of salt to each pint of the cream to be churned. Now leave off the lid of the churn altogether. Do not use the lid at all! Churn rapidly from thirty (30) to fifty (50) minutes, until it is solid throughout. Of course butter commences to churn at 66° of heat, but I think it is best to commence at 70°, as it loses a little heat, especially in the cool and winter weather. Cream always foams when it is cold and of course it will not form butter in such a condition. You should buy yourself a nice 25-cent thermometer to test the cream and you will never fail to be right.

N. B. The butter you put into the cream determines the flavor and quality of the whole churning, so use the best butter always.

From an analysis of the product produced by this process the following results were obtained:

	PER CENT.
Water	41.54
Fat	53.04
Casein	2.96
Ash (salt)	2.46

The flavor of this substance was good but grain and body were lacking and as the amount of water present was so excessive the "butter" would not "stand up."

Another process which has been advertised has the following constituents:

RECIPE.

Alumnae pot. sul	4 ounces
Gum acacie pure	1 ounce
Milk, sugar, sact. lact	2 ounces, 2 drachms
Pure pepsin	5 grains

Compound and mix well.

Use one teaspoonful compound to one pint of milk.

DIRECTIONS FOR USING THE GEM BUTTER COMPOUND.

Take one pound of dairy butter and one pint of sweet unskimmed milk. Warm the butter until soft, but not melted. Warm the milk until about bloodwarm; don't scald it. Add salt and butter color as desired.

Put the whole into a churn and begin to churn at once. Churn until the butter is made, but no longer. The butter will be soft. Take out of churn and put in a suitable dish; let it get cool but not hard. Then press into moulds, tubs or any shape desired. Use some blunt wooden instrument in shaping the butter and work just enough to give desired shape.

The amount of salt and butter color to use will vary, but about a teaspoonful of salt and twelve drops of the butter color will be about right. The butter will be as good without the butter color but will not look as well. Larger or smaller quantities can be made in the above proportions. In making lots of one pound or less, the same result will be attained by using any common household dish and an egg beater or spoon.

If the above directions are followed carefully the result will be about two pounds of good wholesome butter.

An analysis of the product produced by this process gave results as follows:

	PER CENT.
Water	49.64
Fat	41.46
Casein	5.06
Ash	3.84

These results readily show that this so-called butter is a product containing practically one-half water, and while there is no doubt that one can readily detect this amount of water in butter, yet on the other hand there are individuals who will not hesitate to make use of such processes for the adulteration of butter.

Almost any person using butter can easily be imposed upon with such a product. These facts naturally cause one to realize the possibilities of adulteration of butter in other ways besides the addition of fats which are not butter fats, and force us to the conclusion that our states should have laws preventing the excessive amount of water in butter, as well as adulteration by other means.

NATIVE CRAB APPLES AND THEIR CULTIVATED VARIETIES.

JOHN CRAIG AND H. HAROLD HUME.

Indigenous to North America there are several species of Pyrus belong to the Malus or apple group. Sargent, in his Silva of North America, gives three species and one variety. These are P. rivularis Doug., found west of the Rocky mountains from northern California to Alaska; P. angustifolia Ait., ranging from Pennsylvania to Tennessee and Florida; P. coronaria L., in the region from New York to Michigan, southward and westward to Missouri and Kansas; P. coronaria var. Iowensis, Wood, confined to the prairie states. In the American Garden, XII, 473, 1891, Professor Bailey raised var. Iowensis to specific rank, basing his decision upon fruit and leaf characteristics, and in the same article described the Soulard crab as a species. Later, however, he expressed it as his opinion that the latter is a hybrid, so according to the present classification, we have the four species, P. rivularis, P. angustifolia, P. coronaria, and P. Iowensis.

These four are generally looked upon as good species. Centuries of in and in-breeding and adaptation to environments have for the most part stamped their work upon their forms and characteristics, though on the borders of their geographical limits they doubtless blend into one another. Some writers have wondered that hybrids have not more commonly occurred between these species and the common apple. There are many things to be considered; the time of flowering, the adaptability of sexual elements, etc., and again, it is a well known fact in the breeding of animals an old and fixed type is hard to break up; that those having behind them centuries of unbroken strains of pure blood are hard to modify. So, too, in the vegetable world, and in the case of crosses between the unvarying native crab and the varying Pyrus malus, the chances are altogether in favor of the crab's stamping its characteristics upon the offspring. P. Iowensis is an extremely variable species and so far as known it is only with it that natural cross-fertilization has taken place in America. The laws of correlation, of atavism, of prepotency, all the uncertainties of heredity have yet to be explained in relation to the vegetable kingdom, and until that is done, artificial hybridization will be but a haphazard piece of work. More attention must be given to the individual.

PYRUS FUSCA RAFIN.

Pyrus fusca Rafin. Med. Fl. 11: 254: 1828–1830.

Pyrus rivularis Dougl. in Hook. Fl. Bor. Am. 1: 213t. 68. America South. 1833.

Pyrus diversifolia Bongerd. Mem. Acad. Petersb. Ser. VI. 11: 133, 1833.

Pyrus subcordata. Ledeb. Fl. Ross. 11: 95. 1844–46.

Sometimes occurring as a shrub, usually a tree thirty to forty feet in height, bark one-fourth of an inch thick, having the surface broken into large, thin, loose, light brown scales; leaves ovate to ovate-lanceolate, acute or acuminate at the apex, pointed or rounded at the base, finely and sharply serrate, often obscurely and occasionally distinctly three-lobed; mature leaves thick, firm, dark green, glabrous, or slightly pubescent above, pubescent below, one inch to four inches long, one-half inch to one and three-fourth inches wide, borne on rigid slightly grooved petioles one-half inch to one and one-half inches long. The young leaves are covered both above and below with long white tomentum. The flowers which are borne in many flowered cymes are one-half inch in diameter, calyx, densely tomentose on both inner and outer surfaces, dropping before the fruit matures, in which respect it resembles P. baccata. Petals orbicular, undulately margined, remotely inserted; ovary three-celled, pedicel, slender, terete, one and one-half inches to two inches long; the fruit "oblate-oblong" one-half inch to three-fourths inch in length, greenish-yellow or reddish when ripe; flesh dry, acid to the taste. Description made from specimens received from A. H. Aiken, Doe Bay, Washington.

Figure 3. P. fusca Rafin. *a*—longitudinal section. *b*—cross section.

PYRUS ANGUSTIFOLIA AITON.

Pyrus angustifolia Art. Hort. Kew ed. 1. 11: 176 America. 1789.

Pyrus coronaria Wangend. Nord. Am. Holzart 61. t. 21. f. 47. 1787.

Pyrus sempervirens Willd. Enum. Hort. Berol. Suppl. 35. 1813.

A tree about twenty-five feet in height, stem six to eight inches in diameter; bark thin, scales small, dark brown; branchlets at first sparingly pubescent, brown, becoming lead-colored; leaves lanceolate oblong to narrow oval, apex acute or slightly rounded; base acute or oblique, upper surface smooth, dark green and shining, lighter and smooth below, one and one-half inches to three inches long, one-half inch to one and one-half inches wide; young leaves at first pubescent or slightly tomentose, more so on the lower side; borne on rather slender pedicels one-half inch to one and one-half inches long. Flowers one inch across, borne in umbels of four to eight; calyx lobes tomentose within, smooth without or nearly so; petals inserted remote obovate or rounded, undulate or approaching serrate; pedicels slender or slightly tomentose, three-fourths inch to one and one-half inches long (Suwanee river, Columbia Co., Fla., May 13, 1900); fruit depressed globose or sometimes slightly pyriform, and is from three-quarters of an inch to an inch in diameter, pale yellow green, and very fragrant when fully ripe, with hard acid flesh. (Sargent, North Am. Silva IV: 76.)

PYRUS CORONARIA L.

Pyrus coronaria Linn, Sp pl. 480. Am. Bor. 1753.
Pyrus suaveolens Winder. in Linnaea. v. Litt. 55. 1830.

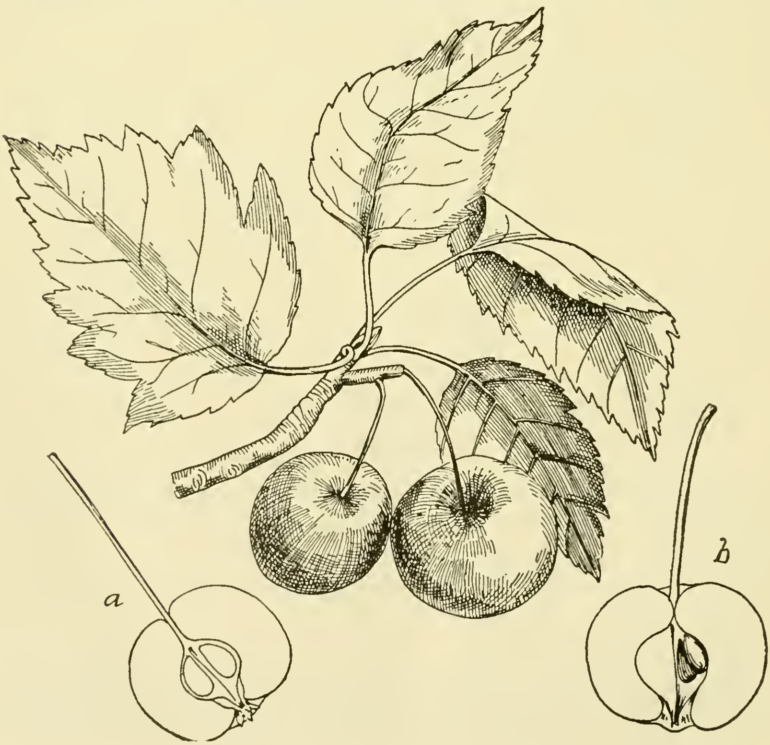


Figure 4. P. coronaria L. (Reduced ⅓.)

Varies from a shrub-like tree, to a tree upward of twenty feet in height; bark one-fourth inch thick, obliquely or longitudinally fissured, the outer layer separating in long brownish-red scales; bark of the younger branches smooth, thin, grayish-brown, lenticles small, scattered; the branchlets at first densely coated with fine white tomentum, which, however, soon disappears; mature leaves ovate or triangular, sometimes distinctly three-lobed, sharply serrate, acute at the apex or occasionally rather blunt; base truncate to subcordate, glabrous above and slightly puberulent or glabrous below; one and one-half to three and one-half inches long, three-fourths to two inches wide; borne on short, slender petioles, one-half to one and one-half inches long; young leaves are bronze in color, tomentose on both surfaces; spines thick, stout, blunt; one-half to two inches long, formed from aborted or unproductive fruit spurs. Flowers appearing after the leaves, borne in bunches of from four to six, on slender, terete pedicels three-fourths to one and one-half inches long, and measuring one to one and one-half inches in diameter when opened fully; petals, inserted remote, ovate, crenately serrate or undulate at the base, and somewhat dentate toward the claw; calyx sparsely without, and densely tomentose within; fruit, five-eighths to one and one-sixteenth inches; form oblate or roundish oblate, color not as deep yellowish-green as *Iowensis*; skin thin, smooth, greasy, specks large and fewer than in *Iowensis*, cavity shallow and irregular with occasional protuberances, lined with heavy tomentum, stem three-fourths to one and three-eighths inches; slender throughout, glandular,

Figure 5. P. Coronaria, from Michigan.

basin irregularly corrugated, sometimes marking core divisions, lined with tomentum; calyx prominent, closed; flesh hard, moderately juicy; flavor acid, markedly astringent, slightly bitter; texture breaking; core small, separating easily from flesh; seed smaller than *Iowensis*, season, winter. In character of seed it closely resembles *Iowensis*. The character of flesh is rather more astringent than *Iowensis*, with a little more juice. Description made from specimens received from Dr. Murrell, Ithaca, N. Y.

PYRUS IOWENSIS BAILEY.

Pyrus coronaria var. *Iowensis Wood*, Class-book. 333. 1860.
Pyrus Iowensis Bailey. Am. Gard. 12:473. 1891.

A small tree, three to eight inches in diameter, ten to twenty-five feet in height, growing singly or in thickets; when growing singly a spreading tree branched to the ground, when growing in thickets it is more slender, taller and not branched down as when growing singly; bark one-fourth of an inch thick, the outer layer fissured, longitudinally or obliquely, into long, narrow, loose, brownish scales; the branchlets are grayish or brownish in color and quite stout, so differing from those of *coronaria* which are quite slender; young twigs densely covered with white tomentum, which persists toward the tips until the following year; mature leaves, thick, firm, ovate, ovate lanceolate to ovate oblong and triangular-ovate, apex obtuse or acute, base acute, roundedor oblique, margin coarsely and bluntly toothed, often deeply cut in young growth and frequently toothed at right angles to the mid-rib, glabrous above, densely white tomentose below, one to five inches long, one-half to two and one-half inches wide and borne on stout terete slightly grooved, densely tomentose petioles, one-half to two inches long; young leaves thickly covered with tomentum.

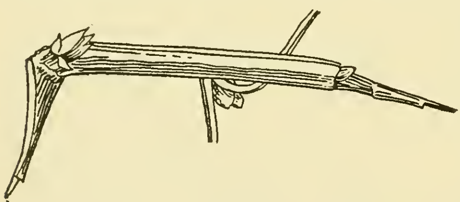


Figure 6. Fruit spur and spine. P. Iowensis.

Exceedingly variable in all leaf characters, differing from *coronaria* in being usually acute at the base, which is scarcely ever or never found in *coronaria*, tomentose beneath, thicker in texture, bluntly toothed and borne on decidedly stouter petioles. The flowers differ little from those of *coronaria* except that the pedicels are much stouter, tomentose, and the calyx is densely tomentose on the outside.

Fruit collected and described at Ames, Iowa. Size variable, large type one and three-eighths inches by one and three-eighths inches or one and one-half inches, small type five-eighths of an inch by seven-eighths of an inch; form exceedingly variable, spherical-pyriform, spherical to oval, usually markedly truncate at calyx end; color green, turning to a light yellow, sometimes slightly flushed on sunny side; skin slightly roughened, greasy, thickly dotted with small gray spots; cavity most constant character of all, small, narrow, shallow, stem three-eighths of an inch to one and one-eighth of an inch, slender, thickened at base and extremely tomentose; basin, well marked corrugations, sometimes deep and broad, sometimes scarcely concave, lined with dense tomentum; calyx prominent, closed; flesh greenish-white, hard, brittle; flavor sharp, astringent, acid; texture fine grain but fibrous; core rather large, clearly separated from flesh; seed plump, dark, or light brown; with or without a slight beak, oval in outline, flat on side of contact; season winter. General notes: Fruit

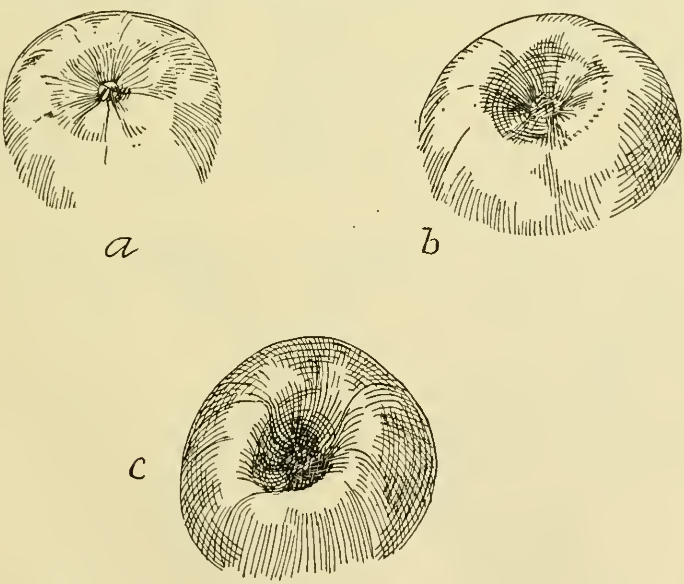


Fig. 7. Fruit of P. Iowensis, showing variation in form of basin. *a*, shallow; *b*, medium; *c*, broad, deep.

shows remarkable variations in form but the character of the flesh and seed cavities seem to be constant throughout.

The fruit inclines more toward an oblong shape than does that of *coronaria* which is quite compressed from cavity to basin, both species very fragrant.

HYBRIDS—SOULARD CRAB.

Pyrus Soulardi Bailey. Am. Gard. **12**:473. 1891.

P. Iowensis x *P. Malus.* Bailey. Ev. Nat. Fr: 189. *pl 11.* 1898.

A tree upwards of thirty-five feet in height with wide spreading top; trunk six inches to fourteen inches in diameter; bark dark, rough, differing in the nature of its scales from that of the wild crab (*Iowensis*), the outer layer breaking into short, longitudinal scaly ridges; the older branches smooth, a dark grayish-brown in color, the one-year-old twigs covered with a dense grayish-brown tomentum like those of the common apple. Mature leaves, broadly oval or approaching oblong, margin irregularly grossly serrate, sometimes deeply cut. A very common peculiarity in the margin is to find one side regularly serrate like those of the common apple while the other side is almost lobed. Base rounded or oblique, apex obtuse or rounded, the upper surface wrinkled, rugose in appearance owing to the depression of the veins, dark green, lighter and densely tomentose below; leaves borne on stout wooly petioles one-fourth inch to one inch long; young leaves thickly tomentose. The flowers are borne in clusters like those of the common apple, pinkish-white in color, rather smaller than those of P. *Iowensis*, one inch to one and one-fourth inches in diameter.

Regarding its botanical relationship, there has been a great diversity of opinion. It has been held to be a variation of P. coronaria, a hybrid of P. *Iowensis*, and a distinct species. Sargent, in his Silva of North America, inclines to the first view. Soulard, took it to be a hybrid. He said, "It is to me conclusive that this crab is the offspring of an accidental hybridization of the wild crab by our common apple." Professor Bailey in the August number of the American Garden, 1891, described it as *Pyrus soulardi, n. sp.* In his "Evolution of Our Native Fruits," however, he says, "I now confess to a belief that *P. soulardi* is not a true species but a hybrid between *Pyrus iowensis* and the common apple, *Pyrus malus.* The chief considerations which led me to this conclusion are the facts that the plant, in a wild state seems to have no connected or normal range, and that various specimens which I have had an oppor-

P. Iowensis, showing variation of fruit and foliage.

tunity to examine during the past few years have shown almost complete gradations from one of those species to the other. I cannot now define *Pyrus soulardi* by any characters which are not also common to one or both of the other species, *Pyrus Iowensis* or *P. malus.*"

After a critical study of flower, leaf, fruit and general characteristics of the Soulard crab, we agree with Professor Bailey's later opinion.

In the fruit of the Soulard there is a very decided lessening of normal seed reproduction. For instance twenty well developed apples selected at random from a tree gave an average of only three seeds to the apple. The leaves also show intermediateness of character. It is totally different from *P Iowensis* in the character of fruit spurs; the thorny aborted spurs of *P. Iowensis* are not present, while the characters of *P. malus* are quite noticeable. The Soulard is a remarkably vigorous tree, one specimen on the college grounds measuring fourteen inches in diameter close to the base, is thirty-five feet in height and forty feet in spread of branches. It bears freely every year.

The Soulard crab, according to Hon. James Soulard, of Galena, Ill., originated on a farm about twelve miles from St. Louis, Mo., where stood an American crab thicket, not enclosed, near a farm house, about 1844. The thicket was cut down, and the ground cultivated. Later, cultivation was discontinued, and a second thicket sprang up in which this crab was found. (Synopsized from a letter dated, Galena, February 13, 1869, written by James G. Soulard, and presented before the State Horticultural Society of Illinois, held at Bunker Hill, December 15–18, 1869.) The crab was propagated and disseminated by Mr. Soulard.

Its fruit has been looked upon as good, bad and indifferent, some claiming for it most excellent qualities, others relegating it to the same category of bitterness, sourness and uselessness as the common crab.

Mr. James G. Soulard says of it: "I consider it the most desirable of all crabs that I have seen. Adding sweetness, it is delicious baked. It makes excellent preserves, being large enough to be quartered, and unsurpassed by any crab for jams, jellies, etc., imparting its delicate taste and rich crab aroma. I have made some cider as clear as wine, with sugar, or a quarter part of sweet apples."

Professor Budd, in "Rural Life," speaks of it as follows: "The only value of the Soulard crab, known to the writer, is for mixing sparingly with good cooking apples for sauce, to which it imparts a marked quince flavor, which most persons like. It is also said to make a jelly superior to that of the Siberian crabs."

D. B. Wier, a fruit grower of Illinois, says: "The fruit, like the type generally, is very fragrant, and cooked with plenty of sugar, it makes a most delicious preserve or sweetmeat, highly prized by the pioneer housewife."

J. S. Harris, La Crescent, Minn., gives these notes on it: "The fruit is used, to some extent, in our western cities as a substitute for the quince for preserves, and mixing with better fruit, to which it imparts its aroma, but it never has had a 'boom,' and hence the demand for the fruit is limited, and its commercial value not great."

The "Farmer's Union," of Minneapolis, published in 1873 the following: "The Soulard crab, of all other crabs, is the most valuable. It cannot be used as an eating apple. It is bitter, worse than a quince, but for preserves it is quite equal, if not superior, to the quince. We consider it to-day the most valuable fruit grown in the northwest."

HOWARD (HAMILTON.)

Branchlets, one year old, brown in color, slightly tomentose; lenticels small, few; older bark, brownish-gray. Mature leaves oval, apex acute; base acute or oblique, margin grossly and sharply serrate or finely and bluntly, with several serrations larger than the rest, veins very prominent, brownish in color, leaves smooth, rugose above, slightly tomentose below; one and one-half to three and one-half inches long, one-half to two inches wide, borne rather stout, rigid, slightly tomentose, petioles three-fourths to one and one-half inches long.

The young leaves are densely white tomentose above and below. The flowers have not been examined. The stems of the young fruit are quite stout, three-fourths to one and one-half inches long, and together with ovary and calyx are densely white tomentose. A striking peculiarity is noticed in the greatly elongated fruit spurs. Spines are absent. Fruit received from E. L. Hayden, Oakville, Iowa. Size, two and one-fourth by two and one-half inches or larger; form roundish or oblique, conical, sometimes oblate; color, dark green, yellow ground when ripe; skin slightly roughened, not

Soulard. Foliage, flowers and fruit.

greasy when green; cavity medium, sloping gradually; stem five-eighths to one inch, stout; basin broad, wide at bottom; calyx closed; flesh firm, meaty; quality brisk acid without astringency; texture pithy, but juicy; core small, ovate; seed small, dark, plump; season probably midwinter. General notes.

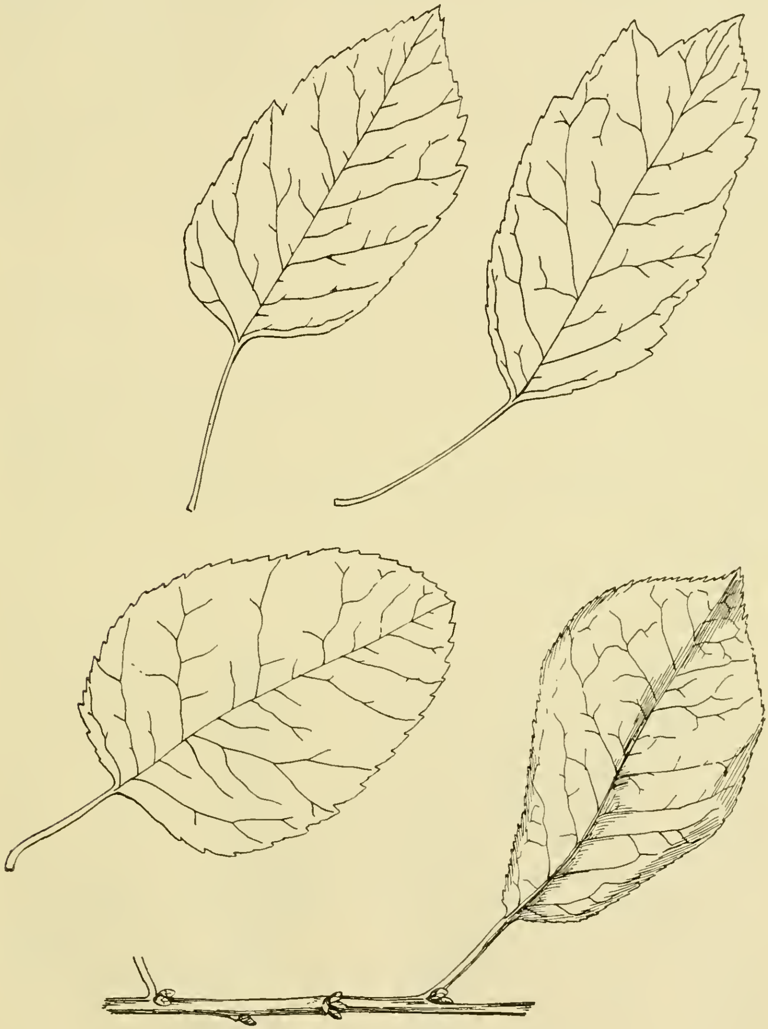


Fig. 8. Variations in leaves of Howard.

The Howard crab is, in all probability, the result of a cross between *P. Iowensis* and *P. malus*. The leaves resemble those of *P. Iowensis* in serrations, but leaves are also present, regularly serrate and oval closely resembling those of *P. malus.* The leaves are very much smoother than those of *P. Iowensis* with more prominent venations, the fruit spurs are exactly intermediate in characteristics between *Iowensis* and *Malus.* The fruit resembles *Malus* in shape, character of core, length of stem, absence of greasiness, and has lost, in some degree, the astringent properties of *Iowensis.* The tree is a vigorous grower, and seed production is very greatly reduced. This last must be accounted for in some other way than by increase of size, for *Pyrus Iowensis*, in its native state, though varying greatly in size, does not vary greatly in the number of seeds. The average number of seeds in the Howard crab is greatly reduced, six apples giving in all twenty developed seeds. The seeds are light brown, quite beaked and plump.

The following letter from Mr. E. L. Hayden, of Oakville, Iowa, explains the synonomy of the variety. "I send you by mail, to-day, a box of wild crabapples. They originated ten or twelve miles south of Oakville, and were first brought to the nursery of the late Benj. Luckenbill by a Mr. Howard, and called, after him, the 'Howard' crab. Afterward they came to the notice of the Iowa State Horticultural society as the 'Hamilton' crab, from the orchard of Jesse Hamilton, of Morning Sun, Iowa."

MERCER COUNTY CRAB.

Mercer county Crab.

Fluke Crab.

The bark of the large branches is smooth, Malus like, brownish-gray in color. One-year-old twigs, smooth, shining grayish, sparingly provided with small circular, slightly yellowish lenticels, young twigs lighter in color, slightly tomentose near the tips. Mature leaves, large ones oval, smaller are almost orbicular, finely and sharply serrate, often with large irregular serrations near the apex. Smaller leaves bluntly serrate or almost crenate. Apex obtuse, usually tipped with a single large serration, base acute or more usually strikingly oblique. Upper surface smooth, dark green, slightly rugose, lower puberulent lighter in color, veins prominent, reddish. When young the leaves are bronze in color and densely tomentose on both surfaces. One-half inch to three inches long, one inch to two inches wide, borne on rather stout tomentose, grooved petioles, one-half inch to two inches long. Flowers light pink, one inch to one and one-fourth inches in diameter, petals obovate, remotely inserted, slightly crenulate, calyx tomentose, pedicels stout, tomentose, one and one-half inches long. The fruit spurs are decidedly like those of Malus and thorns do not occur.

Irregularities in leaf characteristics, vigorous growth, diminution of reproductiveness, all indicative of hybridity, are present, and we give it as our opinion that this crab is the result of a cross of *Malus* and *Iowensis.* The seeds average 3.1 to the apple.

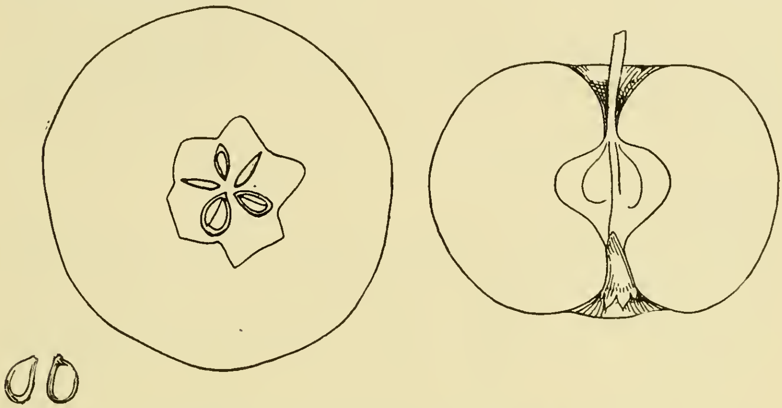


Fig. 9. Section of Mercer, showing seeds. Reduced ¼.

Size two by two, form oblate, color green, turning to yellow, skin smooth, greasy, cavity broad at mouth, sloping gradually, calyx small, closed, basin abrupt, corrugated, stem slender, one-half inch to five-eighths inch, flesh greenish-white, crisp,

Fig. 10. Mercer. Foliage, fruit spur and fruit.

slightly fibrous, quality poor, texture very firm, core small, seed large, short and plump, season midwinter or later.

This crab originated in Mercer county, Ill., and was introduced by N. K. Fluke, of Davenport, Iowa.

W. H. Guilford, Dubuque, Iowa, in the Iowa State Horticultural Report for 1898, page 231, says of the fruit: "I can also speak favorably of the Mercer county crab. It will run about as large as Fameuse. It is delightfully fragrant, with quince flavor; keeps all winter; in bloom it has all the loveliness and fragrance of the wild crab; it is a fine, erect growing tree. When better known it will be largely planted, both for use and ornament."

KENTUCKY MAMMOTH CRAB.

Mathew's Crab.

Leaves two and one-fourth inches by one and one-half inches; three-fourths inches by three-fourths inches. Orbicular or broadly oval in shape, apex mucronate; base rounded, margin varying from entire at the base to finely serrate toward the apex. Upper surface smooth, dark green or shiny, the lower lighter and sparsely tomentose. The pedicel one-fourth inch to one inch in length, slender and tomentose.

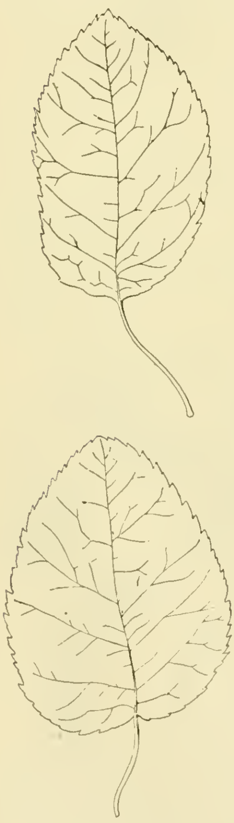


Fig. 11. Kentucky mammoth.

The flowers are produced in cymes, four or five in a cluster, rose pink in color, one inch in diameter; the petals inserted rather remote from each other and slightly crenulate. The calyx is densely tomentose, the peduncle slender, tomentose, one inch long. In fruit, however, the peduncle elongates, varying from one to two inches. The twigs are essentially smooth and grayish-brown in color.

Fruit.—Size, medium to small; form, roundish, sometimes oblate; color, yellowish-green; skin, thick dotted with russet spots; cavity, narrow, regular; stem, three-fourths inch to one inch; basin, moderately deep, slightly wrinkled; calyx, prominent, closed; flesh, firm, crisp, sharp acid; quality, fair; season, later winter.

This differs in a general way from Mercer in being lighter green in color and more oblate in form.

If we take the market as a criterion of the value of the fruit, the Kentucky Mammoth is certainly a superior crab. Mr. B. A. Mathews (Evolution of Native Fruits, Bailey p. 270), says that in 1890 he had fruit of this tree "which sold at $1 per bushel while good fruit of Grimes Golden, Roman Stem, and others was selling for 50 to 75 cents."

Regarding the introduction of this crab, B. A. Mathews in a letter to Professor Craig, dated Knoxville, October 29, 1898, says: "I got the Kentucky Mammoth of Charles Downing about twenty-five years ago. Don't know where he obtained it." The name as given to it by Downing would, however, indicate that it came originally from Kentucky. In connection with further study of this crab it would be advisable to obtain specimens of wild crabs from Kentucky. It has been suggested that it is a hybrid; the greasiness of the skin of the fruit, the astringency of flesh and character of flowers strengthen this assumption.

THE GENUS SALIX IN IOWA.

CARLETON R. BALL.

The genus Salix has long and justly been considered a difficult one to study. It is not that the genus is so large, there being only some 200 living species known, or that these species are so variable in themselves, although a few of them are known to be very much so. The chief difficulty lies in the diœcious character of the plants, and the fact that in the majority of the species the flowers are produced before the leaves appear, or at least before they are large enough to become characteristic.

A complete specimen of any one species of Salix should include the winter twigs, the flowers, and the mature foliage from both the staminate and pistillate plants, as well as a nearly mature fruiting branch. Not only this, but all the specimens of each sex should be taken from the same individual. When, however, we bear in mind that the majority of specimens in our herbaria, both large and small, present but two of the seven important parts mentioned above, and these two usually from different individuals, the reasons for much of our difficulty and confusion become apparent. Not that such a complete specimen as has just been defined is always necessary in order to accurately determine any given plant in hand. Far from it. And besides it is impossible for the general collector to secure complete specimens. But such complete specimens, and many of them, are necessary before we can establish the limits of variability in individuals, in varieties, and in the species themselves.

In my studies of the willows of Iowa, I have been afforded much assistance by the botanists and plant lovers of the state. The work was begun, and nearly completed, in the laboratory of the department of botany of the Iowa State college, where much invaluable advice and assistance was received from Prof. L. H. Pammel. I take this opportunity to express my gratitude to the following persons, also for the use of herbaria and for specimens sent: Prof. T. H. Macbride and Prof. B. Shimek, of the Iowa State university, Prof. B. Fink, of Upper Iowa university, Mr. R. I. Cratty, of Armstrong, Messrs. W. D. Barnes and A. A. Miller, of Blue Grass and Davenport, respectively, Miss Minerva Benshoof, of Blue Grass, Mr. Ferd. Reppert, of Muscatine, Mr. J. H. Mills, of Mt. Pleasant, Mr. A. F. Sample, of Lebanon, Mr. L. R. Walker, of Clermont, and Messrs. E. G. and W. M. Ball, of Little Rock. To Dr. Wm. Trelease, of the Missouri Botanical garden, St. Louis, my thanks are due for the use of the splendid herbarium and library facilities of that institution.

Several local floras, lists of trees and shrubs, etc., have mentioned the occurrence of various species of Salix in Iowa. (A bibliography will be found at the end of the paper.) However, no localities have been recorded or mapped in this paper on the strength of these references. Every locality herein given is based on actual specimens determined by the author and now contained in one or more of the various herbaria in the state. In the locality lists under each species, the letters "S. U. I.," following the collector's name, indicate that the specimen is in the herbarium of the State university of Iowa. "Herb." indicates the private herbarium of that collector. All specimens, not otherwise designated, are in the herbarium of the Iowa State college, Ames. The numbers immediately following the localities in the lists correspond to the numbers on the maps.

There is, in the Engelmann herbarium at the Missouri Botanical garden, a series of unnamed willows, numbered "123-146" inclusive, labeled "M. Jones, Iowa, 1877." These were probably collected in the vicinity of Grinnell, Iowa, by Marcus E. Jones, who was once a student there.

The series includes only our commoner species, viz. *S. nigra* Marsh., *S. amygdaloides* Anders., *S. alba* L., *S. fragilis* L., *S. fluviatilis* Nutt., *S. tristis* Ait., and *S. cordata* Muhl. None of these were listed in the body of the paper.

I. SALIX NIGRA MARSH.

Salix nigra Marsh. Arb. Am. 139, 1785.

This is one of our most common willows. It frequents river banks and similar situations, as may be seen by referring to the map. Single trees or clusters of stems forty to fifty feet in height are not uncommon. The twigs show a great diversity of coloring. The older ones are reddish-brown and usually finely fluted or striated longitudinally. The young twigs are often bright yellowish-green, smooth and shining, gradually becoming reddened by exposure.

The leaves, when mature, are usually quite characteristic. The typical and most common form is narrowly lanceolate, acuminate, acute or rounded to truncate and even subcordate at the base (and all gradations are to be found on a single twig), quite dark green, with midribs and petioles prominently greenish-white. Average size four and one-half inches by one-half inch. The variations from this are, as might be expected, in two directions. One is shorter (three inches) and lighter green. The other is longer (five to five and one-half inches), linear-lanceolate, light green, midribs not prominent. This last form was observed in several specimens from Davenport, Muscatine and Mt. Pleasant, although normal forms were also found at those places. Immature specimens of this species and of *S. amygdaloides* are often very similar in appearance. The just expanding leaves of *S. amygdaloides* do not always show their characteristic shape and glaucous lower surface and there is little of specific value in the flowers.

The aments of both sexes vary in length from one to two and one-half inches when mature. The staminate vary in width from three to five lines. The flowering period is about May 1st to May 31st.

A specimen of this species bearing hermaphrodite flowers was collected by Professor Shimek at Cedar Rapids, Iowa, May 9, 1896. He has written a short account of similar flowers in *S. amygdaloides.*

Armstrong, Emmet Co. 5, *Cratty, Herb (No. 101)*; **Charles City, Floyd Co. 14,** *Arthur, Engelm. Herb. Mo. Bot. Garden)*; **Humboldt Co. 16,** *Macbride, S. U. I.*; **Fort Dodge, Webster Co. 20,** *Stewart*; **Ames, Story Co. 28,** *Hitchcock, Benton, Yeoman, Pammel and Ball (Nos. 1180, 1181), Combs (No. 1182), Ball (No. 1198)*; **Cambridge, Story Co. 29,** *Sample*; **Cedar Rapids, Linn Co. 32,** *Shimek, S. U. I.*; **Iowa City and Johnson Co. 36.** *Miss Berry, Shimek, (2 spec.) S. U. I.*; **Davenport, 39,** *Shimek, S. U. I.*; **Blue Grass, Scott Co. 40,** *Barnes & Miller (Nos 18, 19)*; **Muscatine 41,** *Reppert (2 spec. one No 600)*; **Pottawattamie Co. 42,** *Cameron, S. U. I.*; **Muscatine Island, Louisa Co. 43,** *Meyers (2 spec.) S. U. I.*; **Mt. Pleasant, Henry Co. 44,** *Mills (4 spec Herb.)*; **Keokuk, 46,** *Rolfs*, **Steamboat Rock, Pammel and Hume** *(1039, H. 1945 O)*. **Nos.** *1934* **and** *1940* **are intermediate between this and** *S. amygdaloides.*

II. SALIX AMYGDALOIDES ANDERS.

Salix amygdaloides Anders. Ofv. Vet. Akad. Forh. **15**:114. 1858.

This willow, which has nearly the same range and habits, was once considered a variety of the preceding species, and is often mistaken for it. The mature leaves will easily differentiate the two species but when just in flower they will often puzzle the experts. On some individuals of this species the young leaves will show the glaucous under surface, broadly lanceolate form, long slender petioles, and long acuminate tips as soon as they unfold. Others do not show these distinctive characters until nearly one-third grown, and one can see both forms on the same young twig. One can also see both very large and very small mature leaves on the same tree in the fall, this difference of size seeming to depend on vigor of growth.

Little or no distinction can be made between the staminate aments of this species and those of *S. nigra*, though on an average those of the latter are more slender. The pistillate aments are usually longer in fruit, as are also the capsules and their pedicels. The capsules are from one and one-half to two lines long, and the pedicels from one-half to one and one-half lines in length. The scales are variable, being lanceolate or broader to oblong, acute or obtuse, green. The time of flowering extends from April 25th to May 25th.

Hermaphrodite flowers of this species have been collected in two different localities. Professor Shimek has given a short illustrated account of his Iowa City specimens. The Blue Grass specimen shows the capsules at maturity. They are monstrously broad, and have been developed mostly in the outer half of the ament.

Rock Rapids, Lyon Co. 2. *Shimek* (*2 spec.*) *S. U. I.*; Spirit Lake, Dickinson Co. 4, *Shimek, S. U. I.*; Clear Lake, Cerro Gordo Co. 10. *Shimek, S. U. I.*; Fayette, Fayette Co., 18. *Fink* (*2 spec*) *Herb.*; Fort Dodge, Webster Co. 20. *Shimek, S. U. I.*; Mud Lake, Hamilton Co. 22. *Stewart*; "Ledges," Boone Co. 25. *Pammel and Combs* (*No. 1185*); Ames, Story Co. 28. *Stewart, Arthur, Pammel* (*Nos. 1186, 1190, 1212*), *Ball* (*Nos. 1187, 1188, 1189*), *Sample* (*Herb. Ball*); Marshalltown. 30. *Pammel* (*No. 1184*); High Bridge, Dallas Co. 35. *Shimek, S. U. I.*; Johnson Co. 36. *Shimek, Elliott, S. U. I.*; Blue Grass, Scott Co. 40. *Miss Benshoof* (*Nos. 5, 1183*), *Barnes and Miller* (*Nos. 13, 14*); Muscatine. 41. *Reppert, Herb.*; Council Bluffs 42a. *Hayden, 1853-4. Abundant on the Missouri* (*Engelm. Herb. Mo. Bot. Gard.*); Muscatine Island, Louisa Co. 43. *Myers, S. U. I.*; Keokuk. 46. *Rolfs*; Steamboat Rock, *Pammel and Hume* (*1941k*).

III. SALIX LUCIDA MUHL.

Salix lucida Muhl. Neue Schrift. Ges. Nat. Fr. Berlin. **4**:239. *pl. 6. f. 7.* 1803.

This most beautiful of our willows is a northern plant, and occurs as a small tree or a shrub along rivers and about swampy lakes. It has been found in but two localities in Iowa, Chickasaw and Fayette counties, both in northeastern Iowa, which is about the southern limit of its range in the Mississippi valley. It may be looked for in its favorite situations throughout the northern portion of the state.

Its beauty is due to the leaves, which when mature are ovate-lanceolate, thick, green and glossy, from three to five inches long, and one-third as wide, finely serrate, with gland-tipped teeth. The glands are large and conspicuous, yellow or darker, and are found also on the petiole at the base of the leaf. The twigs are orange or orange-brown, and lustrous. It resembles very much the cultivated *S. pentandra* or *laurifolia*, to which it is closely related.

Lawler, Chickasaw Co. 15. *P. H. Rolfs*; Fayette, Fayette Co. 18. *Fink* (*2 spec.*) *Herb.*

IV. SALIX FLUVIATILIS NUTT.

Salix fluviatilis Nutt. Sylva. **1**: 73. 1842.

Salix longifolia Muhl. Neue Schrift. Ges. Nat. Fr. Berlin. **4**:238. *pl. 6. f. 6.* 1803.

The long-leafed willow is everywhere present along streams and about lakes and ponds. It frequently forms dense thickets in the alluvium along streams, and is often called the sandbar willow. In its general character it is probably the least variable of any of our common species. The leaves vary in length from three to five and even six inches, and in width from two to six lines, although three and one-half is the average. The single leaf which subtends a young twig is usually much broader than the other leaves. They are normally silky pubescent when young, and frequently retain this pubescence when mature, especially in northern regions and the Rocky mountains. A specimen of mature foliage collected at Armstrong, Emmet county, in 1895, by Professor Shimek, is peculiar in that the leaves are nearly all small, short, stiff, and densely silky. A few such leaves are, however, not uncommon on the basal portions of otherwise typical twigs.

This willow has a longer flowering period than any other species in Iowa. It extends from about April 25th to June 15th normally. A staminate specimen from Lee county, collected August 1, 1895 (Bartsch), shows the aments just expanding. Fruit is frequently collected late in July and once by Professor Hitchcock in September. Two or three young aments are generally developed near the base of each one first produced. The pistillate aments vary in length from one to two and one-half inches, with an average of one and one-fourth, and are quite loose in fruit. The staminate aments average one inch in length. The anthers were unusually long in some specimens. The capsules are densely silvery silky when young but often become entirely glabrous when mature. They are short-pedicelled and have an average length of three and one-half lines. The scales are lanceolate, ovate, or sometimes obovate, densely villous.

Rock Rapids, Lyon Co. 2, *Shimek, S. U. I.*; Spirit Lake, Dickinson Co. 4, *Shimek, S. U. I.*; Armstrong, Emmet Co. 5, *Cratty, Herb.* (*3 spec.*), *Shimek, S. U. I.*; Iowa Lake, Emmet Co. 6, *Shimek, S. U. I*; Hackberry Grove, Cerro Gordo Co. 12, *Shimek, S. U. I.*; Charles City, Floyd Co. 14, *Arthur* (*Engelm Herb. Mo. Bot. Gard.*); Fayette, Fayette Co. 18, *Fink, Herb.* (*2 spec.*); Fort Dodge, Webster Co. 20, *Shimek, S. U. I.*; Delaware Co. 23, *Cameron, S. U. I.*; Story City, Story Co. 26, *Pammel and Beyer* (*No. 1175*); Ames, Story Co. 28, *Bessey* (*4 spec*) *Reynolds, Hitchcock, Fay, McKinley, Sample, Ball and Sample* (*No. 1176*); Cambridge, Story Co. 29, *Sample*; Tama Co. 31, *Sirrine*; High Bridge, Dallas Co. 35, *Shimek, S. U. I.*; Johnson Co. 36, *Shimek* (*2 spec.*) *S. U. I.*; Davenport. 39, *Shimek* (*2 spec.*) *S. U. I*; Blue Grass, Scott Co. 40, *Barnes & Miller* (*No. 3*); Muscatine 41, *Reppert, Herb.* (*No. 657*), *Shimek, S. U. I. Ball* (*No. 1174*); Carson. Pottawattamie Co. 42, *Cameron, S. U. I.*, Mt. Pleasant, Henry Co. 44, *Mills, Herb.*; Skunk R. Valley, Lee Co. 45, *Bartsch, S. U. I.*; Keokuk. 46, *Shimek, S. U. I.*

V. SALIX BEBBIANA SARG.

Salix bebbiana Sargent. Gard. & For. **8**:463. 1895.

Salix rostrata Rich. Frank. Journ. App. 753, 1823. Not Thuill, 1799.

This tall tree-like shrub or small tree is not at all common in our state. Its southwestern extra–Iowa range extends to Nebraska and Utah and hence we may hope to find it more widely distributed in Iowa than the present collections indicate. It is found in wet or moist places or on higher and dry ground.

The twigs are orange-red to brown or purplish and are roughened by large, elevated leaf-scars. Not enough specimens were examined to determine the variations of the leaves. They show a peculiar blue-green tinge when young. The pistillate aments when mature are two inches long and an inch wide, becoming quite loose from the lengthening of the pedicels. The mature capsule is four to five lines long and the pedicel one-half that length. The ovate or more commonly oblong scales do not always show the rose color at the tips.

Hackberry Grove, Cerro Gordo Co. 12, *Shimek, S. U. I.*; Charles City, Floyd Co. 14, *Arthur* (2 *spec.*); Fayette, Fayette Co. 18, *Fink* (2 *spec.*) *Herb.*; Marshalltown. 30, *Pammel* (*No. 1192*); Steamboat Rock, *Pammel & Hume* (*No. 1949*).

VI. SALIX DISCOLOR MUHL.

Salix discolor Muhl. Neue Schrift. Ges. Nat. Fr. Berlin. **4**: 234. *pl. 6. f.* 1. 1803.

The glaucous willow, or pussy willow, as this has been called, is very common in swampy places or along river banks in the eastern and central portions of our state. Little collecting having been done in the southwestern part, it is not known whether it is as common there or not, but as that region is about the limit of its western range it would not be surprising if found to be much less common there. Like most of the other common species it presents considerable variation in both leaves and aments. Some of these varieties have been considered by different botanists to be worthy of specific rank. The extremes of these variations are fairly distinct but all gradations are shown by the intermediate forms. A specimen with loose aments or one with dense aments is occasionally accompanied by leaves retaining a ferruginous pubescence when mature, and either one may show long styles and laciniate stigmas.

The stout twigs vary in color from orange-red to purple and are usually densely pubescent when young. The buds are large, four lines or more long, ovate, and reddish-purple. The leaves reach an extreme length of five inches and a width of one and one-half. This species is quite readily recognized by the broad, densely glossy-villous aments which appear very early in spring on the yet leafless branches. The staminate aments of *S. cordata*, before they are fully expanded, are mistaken for those of this species. They have, however, more of a *wooly* appearance than of the silvery silkiness of *S. discolor* and are not as large. The scales in *discolor* are large, oblong or ovate, deep red, and copiously long-villous. The pistillate aments reach a maximum length of one and one-half inches and a width of three-fourths of an inch. The staminate are smaller. Capsules are three to five lines long. The flowering period in Iowa is from the tenth to the last of April.

Spirit Lake, Dickinson Co. 4, *Shimek, S. U. I.;* Armstrong, Emmet Co. 5, *Cratty, Herb.;* Mason City, Cerro Gordo Co. 12, *Shimek, S. U. I.;* Clermont, Fayette Co. 17, *Walker:* Fayette, Fayette Co. 18, *Fink, Herb. (var. prinoides);* Delaware Co. 23, *Cameron (2 spec.);S. U. I;* Ames, Story Co. 28, *Benton, Bessey, Hitchcock (2 spec.) Stewart, Sample (No. 1193), Pammel (No. 1194, var. prinoides), Ball (No. 1195), Ball & Sample (No. 1196);* Clinton (Lyons), Clinton Co. 33, *Pammel;* Iowa City, Johnson Co. 36, *Hitchcock, Shimek, S. U. I.;* Solon, Johnson Co. 37, *Shimek, S. U. I.;* Blue Grass, Scott Co. 40, *Barnes & Miller (No. 8), Miss Benshoof (No. 4);* Muscatine 41, *Reppert (Nos. 453, iii, vii, and ten others) Herb.;* Mt. Pleasant, Henry Co. 44, *Mills, Herb.;* Steamboat Rock, *Pammel & Hume (1946 P).*

VII. SALIX HUMILIS MARSH.

Salix humilis Marsh. Arb. Am. 140. 1785.

The prairie willow is a common species throughout our state, inhabiting uplands and dry soils, and reaching a height of two to ten feet. The twigs when very young are greenish, but as they become older they vary through orange-red to deeper hues and finally become gray. The leaves are sometimes nearly or quite glabrous below when mature. Occasionally broad forms are found on vigorous shoots which resemble the leaves of *S. discolor*. Hybrids of these two species do undoubtedly occur but these vigorous shoots are found on shrubs which are otherwise typical *S. humilis*. Normal leaves vary from one and one-half to three inches long, with an average width of one-half inch. The staminate aments are smaller and more slender than the pistillate. The latter are from one-half to three-fourths of an inch long, and dense. The capsules are from three to four lines in length. Flowering period from April 10th to May 10th.

Granite, Lyon Co. 1, *Shimek, S. U. I.;* Mason City, Cerro Gordo Co. 11, *Shimek, S. U. I.;* Nora Junction, Floyd Co. 13, *Shimek, S. U. I.;* Charles City, Floyd Co. 14, *Arthur (Engelm, Herb. Mo. Bot. Garden);* Dakota City, Humboldt Co. 16, *Stewart;* Fayette, Fayette Co. 18. *Fink. Herb. (2 spec.);* Delaware Co. 23, *Cameron, S. U. I.;* Dubuque. 24, *Th. Engelmann (Engelm. Herb. Mo. Bot. Gard.);* Gilbert, Story Co. 27, *Pammel and Beyer (No. 1202);* Ames Story Co. 28, *Bessey, Hitchcock (2 spec.), Ball and Sample (No. 1198), Pammel and Ball (No. 1199);* Iowa City, Johnson Co. 36, *Linder S. U. I.;* Davenport. 39, *Miller (No. 1200);* Muscatine. 41, *Reppert (Nos. 452, viii, and one other);* Carson, Pottawattamie Co. 42, *Cameron, S. U. I.;* Mt. Pleasant, Henry Co. 44, *Mills, Herb.;* Steamboat Rock, *Pammel & Hume. (Nos. 1930 A, 1931 B, 1935 F, 1947 Q)*, No. 1931 B approaches *S. tristis.*

VIII. SALIX TRISTIS AIT.

Salix tristis Ait. Hort. Kew. **3**: 393. 1789.

This dwarf willow is very much like the preceding species and has the same general range but is nowhere as common as its larger relative. The leaves are smaller and rather densely clustered. The aments are smaller (one-fourth to one-half inch) and fewer—usually about twenty-flowered. The height is given as from one to two feet but there is no hard and fast line of demarcation between the two species. A favorite location for this willow is the border of hillside thickets. Flowering period as in *S. humilis.*

Webster City, Hamilton Co. 21, *Stewart;* "Ledges", Boone Co. 25, *Pammel (No. 1201);* Harrison Co. 34, *Burgess;* Johnson Co. 36. *Shimek, S. U. I. (2 spec.)*

IX. SALIX SERICEA MARSH.

Salix sericea Marsh. Arb. Am. 140. 1785.

This species is quite rare in Iowa. According to Mr. Bebb it occurs commonly as far west as the great lakes, but from there westward is largely replaced by *S. petiolaris.* Granting this to be the fact, we would expect to find a strip of territory, where their ranges overlap, in which the two species would be present in about equal quantities. But as far west as Iowa we would expect to find *S. sericea* much less common than its western representative, *S. petiolaris.* This is exactly what occurs. *S. sericea* is recorded for Iowa from but three localities, all in the eastern part of the state.

There is considerable difficulty in differentiating these two species. However, if the specimen includes either fruit or mature foliage the task is not so difficult. Both species are said to hybridize freely with *S. cordata*, which increases the confusion of forms very considerably. The twigs of *S. sericea* are reddish or yellowish, deepening to purplish. The leaves are lanceolate, two to three inches long by one-half inch wide, densely silky when young and usually retaining part of this pubescence when mature, at least on the lower surface, which has a peculiar gray color, quite distinct from the glaucous under surface of *S. petiolaris*. Neither the discoloration of the foliage in drying nor the length of the petiole can be said to be a good differential character as the discoloration is about the same in both species and the petioles of *S. sericea* are scarcely shorter than those of *S. petiolaris*. The aments are small but dense. The capsules are ovate-oblong, one to one and one-half lines in length, subsessile. Time of flowering, May.

Fayette, Fayette Co. 18, *Fink, Herb.*; Solon, Johnson Co. 37, *Shimek, S. U. I.*; Keokuk, Lee Co. 46, *Rolfs*.

X. SALIX PETIOLARIS SMITH.

Salix petiolaris Smith. Trans. Linn. Soc. **6**: 122 1802.

The petioled willow is not very common in Iowa and yet is sparingly distributed over the greater part of the state. It is a shrub of from five to ten feet in height and is found in low grounds like the preceding. The twigs are reddish or yellowish, deepening to purplish. Typical leaves of the two species are not difficult to distinguish at sight, yet a description of one will apply almost equally well to the other. The leaves of *S. petiolaris* are narrowly lanceolate, silky, until unfolded, glaucous below, acute at both ends, midribs and petioles usually yellowish. The petioles are from two to five lines long, but not distinctly longer than those of *S. sericea*. The leaves are generally discolored in drying.

The aments are one inch long or less, the staminate are slender and of a golden brown color. Mature capsules are slender, three to four lines long; pedicels one-half line in length. The short scales are generally green at the base and red or dark at the tip. Time of flowering, May.

Charles City, Floyd Co. 14. *Arthur* (*2 spec., one in the Engelm Herb.*); Fort Dodge, Webster Co. 20. *Shimek, S. U. I.*; Ames. Story Co. 28. *Pammel* (*No. 1207*) *Ball and Sample* (*No. 1208*); Johnson Co, 36. *Shimek, S .U. I.*; Eldridge, Scott Co. 38. *Barnes and Miller* (*3 spec., Nos. 5, 15, 17*).

XI. SALIX CANDIDA FLUEGGE.

Salix candida Fluegge (in litt.). Sp. Plant. **4**: 708. 1806. [ed. Willd.]

This pretty little willow frequents cold bogs and is rare in Iowa. It can be readily recognized by its narrowly oblong-lanceolate leaves, densely *white* tomentose below and loosely so above. The aments are not large, but the capsules are one-fourth inch in length, ovoid-conic and densely white tomentose.

The long red stigmas present a striking contrast. The stamens are also red. The scales are reddish and long-villous. Only about one third of the capsules on the Johnson county specimen are developed, the remainder being apparently unfertilized.

Lake Edwards, Hancock Co. 9. *Shimek, S. U. l.*; Johnson Co. 36. *Shimek, S. U. l.*

XII. SALIX CORDATA MUHL.

Salix cordata Muhl. Neue Schrift. Ges. Nat. Fr. Berlin. 4:236. *pl. 6. f. 3.* 1806.

The heart-leaved willow is widely distributed and is more variable than any other species inhabiting the state. Notwithstanding the fact that two species (*S. glaucophylla* Bebb, and *S. Missouriensis* Bebb) have been cut out from *S. cordata* within the last ten years, there remains enough variety of form to render identification difficult. How much of this variation should be ascribed to hybridity and how much to the natural results of progressing evolution in a highly plastic species, is still an open question.

This species is a shrub of some ten or twelve feet in height, growing in wet soils and along river banks. A glance at the map will show that it is quite thoroughly distributed over Iowa. The rather stout young twigs are yellow, but this color gradually gives place to red-purple or brownish pubescent toward the tips. The young leaves are generally densely pubescent. The mature leaves are glabrous, or somewhat pubescent along the midrib, oblong or oblong-lanceolate, two and one-half to four inches long, one-half to one inch wide, acute at the tip, narrowed to rounded or cordate at the base, more or less glaucous below, thick and firm. Petioles are from three to six lines or more. The stipules are variable in size and shape, ovate-lanceolate or semilunate to reniform or oblong, very small to one-half inch long.

Staminate aments one to one and one-half inches long, one-half inch wide or less. Filaments in many of the flowers were adnate for about half their length in specimens from Little Rock (Ball Bros.), Ames (Williams), and another bearing no label. The aments of both sexes are bracted at the base. Pistillate aments are from one and one-half to two and one-half inches long. The capsules are greenish when young, becoming lighter when mature, and having a length of from two to three and one-half lines. Pedicels one line or more.

On fully half of the mature capsules examined a very few minute scattered hairs were found. The bracts are very small, red or reddish, densely long-villous. The flowering period extends from April 10th to May 15th or longer.

Little Rock, Lyon Co. 3. *Ball Bros.*; Armstrong, Emmet Co. 5. *Cratty Herb.* (*Nos. 2, 4, 102*); Forest City (near), Hancock Co. 8. *Shimek, S. U. I.*; Charles City, Floyd Co. 14. *Arthur*; Calhoun Co. 19a. *Rigg, S. U. I.*; Hamilton Co. 21. *Rolfs*; Gilbert, Story Co. 27. *Pammel and Beyer* (*No. 1210*); Columbus Junction, *Pammel*, (*1933d*); Ames, Story Co. 28. *Benton, Bessey, Burgess, Reynolds, Hitchcock* (*3 spec.*), *Williams, Pammel* (*Nos. 1203, 1205*), *Pammel and Ball* (*No. 1211*), *Ball* (*No. 1209*); Marshalltown. 30. *Pammel* (*No. 1206*); Johnson Co. 30. *Shimek* (*2 spec.*) *S. U. I.*; Solon, Johnson Co. 37. *Shimek, S. U. I.*; Blue Grass, Scott Co. 40. *Barnes and Miller* (*Nos. 4, 6*); Steamboat Rock, *Pammel and Hume* (*1932 C, 1036 G, 1943 N, 1944 M*); Muscatine. 41. *Reppert, Herb.* (*4 spec.*); Carson, Pottawattamie Co. 42. *Cameron, S. U. I.*; Council Bluffs, 42a. *Hayden, 1853-4* (*Engelm. Herb. Mo. Bot. Gard.*).

CORDATA HYBRIDS.

So imperfect and incomplete was much of the material that little could be done toward accurate recognition of possible hybrids. The following are placed in this list, chiefly on account of the thinly pubescent capsules. It was noted under the discussion of *cordata*, however, that a few short hairs seem to be normally present. The pubescent capsules indicate hybrids with either *S. sericea* or *S. petiolaris*. One of the Fayette specimens is labeled "*S. sericea cordata*, fide Bebb," and the other "*S. cordata sericea* (*S. myricoides*), fide Bebb". In both the *cordata* characters are strongly predominant. The leaves of all these supposed hybrids were too young to afford good diagnostic characters. All were more or less silky, but that is normal in typical *cordata*. They are narrowed at the base in all except the first Fayette specimen mentioned above, in which they show the rounded base, though they are less than one inch long.

Fayette, Fayette Co. 18. *Fink* (*2 spec.*) *Herb.*; Eldridge, Scott Co. 38. *Barnes and Miller* (*Nos. 7, 16*); Blue Grass, Scott Co. 40. *Barnes and Miller* (*No. 4*).

XIII. SALIX MISSOURIENSIS BEBB.

Salix Missouriensis Bebb. Gard. and For **8**: 375. 1895.

Salix cordata var. *vestita* Anders. Monog. Sal. Konig. Sven. Vet. Akad. Handl. **6**: 156. 1867.

This willow was first accorded specific rank by Mr. Bebb, in 1895. It has been found in Missouri, Kansas and Nebraska, and its presence in Iowa occasions no surprise. It is distinguished from *S. cordata* by its larger size, densely puberulent twigs, larger leaves, and longer, fertile aments, and other more minute differences. My determinations of Iowa specimens of this species were made from foliage material only, but this was compared with a large series in the herbarium of the Missouri Botanical garden.

Two general localities are represented, viz., the Missouri river valley, near Sioux City, and the region about Davenport and Muscatine. This latter place is noted for a flora presenting many southern species. The herbarium of the State university contains a specimen collected by Professor Shimek, in the northwest corner of Lyon county, which is also the extreme northwest corner of Iowa. The leaves of this, though immature, approach very closely to those of *S. Missouriensis.* It probably occurs along the entire reach of the Missouri river which borders Iowa on the west.

Sioux City, Plymouth Co. 19. *Pammel;* Davenport. 39. *Shimek, S .U. I.;* Blue Grass, Scott Co. 40. *Miss Benshoof* (*No. 3*).

XIV. SALIX MYRTILLOIDES L.

Salix myrtilloides L. Sp. Plant. 1019. 1753.

The pretty little bog willow is very rare in Iowa, having been found in but a single locality near Armstrong, Emmet county, by Mr. R. I. Cratty. It is an inhabitant of cold bogs and becomes much more common even in the slightly higher latitude of the Minnesota river valley. It grows to a height of from one to three feet, and may be easily recognized by the manual descriptions. The staminate aments are slender, but the fertile aments in fruit are nearly as broad as long. The staminate aments were collected on May 9, 1883, the mature pistillate aments on June 9, 1883, and the mature leaves on August 4, 1884.

Armstrong, Emmet Co. 5. *Cratty.*

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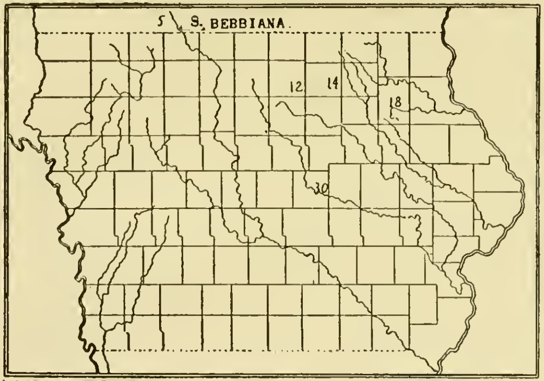

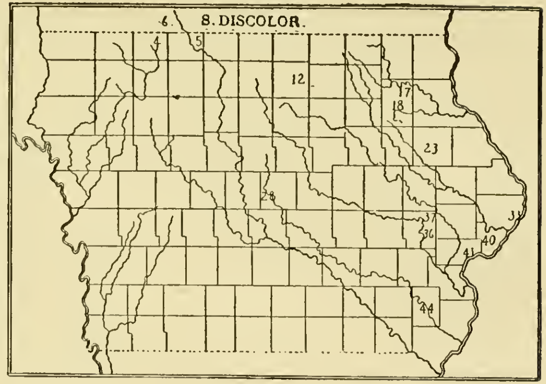

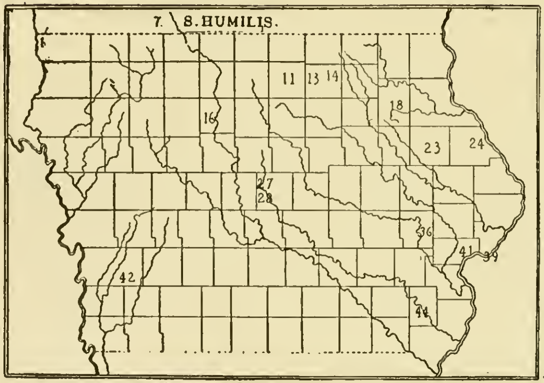

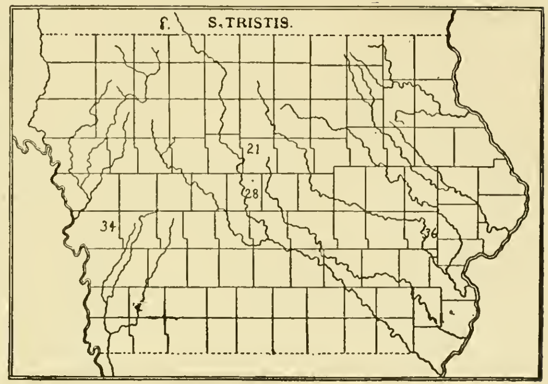

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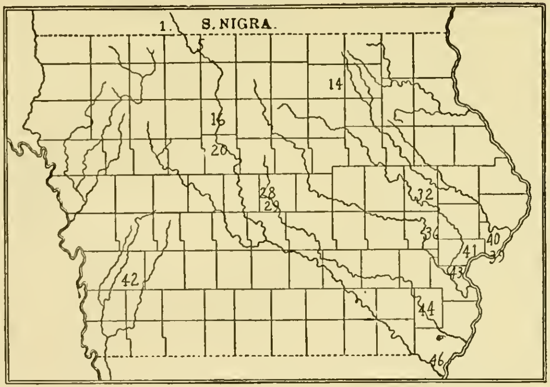

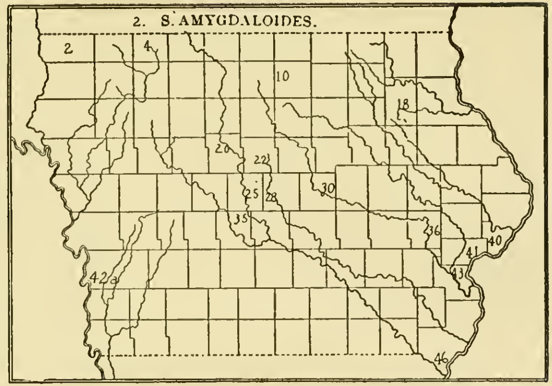

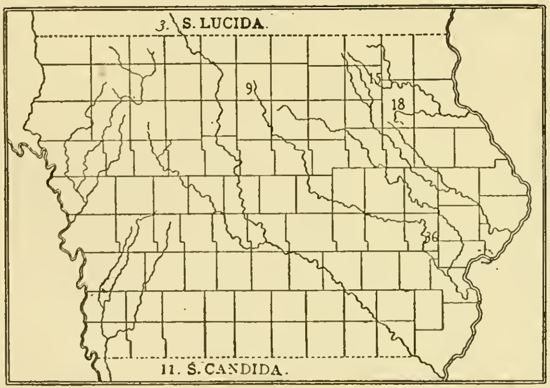

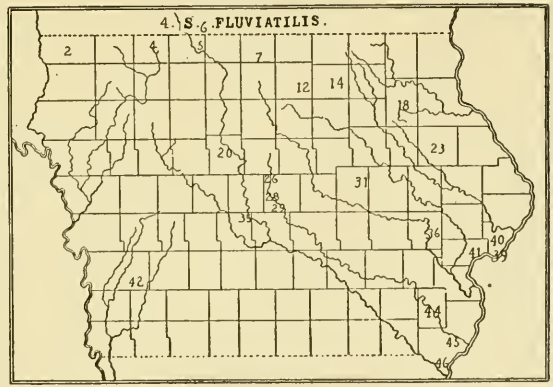

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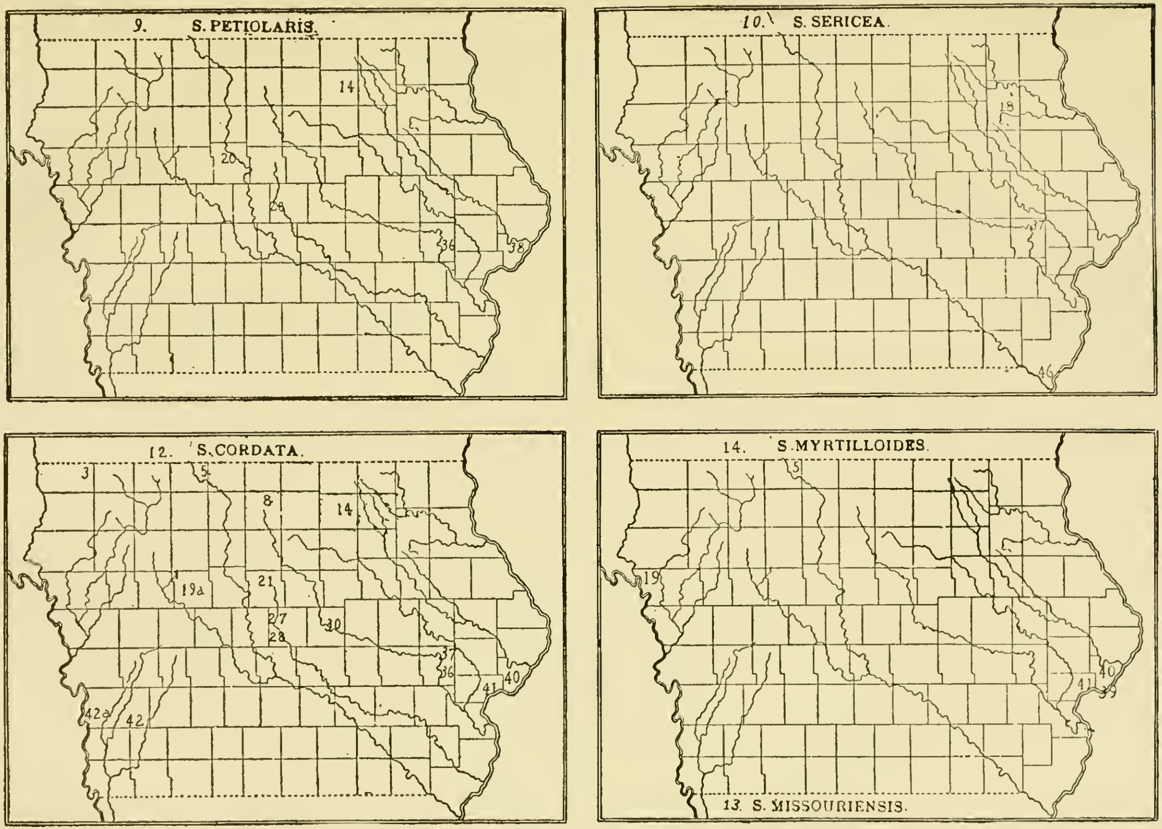

"Ball on Salix."

SOME CERCOSPORAE OF MACON CO., ALABAMA.

BY GEORGE W. CARVER.

The wide distribution and the economic importance of the Cercospora in this county has prompted the writing of this paper. This list by no means represents all of the species of this county, as no special effort has been made to collect Cercospora only. These collections were made while passing hurriedly to and from other duties. With few exceptions, the species were collected in the immediate vicinity of Tuskeegee.

The exceedingly warm and humid atmosphere, together with the very remarkable fluctuations of climate and the rapid development of fungus diseases under these favorable conditions, has made the study doubly interesting. It is quite apparent that from year to year, by careful co-operation, much valuable information will be brought to light. None of our imperfect fungi have been worked over more carfully than the Cercosporeae. I have consulted the following works, Ellis and Everhart*, whose work includes all of the North American species known to them when their work was written. Kellerman and Swingle† for the descriptions of several new species. There are also descriptions of other species in the same journal. Full descriptions of many Alabama species occur in Prof. George F. Atkinson's paper on the Cercosporeae‡ of Alabama. Saccardo§ in his great work on fungi described all of the species known to him. Descriptions of new and interesting southern species were made by Underwood and Earle.‖ Numerous local lists of fungi also record species from various localities. The following are some of the more important: Trelease,¶ Davis,[1] Webber,[2] Tracy and Earle,[3] Hal-

*Jour. Myc. 1:17, 33, 49, 61. 4:1.

†Jour. Myc. 5:74.

‡Some Cercospora from Alabama, from the Journal of Elisha Mitchell. Sci. Soc. 8: Separate.

§Sylloge Fungorum.

‖Bull. Ala. Agr. Exp. Sta. 80:141.

¶Wis. Acad. Sci., Arts and Letters 6:106.

1 A supplementary list of Parasitic fungi of Wis. Acad. Sci., Arts and Letters 9:166.

2 Webber Cat. Fl. Neb.

3 Tracy and Earle Bull. of Miss. Agr. Ex. Sta. 34:116-120 Bulletin 36:150-153.

sted.* I am also indebted to Prof. L. H. Pammel who has kindly examined some of the specimens for me.

In studying this group one easily separates it into three divisions; true parasites, forming distinct spots in living tissues, saphrophytic forms which seem to attack only dead, or languid foliage; facultative, which accommodate themselves to both living and dead tissues. The spores of the second division are somewhat abnormally long and hyaline giving a frosty appearance to the host when present in large numbers. I have arranged the specimens alphabetically. Quite a number have not been definitely determined. Some of these may prove new.

C. acalyphæ, Peck. On leaves of *Acalypha ostryæfolia* and *A. gracilens*. No. 89.

C. agrostidis, Atks. On leaves of *Eupatorium verbenæfolium*. No. 18.

C. alabamensis, Atks. Abundant and destructive to the foliage of *Ipomœa purpurea* No. 67.

C. althæina, Sacc. Abundant and destructive to leaves of *Althea rosea*. No. 68.

C. ampelopsidis, Pk. On leaves of *Ampelopsis quinquefolia*. No. 32.

C. apii, Fres., *Var. pastinaceæ*, Farl. Very abundant and destructive, completely destroying the foliage of *Pastinaca sativa*. No. 5.

C. asclepidora, Ell. & Kell. Frequent on the leaves of *Asclepias tuberosa*. No. 80.

C. atromaculans, E. &. E. On the leaves, stems and fruit of *Sassia tora*. No. 94.

C. asiminæ, E. &. K. Abundant and destructive to leaves of *Asimina sp.* No. 62.

C. beticola, Sacc. Destructive to leaves of *Beta vulgaris*. No. 43.

C. boleana, (Thuem.) Speg. Seriously injuring the leaves of *Ficus carica*. No. 3.

C. brunklii, Ell & Gall. Abundant on leaves of *Pelargonium graveolens*. No. 99.

C. callicarpae, Cke. Abundant and destructive to leaves of *Callicarpa americana*. No. 15.

C. canescena, E. & M. Very abundant on the leaves, stems and fruit of *Phaseolus vulgaris*. No. 13.

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* Halsted, Bull Dept. of Bot. Ia, State Coll. 1888: 102-117.

C. canescens, E. & M. Common on leaves of *Phaseolus lunatus.* No. 52.

C. caulicola, Wint. Does serious injury to leaves and stems of *Asparagus officinalis.* No. 127.

C. cercidicola, Ell. Very abundant on leaves of *Cercis canadensis.* No. 31.

C. cerasella, Sacc. Common on leaves of *Prunus cerasus.* No. 33.

C. clitoria, Atks. Common on leaves of *Clitoria virginiana.* No. 57.

C. consociata, Wint. Common on leaves of *Ruellia ciliosa.* No. 66.

C. crotonifolia, Cke. Abundant on leaves of *Croton glandulosus.* No. 92.

C. cruciferarum, E. & E. Common on leaves of *Raphanus sativa*, and dead leaves of *Brassica oleracea* (Collard & Cabbage). This seems to be a strongly developed form of this polymorphic species. No. 74.

C. cucurbitæ, E. & E. Abundant on leaves of watermelon, cushaw, dipper gourd, flat gourd, pie melon and citron. During the past season this fungus seriously affected the foliage of all these plants. No. 1.

C. davidsii, E. & E. Very destructive to foliage of *Melitotus alba.* No. 69.

C. diodiæ, Cke. Abundant on the foliage of *Diodia teres.* No. 81.

C. diospyri, Thuem. Very abundant and destructive to the leaves of young plants of *Diospyrus virginiana.* The leaves curl up similar to the curling caused by powdery mildew of the cherry. No. 60.

C. dolichi, E. &. E. Completely defoliates the plants of dolichos in poorly cultivated soil. No. 87.

C. elaphantopodis, E. & E. Abundant on leaves of *Elaphantopus carolinianus* and *E. nudatus.* No. 25.

C. eupatoria, Pk. Not uncommon on leaves of *Eupatorium rotundifolium.* No. 35.

C. erythrogena, Atks. Common on leaves of *Rhexia mariana.* No. 64.

C. fuscovireus, Sacc. Very abundant and destructive to leaves of *Passiflora incarnata* and *P. lutea.* No. 46.

C. flagellaris, E. & M. On leaves of *Phytolaca decandra.* No. 29.

C. glandulosa, Ell & Kell. Common on young plants of *Ailanthus glandulosus*. No. 21.

C. gossypina, Cke. Very abundant and destructive to the leaves, stems and fruit of *Gossypium herbaceum* especially in fields where the plants were poorly nourished. No. 6.

C. granuliformis, Ell. & Hal. Common on leaves of *Viola cucullata*. No. 38.

C. hibisci, F. & E. Abundant on languid leaves of *Hibiscus esculentus*. This seems to be closely allied to *C. gossypina*. No. 73.

C. hydrangeæ, E. & E. Common on leaves of cultivated *Hydrangea*. No. 71.

C. Hydrocotyles, E. & E. Common and destructive to the foliage of *Hydrocotyle canbyi* and *H. americana*. No. 41.

C. Hydropiperis, (Thuen.) Speg. Abundant and destructive to leaves of *Polygonum pennsylvanicum*. No. 37.

C. Iliscis, *Ell.* Common on foliage of *Ilex glabra*. No. 125.

C. Jatrophæ, Atk. Abundant and destructive to foliage of *Cnidoscolus stimulosus*. No. 51.

C. Liquidambaris, C. & E. Abundant and destructive to the foliage of *Liquidambar styraciflua*. No. 23.

C. lucosticta, E. & E. Common on leaves of *Melia azedarach*. No. 7.

C. mali, E. & E. Very abundant and destructive to foliage of *Pyrus arbutifolia* Var. *erythrocarpa*. No. 55.

C. moricola, *Cke.* Abundant on leaves of *Morus rubra*. No. 110.

C. occidentalis, Cke. Very destructive to foliage of *Cassia occidentalis*. No. 86.

C. olivacea (B. & K.), Ell. Locally abundant and destructive to leaves of *Gleditschia triacanthos*. No. 123.

C. passaloraides, Winter. Abundant on leaves of *Amorpha fruticosa*. No. 65.

C. personata (B. & C.), Ell. Seriously injuring the foliage and stems of *Arachis hypogea*. No. 8.

C. plantaginis, Sacc. Common on leaves of *Plantago lanceolata*. No. 44.

C. populina, Ell. & E. V. Completely defoliates young trees of *Populus dilatata*. No. 2.

C. prenanthis, Ell. & Kell. Common on *Prenanthes sp.* No .50.

C. prunicola, Ell. & E. V. Common on leaves of *Prunus americana*. No. 79.

C. rhuina, C. & E. Abundant on leaves of *Rhus copallina*, *R. pumila*, *R. toxicondendron*, *R. glabra*, and *R. aromatica*. No. 22.

C. richardicola, Atks. Common on potted plants of *Richardia africana*. No. 90.

C. ricinella, Sacc. & Berl. Quite abundant on fading leaves of *Ricinus communis*. No. 4.

C. rosicola, Pass. Frequent on leaves of cultivated roses. No. 124.

C. rubi, Sacc. Abundant on leaves of *Rubus canadensis*. No. 28.

C. sagittariæ, E. & K. Abundant on leaves of *Saggittaria variabilis*. No. 30.

C. serpentaria, Ell. & E. V. Not uncommon on leaves of *Aristolochia serpentaria*. No. 53.

C. smilacis, Thuem. This species does serious injury to the foliage of several species of wild smilax. No. 36.

C. sordida, Sacc. Very abundant on leaves of *Tecomia radicans*. No. 106.

C. sorghi, E. & E. Very abundant, seriously affecting the foliage, stems and sheaths of *Sorghum vulgare*, and the blades and sheaths of *Zea mais*. No. 16.

C. stylismæ, T. & E. Abundant on *Bueweria humistrata*. No. 59.

C. truncatella, Atks. Common on the leaves of *Passiflora incarnata*. No. 115.

C. tuberosa, E. & K. Abundant and destructive to the foliage of *Apoise tuberosa*. No. 84.

C. verbenicola, Ell. & E. Abundant on leaves of *Verbena carolina*. No. 61.

C. vernoniæ, E. & K. Common on leaves of *Vernonia augustifolia*. No. 119.

C. violæ, Sacc. Abundant on leaves of *Viola odorata*. No. 70.

C. viticola (Ces.), Sacc. Completely defoliates in late fall, the vines of *Vitis labrusca* and *V. rotundifolia*. Also found on other species of wild grapes.

AN ABNORMAL FERMENTATION OF BREAD.

BY C. H. ECKLES.

During the past summer my attention was called to a peculiar abnormal condition which the bread baked in the house underwent a few days after baking. About the same time complaints were made by a number of residents of the town regarding the same trouble. A number of inquiries were also noticed in the magazines, devoted to the household, indicating the trouble was present in other localities. Inquiry among neighboring housekeepers showed that while most of them had never heard of such a trouble with bread, a number of them had seen the condition or known of someone who had at some time been troubled. It occurs about as follows: After the bread has been baked a few days, rarely before the third day, but usually the fourth or fifth, a disagreeable odor and taste is noticed which is usually described as musty or stale. A few hours later if the cut surface of the bread is touched with the finger it feels sticky, and may be observed to adhere to the finger, forming short threads as the finger is removed. By the following day the conditions are much worse, the odor and taste stronger, and the stringiness much more noticeable. At times, when at its worst stage, a piece broken from the loaf will remain attached by numerous fine threads until removed a foot or more away. Occasionally a thread will draw out three feet or more in length. A brownish-yellow color usually appears about twenty-four hours after the sliminess is first present. Cases of greenish-black color have been reported, while a few have observed no color at all in connection with the sliminess. In the latter cases it is probable that the bread was destroyed before the color was produced. The cases of greenish black discoloration did not come under my observation, but it seems probably from the observations of Uffelman that it was due to the presence of mould.

An examination of a loaf just beginning to be stringy will show that the condition appears first at the central part, but later the same condition is found throughout the entire loaf. The decomposition has in every stage advanced farther at the center than near the crust.

The abnormal condition under consideration is usually assigned, by those who observe it, to lack of sufficient heat in baking. The fact that the trouble in no case is present until some time after baking, and then rapidly becomes worse, shows the conditions of baking do not offer an explanation. These facts rather suggest that the process is a fermentation

* Centralblatt für Bakteriologie, Bd. 8, 481.

due to the presence of living organisms which are able to survive the heat of baking.

In all the cases investigated the bread was of good quality when first made, and a portion of the baking had, in most cases been consumed before the trouble was observed. Microscopic examination of the slimy material from several sources showed that in every case immense numbers of spore, forming bacilli, were present. Morphologically they appeared to be of a single species. A majority of the cells contained large spores, and many spores were also noticed with no portion of the original cell attached. The individual cells appeared connected by a mucilaginous mass which produced the stringy condition. Reference to bacteriological literature showed that apparently the same fermentation has been observed by others.

Kratschmer and Niemitowitz,* in 1889, mention an occurrence of a similar abnormal fermentation caused as they observed by by *Bacillis mesentericus vulgatus.* Uffelman,† in 1890, found in a sample of condemned rye bread a stringy decomposition due to the action of bacteria. He isolated two species from the sample he had, one the common potato bacillus, *Bacillus mesentericus vulgatus,* and the other *Bacillus lidermos* (Löeffler). Russell‡ mentions a similar slimy decomposition as being the cause of considerable trouble in Wisconsin. He also attributed the condition to the presence of the potato bacillus.

By newspaper notice, and direct inquiry the facts were brought together as observed by quite a number who had been troubled with this fermentation in their bread. From a study of these reports, and the eight or ten cases which came under my own observation, the following statements are made.

It appears only during the summer months, and generally only during the hottest part of the season. Its occurrence is not dependent upon any particular method of making or baking the bread, as a number of methods reported, and tried, gave the same condtion when the bread was placed in conditions favorable for bacterial development. It is not the result of using any particular kind of yeast, as it has been found where five brands of cake yeast were used, and in one case of home made hop yeast. Russell§ mentions it as also occurring where compressed yeast was used.

*Aus. d. Chem. Lab. d. k. k. öster. Militärsanitäts Comite, 1889.

† Centralblatt für Bakteriologie, Bd. 8, 481.

‡ Fifth Annual Report, Wis. Exp. Station, 1898.

§ loc. cit.

It does not depend upon the use of a particular kind of flour, as a number of brands were used where the condition was present. In all the cases which came to my notice there was one condition uniform; viz, the bread had been kept at a comparatively warm temperature after baking. In no case was the trouble found to occur where the bread was kept in a cellar or other cool place.

THE RELATION OF HEAT.

To test the effect of heat, a loaf was taken from a baking of good quality and cut into halves. One half was placed in an incubator at a temperature of about 95° Fahrenheit, the other in a cool basement with a temperature of about 60° Fahrenheit. Within three days the piece in the incubator showed the typical condition of the fermentation, while the piece in the cool basement showed no change, even after two weeks. A sample was also secured during the month of November from two families who had been troubled during the preceding summer, but at this time the bread appeared to be normal in every respect. This bread placed at 95° Fahrenheit became stringy within two days. Samples were later secured from a number of families in the habit of making their own bread, also from one bakery. The samples were placed in Petri dishes, moistened with distilled water, then heated in the Arnold sterilizer for thirty minutes to destroy any bacteria that might be present by accidental contamination. The bacteria which produce the condition being able to withstand the heat of baking, could survive this temperature, which is about the same. After the heating, the samples were put at a temperature of 95° Fahrenheit. In every case where cake yeast had been used, the stringy condition appeared in the bread. The bread from the bakery had been fermented with compressed yeast and this bread showed no change whatever when kept at the warm temperature. Examination of this yeast, as noted later, showed it was free from the obnoxious bacteria. A sample from a baking of home make bread, fermented with this same compressed yeast was the only home-made bread tested which did not undergo the stringy decomposition when placed at a high temperature.

From these observations we may conclude that a large amount of bread contains the spores of this fermentation and that it is not often recognized because the conditions of keeping are such that it does not develop. It also shows why the trouble appears only during the hot weather of summer.

The writer has been asked why this trouble is not more general. The answer is in the facts given regarding the effect of temperature, and it is also probable that in many cases such fermentation starts to develop and as soon as the first indication, the disagreeable taste and odor appears, the bread is destroyed and the final stringy condition is not seen at all.

The condition of the bread regarding moisture seems to be an important factor in developing the fermentation. The more moisture present in the bread, the more rapidly the fermentation develops, and in this way the conditions of making have some influence.

THE BACILLI CAUSING THE FERMENTATION.

A large number of Petri dish agar cultures were made from different samples of bread, and from particular samples at different stages of development. In all but one case the common potato bacillus, *Bacillus mesentericus vulgatus*, was the most common organism present. With a single exception these samples also contained another species in many respects resembling the potato bacillus, and while differing in some minor respects from the original description, it agreed in the essential points and was considered to be *Bacillus liodermo*, (Lœffler).* The case which did not show the *B. liodermoss* appeared to contain a mixture of *Bacillus mesentericus vulgatus* and *Bacillus subtilis*. One sample apparently contained a pure culture of *Bacillus liodermos*. This sample showed little color but great viscosity. Experiments showed that either the potato bacillus or *B. liodermos* can produce this slimy decomposition in sterile bread but a much more pronounced yellow color is produced under the influence of the potato bacillus. A culture of the potato bacillus was secured from partly sterilized potato and this was found to give the same result as theculture of the same organism secured from the spoiled bread. It is impossible to estimate to what extent each species took part in producing the slimy decomposition. The potato bacillus appeared to be more active during the first part of the process, while later almost pure cultures of *B. liodermos* would be secured in some cases.

* Berliner klin. Wochenschr, 1887, p. 630. Also Sternberg, Manual of Bacteriology, p. 680.

THE NATURE OF THE VISCID MATERIAL.

The question whether the viscid material is a result of the decomposition of the bread or a mucilaginous product of the cells themselves, is one of interest. Both the potato bacillus and *B. liodermos* produce a very viscid growth on the surface of potatoes. The latter also produces a similar gummy substance on the agar agar. The viscid condition of these growths appears to be due to the formation of a mucilage-like substance by the cell itself and the stringy condition of bread seems to be the same. Microscopic examination of the threads formed from the bread showed a linear arrangement of cells with intervening spaces quite regular in size. Neither Welch's glacial acetic acid method or Gram's method show any capsule with either of these species. The *B. liodermos* shows a clear area around the cells when stained with carbol fuchsin indicating the formation of a gelatinous substance in the nature of a capsule. Both of these organisms decompose the nitrogenous part of the bread, as is shown by the uniform presence of ammonia in the fermented material.

EFFECTS OF BACILLUS SUBTILIS.

The presence of this species in one sample of bread and its wide distribution, making it possible that it easily finds its way into many samples of bread, led to an experiment with the object of determining whether it has the power of producing a slimy decomposition. A culture taken originally from hay was used. When grown on sterile bread it produced a slight yellow coloration with an odor somewhat resembling that produced by the potato bacillus, but no stringiness was to be noticed.

HEAT OF BAKING.

It is evident the bacteria causing the fermentation are able to survive the heat of baking. In this connection two experiments were made to determine what the temperature inside a loaf of bread is during baking. A thermometer was inserted in the top of a loaf of bread with the bulb in the center. Just as the bread was ready for removal from the oven the temperature was taken at intervals until the reading sank to 150° Fahrenheit. It was observed in both trials that the temperature of the bread raised several degrees within five minutes after being removed from the oven, then slowly declined. This increase in temperature after removal from the oven was first noted by J. L. Hamilton.* In the first trial, the temperature at the end of one hour's baking was 196° Fahrenheit. Five minutes later it reached 206°, then gradually declined to 150°, within two hours. In the second trial the temperature recorded at the end of baking was 197°, which raised to 208° within five minutes, and within fifteen minutes sank to 200° Fahrenheit and reached 150° in about the same time as in the first trial.

These results are practically the same as found by Dr. Russell, who says at no time is the temperature of baking high enough to kill the spores of the potato bacillus. The same applies to the *Bacillus liodermos* and shows that if either of these bacteria find their way into the bread during the process of bread making, the baking will not destroy them and under favorable conditions of temperature as found during the hot weather of summer, they may develop very rapidly.

HOW THE BACTERIA GET INTO THE BREAD.

In considering how the bacteria came into the bread the following were considered as possible sources of contamination:

First.—From the air or from water or milk used.
Second.—From the addition of potatoes or potato water to the dough.
Third.—From infected flour.
Fourth.—From impure yeast.

The natural habitat of *Bacillus liodermos*, as far as literature on the subject shows, has not been ascertained. It has been found in milk by Loeffler and in spoiled bread. The potato bacillus occurs at times in milk and being a soil organism may accur in water and possibly in the air. The sources mentioned under number one while possible, seem hardly a probable source of contamination in many cases unless the water or milk used be decidedly impure.

The use of potatoes might readily carry over large numbers of the potato bacillus even if the portion used had been boiled. Some of the cases of slimy decomposition occurred where no potatoes had been used, so this is not at least a necessary contamination.

EXAMINATION OF FLOUR.

Two brands of roller process wheat flour were examined to determine if contamination be from that source. Microscopic

*The Lancet (London), 1894 December 8, Abstract, Experiment Station Record, Vol. VII, P. 793

examination of both showed very few bacteria, as would be expected from the dry condition. About half a gram of the flours tested was placed in each of four tubes of sterile milk, and four tubes of peptone bouillon, and allowed to remain at 95° Fahrenheit, for twenty-four hours. The tubes were then heated for thirty minutes in an Arnold sterilizer to destroy all except the resistant spores. After heating, these tubes were placed at 95° Fahrenheit again for development. The results were somewhat variable. Most of the tubes showed the presence of a spore form capable of surviving the heating. A few of the tubes showed no development after the heating, indicating no spores were present. Sterile bread, in Petri dishes, was then inoculated from the tubes, showing by microscopic examination that spores were present. From one brand of flour a typical slimy bread was produced. From the other brand a slight yellow coloration was produced with presence of ammonia, but the typical slimy condition was not present. It is unfortunate that more samples were not examined, but from the observations made it is evident that the flour may act as a source of contamination, but that the number of bacteria in a given amount of flour is probably small.

YEASTS.

The common dry cake yeasts to be purchased in Ames were examined in the same manner as the flour.

Yeast foam.—Used very largely in Ames, and in several cases where spoiled bread had occurred, microscopic examination showed, besides the yeast cells, four forms of bacteria, indicating at least that many species, and also a number of spores. Produced typical slimy colored decomposition on sterile bread.

Yeast wafers.—Microscopic examination showed two distinct forms of bacterial cells, also spores. Produced typical odor on sterile bread. Entire surface covered with a slightly wrinkled, pinkish growth, very viscid. Threads four feet long, forming from one spot when touched with a needle.

On time yeast.—Used in some cases of spoiled bread. Microscopic examination showed bacteria numerous; produced slimy fermentation on sterile bread; very large bacilli, together with smaller ones, present in every sample examined.

Fleischman's compressed yeast. — Microscopic examination showed large bacilli present, but no spores observed. In milk no dissolving of the casein. On sterile bread no effect produced, indicating no spore forms were present in the yeast. Bread from a bakery where this yeast was used was the sample tested that did undergo a slimy decomposition when placed under warm conditions.

These results show that bacteria capable of producing a slimy decomposition are common in some of the brands of yeast most widely used, and it is probably the source of contamination in most cases.

METHODS OF PREVENTION.

The question of the prevention of this abnormal fermentation is one of considerable economic importance and probably will continue to be unless the yeast companies put a purer article on the market. The chief precautions that may be taken to prevent the trouble, are to place the bread in a cool place as soon as practical after baking. The bakings should also be made small so that the bread will be consumed before decomposition begins. If the trouble has occurred where potatoes or potato water are used in any form, it would be advisable to discontinue this use. So conducting the process of making that the bread will not be very moist, will help to prevent an occurrence of this trouble. No fear may be had regarding the effect on the health from eating bread containing this putrefaction, as the bacteria producing it are harmless saprophytes and the products formed by the decomposition are not known to be injurious. After the change has reached the later stages, the taste, odor, and physical condition are so marked that there is no difficulty in detecting it.

ADDITIONS TO LICHEN DISTRIBUTION IN THE MISSISSIPPI VALLEY.

BRUCE FINK.

During the last few years I have examined a large number of lichens from various parts of the Mississippi valley, and a few of these have never been recorded from the states in which they were collected, either in my own papers, or, so far as I know, in other publications. In a paper* read before

* Fink, B. Notes on Lichen Distribution in the upper Mississippi valley. Memoirs of the *Torrey Bot.* Club. 6: No. 5. 385-307. 1 D 1899.

the botanical section of the A. A. A. S. at the Columbus meeting I made mention of some of these plants, but several are of special interest because rare or difficult to detect, and I have thought it worth while to record all for distribution. Aside from a single collection by myself in Illinois, the collectors are L. H. Pammel, E. Bartholomew, C. J. Herrick, C. H. Demetrio and R. Dunlevy. The collection made by Professor Pammel at La Crosse, Wis., is of special interest because it contains an unusually large number of interesting lichens for a small collection. With the exception of the single specimen from Illinois, the plants are all recorded from states whose lichen floras are little known; hence the record is the more needed.

LIST OF SPECIES AND VARIETIES.

Usnea barbata (L.) Fr., var. *florida* Fr. On trees, Socorro county, New Mexico, March, 1895. Coll., C. J. Herrick. Plants well developed but sterile.

Theloschistes parietinus (L.) Norm.? On *Celtis occidentalis.* Rooks county Kan., December, 1893. Coll., E. Bartholomew. Sterile, but the thallus seems characteristic.

Theloschistes lychneus (Nyl.) Tuck. On *Celtis occidentalis.* Rooks county, Kan., December, 1893. Coll., E. Bartholomew. Specimens finely fruited and approaching *Theloschistes polycarpus* Ehrh., Tuck.

Parmelia conspersa (Ehrh.) Ach. On rocks, Socorro county, New Mexico, April, 1895. Coll., C. J. Herrick.

Physcia stellaris (L.) Tuck. On trees. La Crosse, Wis., January, 1895. Coll., L. H. Pammel. Socorro county, New Mexico, March, 1895. Coll., C. J. Herrick.

Eq Physcia stellaris (L.) Tuck., var. *apiola* Nyl. On rocks. Socorro county, New Mexico, April, 1895. Coll., C. J. Herrick. Thallus lobes poorly exhibited in specimen seen.

Physcia obscura (Ehrh.) Nyl. On old wood. Cole county, Mo., August, 1898. Coll., C. H. Demetrio.

Peltigera pulverulenta (Tayl.) Nyl.? On earth. La Crosse, Wis., January, 1895. Coll., L. H. Pammel. The sterile specimen may be *Peltigera horizontalis*, L. Hoffm., instead, as the spores are needed to render determination certain.

Pannaria languinosa (Ach.) Koerb. On shaded rocks. Winfield Kan., 1896. Coll., R. Dunlevy.

Ephebe sp. On rocks. Socorro county, New Mexico, April, 1895. Coll., C. J. Herrick. The plant is sterile and shorter, and more densely tufted than *Ephebe pubescens* Fr.

Omphalaria pulvinata (Nyl.) On limestone. Cole county, Mo., August, 1898. Coll., C. H. Demetrio. Sterile, but the habit thoroughly characteristic as well as presence of *Gloeocapsa* as the algal symbiont.

Leptogium lacerum (Sw.) Fr. On mosses along ledges. Cole county Mo., August, 1898. Coll., C. H. Demetrio.

Leptogium chloromelum (Sw.) Nyl.? On dead branches. Cole county Mo., August, 1898. Coll., C. H. Demetrio. Sterile, and upper surface densely granulate.

Placodium elegans (Link.) DC. On limestone. La Crosse, Wis., January, 1895. Coll., L. H. Pammel.

Placodium cinnabarrinum (Ach.) Anz. On rocks. Socorro county, New Mexico, March, 1895. Coll., C. J. Herrick.

Placodium aurantiacum (Lightf.) Næg. and Hepp. On rocks and trees. La Crosse, Wis., January, 1895. Coll., L. H. Pammel.

Placodium cerinum (Hedw.) Næg. and Hepp. On trees. La Crosse, Wis., January, 1894. Coll., L. H. Pammel. The peculiar waxy-yellow form with some *Pruinose apothecia*; common on *Ulmus.*

Placodium ferrugineum (Huds.) Hepp. On trees. La Crosse, Wis., January, 1895. Coll., L. H. Pammel.

Placodium vitellinum (Ehrh.) Næg and Hepp. On sandstone. La Crosse, Wis., January, 1895. Coll., L. H. Pammel, and on some substratum from Winfield, Kan., 1896. Coll., R. Dunlevy.

Lecanora subfusca (L.) Ach. On trees. La Crosse, Wis., January, 1895. Coll., L. H. Pammel.

Lecanora varia (Ehrh.) Nyl. On trees. Emma, Mo., July, 1898. Coll., C. H. Demetrio.

Lecanora calcarea (L.) Sommerf., var. *contorta* Fr. On limestone. La Crosse, Wis., December, 1894. Coll., L. H. Pammel. A widely distributed, but rare lichen.

Lecanora privigna (Nyl.) var. *pruinosa* Auctt. On rocks. Cole county, Mo., August, 1898. Coll., C. H. Demetrio.

Rinodina oreina (Ach.) Mass. On rocks. Socorro county, New Mexico, March, 1895. Coll., C. J. Herrick.

Pertusaria velata (Turn.) Nyl. On trees. La Crosse, Wis., January, 1895. Coll., L. H. Pammel.

Caldonia symphycarpa (Fr.) On earth. Cole county, Mo., August, 1898. Coll., C. H. Demetrio.

Caldonia cristatella (Tuck.) On old wood. Cole county, Mo., August, 1898. Coll., C. H. Demetrio.

Biatora russellii (Tuck.) On limestone. La Crosse, Wis., Janнary, 1895. Coll., L. H. Pammel.

Biatora rubella (Ehrh.) Rabenh. On trees. Emma, Mo., October, 1898. Coll., C. H. Demetrio.

Biatora fuscorubella (Hoffm.) Tuck. On trees. La Crosse, Wis., December, 1894 Coll., L. H. Pammel.

Biatora atrogrisea (Delis.) Hepp. On *Ulmus americana*. Rooks county, Kan , December, 1893. Coll., E. Bartholomew. Exciple dark and hypothecium brownish-yellow. Spores twenty-five to forty-five by three to four mic. A lichen seldom collected in the territory.

Lecidea enteroleuca (Fr) On trees. La Crosse, Wis., December, 1894. Coll., L. H. Pammel.

Buellia spuria (Schær.) Arn. On rocks. Socorro county, New Mexico, March, 1895. Coll., C. J. Herrick.

Buellia myriocarpa DC., (Mudd.) var. *polyspora* Willey. On trees. La Crosse, Wis., December, 1894. Coll., L. H. Pammel. A lichen seldom detected.

Graphis scripta (L.) Ach. On trees. La Crosse, Wis., December, 1894. Coll., L. H. Pammel. And Emma, Mo., October, 1898. Coll., C. H. Demetrio.

Arthonia lecideella (Nyl.) On trees. La Crosse, Wis., December, 1894. Coll., L. H. Pammel. A lichen common in the territory, but little known till recently.

Arthonia dispersa (Schrad.) Nyl. On *Fraxinus viridis*. Rooks county, Kan., December, 1893. Coll., E. Bartholomew.

Endocarpon miniatum (L.) Schær. On rocks. La Crosse, Wis., December, 1894. Coll., L. H. Pammel. And Magdalena mountains, New Mexico, April, 1895. Coll., C. J. Herrick.

Endocarpon pusillum (Hed.) On limestone. La Crosse, Wis., January, 1895. Coll., L. H. Pammel.

Endocarpon pusillum (Hedw.) var. *Garovaglii* Kph. On earth. Kane county, Ill., July, 1895. Coll., B. Fink.

Endocarpon hepaticum (Ach.) On earth. Cole county, Mo., August, 1898. Coll., C. H. Demetrio.

Staurothele umbrina (Wahl.) Tuck. On rocks. La Crosse, Wis., December, 1894. Coll., L. H. Pammel. A lichen not commonly collected.

Verrucaria fuscella (Fr.) On limestone. La Crosse, Wis., January, 1895. Coll., L. H. Pammel. Quite as rarely collected as the last.

Verrucaria muralis (Ach.) On limestone. Rooks county, Kan., March, 1893. Coll., E. Bartholomew. And La Crosse, Wis., January, 1895. Coll., L. H. Pammel.

Pyrenula punctiformis (Ach.) Naeg., var. *Fallax* Nyl. On trees. Emma, Mo., July, 1898. Coll., C. H. Demetrio.

Pyrenula thelena (Ach.) On trees. Emma, Mo., July, 1898. Coll., C. H. Demetrio.

POWDERY MILDEW OF THE APPLE.

BY L. H. PAMMEL.

There has been much discussion on the subject of powdery mildew of the apple. It has been referred to several genera but Sorauer* in his book on "Plant Diseases" and Tubeuf† in his work on "Plant Diseases" reports the *Podopshœra oxyacanthœ* DC., as destructive to the apple, and makes the statement that it is abundant upon the apple and pear in America. Frank‡ in the second edition of his work on "Plant Diseases" makes a statement somewhat similar to that of Tubeuf. These statements are undoubtedly based upon the work of Galloway,§ who paid some attention to the subject of a powdery mildew upon the apple. Several American writers have briefly referred to the occurrence of a mildew upon apples, among them, Fairchild and Galloway, who made some experiments in treating this disease. Professor Galloway,‖ in a paper on the common mildew of the cherry, records the occurrence of this fungus upon the apple, and it is also recorded here upon the quince and wild crab. In a circular issued by Galloway,¶ mention is made of this fungus under the name of *Podosphœra oxyacanthœ* and in a later paper** the fungus is again referred to under the

* Pflanzen Krankheiten 330.
† Pflanzen Krankheiten 193.
‡ Die Pilzp. Frank. d Pflanzen 259.
§ Circ. U. S. Dept. of Agrl., Div. of Vegetable Pathology 8.
‖ Rep. Dept. Agrl. 1888: 353.
¶ U. S. Dept. Agrl., Div. Veg. Path. 8. See also Zeitsch f. Pflanzen 1:97.
** Jour. Myc. 6:14.

name of *Podosphaera oxyacanthae* in which Galloway* makes the statement that powdery mildew, *Podosphaera oxyacanthae*, is especially destructive to seedlings in the nursery, attacking them soon after the leaves unfold and continuing throughout the growing season, making it impossible to bud them with any success. There is still another reference by Galloway† to this same fungus.

There may be several fungi concerned in this work. Dr. Magnus‡, in 1898, reported the fungus *Sphaerotheca mali* from Süd Tirol on apple in which he confirms the conclusions of Professor Burrill. The same year he reported it from Tirol.§

Galloway‖ was aware of the occurrence of another fungus on the apple, as will be seen from the following, which appeared as a foot note in his article on powdery mildew: "We have recently received from Mr. Swingle, of Kansas, an erysiphæ infesting apple seedlings, which does not appear to be this species." Whether actual perithecia of *Podosphœra oxyacanthœ* on apple have been commonly seen in this country is very doubtful. It has been assumed to be *Podosphaera oxyacanthœ* in most cases. Like other mildews, climatic conditions do not always favor the development of perithecia. As an illustration we may cite *Erysiphe graminis*, which rarely produces perithecia in Iowa.

F. von Thümen¶ records the *Sphœrotheca castagnei* Lev. *F. mali* in Austria. He considers it only a well developed form of the species. In this he agrees with the well-known German phytopathologist, Sorauer. Sorauer[1] states that perithecia have not been found on leaves, although the conidia are abundant. Perithecia, however, occurring on the shoot.

Fairchild[2] in his report on the successful treatment of this disease, doubtfully refers this fungus to *Podosphœra oxyacanthae.*

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* Rep. U. S. Dept. of Agr. 1889: 414.

† Farmers' Bulletin, Office of Exp. Sta. 7:14. (Jour. Myc. 7:256.)

‡ Ber. d. Dutsch. Bot. Gesellsch, 16: 331. 1898.

§ Die Enpipheen Tirols, Ber. Naturw-Med. Ver. Innsbruck 24: Separate, 5. 1898.

‖ Rep. U. S. Dept. of Agrl. 1889: 414.

¶ Ueber einige besonders beachtenswerthe durch parasitiche Pilze hervorgerufen Krankheiten der Apfelbaumblatter. Lab. Chem-phys. Versuchss Stat. f. Wein u. Obsbau. Klosterneuburg 14: Abst. Zeitsch f. Pflanzenk 1: 167.

1 Phytopathologische Notizen. Der Mehlthau der Apfelbaume Hedwigia 28: 8. He also has a foot note under the Galloway article, Zeitsch f. Pflanzenk 1: 97 in which he states what has been found in Germany.

2 Jour. Myc. 7: 256.

A reference to the occurrence of the disease in New Jersey is made by Dr. Halsted,* who states that the fungus is very destructive to young twigs, and does its greatest damage to young nursery stock.

Professors Burrill and Earle† do not record it under *Spaerothœca castagnei*, or *S. pannosa*, the form occurring upon other members of the order *Rosaceœ*, nor do they mention the fungus *Podosphœra oxyacanthœ* as occurring upon *Pyrus*, although they record it upon several species of *Cratœgus*. Professor Earle,‡ in a paper on notes on North American forms of *Podosphœra oxyacanthœ*, discusses the various American forms of this polymorphic species in which he records the variability of the species upon various members of genus *Prunus*, *e. g.*, *Prunus cerasus*, *P. americana*, *P. domestica*, *P. padus*, and describes the fungus also on *Spiraea tomentosa* and *Amelanchier canadensis*. The *Podosphaera oxyacanthae* on *Amelanchier canadensis* is also mentioned by Tracy and Galloway,§ and likewise on two species of *Crataegus*.

Bessey‖ reports the occurrence of *Podosphaera kunzei* Lev., which is of course synonymous with *Podosphaera oxyacanthae* on seedling apples, frequently producing much injury. In a later paper Bessey¶ records the same species on the apple.

Atkinson,[1] in his paper on Erysipheæ, from Carolina and Alabama, reports *Podosphaera oxyacanthae* upon *Crataegus punctata*, but makes no mention of a mildew on the apple.

Dr. Davis,[2] in a supplementary list of parasitic fungi of Wisconsin, makes a statement that *Podosphaera oxyacanthae* was rather common on *Pyrus coronaria* in 1888, and records it also on *Cratœgus tomentosa*.

Trelease[3] under *Podosphaera tridactyla*, which is synonymous with *P. oxyacanthae*, mentions the common occurrence of this species on *Prunus*, but does not refer to its occurrence on the apple.

Seymour[4] lists the *Podosphaera oxyacanthae* on *Prunus and*

*Rep. Bot. Dept. New Jersey Agr. Ex. Sta. 1892: 337.

† Parastic fungi of Ill. State Lab. Nat. Hist. Pt. 2.

‡ Bot. Gazette 9: 24.

§ Jour. Myc. 4: 34.

‖ Erysiphei, Biennial Rep. Ia. Agr. Coll. 1877: Separate 4.

¶ Bull. Ia. Agr. Coll. Dept. Bot. 1884: 141.

1 Jour. of Elisha Mitchell Sci. Soc. 7: Separate 9.

2 Wis. Acad. Sci. Arts and Letters, 9: 157.

3 Preliminary list of Parasitic Fungi of Wis. Trans. Wis. Acad. Sci. Arts and Letters 6: 112. Separate 9.

4 List of fungi Coll. in 1891 along Northern Pacific R. R., Proc. Boston Soc. Nat. Hist. 24: 184.

Spiraea, but there is no mention of its occurrence on *Pyrus*.

Hitchcock* records the occurrence of *Podosphaera tridactyla* upon *Crataegus tomentosa*, *C. punctata* and seedling cherries, but he does not mention the apple.

Weber† reports *Podosphaera tridactyla* on cultivated cherry and wild plum, but nowhere is any mention made of *Sphaerotheca mali* or any other mildew upon the apple.

In the *Perisporaceae* of the Kellerman & Werner‡ list in the catalogue of Ohio plants, *Podosphaera oxyacanthia* is reported on *Spyraea* and *Prunus cerasus*, but there is no mention of the occurrence of powdery mildew on the apple.

Ellis and Gerard,§ who worked up the fungi in catalogue of plants of New Jersey, do not report the apple as affected.

Burrill‖ correctly refers the apple powdery mildew to *S. mali* (Duby), Burrill.

Duby¶ wrote a very short description of this species under *Erysiphe mali.* Burrill who examined the *E. mali* Duby, in Roumeger's fungi Gallici exsiccati, says it appears to be a *Sphaeratheca* and the same as the American material. There is also another *E. mali*, Moug[1] which is considered to be by these authors a form of *Alphitomorpha adunca.* There can be little doubt that our fungus is identical with that described by Duby, and that the European *Sphaerotheca castagnei* f. *mali*, sometimes referred to this species, is identical with the American form. The *S. leucotricha* E. and E.,[2] has also been referred to the species.

The writer, in 1893, called attention to the common occurrence of this fungus in Iowa[3] under the name of *Sphaerotheca mali*, following the Burrill nomenclature.

Fink[4] called attention to its occurrence in the vicinity of Fayette, in 1894. The writer distributed this fungus from Iowa[5] in 1893?, and A. J. Grant,[6] from Newfane, Vt., in 1895. Quite recently Grant[7] has figured and described the fungus.

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* Bull. Ia. Agr. Coll. Bot. Dept. 1886: 64.

† Cat. Fl. Nebr. 50.

‡ Geology of Ohio, 7: 350.

§ New Jersey Geological Survey 2: 507.

‖ In Ellis and Everhart, N. A. Pyrenomycetes 6.

¶ Bot. Gallicum 1: 869.

1 Wallroth Fl. Cyrpt. Germ. 4: 755.

2 Jour. Myc. 4: 58 Burrill, in Ellis and Everhart N. Am. Pyreu. 6.

3 Bull. Ia. Agrl. Exp. Sta. 23: 921. Proc. Ia. Acad. of Sci. 1[4]: 92. 1893.

4 Proc. Ia. Acad. of Sci. 1[4] 103. Blights, Orchids and Ferns 7: 1894.

5 Ellis and Everhart N. Am. Fung. No. 3213.

6 Fung. Colunb. No. 926.

7 Bull. Torrey Bot. Club. 26: 373. *pl. 364*.

He first found the fungus late in November, 1892, on a few belated leaves clinging to the adventitious shoots from the stump of a young apple tree in Newfane, Vt. He has had access to the material in the Ellis herbarium, and finds it represented from Missouri (Demetrio), Kansas (Kellerman & Swingle). Grant observes that this mildew is probably not uncommon, but is rarely collected because its perithecia are on the shoots instead of the leaves, and also because the perithecia do not mature until very late in the autumn. In the Mississippi valley the perithecia mature much earlier. They are common in September, and some may be found in August. But our climate is so much drier than that of the New England states, and this accounts for the early maturation of the perithecia at Ames.

So far as the writer knows the apple fungus occurring in Iowa is *Sphærotheca mali* and not *Podosphæra oxyacanthæ*. Professor Burrill, however, also reports the *Podosphærn oxyacanthæ* on *Pyrus malus*. This fungus may be characterized as follows: Amphigenous, mycelium white or frequently slightly fuscous, submembranceous, persistent. Perithecia few or numerous, immersed in the mycelium; small; seventy-five to eighty-five appendages of two kinds; one kind consists of one or more dark, straight, jointed, occasionally forked at the end; the other consists of short, colorless, floccose, rudimentary appendages. Each perithecium has a single ascus which usually contains six ascospores. This fungus occurs on the leaves and stems in the nursery, especially sprouts around old trees. In such places it is extremely abundant at times. It is as abundant in Illinois as in Iowa.

Professor Burrill in commenting upon this fungus says: "This exceedingly interesting species has not been well separated from *Podosphæra oxyacanthæ* which occurs on the same host and to casual observation has much the same appearance. In our species the tips of the large appendages are occasionally forked (once or even slightly twice), which again may have been confusing. But these vague, stiff branches are totally unlike the dichotomous divisions of *Podosphæra*, and otherwise the species are very distinct. The tuft of short, interwoven rudimentary appendages, like a dense cluster of short roots, is a very characteristic mark."

This fungus is of considerable economic importance. Mr. Stewart writes me he has not commonly met with it in New

York the past season. The colorless mycelium creeping over the surface sends small rounded suckers (haustoria) into the epidermal cells, and produces numerous colorless erect hyphæ (conidiophores) that bear the spores (conidia) in chains. The conidia germinate in a short time by producing a short thread. They may often be found germinating on the plant. These spores serve to propagate the fungus during the summer while the spores found in the brown perithecia tide the fungus over the following spring. As a result of the attacks of this fungus the leaves become dry and so far as their function is concerned, that of assimilating food, are entirely worthless. As stated from the quotation from Professor Galloway they are unfit for budding.

Treatment.—Professor Galloway has shown that ammoniacal carbonate of copper will effectually prevent the disease, and I may add that inasmuch as Bordeaux mixture has proved so effectual on the college grounds in holding in check the powdery mildew of the cherry, it may prove efficacious for this disease, and we advise the use of this fungicide in preference to ammoniacal carbonate of copper.

QUINCE FRUIT WITH AN IMMENSE NUMBER OF SEEDS.

BY L. H. PAMMEL.

Several years ago there was brought to me a quince, *Pyrus cydonia*, containing much more than the usual number of seeds. The genus *Pyrus* has from two to five ovaries and in each ovary are two ovules. Bailey in the revised edition of "Gray's Field, Forest and Garden Botany"* states that the five cells are normally many seeded. In the case under consideration the fruit had a perfectly normal appearance of five cells and over one hundred seeds. They are shown in the accompanying illustrations.

*161.

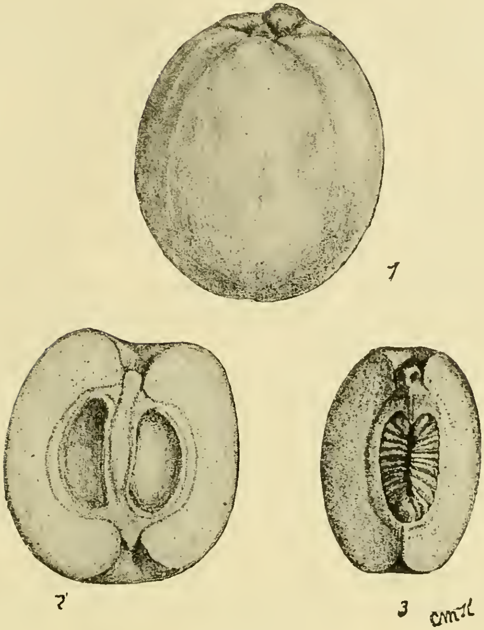

Fig. 12.

BASIDIOMYCETÆ OF CENTRAL IOWA.

ALICE WARD HESS AND HARRIET VANDIVERT.

A number of investigators have listed the Phanerogams in different parts of the state. There are, however, only a few lists of the Saprophytic fungi of the state. Bessey* under the head of "Preliminary list of Carpophytes of the Ames Flora" lists quite a number of species and Macbride† also makes a contribution along this line, especially the species found by him in eastern Iowa.

Although Ames is in a prairie country, a number of interesting species occur in the woods along the Skunk river and its tributaries. The large woods along Squaw creek, west of the college, afford a number of interesting species. We are greatly indebted to Prof. Charles H. Peck, of Albany, N. Y., who has identified many of the species for us. Dr. Wm. Trelease has identified some of the *Lycoperdaceæ*. Our thanks are

* Bull. Dept. of Bot. Ia. Agrl. Coll. 1884:145.
† The Saprophytic Fungi of Eastern Iowa. Bull. Lab. Nat. Hist. 1:30, 181.

also due to C. M. Perrin for a number of interesting puff balls and Prof. George F. Atkinson for several favors. Specimens of all the species have been preserved in the Herbarium of the Iowa State College.

BASIDIOMYCETÆ.

NIDULARIACEÆ.

Crucibulum vulgare Tul. Ames.

Cyathus vernicosus, DC. Ames.

LYCOPERDACEÆ.

Geaster saccatus Fr. Ames. (Perrin, Carver.)

Lycoperden atropurpurem Vittad. Ames. (Perrin.)

L. bovista L. *L. giganteum* Batsch. This large puff ball is not infrequent in open pastured woods in Boone and Story counties. Ames. (Pammel, Bessey.)

L. cyathiforme Bosc. Ames. (Pammel.)

L. favosum Rosk. Ames. (Perrin.)

L. gemmatum Batsch. Ames. (Pammel, Carver, Brown, Hess, Perrin.)

L. pyriforme, Shaeff. Ames. (Pammel, Raymond.)

L. wrightii, B & C. Ames. (Pammel, Hess, Vandivert, Raymond.)

Secotium acuminatum Mont. Ames. (Perrin, Perrin and Otto, Pammel, Raymond.)

Bovista plumbea Pers. Ames. (Pammel, Carver, Perrin, Hess and Vandivert).

B. pilèa ,B & C. Ames. (Hess and Vandivert.) Apparently not common. The species reported by Bessey. l. c. 145.

Mycenastrum spinulosum Pk. Ames. (Pammel, Perrin.) Common some years ago.

PHALLACEÆ.

Phallus impudicus L. Ames. (Pammel.) Bessey l. c. 135 also reports *Simblum rubescens* Gerard and *Phallus duplicatus* Bosc.

AGARICACEÆ.

Collybia radicata Rehl. Ames (Hess and Vandivert).

C. amabilipes Pk. Ames (Hess and Vandivert).

C. platyphylla Fr. Ames (Hess and Vandivert).

Crepidotus mollis Schaeff. Ames (Hess and Vandivert).

Cropinus comatus Fr. Ames, common.

C. plicatilis (Curt) Fr. Ames (Hess and Vandivert).

C. micaceus (Bull) Fr. Ames (Hess and Vandivert).

C. atramentarius (Bull) Fr. Ames (Hess and Vandivert).

Lentinus LeComtei Fr. Ames (Hess and Vandivert).

L. lepidieus Fr. Ames (Hess and Vandivert).

Lepiota morgani Peck. Ames (Hess and Vandivert). Abundant, forming large fairy rings.

L. acutesquamosa Weinm. Ames (Hess and Vandivert).

L. pusillomyces Pk. Ames (Hess and Vandivert).

Marasmius campanulatus Peck. Ames (Hess and Vandivert).

M. ratula (Scop) Fr. Ames (Hess and Vandivert).

Mycena galericulata Scop. Ames (Ethelda Morrison).

Omphalia campanella Batsch. Ames (Hess and Vandivert).

Panus torulosus Fr. Ames (Hess and Vandivert).

Pleurotus atrocaeruleus Fr. Ames (Hess and Vandivert).

P. griseus Pk. Ames (Hess and Vandivert).

P. ostreatus Fr. Ames (Hess and Vandivert).

Pluteus cervinus Schaeff. Ames (Ethelda Morrison, Vandivert).

Schizophyllum commune Fr. Ames (Hume, Hess and Vandivert).

Stropharia stercoraria Fr. Ames (Hess and Vandivert).

POLYPORACEÆ.

Daedalea confragosa Pers. Ames (Hess and Vandivert).

Favolus canadensis Klotsch. Ames (Hess and Vandivert). Common.

Fistulina hepatica Fr. Ames (Carver).

Gloeoporus conchoides Mont. Ames (Hess and Vandivert).

Merulius lachrymans Ames (Barnes).

Fomes applanatus (Pers) Wallr. Ames (Pammel).

F. lucidus Leys. Ames (Hess and Vandivert).

F. igniarius (L) Fr. Steamboat Rock (Pammel and Hume).

Polyporus brumalis F. Ames (Hess).

P. sulphureus (Bull) Fr. Ames (Pammel).

P. picipes Fr. Ames (Hess and Vandivert).

P. gilvus Schw. Ames (Hume, H. L. Eckles).

P. adustus Willd. Ames (Hess and Vandivert).

P. brumalis (Pers) Fr. Ames (Hess and Vandivert).

P. resinsous Ames (Hess and Vandivert).

P. radiatus Schw. Ames (Hess and Vandivert).

Polystictus versicolor Fr. Ames (Pammel, Hess and Vandivert). Very common.

P. zonatus Fr. Olin (Hess).

P. pergamenus Fr. Ames (Hess and Vandivert).

P. velutinus Fr. Ames (Hess and Vandivert).

Trametes cinnabarina Fr. Ames (Hess and Vandivert, Perrin, Carver, Pammel).

T. pickii Fr. Ames (Hess).

T. olivensis Berk. Ames (Hess and Vandivert).

T. lanatus Fr. Ames (Hess and Vandivert).

HYDNACEÆ.

Hydnum coralloides Scop. Ames (Hess and Vandivert).

Irpex sinuosus Fr. Ames (Pammel).

CLAVARIACEÆ.

Physalacria inflata Pk. Ames (Hess and Vandivert).

THELEPHORACÆ.

Stereum fasciatum Schm. Ames (Hess and Vandivert).

Corticium oakesii Ames (Hume).

Thelephora cladonia Schw. Ames (Hess and Vandivert).

TREMELLACEÆ.

Hirneola auricula-judaea (L) Berk. Ames (Hume).

GUEPINIA BIFORMIS PECK.

Pileus stipitate, cupulate and erect when young, becoming curved to one side with age and often unilaterally split to the base and lobed on the margin, tough and gelatinous when moist, tapering below into the stem, minutely tomentose or velvety, grayish buff; hymenium glabrous, reddish-brown or raisin color, even or marked with radiating folds or ridges; stem distinct or sometimes seriately confluent at the base, terete or compressed, tough, velvety tomentose, grayish buff; spores oblong, colorless, often curved, continuous or obscurely one-to three-septate ten to fifteen *u* long, 6 to 7.5 broad.

Pileus 6 to 12 mm. broad; stem 4 to 10 mm. long, 2 to 4 thick. Decaying wood of deciduous trees. Ames, Iowa, September, 1899. Miss Alice Hess.

Since this paper has been prepared the description has been published in Bull. Torrey Bot. Club, **27**:20.

EXPLANATION TO PLATE,

I. Polyporous brumalis (Per.) Fr.
II. Hydnum coralloides Scop.
III. Morchella esculenta Pers. *a* spore sack containing eight spores.
IV. Guepinia biformis Peck. *b* Mycelium, *c* spores.
V. Lycoperdon giganteum Batsch. *d* Capillitium, *e* spores.
VI. Panus torulosus Fr.

THE ORCHIDACEÆ OF IOWA.

BY T. J. AND M. F. L. FITZPATRICK.

The Orchidaceæ comprises 5,000 species distributed among 410 genera. The species are mostly tropical but are found in temperate climates, one as far north as the 68th degree of latitude. The orchids are of especial interest to lovers of flowers because of their great beauty, peculiar forms, sweet fragrance and strange habits, and are great favorites with floriculturists in the old world as well as in the new.

Several of our Iowa species are of brilliant color, sweet odor, and attractive form; the remaining ones being quite inconspicuous. They all merit protection and cultivation if only to perpetuate them in their native haunts. No doubt it would be more or less difficult but nevertheless a very worthy effort for Iowa floriculturists to collect and perpetuate cur native forms.

At no distant date with the increasing cultivation of the soil our members of this singularly beautiful family are apparently destined to disappear from our state. Several of them are already rare and the others fast becoming so. The changing conditions incident to the settling of the state have upset the pre-existing balance of nature and in the new order of things many species of plants turn tramp and set out for more congenial surroundings, but our species of the orchids seem to be too respectable to be tramps and like most members of a worn-out nobility they face extinction.

Of the twenty-two species belonging to the state and representing eleven genera our collection contains twenty.

From the data at hand we find sixteen species in Johnson county; Muscatine and Fayette counties, each with thirteen; ten in Winneshiek; seven in Story; Scott, Emmet, and Jasper counties, each with four; Woodbury county, three; Hamilton, Delaware, Cherokee and Poweshiek counties, each with two; and one in each of the following counties, viz: Jones, Howard, Winnebago, Webster, Pottawattamie, Hancock, Wayne, Benton, Page, Crawford, Appanoose, Allamakee, Ringgold, and Jefferson. This would indicate that the majority of the species are confined to the eastern portion of the state.

Cypripedium hirsutum Mill. (1768.) This is our most frequent lady's slipper, once common in rich woods and thickets, usually near water courses throughout our area, now gradually disappearing because of the destruction of the timber and too close pasturing. In favored nooks this species may still be found in considerable numbers but such localities are few and remote. Specimens vary from twelve to twenty inches in height and are pubescent or hairy. The sepals are yellowish or greenish, often more or less purplish. Petals more or less twisted. The lip varies from one to two inches in length, pale yellow, with purple lines. Most writers state that this species is inodorous, but this is not true. Many specimens have a penetrating, sweet, honey-like odor which is very noticeable when a number are placed in a vasculum for a short time. It has been discovered by Prof. D. T. MacDougal that the glandular hairs contain a poisonous oil which affects the skin in a similar manner to that of toxicodendrol. We have had no poisonous results but it is claimed that one-half the people are immune and we may belong to that class.

The specimens in our herbarium have been collected from Winneshiek, Fayette, Muscatine, Johnson, and Decatur counties. We have observed the species in Allamakee and Ringgold counties and have seen specimens from Delaware county in the S. U. I. herbarium. It is reported from Scott (Nagel and Haupt), Story (Hitchcock), and Cherokee and Woodbury (Pammel) counties. Fruiting specimens were collected in Winneshiek and Appanoose counties.

A handsome species.—Much of the effort wasted upon foreign house plants could well be given to this native plant and meet with happy returns. *C. pubescens* Willd, (1805).

Arthur's Flora of Iowa, 1876, p. 31; Bul. Lab. Nat. Hist., S. U. I., Vol. 3, p. 212; Proc. Iowa Acad. of Sciences, Vol. 3, p. 133; Vol. 4, p. 103; Vol. 5, pp. 128 and 165; Vol. 6, p. 197; St. Louis Acad. of Science, Vol. 5, p. 519; Nagel and Haupt in Proc. Dav. Acad. of Sciences, Vol. 2; Bul. Torr. Bot. club, Vol. 6, p. 206.

Cypripedium parviflorum Salisbury (1791). Forms in our collection from Winneshiek, Johnson, Decatur, and Crawford counties have been referred to this species. It is also reported from Scott county by Nagel and Haupt in Proceedings of Davenport Academy of Sciences.

We have long doubted that this is a valid species. At best it very closely simulates the preceding. It is usually distinguished by its smaller size, brighter color and smaller size of the lip, and the presence of a sweet odor. Our material affords specimens varying in height from seven to twenty inches. The color of the flowers of the specimens determined by Professor Norton of the Missouri Botanical gardens, and of specimens collected in Muscatine county by Mr. Reppert, agree with the small stature and small flowered forms which may with safety be referred to this species if such is possible. As to the character of possessing an odor we have no faith in it whatever as a distinguishing factor. The length of the lip varies in our material from one to one and a half inches, while the lip of the preceding species varies in length from one to two inches. Professors Beal and Wheeler in their "Flora of Michigan," page 138, say that the preceding species is, "Much coarser in every way, with strongly plaited hairy leaves, and large light yellow flowers, more or less brown spotted. Small forms of this are often mistaken for *C. parviflorum*, but the two species are apparently distinct in Michigan." From this plain statement it will be readily perceived that the two forms at best are *not* readily distinguished and further that the size of the lip is no constant character. Britton and Brown in their "Illustrated Flora," Vol. 1, page 459, admit that this form appears to intergrade with the preceding, or of which it may be but a form. Professor Gray in his Manual, sixth edition, says it seems to pass into the preceding. Professor Wood, in his Botanist and Florist, says that *C. pubescens* Sw., a synonym for the preceding, has the "Stems usually clustered," which is contrary to our experience, though in more favored localities this could readily be the case, and further, "Lip compressed laterally, *moccasin-shaped*, leaves broadly lanceolate," whereas for *C. parviflorum* Salisb. he gives, "Leaves lanceolate, lip depressed." The depression of the lip seems not to be considered of any importance by botanists generally, while any distinction founded upon difference in the form of the leaves will so far as these two forms are concerned end in disappointment. Professor MacMillan in his "Metaspermae of the Minnesota Valley," page 163, gives the two species but makes no comment as to their relationship or identity. Bigelow in his "Florula Bostoniensis," second edition, 1824, p. 327, gives only *C. parviflorum* Willd. and, as a synonym, *C. calceolus* Mx. The description there given will apply as well to one form as the other; that is, as well to *C. hirsutum* Mill. as to *C. parviflorum* Salisb.

Dr. Torrey, in his "Flora of the State of New York," Vol. 2, page 287, says: "This *C. parviflorum* Salisb. and the preceding species, *C. pubescens* Swartz, are very nearly allied, and many of our botanists do not consider them distinct. Since my attention has been particularly directed to these plants, I have had no opportunities of comparing them in the living state. The diagnostic characters given above are those of Hooker, who has no doubt (having examined cultivated specimens) that they are perfectly distinct." On comparing the characters of the two forms the only difference discernible is the size and depression of the lip, the form of the sepals, and some imaginary distinctions in the coloring of the sepals and petals.

Amos Eaton, in his "Manual of Botany of North America," seventh edition, 1836, page 271, gives, after eliminating the common phrases, the following for *C. parviflorum*, ' Lobes of the style triangular, acute," and for *C pubescens*, "Lobes of the style triangular, oblong, obtuse " The other apparent differences are merely a play on words.

Professor Rafinesque, in his "Medical Flora," edition, 1828, page 142, says, "Many botanists have made two species, *C. pubescens* and *C. parviflorum* of this, to which the previous and better name of *C. luteum* ought to be restored. I have ascertained that they form only one species, affording many varieties, some of which are: var. *pubescens*, entirely pubescent, even the flowers; var. *glabrum*, nearly smooth; var. *grandiflorum*, slightly pubescent, labellum very large; var. *parviflorum*, slightly pubescent, labellum very small; var. *maculatum*, labellum more or less spotted, with red dots, lobule often red; var. *biflorum*, with two flowers and bracteoles; var. *concolor*, the whole flower yellow or yellowish, unspotted; var. *angustifolium*, leaves and bracteoles lanceolate. A multitude of intermediate varieties or deviations may be seen, with undulate or spiral sepals, obtuse or acute lobule, broader or narrower leaves, etc."

While all this may not be to the reader's taste yet the description together with the figure given leaves no doubt in our minds as to what Rafinesque referred and further it well illustrates the difficulty of trying to make distinctions upon supposed differences.

Professor Hitchcock, in Trans. St. Louis Acad. of Science, Vol. 5, p. 519. says, "*C. parviflorum* Salisb. has been reported, but I doubt if it occurs." The locality he refers to is Ames, Story county.

We have now clearly shown the confusion into which botanists have fallen in trying to make two species out of forms having no well defined limit between them. The only way out of the difficulty is to recognize but one species. As *C. hirsutum* Mill. is the older it should stand, *C. parviflorum* Salisb. must fall.

Bul. Lab. Nat. Hist., Vol. 3, p. 212; Proc. Iowa Acad. of Sciences, Vol. 5, p. 165; Vol. 6, p. 197; Nagel and Haupt in Proc. Dav. Acad. of Sciences, Vol. 2; Trans. St. Louis Acad. of Science, Vol. 5, p. 519.

Cypripedium candidum Willd. (1805.) A pretty little species, six to twelve inches high, with elliptic or lanceolate leaves, and solitary flowers. The lip is white, purple inside. This species is found in bogs and low prairies, from May to July, and seems formerly to have been quite frequent but is now rarely found. Our rapid development has no doubt changed conditions so radically that the species is unable to adapt itself to its new environment and must soon perish.

The specimens examined were collected in Emmet, Fayette, Muscatine, and Page counties It has been reported from Scott (Nagel and Haupt), Benton and Johnson (Shimek), Story (Hitchcock), and Hamilton (Pammel) counties. Dr. E. M. Reynolds informs us that it was formerly frequent in Appanoose county, but none were collected and the species is probably extinct.

Bul. Nat. Hist. S. U. I., Vol. 3, p. 212; Proc. Iowa Acad. of Sciences, Vol. 4, p. 103; Vol. 5, p. 165; Vol. 6, p. 197; Nagel and Haupt in Proc. Daven. Acad. of Sciences, Vol. 2; Plant World, Vol. 2, p. 45; St Louis Acad. of Science, Vol. 5, p. 519.

Cypripedium reginae Walt. (1788). This species is the crowning glory of the Cypripediums and like most beautiful objects it is rare and approaching extinction. When the state was in its primeval condition this species is said to have been common, but now it is rarely observed. Our specimens are from Winneshiek, Johnson, and Jasper counties; the S. U. I. herbarium has specimens collected from Winnebago (Shimek) and Muscatine (Reppert) counties. It has been reported from Fayette (Fink) and Story (Hitchcock) counties. Dr. E. M. Reynolds informs us that it was formerly frequent on the brakes of Soap creek in Appanoose county.

This species is one to two feet high, and may be found in bogs and wet woods in June and July. Two flowered forms are comparatively not uncommon. *C. spectabile* Salisb. (1791); *C. album* Ait. (1789); *C. canadense* Mx. (1803).

MacMillan, Metaspermae of the Minnesota Valley, page 163; Gray's Manual, sixth edition, p. 511; Bigelow Florula Bostoniensis, p. 328; Wood's Botanist and Florist, edition 1889, p. 326, Eaton's Manual, p. 271; Torrey's Flora of New York, p. 287; Arthur's Flora of Iowa, p. 31; Bul. Lab. Nat. Hist., S. U. I., Vol. 3, p. 212; Proc. Iowa Acad. of Sciences, Vol. 4, p. 102; Vol. 5, p. 165; Vol. 6, p. 197; Trans. St. Louis Acad. of Science, Vol. 5, p. 519.

Orchis spectabilis L. (1753). This species is to be found in rich woods during the months of May and June. It is at best only locally frequent though quite widely distributed throughout the state. Our specimens are from Fayette (Fink), Johnson, and Poweshiek (Norton) counties. We have seen specimens in the S. U. I. herbarium which were collected in Muscatine, Webster, and Pottawattamie counties. This species is reported from Story (Hitchcock) and Woodbury (Pammel) counties. A handsome species and is worthy of the attention of floriculturists.

Trans. St. Louis Acad. of Sciences, Vol. 5, p. 519; Trans. Iowa Acad. of Sciences; Vol. 3, p. 133; Vol. 4, p. 102; Vol. 5, p. 165; Bul. Lab. Nat. Hist., Vol. 3, p. 212.

Habenaria hookeriana A. Gray. (1836). During the last season we received three handsome specimens collected in June, 1899, in Winneshiek county by Herbert Goddard of Decorah. It is reported from Winneshiek county by Arthur and from Fayette county by Fink. Its native haunts are woods; in Iowa is rarely found. The variety *oblongifolia* Paine is reported from Fayette county by Fink, but this variety is no longer recognized. The locality in Winneshiek county given by Arthur is Hesper. *H. orbiculata* Goldie (1822), *H. hookeri* var. *oblongifolia* Paine (1865).

Proc. Daven. Acad. of Sciences, Vol. 3, p. 170; Gray's Manual, sixth edition, p. 508; Britton and Brown's Flora, Vol. 1, p. 461.

Habenaria bracteata (Willd.) R. Br. This species occurs in rich woods, usually solitary, once we found two together, fairly well distributed, and is infrequently found. Our material is from Winneshiek, Fayette, Johnson, Poweshiek, Jasper, and Decatur counties; specimens were examined from Muscatine county; and it is reported from Delaware county by Shimek and from Story county by Hitchcock. *Orchis bracteata* Willd. (1805); *Habenaria bracteata* R. Br. (1813); *H. viridis* R. Br. var. *bracteata* Reichenb. (1851). This species presents considerable variation in the form of its leaves and in the arrangement of its flowers.

Gray's Manual, sixth edition, p. 507; Arthur's Flora of Iowa, p. 31, edition 1876; Bul. Nat. Hist., S. U. I., Vol. 3, p. 212; Proc. Iowa Acad. of Sciences, Vol. 4, p. 102; Vol. 5, pp. 128 and 165.

Habenaria clavellata (Mx.) Spreng. Our specimens are from Fayette county and were collected by Professor Fink who reports, "Border of woods, rare." There are specimens in the S. U. I. herbarium from Muscatine county, contributed by Mr. Reppert who, in a note with the specimens, says, "Infrequent, first collected by Kenneth MacKensie, 1893; these July and September, 1894." No other localities are at present known. *Orchis clavellata* Mx. (1803); *O. tridentata* Willd. (1805); *H. tridentata* Hook. (1825); *H. clavellata* Spreng. (1826).

Proc. Iowa Acad. of Sciences, Vol. 1, part 4, p. 103.

Habenaria flava (L.) A. Gray. Our only Iowa specimen is from Muscatine county, collected by Mr. Reppert. *Orchis flava* L. (1753); *O. virescens* Willd. (1805); *Habenaria virescens* Spreng. (1826); *H. flava* A. Gray. (1840).

Habenaria leucophaea (Nutt.) A. Gray. This species is of frequent occurrence in the southern portion of the state. It may be collected during the month of June in moist low places in prairie soil. In one corner of Rose Hill cemetery, Lamoni, Decatur county, this species is frequent, as well as in many other localities in the county where the prairie soil is undisturbed. About two miles east of Humeston, Wayne county, along the Keokuk & Western track many specimens were collected on June 29, 1899. Many were three feet high. Within the railway right of way seems to be this species' only refuge. Jasper and Emmet counties are represented by specimens in our collection. The S. U. I. herbarium has a specimen from Hancock county. The species is reported from Fayette (Fink), Johnson (Shimek), Story (Hitchcock), and Cherokee (Pammel) counties. *Orchis leucophaea* Nutt. (1833–'37); *Habenaria leucophaea* A. Gray (1867).

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Arthur's Flora of Iowa, p. 31, edition 1876; Bul. Nat. Hist., S. U. I., Vol. 3, p. 212; Proc. Iowa Acad. of Sciences, Vol. 3, p. 133; Vol. 4, p. 103; Vol. 5, p. 165.

Habenaria psychodes (L.) Gray. This is reported from Fayette county by Professor Fink, who records it as rare and the habitat, wet river banks. *Orchis psychodes* L. (1753); *O. fimbriata* Ait. (1789); *Habenaria psychodes* A. Gray. (1840).

Proc. Iowa Acad. of Sciences, Vol. 1, part 4, p. 103.

Habenaria hyperborea (L.) R. Br. Reported from Winneshiek county by Arthur, who gives the locality as Hesper. Proc. of Daven. Acad. of Sciences, Vol. 3, p. 170. There are three specimens in the S. U. I. herbarium that are supposed to be Iowa specimens, but the locality for them is unknown.

Gray's Manual, sixth edition, p. 507.

Pogonia trianthophora (Sw.) B. S. P. This is a rare and local plant in Iowa. It blooms during the month of August. Our specimens are from Fayette county, collected by Professor Fink, and from Johnson county. It occurs in rich woods. *Arethusa trianthophora* Sw. (1800); *Pogonia pendula* Lindl. (1825); *P. trianthophora* B. S. P. (1888).

Arthur's Flora of Iowa, edition 1876, p. 31; Bul. Lab. Nat. Hist., S. U. I., Vol. 3, p. 212; Proc. Iowa Acad. of Sciences, Vol. 4, p. 102; Vol. 5, p. 165.

Gyrostachys cernua (L.) Kuntze. This species may be found in bogs, low prairies, and wet banks, and may be collected in August or early September. It is widely distributed over the state but is infrequently collected. Our specimens are from Muscatine (Reppert), Emmet (Cratty), Johnson, and Decatur counties. It has been reported from Fayette (Fink), Story (Hitchcock), Hamilton and Woodbury (Pammel) counties. Formerly frequent but now disappearing. *Ophrys cernua* L. (1753); *Spiranthes cernua* L. C. Rich. (1817); *Gyrostachys cernua* Kuntze (1891).

Arthur's Flora of Iowa, edition 1876, p. 31; Proc. Iowa Acad. of Sciences, Vol. 3, p. 133; Vol. 4, p. 102; Vol. 6, p. 197; Plant World, Vol. 2, pp. 44 and 183; Trans. St. Louis Acad. of Science, Vol. 5, p. 519.

Gyrostachys gracilis (Bigelow) Kuntze. Usually collected in August in open upland woods and prairies. Rather rare but occasionally frequent locally. Our specimens are from Johnson and Decatur counties. It has been reported from Winneshiek county by Arthur, who gave the locality as Decorah.

Contr. to Flora of Iowa, No 6, Proc. Daven. Acad. of Sciences. *Neottia gracilis* Bigelow (1824); *Spiranthes gracilis* Beck (1833); *Gyrostachys gracilis* Kuntze (1891).

Bigelow Florula Bostoniensis, p. 322; Bul. Lab. Nat. Hist., S. U. I., Vol. 3, p. 211; Proc. Iowa Acad. of Sciences, Vol. 5, p. 164; and Vol. 6, p. 197.

Peramium pubescens (Willd.) MacM. This species seems to be found only in the eastern portion of the state. It may be found in dry upland woods, flowering usually in August. Because of the evergreen character of the leaves this species may be collected during the winter season, but of course, only the root and leaves will be secured. As a whole the species is infrequent. Our specimens are from Muscatine (Reppert) and Johnson counties We have seen specimens from Winneshiek and Jones counties. *Neottia pubescens* Willd. (1805); *Goodyera pubescens* R. Br. (1813); *Peramium pubescens* MacM. (1892).

Bul. Lab. Nat. Hist., S. U. I., Vol. 3, p. 198; Proc. Iowa Acad. of Sciences, Vol. 5, pp. 128 and 164; Plant World, Vol. 2, p. 186.

Achroanthes unifolia (Mx.) Raf. This species seems to be the rarest of the Orchid family as represented in Iowa. Our single Iowa specimen was collected in low woods in Johnson county. The S. U. I. herbarium has one specimen from Johnson county and two specimens from Muscatine county. The Muscatine specimens were contributed by Mr. Reppert who, in a note with the specimens, says, "Found a few, once by Kenneth MacKensie, July, 1893." It is reported from Winneshiek county by Arthur, who gives the localities, Decorah and Hesper. Proc. Daven. Acad. of Sciences; Vol. 3, p. 170. *Malaxis unifolia* Mx. (1803); *Achroanthes unifolia* Raf. (1808); *Microstylis ophioglossoides* Nutt. (1818).

Bul. Lab. Nat. Hist., Vol. 3, p. 211; Proc. Iowa Acad. of Sciences, Vol. 5, p. 164.

Leptorchis liliifolia (L.) Kuntze. This species is to be found in open upland woods during May and June. It is often locally frequent but generally very infrequent. Our specimens are from Winneshiek (Goddard), Muscatine (Reppert), Johnson, and Jasper (Norton) counties. It is reported from Scott county by Nagel and Haupt in Proc. of Daven. Acad. of Sciences, Vol. 2. The data limits the species to the eastern portion of the state. *Ophrys liliifolia* L. (1753); *Liparis liliifolia* L. C. Rich. (1825); *Leptorchis liliifolia* Kuntze (1891).

Arthur's Flora of Iowa, edition 1876, p. 31; Bul. Lab. Nat. Hist., S. U. I., Vol. 3, p. 210; Proc. Iowa Acad. of Sciences, Vol. 5, p. 164.

Leptorchis loeslii (L.) MacM. This species is rare within our limits. It occurs in hillside bogs and wet thickets and may be found during May and June. Specimens before us are from Muscatine (Reppert) and Emmet (Cratty) counties. *Ophrys loeslii* L. (1753); *Liparis loeslii* L. C. Rich. (1825); *Leptorchis loeslii* MacM. (1892).

Bul. Lab. Nat. Hist., S. U. I., Vol. 3, p. 198; MacMillan's Metaspermae of the Minn. Valley, p. 173.

Corallorhiza odontorhiza (Willd.) Nutt. We have collected this species only on two occasions in Johnson county. It is usually considered rare. In August, 1896, it was common but has not been observed since. So far as we are aware this is the only locality known in the state, but it probably occurs near the Mississippi river. It may be found in rich upland woods where there is a considerable depth of decaying leaves. *Cymbidium odontorhiza* Willd. (1805); *Corallorhiza odontorhiza* Nutt. (1818).

Bul. Lab. Nat. Hist., S. U. I., Vol. 3, p, 215; Proc. Iowa Acad. of Sciences, Vol. 4, p. 108; and Vol. 5, p. 164.

Limodorum tuberosum L. (1753). This species is infrequent in the eastern portion of the state, occurring in bogs and low places during June and July. Our specimens are from Fayette (Fink), Muscatine (Reppert), and Johnson counties; and there is a specimen in the S. U. I. herbarium from Howard county. *Cymbidium pulchellum* Willd. (1805); *Calopogon pulchellus* R. Br. (1813).

Arthur's Flora of Iowa, edition 1876, p. 31; Bul. Lab. Nat. Hist., Vol. 3, p. 212; Proc. Iowa Acad. of Sciences, Vol. 4, p. 102; and Vol. 5, p. 165.

Aplectrum spicatum (Walt.) B. S. P. This species is to be found only in rich woods. Its occurrence is rather infrequent. Our specimens are from Fayette (Fink), and Johnson counties. Our last collection was obtained on May 26, 1898. *Arethusa spicata* Walt. (1788); *Cymbidium hyemale* Willd. (1805); *Aplectrum hyemale* Nutt. (1818); *A. spicatum* B. S. P. (1888).

Arthur's Flora of Iowa, edition 1876, p. 31; Proc. Iowa Acad- of Sciences, Vol. 4, p. 102; and Vol. 5, p. 164; Bul. Lab. Nat. Hist., Vol. 3, p. 211.

THE GENUS VIBURNUM IN IOWA.

BY T. J. AND M. F. L. FITZPATRICK.

Our Viburnums are few in number of species and rapidly becoming scarce in the number of individuals. They are to be found in the wooded portions, mostly eastern, of the state. The fruits of some are edible but have not been considered promising enough to warrant cultivation.

Viburnum lentago L. This is our most frequent and most widely distributed species. It seems to prefer low woods, along streams. Its white showy flowers appear in May and the bluish-black fruit, often, a half inch or more in length, matures in September. The stones are very flat and oval. The fruit of this species is sweet and edible and perhaps with proper care could be greatly improved, while the ornamental aspect of the species appeals to all. We have collected the species in Winneshiek, Allamakee, Johnson, Jefferson, Decatur, and Union counties. We have observed it in Dubuque and Appanoose counties and have examined specimens in the S. U. I. herbarium which were collected in Emmet, Delaware, Muscatine, Winnebago and Pottawattamie counties. It has been reported from Fayette (Fink), Scott (Nagel and Haupt), Story (Hitchcock), Humboldt (Macbride), and Floyd (Arthur) counties.

Arthur's Flora of Iowa, edition 1876, p. 16; Proc. Iowa Acad. of Sciences, Vol. 4, p. 90; Vol. 5, pp. 117 and 147; Vol. 6, p. 186; Flora of Iowa, p. 69; Iowa Geological Survey, Vol. 7, p. 106: Vol. 8, p. 197; Vol. 9, pp. 151 and 385; Macbride Forestry notes of Dubuque county, p. 21, Iowa Geol. Sur., Vol. 10; Trans. St. Louis Acad. of Science, Vol. 5, p. 497.

Viburnum prunifolium L. This species much resembles the preceding, from which it differs in ovate or oval obtuse or acutish leaves and slightly smaller fruit. It is reputed to have been formerly quite frequent. It is now very rarely collected. It is said to be still frequent in our southern counties but we have not detected it, more probably the southeastern counties are meant. We have rarely collected the species in

Johnson county. It is reported from Humboldt and Dubuque counties by Professor Macbride.

Proc. Iowa Acad. of Sciences, Vol. 6, p. 186; Flora of Iowa, p. 69; Iowa Geol. Sur., Vol. 7, p. 106; Vol. 9, p. 151; Macbride Forestry notes of Dubuque county, p. 21, Iowa Geol. Sur., Vol. 10.

Viburnum opulus L. This species seems to be limited to the northeastern portion of the state. We have examined specimens in the S. U. I. herbarium from Allamakee and Delaware counties. It is reported from Fayette (Fink) and Dubuque (Macbride) counties. It is found in the rough wooded portions near the streams. The fruit is globose or oval, red, edible, sometimes used as a substitute for cranberries. The species is very ornamental and in cultivation is known as the snowball.

Arthur's Flora of Iowa, edition 1876, p. 16; Bul. Lab. Nat. Hist., Vol. 3, p. 203; Proc. Iowa Acad. of Sciences, Vol. 4, p. 90; Flora of Iowa, p. 69; Iowa Geol. Sur., Vol. 8, p. 197; Macbride Forestry notes of Dubuque county, p. 20, Iowa Geol. Sur., Vol. 10.

Viburnum pubescens (Ait.) Pursh. This species is a small shrub, growing in clumps, in rocky upland woods. The leaves are sessile or on short petioles, ovate or oval, rounded or somewhat cordate at the base, acute or acuminate, coarsely dentate, velvety-pubescent beneath, mostly glabrous above. The flowers appear in May. Drupes oval, black or blackish; stone two-grooved on both faces. Our specimens are from Fayette (Fink) and Decatur counties. Specimens that are referred to this species are in the S. U. I. herbarium from Emmet and Cerro Gordo counties.

Arthur's Flora of Iowa, edition 1876, p. 16; Proc. Iowa Acad. of Sciences, Vol. 4, p. 90; Flora of Iowa, p. 69; Trans. St. Louis Acad. of Science, Vol. 5, p. 497.

V. pubescens petiolum n. var. A low shrub, three to five feet high, with slender grayish branches, opposite leaves, and cymose flowers. The leaves are broadly oval to nearly orbicular, acuminate, sharply and somewhat irregularly dentate, velvety-pubescent beneath, glabrous above, base cordate, petioles one half an inch to an inch in length; fruit oblong or oblong-oval, three to four-tenths of an inch long by two-tenths of an inch wide; stone mostly plane on one side and convex on the other, two-grooved on both surfaces.

Rocky woods; May; fruit ripe in September; infrequent; Johnson and Jefferson counties. The type was collected along Rock creek, in the southeastern part of Jefferson county. The specimens from Johnson county have heretofore b reenefèrred to *V. dentatum* L. It is possible that many Iowa specimens labeled *V. dentatum* L. belong here. Britton and Brown in their Illustrated Flora, Vol. 3, p. 230 in commenting on a form of *V. pubescens* (Ait.) Pursh. say, "A form of this species, or a related plant, with petioles one-half inch long or more, occurs in Missouri." They, doubtless, refer to the above named variety. Further study may warrant the raising of the variety to specific rank.

V. dentatum L. This species often reaches a height of twelve to fifteen feet. The leaves are glabrous on both sides or pubescent in the axils of the veins beneath. Drupe globose-ovoid, stone grooved on one side, rounded on the other. This species has been reported from Dubuque, Delaware, Jackson, Johnson, Dallas, and Winnebago counties. We have not been able to examine the material since our attention has been especially given to the genus except as to the Johnson county material which so far as we have seen belongs to the preceding. Hence its reference to *V. dentatum* L., Proc. Iowa Acad. of Sciences, Vol. 6, p. 186, is an error.

Flora of Iowa, p. 69; Iowa Geol. Sur., Vol. 8, p. 197; Macbride Forestry notes of Dubuque county, p. 20, Iowa Geol. Sur., Vol. 10; Iowa Geol. Sur., Vol. 7, p. 106.

KLEBS—LEOFFLER BACILLUS.

BY GERSHOM H. HILL, M. D., INDEPENDENCE, IOWA.

This is a scientific age. The use of scientific methods in the vocation by which a man gains a livelihood makes it both interesting and profitable. The scientific man realizes the necessity of telling the truth, the whole truth and nothing but the truth. Scientific work makes a man careful, accurate and a close observer. The scientific American is somewhat different from the scientific German. The former places a high cash value on his time; he is intensely utilitarian. The geologist is expected to furnish the cities with clay and coal to make brick for paving and for other purposes. Students in zoology and in botany must help the farmer. Thus the American people are provided with comforts and luxuries. Money is getting plenty and is being freely paid to high priced doctors and to trained nurses. The common people are learning sanitation, thus health is promoted and life prolonged.

I am a new member of the Academy of Sciences, and represent the medical profession. I embrace this opportunity to give evidence that physicians are becoming more and more scientific —hence more skillful. The physician who is not well educated, who cannot use the microscope and who does not persist in the study of medicine is not fit to practice in this one of the learned professions.

The microscope has long been used in medical colleges by students in physiology and in the examination of post mortem specimens. Now this all important instrument is being used daily by the practitioner in diagnosticating disease of the kidneys, of the luugs and of other organs. Physicians no longer put money into leather covered books. The cheapest bound books will outlive their usefulness. In order to succeed in the practice of medicine and surgery nowadays the physician must be familiar with the contents of new books and take time to glance through the latest medical journals. The microscope is as necessary to the study of some diseases as the telescope is to the obtaining an exact knowledge of the stars

Dr. Edwin Klebs of Chicago, formerly of Zurich, discovered the disease germ which is peculiar to diphtheria. Since this same germ was independently detected, identified, and utilized by Loeffler, one of our most famous bacteriologists, the medical profession has decided to call this germ peculiar to diphtheria the Klebs-Loeffler bacillus. While this germ may be found occasionally in the throats of persons who are not sick, and disease of the throat is not diphtheria unless these particular germs are present, the causative agent of diphtheria is this germ. Each case comes from some other case, and this disease is highly contagious. The period of infection is from two to seven days—oftenest two days. The constitutional symptoms of diphtheria are an elevation in the body temperature, slight chilliness, and aching in the bones. In mild cases the indisposition is not sudden nor well marked at first. The local symptoms are swelling about the neck and soreness of the throat.

Diphtheria is a Greek word which means skin. Its chief characteristic is a grayish-yellow membrane on the tonsils and other parts of the throat. This disease is endemic in large cities and more prevalent now than ever before.

Diphtheria is very contagious, being communicated not only by persons having it, but in various ways by persons who have it not, but who have been exposed to the disease by association or contact. Children and young people in delicate health or having enlarged tonsils are most susceptible to it.

The Klebs-Loeffler bacillus is always present in the exudate during diphtheria. It is non-mobile, from 1.5 to 6.5 micromillimeter in length and from .3 to .8 of a micromillimeter in thickness. It is rod-like with rounded ends. It grows best on a mixture of glucose, bouillon, and blood serum at the temperature of the human body, and forms on the surface of the culture medium large grayish-white colonies.

This germ is occasionally found in the mouths of healthy persons when an epidemic prevails; but no matter how badly the throat may be diseased it is not diphtheria if, by repeated and careful examination, the Klebs-Loeffler bacillus cannot be found. These germs do not enter the blood. They are not found in any of the organs of the patient having diphtheria. Although this disease rapidly destroys more or less of the mucous membrane lining the air-passages, yet the greatest mischief is due to poisoning the blood, and the virus causing this condition is called toxin.

Dr. Edward Jenner, 100 years ago, discovered that immunity from smallpox can be secured with cowpox virus, but only five years ago was it found that the serum of the immunized horse will both prevent and cure diphtheria. This medicine is called anti-diphtheretic serum, also antitoxin.

Parke, Davis & Co., the famous pharmaceutical manufacturers of Detroit, have stables in which are kept heifers from which bovine virus is obtained, and horses from which anti-diphtheretic serum is procured. The sero-therapeutic method of treating diphtheria is a great discovery. This way of curing diphtheria has only been in use four years. The remedy is administered with a hypodermic syringe.

Prior to the antitoxin period the average case mortality in hospital and private practice in Chicago was about 35 per cent. In 1896 this was reduced to about 20 per cent, or a little more than three times greater than the mortality shown in the cases treated by the department of health physicians; in 1897 the average case mortality was only 15 per cent, or more than twice as great as the department cases; and in in 1898 the average case mortality was only 12.5 per cent, but still one third greater than the department case mortality. Hence the total 956 deaths represent 4,785 cases; the 702 cases in 1897 and the 622 deaths in 1898 represent about 9,000 cases.

The conclusions from the above are irresistible that Chicago physicians are using antitoxin in the treatment of diphtheria more generally and more successfully than any other similar number of their brethren elsewhere in the world; and that to the facilities afforded by the department and to the cordial cooperation of the profession with the department of health is due the most astonishing results.

If only the three years before and after the introduction of antitoxin be compared, the decline is still more striking. In 1893-95 there were 4,505 deaths from diphtheria and all croup; in 1896-98 there were only 2,552 such deaths—a decline of 43 per cent, or an actual saving of 1,953 lives in the last three years as compared with the preceding three years. A prominent factor of success in the antitoxin treatment is the early injection of the serum. In Chicago the mortality rate was .28 in those treated the first day; 1.67 in those treated the second day; 3.77 in those treated the third day; 11.39 in those treated the fourth day and 25.37 in all cases treated after the fourth day.

In preparing the blood serum of the immunized horse it is very desirable, of course, to have a uniform standard of strength. One-tenth of 1 c. m. of what Behring calls his normal serum will counteract ten times the minimum of diphtheria poison fatal for a guinea-pig weighing 300 grammes. 1 c. m. of this normal serum he calls an antitoxin unit.

Parke, Davis & Co., also H. K. Mulford Co., Philadelphia, put up antitoxin serum in bottles which they number 1, 2, 3, 4 and 5. No. 1 contains 500 units; No. 2, 1,000 units; No. 3, 1,500 units; No. 4, 2,000 units; No. 5, 3,000 units. It has been determined by experimentation that 500 units will immunize the attending physician, or the nurse or members of the family who have been exposed to diphtheria for a period of thirty days. Unless the case of diphtheria seems to be severe, a dose of 1,000 units is sufficient if administered the first day of the attack. If this treatment is not given until the second day 2,000 units should be used; on the third day 3,000 units and on the fourth day 4,000 units. If the case seems to be dangerous when first seen by the physician 2,000 or 3,000 units should be given at once, even though it is said to be only the first day of the attack. If the patient does not yield to the treatment very satisfactorily by an improved condition of all the symptoms within thirty-six hours a second 2,000 units should be given.

This serum is now so well adapted for this purpose that it can be administered without hesitation to small children in large doses and can be repeated with impunity when heroic doses are indicated. When this remedy does not work like a charm in this disease it is probable that the patient does not have diphtheria and is not suffering from toxin poison or else that the dose already given was not large enough to neutralize the poison.

Local applications should frequently be made to the throat, and nerve tonics given often at first and continued more moderately until convalescence is completed.

Quarantine rules and regulations are made by boards of health, but in diphtheria every case should remain in quarantine until repeated examinations demonstrate that all the Klebs-Loeffler bacilli have certainly disappeared from the throat.

The best means of disinfection is by fire. Thus, everything which has been exposed to the germs of this disease should be destroyed unless too valuable to be lost. The next method of disinfection is by boiling all articles of clothing which will not be damaged by this process. The best means of disinfecting letters written by patients and other persons in quarantine to be mailed is by sterilizing them with dry heat in an oven. Large ovens are sometimes used, furnished wholly with dry heat or partially with dry heat and partially with live steam, for sterilizing mattresses, pillows and bedding.

The two germicides most commonly in use for disinfecting dishes and various other articles in the sick room are solutions of carbolic acid and of bichloride of mercury. The latter is more desirable because it is without odor. It is inexpensive; can be used freely to soak bedding and wearing apparel in, also to use in washing ceilings, walls and floors.

Formaldehyde gas is par excellence the thing to use in disinfecting valuable garments which would be damaged by washing, or by being roasted in an oven, or by being fumigated with sulphur. Tablets in convenient form and a stove in which to burn them, and thus create gas, are furnished by Schering & Glatz of New York. H. K. Mulford Co. have also devised a regenerator which converts formaldehyde solution into gas in large quantities so that the work of disinfecting public institutions, like schoolrooms and hospital wards, can be done quickly and in a thoroughly satisfactorilly manner. The work of disinfection should always be under the direction of a physician or some other scientific person who knows how strong the disinfectant must be in order to surely destroy all of the disease germs. Some skill is also required in order to properly expose carpets, upholstered furniture, books papers, bedding and wearing apparel so that the disinfecting gas may thoroughly penetrate every part of the thing which requires disinfection.

TREES AND SHRUBS OF HAMILTON COUNTY.

H. A. MUELLER.

Hamilton county is the fourth from the north and the sixth county from the Missouri river, thus placing it in the north central portion of Iowa.

The county is a distinctly prairie country, situated on a level divide between the Des Moines river on the west and Iowa river on the east, neither stream touching the borders of the county.

The general surface of the county is quite level, dotted here and there with small lakes and ponds. Of late, these depresions have been drained and converted into valuable farm land. The only streams of any note within the borders of the county are Boone river in the western and Skunk river in the southeastern part. The latter stream has its source near the east central portion, flows south, crossing the south line about six miles from the southeast corner. Skunk river has cut a narrow, shallow channel through the Wisconsin drift plain, and there are no banks worth mentioning. The timber along this stream is limited to an area about ten miles long and about one-fourth mile wide.

The only hills of any importance in the county are found along the Boone river. This stream enters the county about four miles from the northwest corner, flows south and southwest, crossing the west line about seven miles from the southwest corner, where it soon empties into the Des Moines river. White Fox creek is the only tributary of any size.

Boone river has cut quite a deep channel below the general surface and the bluffs are quite precipitous. The bottoms are very narrow, and in many places the river has cut through the land, leaving quite steep banks on either side. At the top of the bluffs the general surface plain begins and continues until another stream is reached.

This portion of Iowa was invaded by the Wisconsin glacier, so the topography of the country is, geologically speaking, quite young. The soil is a dark rich loam, somewhat sandy in many localities. Below it is the Wisconsin drift, a yellowish till varying from five to twenty feet in thickness. The Wisconsin drift is well exposed along the bluffs of Boone river. From Jewell Junction to Blairsburg and northward there is a chain of low hills known as the moraines of the Wisconsin glaciers. Below the Wisconsin drift are beds of sand and gravel which may probably be correlated with the "Buchanan gravels." The Kansan drift is well exposed at Webster City, varying from five to ten feet. It rests upon a sandstone of the St. Louis stage. In the south part of Webster City, on Brewer creek, there are three quarries from which a considerable amount of quite serviceable building stone are taken, both sandstone and limestone. Beds of the latter are below and occur in heavy ledges. Farther south in Webster township the upper Carboniferous is exposed. Some cannel coal is mined in that locality.

It is along Boone river that the forest of Hamilton county is found. The timber area covers a territory of about twenty-five miles long and varies from one-half to three miles in width.

The native forest consisted of some very valuable timber, but little of it remains standing with the exception of some tracts that have been reserved. From these groves an observer may form an idea of the extent and value of the original forest, that greeted the early pioneer. It was along the timber that our civilization and early colonization began, for upon it the early settler depended for the material to build a home, the rails to protect his crops, and fuel for his fireplace.

The timber, at present, is practically of a second growth with the exception of some large trees that were not fit for the sawmill. The principal use of the forest at the present day is for fence posts and fuel. Dry wood sells in Webster City for from $3.50 to $4.50 per cord.

The trees most conspicuous along the banks of the streams are the willow, soft maple, white elm, and cottonwood; farther away are the box elder, black walnut, hard maple, white and black ash. On the upland there are the bur and red oak, shell bark and bitternut hickory, red elm and quaking asp. The following list of about fifty species were found principally about Webster City:

List of the shrubs and forest trees found growing in Hamilton county:

TILIACEÆ.

Tilia americana L. Basswood. Linden. Quite common along the banks of ravines.

RUTACEÆ.

Xanthoxylum americanum Mill. Prickly ash. Frequent in the woods.

CELASTRACEÆ.

Celastrus scandens L. Climbing bittersweet. Found on upland climbing over small trees or shrubs.

VITACEÆ.

Vitis viparia Michx. Wild grape. Very common on low rich soil.

Ampelopsis quinquefolia Michx. Virginia creeper. Not rare.

SAPINDACEÆ.

Acer dasycarpum Ehrh. Soft maple. Very common along the banks of streams. Much planted for groves.

Acer saccharinum L. 1753. White maple. Very common along the banks of streams. Much planted for groves.

Acer saccharinum Wang. 1787. Sugar, or rock maple. Common on second bottom and hillsides.

Acer barbatum Mx. 1803. Sugar, or rock maple. Common on second bottom and hillsides.

Negundo aceroides Moench. Box elder. Common along all streams and low bottoms. Much used for shade trees.

ANACARDIACEÆ.

Rhus glabra L. Smooth sumach. Common in thickets along the bluffs, or on the upland.

Rhus toxicodendron L. Poison ivy. Rich soil.

LEGUMINOSÆ.

Robinia pseudacacia L. Common, or black locust. Not common.

Gymnocladus canadensis Lam. Kentucky coffee tree. Rare.

Gleditschia triacanthos L. Honey locust. Quite frequent.

ROSACEÆ.

Prunus americana Marshall. Wild plum. Very common in clumps on rich soil. It also grows on upland among the hazel.

Prunus serotina Ehrh. Wild black cherry. Quite common.

Prunus virginiana L. Choke cherry. Common in thickets on low land.

Rubus strigosus Michx. Wild red raspberry.

Rubus occidentalis L. Black raspberry.

Rubus villosus Ait. Common blackberry.

Rosa blanda Ait. Wild rose. Common.

Pyrus coronaria L. Crab apple. Common on low ground.

Crataegus coccinea L. Hawthorn. Red haw.

Crataegus coccinea var. *mollis* Torr. and Gray. The two species above are quite common on the bottoms and along ravines.

Amelanchier canadensis Torr. and Gray. Service berry. June-berry. Common along banks of ravines.

SAXIFRAGACEÆ.

Ribes oxyacanthoides L. Common wild gooseberry.

HAMAMELIDÆ.

Hamamelis virginiana L. Witchhazel. Very common. Found on upland growing among the hazel thickets.

CORNACEÆ.

Cornus stolonifera Michx. Red osier dogwood.

Cornus paniculata L'Her. Panicled cornel. Common dogwood. Common.

CAPRIFOLIACEÆ.

Sambucus canadensis L. Blackberried elder. Common on rich soil.

Viburnum prunifolium L. Black haw. Quite common on low, rich ground.

OLEACEÆ.

Fraxinus americana L. White Ash. Very common. North of Webster City a tree was found three feet in diameter and seventy-five feet high.

Fraxinus sambucifolia Lam. Black ash. Common on low bottom land. Trees were found sixty feet high and eighteen inches in diameter.

URTICACEÆ.

Ulmus fulva Michx. Slippery or red elm. Common in upland woods.

Ulmus americana L. White, or American elm. Very common on banks of streams and low lands. Planted for shade and street trees.

Ulmus racemosa Thomas. Rock or cork elm. Rare. River bottom.

Celtis occidentalis L. Hackberry. Quite common along the river bottoms.

JUGLANDACEÆ.

Juglans cinerea L. Butternut. White walnut. Common on bottoms and upland.

Juglans nigra L. Black walnut. Very common along the rich river bottoms. The most valuable trees have been cut and shipped to the east.

Carya alba Nutt. Shell bark hickory. Common in upland woods.

Carya amara Nutt. Bitternut. Very common on hillsides and upland.

CUPULIFERÆ.

Corylus americana Walt. Hazelnut. Very common in open woods and along the border of the prairies.

Ostrya virginica Willd. Ironwood. Common along the small streams.

Quercus alba L. White oak. Not common. Found on high clay points.

Quercus macrocarpa Michx. Bur oak. Very common everywhere, most abundant on upland. A valuable tree for fence posts.

Quercus rubra L. Red oak. The most abundant of the black oak species. Found on upland in connection with the hickory and bur oak.

Quercus coccinea var. *tinctoria* Wang. Black oak. Not common.

SALICACEÆ.

Salix nigra Marsh. Black willow. Very abundant along banks of the streams.

Salix discolor Muhl. Pussy willow.

Populus tremuloides Michx. American aspen. Very common on low damp soil. This is one of the most conspicuous trees on the upland, growing along the edges of wet places.

Populus monilifera Ait. Cottonwood. Common on rich soils along the banks of streams and in low places.

GYMNOSPERMÆ.

CONIFERÆ.

Juniperus virginiana L. Red cedar. Quite common, found growing among the trees on the upland. They are transplanted before the trees become any size.

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