STATE CAPITOL, AT TOPEKA.
In this building the Kansas Academy of Science rooms are located.

TRANSACTIONS

OF THE

KANSAS

ACADEMY OF SCIENCE.

VOL. XIX.

EDITED BY THE SECRETARY,
G. P. GRIMSLEY.

CONTAINS

LIST OF OFFICERS, PAST AND PRESENT; MEMBERSHIP LIST JANUARY 10, 1905; HISTORICAL SKETCH OF THE ACADEMY; CONSTITUTION AND BY-LAWS; MINUTES OF THE THIRTY-SIXTH AND THIRTY-SEVENTH ANNUAL MEETINGS; AND SOME PAPERS READ.

TOPEKA, KANSAS:
GEO. A. CLARK, STATE PRINTER.
1905.

OFFICERS OF THE ACADEMY, 1905.

President	L. C. Wooster	Emporia.
Vice-president	F. W. Bushong	Kansas City, Kan.
Vice-president	W. A. Harshbarger	Topeka.
Treasurer	Alva J. Smith	Emporia.
Secretary	J. T. Lovewell	Topeka.

Past Officers of the Academy.

PRESIDENTS.

1869, '70.... B. F. Mudge.
1871-'73.... John Fraser.
1874-'78.... F. H. Snow.
1879, '80.... B. F. Mudge.
1881, '82.... J. T. Lovewell.
1883........ A. H. Thompson.
1884, '85.... R. J. Brown.
1886........ E. L. Nichols.
1887........ J. D. Parker.
1888........ J. R. Mead.
1889........ T. H. Dinsmore, jr.
1890........ G. H. Failyer.
1891........ Robert Hay.
1892........ E. A. Popenoe.
1893........ E. H. S. Bailey.
1894........ L. E. Sayre.
1895........ Warren Knaus.
1896........ D. S. Kelly.
1897........ S. W. Williston.
1898........ D. E. Lantz.
1899........ E. B. Knerr.
1900........ A. S. Hitchcock.
1901........ E. Miller.
1902........ J. T. Willard.
1903........ J. C. Cooper.
1904........ Edward Bartow.

VICE-PRESIDENTS.

1869, '70.... J. S. Whitman.
1871........ B. F. Mudge.
1872, '73.... B. F. Mudge, Dr. R. J. Brown.
1874........ J. A. Banfield, J. D. Parker.
1875........ B. F. Mudge, J. D. Parker.
1876, '77.... B. F. Mudge.
1878........ B. F. Mudge, J. H. Carruth.
1879-'82.... J. H. Carruth, Joseph Savage.
1883........ J. R. Mead, G. E. Patrick.
1884........ F. H. Snow, Joseph Savage.
1885........ E. L. Nichols, G. H. Failyer.
1886........ J. D. Parker, N. S. Goss.
1887........ J. R. Mead, E. H. S. Bailey.
1888........ E. H. S. Bailey, T. H. Dinsmore, jr.
1889........ E. H. S. Bailey, G. H. Failyer.
1890........ D. S. Kelly, F. W. Cragin.
1891....... F. W. Cragin, O. C. Charlton.
1892........ F. O. Marvin, Mrs. N. S. Kedzie.
1893........ J. T. Willard, E. B. Knerr.
1894........ I. D. Graham, J. D. Hewitt.
1895........ I. D. Graham, S. W. Williston.
1896........ S. W. Williston, D. E. Lantz.
1897........ D. E. Lantz, A. S. Hitchcock.
1898........ C. S. Parmenter, L. C. Wooster.
1899........ A. S. Hitchcock, J. R. Mead,
1900........ E. Miller, J. C. Cooper.
1901........ J. C. Cooper, L. C. Wooster.
1902........ Edward Bartow, J. A. Yates.
1903 .... Edward Bartow, J. A. Yates.
1904........ L. C. Wooster, B. F. Eyer.

SECRETARIES.

1869-'73.... J. D. Parker.
1874, '75.... John Wherrell.
1876, '77.... Joseph Savage.
1878-'89.... E. A. Popenoe.
1890-'92.... E. H. S. Bailey.
1893........ A. M. Collette.
1894-'98.... E. B. Knerr.
1899-1901... D. E. Lantz.
1902-'04.... G. P. Grimsley.

TREASURERS.

869-'73.... F. H. Snow.
1873-'75.... R. J. Brown.
1876, '77.... W. K. Kedzie.
1878-'83.... R. J. Brown.
1884, '85.... A. H. Thompson.
1886-'90.... I. D. Graham.
1891........ F. O. Marvin.
1892-'95.... D. S. Kelly.
1896........ L. E. Sayre.
1897-1900... J. W. Beede.
1901, '02.... E. C. Franklin.
1903........ Alva J. Smith.

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LIST OF PLATES.

MEMBERSHIP OF THE ACADEMY

January 10, 1905.

HONORARY MEMBERS.

G. P. Grimsley, Ph. D., 1904, assistant state geologist....	Morgantown, W. Va.
Rev. Johns D. Parker, 1897	New Haven, Conn.
Arnold B. Johnson, 1897, United States Lighthouse Board,	Washington, D. C.
W. A. Kellerman, Ph. D., 1897, Ohio State University....	Columbus, Ohio.
Edw. L. Nichols, Ph. D., 1897, Cornell University........	Ithaca, N. Y.
W. S. Franklin, Sc. D., 1897, Lehigh University	South Bethlehem, Pa.
George Wagner, Phar. C., 1904, University of Wisconsin..	Madison, Wis.
S. W. Williston, Ph. D., 1902, University of Chicago.....	Chicago, Ill.

ASSOCIATE MEMBERS.

Mrs. R. J. Brown, 1903....................	Leavenworth.
Mrs. Mary Savage, 1897................................	Lawrence.

LIFE MEMBERS.

Dates printed in the following list signify date of election to membership in the Academy.

E. H. S. Bailey, Ph. D., 1883, University of Kansas......	Lawrence.
F. W. Cragin, M. S., 1880..............................	Colorado Springs.
L. L. Dyche, M. S., 1881, University of Kansas..........	Lawrence.
Geo. H. Failyer, Ph. D., 1879, Department of Agriculture..	Washington, D. C.
E. C. Franklin, Ph. D., 1884, Leland Stanford Jr. University	Stanford Univ., Cal.
I. D. Graham, 1879, *Kansas Farmer*..................	Topeka.
Erasmus Haworth, Ph. D., 1882, University of Kansas....	Lawrence.
Warren Knaus, M. S., editor McPherson *Democrat*......	McPherson.
D. E. Lantz, M. S., 1887, biological survey..............	Washington, D. C.
J. T. Lovewell, Ph. D., 1878, secretary Academy of Science,	Topeka.
F. O. Marvin, C. E., 1884, University of Kansas..........	Lawrence.
J. R. Mead, 1879...	Wichita.
Ephraim Miller, Ph. D., 1873, University of Kansas......	Lawrence.
E. A. Popenoe, A. M., 1872, Kansas Agricultural College,	Manhattan.
L. E. Sayre, Ph. M., 1885, University of Kansas..........	Lawrence.
B. B. Smyth, 1880, curator of Goss ornithological collection,	Topeka.
F. H. Snow, Ph. D., 1868, University of Kansas..........	Lawrence.
A. H. Thompson, D. D. S., 1873........................	Topeka.
D. M. Valentine, LL. D., 1878..........................	Topeka.
M. L. Ward, D. D., 1880, Ottawa University............	Ottawa.
J. T. Willard, M. S., 1883, Kansas Agricultural College...	Manhattan.
S. W. Williston, Ph. D., 1880, University of Chicago.....	Chicago, Ill.

ANNUAL MEMBERS.

L. O. Adams, 1903, University of Kansas	Lawrence.
Orr Adams, 1898...	Telluride, Colo.
H. C. Allen, 1904	McPherson.
John J. Arthur, 1904...................................	Topeka.
W. R. Arthur. B. A., 1903, high school	Logan.

ANNUAL MEMBERS.

C. H. Ashton, 1903, University of Kansas................. Lawrence.
Alfred W. Ayers, 1904, minister Congregational church... Onaga.
Harvey W. Baker, 1902, Kansas Agricultural College..... Manhattan.
M. A. Barber, 1904, University of Kansas................ Lawrence.
Elam Bartholomew, M. S., 1895.......................... Stockton.
Edward Bartow, Ph. D., 1897, University of Kansas...... Lawrence.
Wm. C. Bauer, A. M., 1897, Baker University............ Baldwin.
W. J. Baumgartner, 1904, University of Kansas.......... Lawrence.
Frank G. Bedell, 1904.................................. Iola.
J. W. Beede, Ph. D., 1894, University of Indiana......... Bloomington, Ind.
Edw. Bumgardner, M. D., 1896.......................... Lawrence.
F. W. Bushong, B. S., 1896, Kansas City University...... Kansas City, Kan.
H. P. Cady, 1904, University of Kansas.................. Lawrence.
M. E. Canty, 1903 .... Buffalo.
Clarence L. Cole, M. D., 1902.......................... Washington, D. C.
Ewing N. Collett, 1903, Indian University................ Bacone, I. T.
Rev. John T. Copley, 1903.............................. Clinton.
J. C. Cooper, 1899 .... Topeka.
W. R. Crane, 1904, University of Kansas................. Lawrence.
Ralph K. Crawford, 1904, University of Kansas.......... Lawrence.
F. F. Crevecœur, 1899 .... Onaga.
Robert W. Curtis, Ph. D., 1904, University of Kansas.... Lawrence.
F. B. Dains, Ph. D., 1902, Washburn College............ Topeka.
R. E. Davis, 1904...................................... Fort Scott.
Geo. A. Dean, 1903, Kansas Agricultural College......... Manhattan.
S. D. Dice, 1904, public schools........................ Alma.
James Dickson, 1904, University of Kansas.............. Lawrence.
Hugo Diemer, M. E., 1903, University of Kansas......... Lawrence.
R. B. Dunlevy, B. S., 1896, Southwest Kansas College.... Winfield.
Harry Eagle, 1905...................................... Topeka.
J. Whit Ebey, 1903, science teacher..................... Howard.
H. W. Emerson, 1904, University of Kansas.............. Lawrence.
H. W. Ewing, D. D. S., 1903, Iola Gas Company.......... Iola.
B. F. Eyer, B. S., 1894, Kansas Agricultural College..... Manhattan.
Fred Faragher, 1904.................................... Lawrence.
A. O. Garrett, 1901, high school........................ Salt Lake City, Utah.
Chas. N. Gould, B. S., 1903, University of Oklahoma..... Norman, Okla.
C. F. Gustafson, 1899, University of Kansas.............. Lawrence.
Brice E. Hammars, 1904, chemist Santa Fe shops....... Topeka.
J. O. Hamilton, 1903, Kansas Agricultural College ...... Manhattan.
Dr. Eva Harding, 1904.................................. Topeka.
H. J. Harnly, B. S., 1893, McPherson College............ McPherson.
W. A. Harshbarger, B. S., 1902, Washburn College...... Topeka.
L. D. Havenhill, 1904, University of Kansas .... Lawrence.
H. D. Hess, 1904, University of Kansas.................. Lawrence.
W. E. Henderson, 1901.................................. Iola.
W. C. Hoad, 1904, University of Kansas .... Lawrence.
Geo. J. Hood, 1904, University of Kansas................ Lawrence.
Geo. W. Hoxie, M. D., 1902, University of Kansas........ Lawrence.
W. F. Hoyt, A. M., 1902, Kansas Wesleyan University... Salina.
Albert K. Hubbard, 1904, University of Kansas.......... Lawrence.

ANNUAL MEMBERS.

Thos. M. Iden, 1897, State Normal School .... Emporia.
F. B. Isely, B. S., 1902, high school .... Wichita.
John J. Jewett, 1902 .... San Diego, Cal.
Carl Johns, 1900, Bethany College .... Lindsborg.
A. W. Jones, B. S., 1894, Kansas Wesleyan University... Salina.
Hugo Kahl, 1897, Carnegie Museum .... Pittsburg, Pa.
George F. Kay, 1904, State University .... Lawrence.
W. H. Keller, 1898, high school .... Hays City.
Harry L. Kent, 1904, high school .... Hays City.
John H. Klopfer, 1904 .... Topeka.
E. B. Knerr, Sc. D., 1889 .... Atchison.
Rev. James G. Knotter, 1903 .... Dexter.
Pierce Larkin, 1902, University of Oklahoma .... Norman, Okla.
B. E. Lewis, 1904, city schools .... Eureka.
Miss Hester E. Loveall, 1904, manual-training school..... Pittsburg.
H. T. Martin, 1902, University of Kansas .... Lawrence.
R. Matthews, D. D. S., 1898 .... Wichita.
Walter E. Matthewson, 1903, Kansas Agricultural College, Manhattan.
F. M. McClenahan, 1903, Kansas Agricultural College.... Manhattan.
E. C. McClung, 1903, University of Kansas .... Lawrence.
Elmer V. McCollum, 1902, University of Kansas .... Lawrence.
Edith A. McIntyre, B. S., 1902 .... Middletown, N. Y.
D. F. McFarland, 1903, University of Kansas .... Lawrence.
J. M. McWharf, M. D., 1902 .... Ottawa.
W. G. Medcraft, 1904, Kansas Wesleyan University ...... Salina.
Grace R. Meeker, 1899, high school .... Ottawa.
C. F. Menninger, M. D., 1903 .... Topeka.
H. L. Miller, 1904, high school .... Topeka.
Roy L. Moodie, 1904, University of Kansas .... Lawrence.
L. N. Morscher, 1900, high school .... Lawrence.
Travis Morse, 1903 .... Iola.
J. H. Newby, 1899, photographer .... Osage City.
A. M. Nissen, A. M., 1888, high school .... Wetmore.
D. H. Otis, M. S., 1897 .... Oswego.
W. K. Palmer, M. E., 1897, consulting engineer .... Kansas City, Mo.
Frank Patrick, 1903 .... Topeka.
Leslie F. Paull, 1903, manual-training school .... Kansas City, Mo.
L. M. Peace, 1904, University of Kansas .... Lawrence.
Norman Plass, D. D., 1902, president of Washburn College, Topeka.
S. F. Poole, B. S., 1902, Fairmount College .... Wichita.
Charles H. Popenoe, 1903, Kansas Agricultural College... Manhattan.
J. M. Price, A. M., 1900 .... Atchison.
C. S. Prosser, M. S., 1892, Ohio State University .... Columbus, Ohio.
W. S. Prout, 1904 .... Topeka.
Albert B. Reagan, 1904, Indian School .... Rosebud, S. Dak.
W. F. Rice, 1902, public schools .... Marion.
A. P. Reudiger, 1905 .... Lawrence.
Lumina C. Riddle, M. S., 1902 .... Columbus, Ohio.
Arthur Ringer, 1902, county high school .... Effingham.
D. C. Schaffner, 1903, College of Emporia .... Emporia.
J. H. Schaffner, A. M., M. S., 1902, Ohio State University, Columbus, Ohio.

ANNUAL MEMBERS.

Theo. H. Scheffer, 1903, Kansas Agricultural College..... Manhattan.
Eva Schley, 1903, high school........................... Topeka.
Aaron Schuyler, 1904, Kansas Wesleyan University...... Salina.
C. H. Shattuck, 1899, Washburn College................ Topeka.
Roscoe H. Shaw, 1904, Kansas Agricultural College...... Manhattan.
J. L. Shearer, 1902, public schools....................... Halstead.
E. T. Shelley, M. D., 1892............................... Atchison.
J. A. G. Shirk, 1904, University of Kansas............. Lawrence.
Alva J. Smith, 1893, county surveyor.................... Emporia.
Eugene G. Smyth, 1901.................................. Topeka.
Wesley N. Speckman, Ph. D., 1903, Kansas Wesleyan University.. Salina.
B. T. Stauber, D. D., 1903............................... Salina.
S. G. Stewart, M. D., 1904.............................. Topeka.
Chas. M. Sterling, 1904, University of Kansas........... Lawrence.
Chas. H. Sternberg, 1895................................ Lawrence.
Teresa Stevenson, 1901.................................. Ottawa.
W. C. Stevens, 1904, University of Kansas.............. Lawrence.
E. F. Stimpson, University of Kansas.................... Lawrence.
A. J. Stout, 1904, high school........................... Topeka.
R. S. Sherwin, 1901..................................... Norman, Okla.
Olin Templin, 1904...................................... Lawrence.
A. M. Ten Eyck, 1903, Kansas Agricultural College...... Manhattan.
F. J. Titt, B. S., 1898, Kingfisher College............... Kingfisher, Okla.
E. S. Tucker, 1904, University of Kansas............... Lawrence.
J. D. Walters, M. S., 1894, Kansas Agricultural College.. Manhattan.
C. D. Weaver, M. D., 1902............................... McPherson.
Ella Weeks, 1903, Kansas Agricultural College........... Manhattan.
J. E. Welin, 1899, Bethany College...................... Lindsborg.
W. B. Wilson, 1903, Ottawa University.................. Ottawa.
L. B. Wishard, 1903, high school........................ Iola.
C. H. Withington, 1903, Kansas Agricultural College.... Manhattan.
H. I. Woods, M. S., 1902, Washburn College............. Topeka.
L. C. Wooster, 1897, State Normal School............... Emporia.
J. A. Yates, M. S., 1898, Ottawa University.............. Ottawa.

Total number of members, 172.

NOTE.—The following names should have been printed in the list at top of page 21, viz.: M. A. Barber, Lawrence; W. C. Hoad, Lawrence; L. D. Havenhill, Lawrence; H. L. Miller, Topeka; W. C. Stevens, Lawrence; C. M. Sterling, Lawrence; H. L. Kent, Hays City; J. H. Klopper, Topeka; John A. Arthur, Topeka.

HISTORICAL SKETCH.

THE organization of a Kansas association of scientific men at an early date was due to the efforts of Rev. Johns D. Parker and Prof. B. F. Mudge, who, in July, 1868, issued a call signed by seventeen men for a meeting of all persons in the state interested in natural sciences to meet in Topeka.

The first meeting was held in September of that year, in Lincoln College (now Washburn), and the Kansas Natural History Society was organized and officers elected. The object, as stated in the original draft of the constitution, "shall be to increase and diffuse a knowledge of the natural sciences, particularly in relation to the state of Kansas." At the fourth annual meeting, held in Leavenworth, in 1871, the name was changed to the Kansas Academy of Science. In 1873 the Academy became a coordinate department of the State Board of Agriculture by the terms of the following act of the legislature:

"The Academy of Science shall be a coordinate department of the State Board of Agriculture, with their office in the agricultural rooms, where they shall place and keep for public inspection the geological, botanical and other specimens, the same to be under the direction and control of the officers of the said Academy of Science. An annual report of the transactions of said Academy of Science shall be made on or before the 15th day of November of each year to the State Board of Agriculture, for publication in the annual transactions of said board."

The Academy has increased in membership from the original small body of scientists to nearly 200. It has held thirty-seven annual meetings, of which eighteen have been held in Topeka, five in Lawrence, four in Manhattan, two in Leavenworth, two in Emporia, and one each in Atchison, Baldwin, Iola, McPherson, Ottawa, and Wichita.

Nineteen volumes of the Transactions have been published, varying in size from a few pages in the early numbers to 350 pages in the later volumes. These publications contain many papers of recognized scientific value. The exchange list includes over 500 names of societies and libraries.

The Academy is now installed in the west wing of the capitol building, at Topeka, in rooms on the ground floor. It has three connecting rooms, used for the office, library, and museum.

The museum has been greatly increased by the gift of the state mineral display erected at the St. Louis Exposition, and given suitable cases to hold this large amount of material. It thus has the finest economic collection of the Kansas mineral industries in the state—an exhibit which received two gold medals, twenty-two silver medals, and fourteen bronze medals.

Constitution of the Academy.

SECTION 1. This association shall be called the Kansas Academy of Science.

SEC. 2. The objects of this Academy shall be to increase and diffuse knowledge in the various departments of science.

SEC. 3. Members of this Academy shall consist of two classes, active and honorary (including associate). *Active members* may be annual or life members. *Annual members* may be elected at any meeting of the Academy, and shall sign the constitution and pay a fee of one dollar and annual dues of one dollar; but the secretary and treasurer shall be exempt from the payment of dues during the years of their service. Any person who shall at one time contribute twenty dollars to the funds of this Academy may be elected a *life member* of the Academy, free of assessment. Any member who has paid dues to the Academy for ten consecutive years, or who has been legally exempt during any portion of that time, may be elected a *life member* on the payment of ten dollars. Any member who has been a member of this Academy in good standing for twenty years may be elected a *life member* without payment of further fees or dues. *Honorary members* may be elected on account of special prominence in science, on the written recommendation of two members of the Academy. In any case, a two-thirds vote of members present shall elect to membership. Applications for membership in any of the foregoing classes shall be referred to a committee on applications for membership, who shall consider such application and report to the Academy before the election.

SEC. 4. The officers of this Academy shall be chosen by ballot at the annual meeting, and shall consist of a president, two vice-presidents, a secretary, and a treasurer, who shall perform the duties usually pertaining to their respective offices. The president, secretary and treasurer shall constitute an executive committee. The secretary shall have charge of all the books, collections and material property belonging to the Academy.

SEC. 5. Unless otherwise directed by the Academy, the annual meeting shall be held at such time and place as the executive committee shall designate. Other meetings may be called at the discretion of the executive committee.

SEC. 6. This constitution may be altered or amended at any annual meeting, by a vote of three-fourths of attending members of at least one year's standing. No question of amendment shall be decided on the day of its presentation.

By-laws of the Academy.

I. The first hour, or such part thereof as shall be necessary, in each session, shall be set aside for the transaction of the business of the Academy. The following order of business shall be observed, as far as practicable:

1. Opening.
2. Reports of officers.
3. Reports of standing committees.
4. Appointment of special committees.
5. Unfinished business.
6. New business.
7. Reports of special committees.
8. Election of officers.
9. Election of members.
10. Program.
11. Adjournment.

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

III. No meeting of this Academy shall be held without a notice of the same having been published in the papers of the state at least thirty days previous.

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

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

VI. The secretary shall have charge of the distribution, sale and exchange of the published Transactions of the Academy, under such restrictions as may be imposed by the executive committee.

VII. Eight members shall constitute a quorum for the transaction of business.

VIII. The time allotted to the presentation of a single paper shall not exceed fifteen minutes.

IX. No paper shall be entitled to a place on the program unless the manuscript, or an abstract of the same, shall have been previously delivered to the secretary.

MINUTES.

Thirty-sixth Annual Meeting, Kansas Academy of Science, November 26, 27, and 28, 1903.

MANHATTAN, KAN., November 26, 1903.

THE thirty-sixth annual meeting of the Kansas Academy of Science was opened at 8:30 P. M. in the lecture-room in the Physical Science hall at the Kansas Agricultural College, with the secretary, G. P. Grimsley, as chairman, in the absence of the other officers. Later in the evening Dr. Edward Bartow, first vice-president, took the chair.

The following eighteen members were in attendance at the opening session: E. H. S. Bailey, H. W. Baker, Edward Bartow, G. P. Grimsley, W. F. Hoyt, A. W. Jones, Warren Knaus, D. E. Lantz, E. A. Popenoe, Lumina Cotton Riddle, Alva J. Smith, Eugene Smyth, B. B. Smyth, L. E. Sayre, Chas. H. Sternberg, J. T. Willard, L. C. Wooster, E. Bartholomew.

At this session a large number of visitors were present. In the absence of the president and vice-presidents, the general business meeting was postponed, and papers were read as follows:

1. The great flood of 1903 in central Kansas, A. W. Jones.
2. The cocooning habits of spiders, Theo. H. Scheffer.
3. Sanitary science, Dr. J. M. McWharf. (Read by secretary.)
4. Bibliography of the loco weed, résumé given by L. E. Sayre.

It was moved that this paper and the two following ones be read by title and referred to committee on publication. Motion carried.

5. Some mineral waters of the Indian Territory, R. S. Sherwin.
6. A review of the weather during the crop season, 1903, T. B. Jennings.

The following committees were then appointed by the acting president, Edward Bartow:

Program: G. P. Grimsley, J. T. Willard.

Membership: E. H. S. Bailey, W. Knaus, C. H. Sternberg.

Necrology: D. E. Lantz, A. W. Jones.

Press: L. E. Sayre.

Nominations: L. E. Sayre, A. J. Smith, E. Bartholomew.

Resolutions: B. B. Smyth, L. C. Wooster.

The Academy then adjourned, to meet at nine A. M., Friday, November 27, 1903.

FRIDAY MORNING, November 27, 1903.

The Academy met at the Physical Science hall at ten A. M., with Doctor Bartow in the chair.

Additional members at this session: B. F. Eyer, F. H. Snow, M. L. Ward.

The minutes of the preceding meeting were read and approved.

The secretary's report was read, and received by vote, and accepted

REPORT OF THE SECRETARY.

INTRODUCTION.—The Kansas Academy of Science is located in comfortable quarters in the state house, at Topeka, as described in the report to the Academy at its last meeting. The present Executive Council of the state appears to be interested in our welfare, and continues the kind favors of the last council, which gave us these rooms. An additional room has this month been given to the Academy for its library and extra books. The legislature at its last session placed the Academy on a permanent basis, appropriating $1000 salary for the secretary and $300 for contingent expenses. This attitude of the state is very encouraging for a successful State Academy. We now have the entire north side of the west wing basement floor in state-house.

MUSEUM.—The museum of mineral industries has been arranged and much valuable material added, including specimens of glass, tile, salt, Welsbach gas mantles. The secretary has charge of the mineral displays at St. Louis, and expects at the close of that exposition to place the cases and best displays in this room, which will make one of the best economic museums in the West. Eight new show-cases were purchased this past year and are now in museum.

LIBRARY.—A new bookcase, revolving bookcase, dictionary and holder have been added to the library furniture equipment.

The additions to the library during the present year have been 100 bound volumes and 1000 pamphlets. Missing numbers for forty-five volumes of our journals have been secured and ten new exchanges added. One hundred volumes were bound in the summer and fall of 1902 and added to the library.

The State Printing Board has recently honored a requisition for 500 volumes of binding, an order equal to our requisitions for the past six years, and this order will enable us to clear up our mass of loose pamphlets, which are difficult to care for. Two hundred and fifty of these volumes are now at the state bindery, and others will be sent near the end of the year. An effort is being made to enlarge our library and make it more complete, and the secretary recommends that the Academy set aside a fund of $100 for new books.

PHOTOGRAPHS.—The secretary has secured fifty photographs of Academy members. These have been secured through repeated letters, sent in some cases three or four times. We have photographs of nearly half the members now and we are going after the other half; so be prepared for another set of letters on this subject.

DUES.—The secretary last year, with the consent and approval of the treasurer, sent out printed statements of dues unpaid, and the sum of eighty-six dollars was collected through this office and probably twenty-five dollars was paid to the treasurer direct in response to these notices. Those who failed to respond to our invitation were warned twice of penalty of being dropped from our roll, and this we unfortunately had to do in a number of cases. Similar notices were sent this year and nineteen dollars have been collected, and the rest we hope will be paid at this meeting.

MEMBERSHIP.—To repeat what was said a year ago and which is still true, our membership is about half what it ought to be. We have in all 116 members. In our preceding publication (vol. xvii) 148 names were recorded and we added twenty-five at the last meeting, which means that about fifty-seven names were dropped. The reasons for this loss are partly explained above—non-payment of dues after proper warning, and, partly, removal from the state.

The secretary this year set the mark for fifty new members, and letters have been written to about fifty science people in the state who are not members but ought to be. Requests were sent to the members to supply names for our directory of science people in Kansas, and we have listed about eighty names. I will be glad to have the members send in additional names, for in this way we have a chance to interest such persons in our work.

Let us try to add fifty new members at our next meeting. If each member could secure one more we would have a large enrolment next year.

PUBLICATIONS.—The eighteenth volume of Transactions of the Academy was printed in June, 1903, and sent to the members and exchanges; 1200 copies were printed—1000 in cloth and 200 in paper. The volume contains 287 pages, 15 plates, 36 figures, and a general index of authors and subjects for all the volumes from one to eighteen.

Five hundred copies of reprint of list of members, constitution, history, and president's address at Iola, were issued, under the style of "Announcement of Kansas Academy of Science."

DEATHS AND REMOVALS.—Two life members died in the past year:

S. A. Baldwin, of Wabaunsee, born in Meriden, Conn., June 29, 1827, and died at Lawrence, March 31, 1903, aged seventy-five years. He was elected active member of Academy in 1879.

Dr. Peter McVicar, of Topeka, born in New Brunswick, Canada, in 1829, and died at Topeka, June 5, 1903, aged seventy-four years. He was one of the first members of Academy, becoming an active member in 1868.

Removals.—Prof. E. C. Franklin: Removed from Lawrence to Leland Stanford, Cal. Prof. F. D. Barker: Ottawa to University of Nebraska. T. D. A. Cockerell: Las Vegas to Colorado Springs, and wishes name dropped from list. John J. Jewett: Topeka to Albuquerque. Miss Edith McIntyre: Manhattan to Newark, N. J. Geo. F. Weida: Manhattan to Ripon, Wis.; wishes name dropped. E. H. Heacock: Topeka to Chicago, Ill.

Topeka, November 1, 1903. G. P. GRIMSLEY, *Secretary.*

Profesor Ward was appointed to audit treasurer's accounts.

The committee on election of members reported through Professor Bailey the following twenty-eight names for membership in the Academy: W. R. Arthur, Logan; C. H. Ashton, Lawrence; Miss L. May Beatty, Ottawa; Ewing N. Collett, Bacone, I. T.; Geo. A. Dean,* Manhattan; Hugo Diemer, Lawrence; C. F. Menninger, Topeka; Travis Morse, Iola; Frank Patrick, Topeka; Leslie F. Paull,* Manhattan; D. C. Schaffner, Emporia; Theo. H. Scheffer,* Manhattan; J. Whit Ebey, Owatonna, Minn.; H. W. Ewing, Iola; Chas. N. Gould, Norman, Okla.; Chas. A. Hiller, Salina; S. J. Hunter, Lawrence; James G. Knotter, Onaga; N. S. Mayo,* Man-

* Present at Manhattan meeting.

hattan; F. M. McClenahan,* Manhattan; Miss Eva Schley, Topeka; Wesley N. Speckman, Salina; John N. Van der Vries, Lawrence; Miss Ella Weeks,* Manhattan; John W. Wilson, Effingham; W. B. Wilson, Ottawa; L. B. Wishard, Iola; C. H. Withington,* Manhattan.

It was voted report be accepted and that the secretary cast the ballot for these persons.

It was also recommended and voted that Mrs. R. J. Brown, of Leavenworth, be made an associate member.

The reading of papers was then resumed:

7. Native zinc, by J. T. Willard.

8. Observations on microscopic plants and animals, by Lumina Cotton Riddle.

9. Kansas petroleum (second paper), by Edward Bartow.

10. The results of an entomological collecting expedition to Clark county, Kansas, by F. H. Snow.

11. Medicinal and commercial value of Kansas plants, by L. E. Sayre.

Moved and voted Academy adjourn, to meet at 1:30 P. M. to visit the buildings of the Agricultural College, and to meet at 2:30 for reading of papers.

FRIDAY AFTERNOON, November 27, 1903.

The Academy met in Physical Science hall at three P. M., Edward Bartow in the chair, and later the president, J. C. Cooper, arrived and presided.

Additional members present: L. L. Dyche, J. C. Cooper, J. T. Lovewell, J. D. Walters—twenty-five in all.

The treasurer's report was read and referred to auditing committee: Balance on hand, $191.23, not counting dues paid at this meeting.

Moved by Professor Lantz that the secretary be allowed to buy books to the extent of $100, and preference be given to numbers necessary to complete files of journals. Carried.

The committee on nominations reported as follows:

President, Edward Bartow, Lawrence.

Vice-president, L. C. Wooster, Emporia.

Vice-president, B. F. Eyer, Manhattan.

Treasurer, Alva J. Smith, Emporia.

Secretary, G. P. Grimsley, Topeka.

It was moved and voted that the report be adopted, and that the chairman of the committee cast the ballot for these officers.

The committee on necrology reported the death of Mr. S. A. Baldwin, and recommended that Professor Willard prepare a sketch of his

* Present at Manhattan meeting.

PLATE II.—Kansas Academy of Science Office and Library—Capitol Building, Topeka.

life for publication in the Transactions; also Dr. Peter McVicar, and recommended that the secretary, G. P. Grimsley, prepare a sketch of his life for the Academy Transactions.

Moved and voted the report be accepted and the recommendations be adopted.

Committee on membership reported the following names: L. O. Adams, Lawrence; F. H. Ayres, Kansas City, Mo.; J. O. Hamilton,* Manhattan; J. Lofty, Salina; Walter E. Matthewson,* Manhattan; E. C. McClung, Lawrence; D. F. McFarland,* Lawrence; Chas. H. Popenoe, Manhattan; H. F. Roberts,* Manhattan; Roscoe H. Shaw,* Manhattan—ten, or thirty-nine in all.

Moved and voted report be accepted, and that the secretary cast the ballot for these persons.

The reading of papers was resumed:

12. Recent advances in astronomy, by W. F. Hoyt.

13. The preparation of lithological slides, by A. J. Smith.

14. Additions to the list of Kansas Coleoptera for 1903, by Warren Knaus.

15. Some miscellaneous notes on geology of Kansas, by L. C. Wooster.

16. What rights have educational institutions for duty-free importations? by E. H. S. Bailey.

17. Preliminary list of Kansas spiders, by Theo. H. Scheffer.

18. Observations on mirages, by B. B. Smyth.

19. Notes on the birds of Kansas, by F. H. Snow.

20. The action of ethyl-chlorosulfonate upon aniline, by F. W. Bushong.

21. Analysis of salt water from Atchison coal-mine, by E. B. Knerr.

22. Geological effects of Kansas river flood of 1903, by Erasmus Haworth.

23. Notes on the archæology of Butler county, by J. R. Mead.

24. July 1 flora of Grayback, Colo., by H. J. Harnly.

Moved and voted that, in absence of the authors and the papers, the last five papers above be read by title and referred to committee on publication when the papers should be presented.

25. *Protostega gigas* and other Cretaceous reptiles and fishes of the Kansas chalk, by Chas. H. Sternberg.

The Academy adjourned at six P. M., to meet at eight P. M.

* Present at meeting.

FRIDAY EVENING, November 27, 1903.

The Academy met in Physical Science hall, at 8:15 P. M., with Pres. J. C. Cooper in the chair.

The following papers were read:

26. Notes on the culture of wild flowers, by H. W. Baker.

27. Well borings at Wamego and Smoky Hill, by J. T. Lovewell.

28. The results of an entomological collecting expedition to the Arizona desert, by F. H. Snow.

It was moved and voted the next meeting of the Academy should be held at Topeka; also voted the time of meeting be left to the executive committee.

Pres. J. C. Cooper then delivered his address on "Oxygen in its Relation to Mineralogy." After the president's address, the members and friends of the Academy were tendered a most pleasant reception, given by the faculty of the Agricultural College in the Women's Gymnasium building.

SATURDAY MORNING, November 28, 1903.

The Academy met in Physical Science hall, at 8:45 A. M., with Pres. J. C. Cooper in the chair.

The minutes of the three preceding sessions were read and approved.

Reading of papers was resumed:

29. The fauna of the Mentor (outline only given), by A. W. Jones.

30. Notes on the caves of Cuba, by J. W. Beede. (Read by A. W. Jones.)

31. Notes on fasciation, by Lumina C. Riddle.

32. The Buprestidæ and Scarabeidæ of Kansas, by W. Knaus.

33. Notes on the mound-building prairie ant, by Geo. A. Dean.

34. Two new diseases of economic plants, by Leslie F. Paull.

35. Life-history of *Microbembex monodonta*, by Lumina C. Riddle.

36. Notes on collecting Cicindelidæ, by D. E. Lantz.

37. Notes on collecting Cicindelidæ, by Eugene Smyth.

38. The Coleoptera of New Mexico, II, by Warren Knaus.

A new auditing committee—D. E. Lantz and W. F. Hoyt—was appointed, as Professor Ward, already appointed, was absent.

39. Progress in production of high-protein corn, by J. T. Willard and R. H. Shaw.

40. On the action of hydrogen chloride on certain hydrous chlorides, by F. M. McClenahan.

41. Harmonic cubes and other solid forms, by B. B. Smyth.

42. The salt industry in Kansas, by E. H. S. Bailey.

43. Atchison coal-mines, by E. B. Knerr.

44. Life of a fossil hunter, by Chas. H. Sternberg.

The auditing committee reported treasurer's accounts were correct. Moved and voted the report be accepted.

The committee on resolutions reported the following:

Your committee is highly pleased to note the evidence of prosperity in the State Agricultural College, in its efficient president and faculty, in the beautiful new buildings, erected according to the dictates of the latest scientific knowledge in sanitation, in the greatly increased attendance, and in the improved curriculum.

Resolved, That we return our thanks to the faculty of the college for the use of the buildings for our meetings and for the very pleasant reception tendered by the faculty.

B. B. Smyth,
L. C. Wooster,
Committee.

The committee on membership reported the following new members: M. E. Canty, Chanute; John T. Copley,* Manhattan; Rev. B. T. Stauber, Salina; A. M. Ten Eyck,* Manhattan.

Moved and voted report be accepted and secretary cast ballot for these persons.

There were forty-three new members elected and fourteen of these were present; twenty-five old members were present — making thirty-nine members present at Manhattan meeting.

The minutes of this session were read and approved. The Academy adjourned *sine die* at 11:45 A. M.

G. P. Grimsley, *Secretary*.

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* Present at meeting.

MINUTES.

Thirty-seventh Annual Meeting, Kansas Academy of Science, December 29, 30, and 31, 1904.

TOPEKA, KAN., December 29, 1904.

THE thirty-seventh annual meeting of the Kansas Academy of Science was called to order in the Academy museum room at the state-house, with President Bartow in the chair.

The following members were present at the Topeka sessions: L. O. Adams, H. W. Baker, Edward Bartow, F. W. Bushong, J. C. Cooper, John T. Copley, G. P. Grimsley, W. A. Harshbarger, W. F. Hoyt, F. B. Isely, J. T. Lovewell, F. O. Marvin, J. R. Mead, C. E. McClung, D. F. McFarland, J. M. McWharf, Grace Meeker, Frank Patrick, L. F. Paull, Norman Plass, Chas. H Popenoe, E. A. Popenoe, Eugene Smyth, B. B. Smyth, Teresa Stevenson, F. H. Snow, C. H. Shattuck, A. J. Smith, L. E. Sayre, Eva Schley, A. H. Thompson, L. C. Wooster, J. T. Willard, H. I. Woods, J. A. Yates.

Eleven of the new members were present and a number of visitors, making in all forty-six members present.

Committees were appointed as follows:

On nominations: L. E. Sayre, J. C. Cooper, W. A. Harshbarger.

Resolutions: E. H. S. Bailey, L. C. Wooster.

Press: L. E. Sayre.

Treasurer reported $321.21 in treasury up to this meeting, and probably $50 taken at this meeting. This report was then referred to F. W. Bushong as an auditing committee.

Voted that a committee of three be appointed to consider matter of a luncheon on Friday evening in honor of the retiring secretary, and A. H. Thompson, F. B. Isley and A. J. Smith were appointed.

The following papers were then read:

1. Additional notes on loco weed, by L. E. Sayre.

2. *Echinacea angustifolia*, by L. E. Sayre.

4. Food preservatives—how far are they injurious to health? by L. E. Sayre.

Committee on membership reported the following fifty-one names for new members. and it was voted that the secretary cast the ballot for these persons, which was so cast: H. C. Allen, McPherson; Alfred W. Ayers, Onaga; W. J. Baumgartner. Lawrence; Frank G. Bedell, Iola; R. L. Biggart, Abilene; H. P. Cady, Lawrence; C. I. Corp, Lawrence; Ralph K. Crawford, Lawrence; W. R. Crane, Lawrence; Robert W. Curtis, Lawrence; Roger Dean, Lawrence; S. D. Dice, Alma; James Dickson, Lawrence; Herbert W. Emerson, Lawrence; Fred Faragher, Lawrence; R. M. Freeman, Lawrence; Dr. Eva Harding, Topeka; H. D. Hess, Lawrence; Geo. J. Hood, Lawrence; C. E. Houdyshel, Lawrence; Albert K. Hubbard, Lawrence; Ida H. Hyde, Lawrence; Chas. E. Johnston, Wellington; Geo. F. Kay, Lawrence; B. E. Lewis, Eureka; Hester E. Loveall, Pittsburg; Henry B. Miller, Rossville; Roy L. Moodie, Lawrence; Eleanor E. Morse, Lawrence; Chas. E. Mull, Wa Keeney; H. B. Newson, Lawrence; L. M. Peace, Lawrence; Albert B. Reagan, Rosebud, S. Dak.; H. C. Riggs, Lawrence; Charles G. Rogers, Lawrence; J. A. G. Shirk, Lawrence; Dr. S. G. Stewart, Topeka; E. F. Stimpson, Lawrence; Olin Templin, Lawrence; E. S. Tucker, Lawrence; J. N. Van der Vries, Lawrence; Barclay C. Winslow, Hutchinson.

A committee on necrology was appointed, consisting of J. R. Mead and Warren Knaus.

Reading of papers resumed:

4. The culture emergence of man, by A. H. Thompson.

It was voted that Chancellor Strong and Prof. W. H. Johnson be given privileges of the floor.

5. Physical characteristics of water and its relation to tree growth, by B. B. Smyth.

6. Additions to the list of Kansas Hemiptera, by F. F. Crevecœur.

7. Some variations in some of our Kansas wild flowers, by F. F. Crevecœur.

Academy adjourned, to meet in museum room Friday, nine A. M.

FRIDAY MORNING, December 30, 1904.

Academy was called to order at nine A. M. Minutes of the preceding meeting were read and approved.

The report of the secretary was then read, and it was voted the report be accepted and the thanks of the Academy be extended to the secretary for his services. The report was as follows:

REPORT OF THE SECRETARY.

During the past year the secretary of the Academy has devoted much time to the collection and installation of the Kansas mineral exhibit at the St. Louis Exposition. This work has been done, with credit given to the Academy for the work done, and with the understanding that at the close of the exposition the exhibits would be placed in the Academy museum.

This has made necessary a loss of time from the Academy office, and during this time when I was away from the office Mrs. Grimsley was in charge. The work on the library, correspondence and arrangement of the program for this meeting, the canvass for new members and the preparation of a portion of our next volume of the Transactions have been done by her. I feel sure that the Academy has not lost by my absence, and that the advertisement of the

Academy and the acquisition of the valuable St. Louis exhibits have been most valuable for its future strength as a state organization. We now have a valuable museum of which we may well be proud.

LIBRARY.—We were fortunate this past year in having a requisition allowed the Academy for the binding of 500 volumes of our journals. This represents a very valuable addition to our library. This requisition is the largest ever allowed the Academy, and is evidence that we still have the favor of the state authorities. These volumes, with the former books in the library, have been classified, arranged on our shelves, and a card catalogue made giving the shelf location, so they may be readily located on demand. The old card catalogue of subjects of papers in these volumes has been to a large extent arranged in the card-catalogue cabinet.

There have been added to the library this past year 700 pamphlets and 75 bound volumes.

The Academy at the last meeting (Manhattan) allowed the sum of $100 for the purchase of new books and completion of files of our journals. With the small book fund it was difficult for the secretary to decide on the books that would be most useful to the members, and many journals ordered were donated to the Academy, so that only a small portion of the fund was expended. The secretary would suggest that another fund be established, and an advisory committee selected to decide on the best books to purchase for the Academy.

Our library, in its contents and arrangement, may be looked upon with pride by the Academy members, and to-day we have as good quarters as any department in the state-house in proportion to our needs.

MUSEUM.—The museum of the state's mineral industries under our charge is the most complete in the state. We have secured the cases and exhibits from St. Louis, which represent an addition to our assets of at least $8000. It will make the Academy rooms one of the most attractive places in the city for visitors and I hope will insure the future financial aid of the state. The state can well afford to maintain this permanent advertisement of its mineral resources.

MEMBERSHIP.—The Academy added forty-five members at the Manhattan meeting and forty-two of these qualified by paying their dues. The secretary's office presents fourteen names for new members this year, and the members of the Academy will add to this list at this meeting. We regret to propose a list of former members whose names should be dropped from our rolls for non-payment of dues though notified six to eight times. We have made an effort to collect past dues from the members and during the year have collected $91 in dues.

CONCLUSION.—The present secretary has been in office for three years and the results of the work are known to the members, and I will leave the work for the members to decide whether it has been successful or not, for the welfare and standing of the society.

A combination of circumstances has arisen this past year which indicates that my best interests call me from this state back to the East. I therefore present my resignation as secretary of the Academy with this report. I would recommend that it take effect January 10, in order that I may be able to arrange for the printing of the next volume of our Transactions, which includes the work during my past two years.

I expect to continue my membership and shall always take the greatest interest in your work. In conclusion, I wish to thank the members for their support in this work and to express the hope that the sincere friends made in this Academy work may ever continue as such. G. P. GRIMSLEY, *Secretary.*

December 29, 1904.

Voted that money be appropriated sufficient to pay for 400 copies of nineteenth Transactions bound in paper.

A sketch of the life of S. A. Baldwin, by J. T. Willard, and one of Peter McVicar, by G. P. Grimsley, were read.

The following new members were elected: R. E. Davis, Fort Scott; W. G. Medcraft, Salina; Wm. S. Prout, Topeka; F. W. Simmons, Mankato. Also, Alva J. Smith elected life member on meeting the requirements.

Reading of papers resumed:

8. The Emporia blue limestone, by A. J. Smith.

It was voted that a committee of three be appointed to revise names of geological outcrops of Kansas and report at next meeting. Alva J. Smith, A. W. Jones, Geo. F. Kay, were appointed.

9. Use and care of reflecting telescopes, by W. H. Hoyt.

10. A new calendar of the Christian era, by John T. Copley.

11. Notes on Kansas birds, by F. H. Snow.

12. A tropical bird in Kansas, by L. C. Wooster.

13. Notes on Kansas Orthoptera, by F. B. Isely.

14. A fossil forest in Jackson county, by C. H. Shattuck.

15. Additions to the list of Kansas Coleoptera for the years 1903–'04, by Warren Knaus.

16. Composition of a gas from a well at Dexter, Kan., by D. F. McFarland.

17. Food habits of the Golden eagle, by L. L. Dyche.

Banquet committee reported members would meet at the Copeland hotel at six P. M.

Academy adjourned, to meet at two P. M.

FRIDAY AFTERNOON, December 30, 1904.

Academy met in museum at 2:15 P. M., and voted a committee of three be appointed to consider time and place of next meeting. E. H. S. Bailey, Warren Knaus, J. A. Yates, were appointed.

Voted a committee of five from the various sections be appointed for selection and purchase of new books, and $150 be allowed for this purpose.

The committee on nominations, through Professor Sayre, recommended:

For president, L. C. Wooster, Emporia.

For vice-president, F. W. Bushong, Kansas City, Kan.

For vice-president, W. A. Harshbarger, Topeka.

For treasurer, Alva J. Smith, Emporia.

For secretary, J. T. Lovewell, Topeka.

Moved and voted the report be accepted, and the rules be set aside and secretary cast the ballot for the persons named. Ballot so cast.

Reading of papers resumed:

18. The fossil buffalo of Kansas, by C. E. McClung.
19. Physical development and school life, by Dr. J. M. McWharf.
20. The medullary ray, by W. C. Stevens.
21. Structure of echinacea root, by C. M. Sterling.
22. Instinct—Doctor Loeb's view, by H. L. Miller.
23. The genesis and development of human instincts, by L. C. Wooster.

Voted privileges of floor be extended to Prof. F. W. Ellis and Judge Grover.

24. The quality of commercial cream of tartar, by L. D. Havenhill.
25. Construction of micrometer eyepieces, by L. M. Peace.
26. The composition and properties of some typical flours, by W. E. Matthewson.

Academy adjourned to evening.

FRIDAY EVENING, December 30, 1904,

Some forty members of the Academy assembled at six P. M. at the Copeland hotel for the banquet. After the banquet, toasts were given, with Dr. A. H. Thompson as toastmaster.

J. C. Cooper gave the welcome to visiting members, and Edward Bartow spoke for the out-of-town members.

L. E. Sayre responded to the toast "Our Secretary," and G. P. Grimsley spoke for the defense.

J. R. Mead gave reminiscences of past history of the Academy.

F. H. Snow spoke of the founders of the Academy.

The banquet proved a success, and added greatly to the interest of this meeting.

FRIDAY EVENING, December 30, 1904.

The evening session of the Academy opened at 8:15 P. M., with Vice-president L. C. Wooster in the chair. President Bartow delivered his presidential address, on the subject "Water-supplies of Southeastern Kansas."

It was voted that the president's address be referred to a committee of three to consider its recommendations and report back to the Academy, and Professors F. O. Marvin, J. T. Willard and E. H. S. Bailey were appointed.

It was voted that the secretary be requested to endeavor to send one copy only of the Transactions to each member, and, if possible, also twenty-five reprints of papers to the author.

Reading of papers resumed:

27. Effect of clay and loam on cement mortars, by W. C. Hoad.
28. Brick testing, by F. O. Marvin.

PLATE III.—Kansas Academy of Science Museum, 1903—Capitol Building, Topeka.

29. On the insect fauna of Oak Creek canyon, Arizona, by F. H. Snow.

Committee on membership reported names of Aaron Schuyler, Salina; A. J. Stout, Topeka.

Academy adjourned to Saturday at nine A. M.

SATURDAY MORNING, December 31, 1904.

Academy was called to order by President Bartow at 9:15 A. M.

Committee on time and place of next meeting recommended that the Academy meet at Lawrence, and the time be left to the executive committee. Report was adopted.

Auditing committee, F. W. Bushong, reported treasurer's accounts correct, and report was approved.

A sketch of life of Mrs. Mary Mudge was given by J. T. Willard.

It was voted that the committee on necrology be requested to secure photographs and prepare sketches of lives of Richard Cordley and J. S. Whitman, who were early members of the Academy and have died in the past year. Prof. F. H. Snow was requested to prepare these sketches.

Committee on resolutions reported the following, which were adopted:

WHEREAS, Our secretary, Dr. G. P. Grimsley, on account of his removal from the state, is not eligible for reelection to this office: be it

Resolved, That we acknowledge our great indebtedness to him for his efficient services while acting as secretary; not only for his efforts to increase the membership of this Academy, but also for the variety of valuable papers obtained from the members, and their prompt and satisfactory publication.

Resolved, That we appreciate the successful efforts of our secretary to establish and maintain an industrial museum of the natural and manufactured products of the state in the capitol building, and we request the incoming secretary of the Academy to use every possible effort to increase and improve this museum.

E. H. S. BAILEY,
TOPEKA, December 30, 1904. L. C. WOOSTER,
Committee.

The committee on purchase of books was appointed, to consist of: Biology, C. E. McClung; chemistry, F. B. Dains; psychology, H. L. Miller; geology, Alva J. Smith; Pres. L. C. Wooster.

Committee on president's address, through F. O. Marvin, presented the following report, which was adopted:

Your committee appointed to consider suggestions made by President Bartow in his annual address desire to offer the following preamble and resolution as their report:

WHEREAS, The health and prosperity of the people of the state demand legislation that will provide for effective investigation and supervision of the water supplies of the state and of the means for the treatment and disposal of sewage and waters otherwise contaminated, as suggested in the presidential address by Professor Bartow: therefore, be it

Resolved, By the Kansas Academy of Science, that it strongly indorses legislation placing such investigation and sanitary supervision under the control and authority of the State Board of Health;

And be it further resolved, That the secretary be instructed to send a copy of this preamble and resolution to the governor elect, with the request that this matter receive attention in his message making recommendations to the legislature.

F. O. Marvin,
J. T. Willard,
E. H. S. Bailey,
Committee.

Reading of papers resumed:

30. Action of ethyl chlorsulfonate upon aniline, by F. W. Bushong.

31. The need of investigations in human nutrition, by J. T. Willard.

32. The deep well at Emporia, by A. J. Smith.

33. The puma or American lion (*Felis concolor*), by L. L. Dyche.

34. Problems in harmonic forms, by B. B. Smyth.

35. Origin of gypsum, with special reference to the origin of Michigan deposits, by G. P. Grimsley.

36. The Kansas mineral exhibit at St. Louis, by G. P. Grimsley.

Committee on membership recommended L. I. Blake, Lawrence, for life membership on complying with requirements; Brice Hammars, Topeka, annual member; Geo. Wagner, Madison, Wis., for honorary membership; G. P. Grimsley, for honorary membership. These persons were unanimously elected.

37. Notes on Buprestidæ collecting in Arizona, by Eugene Smyth.

38. A new derivative of azo-amido-benzene, by Edward Bartow and H. E. Allen.

The following papers were read by title:

40. On the reactions between acid and basic amides in solutions of liquid ammonia, by E. C. Franklin.

41. Notes on the topography and geology of New Mexico, by J. J. Jewett.

42. Myxomycetes of Clay county, Kansas, by John H. Schaffner.

43. The mammals of Kansas, by D. E. Lantz.

44. Dissemination and germination of seeds, by Wesley N. Speckman.

45. Non-Euclidean geometry, by E. Miller.

46. Steinerian of quartic surfaces, by J. N. Van der Vries.

47. Autographic recording machines for tension tests, by Geo. J. Hood.

48. Notes and descriptions of Orthoptera from the Western United

States in the collection of the University of Kansas, by A. G. Rehn. (Presented by F. H. Snow.)

49. Notes and descriptions of Hymenoptera of Kansas, New Mexico and Arizona in the collection of the University of Kansas, by H. L. Vierech. (Presented by F. H. Snow.)

50. On the insect fauna of Galveston, Tex., by F. H. Snow.

51. A comparison of the Diptera of Kansas and New Mexico, by F. H. Snow and T. D. A. Cockerell.

52. On the use of different oxidizing substances in making color tests for strychnine, by E. H. S. Bailey.

53. Catalogue of the flora of Kansas, by B. B. Smyth and J. H. Schaffner.

54. The Mentor fauna, by A. W. Jones.

Voted that those papers from authors who were not present and had sent no word to the Academy concerning the papers should be dropped from the list.

55. The law of similars, by Dr. Eva Harding.

56. Catalogue of the Goss ornithological collection, with ornithological notes by Colonel Goss, by B. B. Smyth.

57. Bruchidæ, Tenebrionidæ, Mordellidæ, and Melodiæ, by Warren Knaus.

Academy adjourned *sine die* at 12:15 P. M., to meet in Lawrence

G. P. GRIMSLEY, *Secretary.*

ADDRESSES DELIVERED AND PAPERS READ

BEFORE THE

KANSAS ACADEMY OF SCIENCE,

AT

MANHATTAN, 1903,

TOPEKA, 1904.

I.

PRESIDENTIAL ADDRESSES.

"Oxygen in its Relation to Mineralogy."
By J. C. Cooper, Topeka, Kan.

"Water supplies of Southeastern Kansas."
By Prof. Edward Bartow, of the University of Kansas, Lawrence.

PLATE IV.—Kansas Academy of Science Museum, 1905 (looking east)—Capitol Building, Topeka.

OXYGEN IN ITS RELATION TO MINERALOGY.

By J. C. Cooper, Topeka, Kan.

An address delivered at Manhattan, November 28, 1903, before the thirty-sixth annual meeting of the Kansas Academy of Science.

OXYGEN is a simple word, but it has a wide relation. It is the name of the most important element in all of nature's operations. It is, like the air, transparent, and without color, odor, or taste. It is the most abundant of all substances. It makes nearly one-half of the entire bulk of material substances in and of our earth. It constitutes by weight nearly one-fifth of the atmosphere, eight-ninths of the waters of the earth, and about one-third of the earth's solid mass.

It enters into combination with all the elements that make the natural substance of this world, and probably all worlds—for it is generally accepted that this world, though so small an atom, is an epitome of the universe.

In the mineral kingdom especially is it associated with all the elements. Its wide range of association makes it the most interesting element in the mineral kingdom.

The chemist tells us that there is but one element with which oxygen does not combine, and that is chlorine. This is not the case with any other of the elements. That is, it does not unite with chlorine singly or alone, but it enters into combinations with other minerals that are attached to chlorine; for instance, potassium chlorate, which is one of the common substances from which oxygen is obtained. The potassium chlorate is composed of three elements—the two gases, oxygen and chlorine, and the metal potassium, in the proportion of one atom each of potassium and chlorine and three atoms of oxygen. The oxygen is driven off by heat, and the chlorine remains with the potassium, leaving what is called potassium chloride.

We have a practical illustration here of the lack of affinity with chlorine. The potassium is satisfied in its affections with the chlorine, and freely lets go of the oxygen under the persuasion of a little heat. Indeed, it gives it up so freely that there is some danger of explosion in obtaining oxygen from potassium chlorate alone—the oxygen being so ready to leave, I suppose, in consequence of its dislike to chlorine, that large quantities of the gas are apt to be set free suddenly. This danger is prevented by mixing it with an equal weight of manganese dioxide.

What is very singular in this whole proceeding is that the oxygen has a very strong affection for the manganese, and consequently the manganese does not give up any of its oxygen under the persuasion of heat alone. It only acts as a restraining force to make the oxygen leave the potassium in a quiet and orderly manner and not violently and in anger, as it would be likely to do.

We have seen how indifferently potassium lets oxygen go away when it has chlorine for a companion. Let us, for an illustration, observe how potassium behaves with oxygen when all the company is congenial.

Take, for instance, potassium carbonate, which is composed of two parts of potassium, one of carbon, and three of oxygen. Here the affection of the potassium for the oxygen is so strong that the metal potassium must be heated until it becomes a vapor before it will consent to part with the oxygen.

If we conduct proper experiments with these apparently inert and indifferent substances and observe carefully their action, we will come to the conclusion that there are affectionate attachments between minerals as well as between human beings and animals.

This element, like all elements, has its individual affections. It apparently does not love all alike.

With the metals it unites in varying combinations. These combinations are as fixed in nature's operations as our idea of the laws of the Medes and Persians.

With some metals it always divides fair, one atom of oxygen to one atom of metal. It is then known as a monoxide or one oxide.

With some metals it is a little more generous, and will put into the business two atoms of oxygen to one of the metal. This firm is called a dioxide, or two oxides.

Then with some metals it is lavish in its generosity, and will put in three atoms, or shares, to one of the metal; and this partnership is known as a trioxide, or three oxides. The prefixes mono, di, tri, are derived from Greek words, meaning one, two, three.

Then there are some metals with which it goes into partnership on the basis of one and a half to one; but, as there are no half atoms in nature, it gets around the difficulty by putting in three atoms of oxygen as a sesquioxide, the Latin prefix *sesqui* meaning one and a half. This is the common combination with iron. The most abundant ores of iron are sesquioxide. There are two other oxides of iron—one, the monoxide, which is not of so much importance, and the magnetic oxide, which has three atoms of iron to four atoms of oxygen. But I will not afflict you with the technical properties of this element. This knowledge you can secure more completely and in a more satisfactory manner from chemistries and encyclopedias.

While oxygen is one of the chief components of all vegetable and animal substances, and its work in the animal kingdom is absorbingly interesting, I wish at this time to attract your attention more particularly to its special importance in the mineral kingdom. However, it would be well to bear in mind that everything on the earth, and of the earth, and about the earth, is mineral. The air we breathe, the food we eat, the clothes we wear, every article in use by man, our bodies, every living and inanimate thing, are made up of mineral elements and are resolvable into mineral elements.

We might justly call oxygen the Ariel among the elements, marshaling its fairy hosts at will in every conceivable parade of beautiful crystalline forms and colors. Its combinations with the metals gives the coloring matter that tints all the beautiful varieties of minerals, as well as all the brilliant and varied colors of the flowers and the vegetable kingdom.

Its combinations with silicon, calcium and potassium make it practically the most important constituent of all rocks. The primal granites, all the igneous and metamorphic rocks, all of the felsites, quartzites, the sandstones, the shales and limestones, owe their hardness, their durability and their existence to this fairy, airy element, light and colorless as the air.

Nearly all the beautiful crystallizations of every variety of form and color that make up the gems of the earth are the affectionate and obedient subjects of this master element. With varying proportions of silicon and other elements it makes the hard, durable granites, quartzites, diorites, trachytes, rhyolites, as well as the sandstones and softer shales. Associated with carbon it unites with calcium, and makes the limestones in all their variety, from the coarse, argillaceous, magnesian limes to the perfectly crystallized white and colored marbles and the brilliant, transparent calcites.

One of the most remarkable illustrations of its fancy is exhibited in its union with the soft, white element aluminum, making alumina, more commonly known as corundum, or emery, the mineral next in hardness to the diamond; and when it is found pure and transparent it makes the most valuable and most beautiful gems of the earth — the ruby, the sapphire, and the emerald. These gems, when pure, are simple oxides of aluminum, colored with the presence of a metallic oxide so small in quantity that the skill of the chemist cannot measure it.

Oxygen is the life-giving and sustaining element; the active principle of combustion; the heart of fire. Life cannot exist in the animal kingdom but a few moments without it.

While it is the life builder and the life-sustaining force in nature, yet, strange contrariety, immediately upon the cessation of life its special work is to tear the dead carcass to pieces and liberate the elements of which it is composed, so that they may again become industrial activities in the laboratory of nature.

In the animal and vegetable kingdoms we can witness the ceaseless activity of oxygen in building up while there is life, and its destructive force in tearing to pieces when life has ceased. But in the so-called mineral kingdom the processes are so slow, to our finite observation, that they are not so apparent. Yet oxygen is at work upon the dead rocks, and, in the language of the poet, "the ceaseless tooth of time" is constantly at work tearing the dead rocks to pieces and liberating their elements for renewed activity.

I want to take the liberty of availing myself of the opportunity in this gathering of active educational workers to ask them to give more attention to the teaching and study of mineralogy in our schools than they have been in the practice of doing.

The world is waking up to a better comprehension of the vast and useful field of mineralogy. How intimately it concerns all the necessities of man. Chemistry is wholly dependent upon it. It would have no material to work upon without it. Medicine is dependent upon it for all its remedies to heal the sick. All the industries that mark the progress of man and help him to a better enjoyment of life are dependent upon the materials of this useful kingdom.

The industries are to-day taxing the best skill of the chemist to study out new combinations of mineral elements to meet their growing wants. The mineral industry of this country is giving active and profitable employment to about one one-hundredth of the entire population of the country, counting men, women, and children. Its product is nearly eqúal in money value to all the other products of the fields. It is calling for the best educated skill to meet its growing wants. Its rewards for intelligent and skilful labor equal any line of industrial work giving employment to man.

The subject is constantly widening. Students of sciences are only beginning to comprehend its far-reaching possibilities. "Nearer, my God, to Thee" is a sweet song, but nowhere in nature do we get nearer to the creator of all things than in the study of mineralogy, with its wonderful variety of forms, and its gems of infinite beauty.

A new field is opening to it. The necessity of minerals to the existence of life are set forth in a paper, "The Predominant Rule of Mineral Substances in Biological Phenomena," by M. Herrera, in Revùe Scientifique. He says:

"Science made a great step when she succeeded in obtaining imitations of protoplasm, whose structure has once been looked upon as an almost supernatural phenomenon. But the progress was still greater when she succeeded in preparing perfect imitations of organic bodies with inorganic material, such as calcium chlorid, sodium phosphate, and calcium carbonate—substances that are found everywhere. Beside, the structure of living beings, whether organic or inorganic, would be useless without the water and salts to determine the tonus and the nutritive osmotic currents.

"Although substances from the organic kingdom are sufficient in themselves for the support of life, it is because they always contain a certain proportion of mineral matter.

"We cannot deny the importance of the 600 organic substances extracted from plants, but neither can we deny that living beings proceed out of inorganic forces and substances. If my views are correct, living beings must be regarded as mineral colloids, and zoology and botany as chapters of mineralogy."

M. Herrera should have gone farther; instead of saying, "it is because they always contain a certain proportion of mineral matter," he should have said, "it is because they are wholly made up of mineral matter."

I know of but two colleges in this country that give distinctive prominence to mineralogy in their work. Those are Yale College and Columbia College. Yale College owes a large part of its fame to having had a Dana conspicuously connected with it. James A. Dana has left an imperishable monument to commemorate his memory in his "System of Mineralogy," which is now the recognized authority on mineralogy in the English language; and I am told by those who are familiar with other languages that there is no work in existence that covers the field so completely. A worthy son is following in his father's footsteps and carrying on the work.

The rapid development of our mineral resources and the proud position our country has attained in mineral production, giving evidence of possessing mineral resources far surpassing any other equal area on the globe, should arouse us to the importance of giving more attention to the study of mineralogy.

As mineralogy practically covers the useful field of geology, and it is more essentially the science of to-day and of the future, it should be made the leading branch of natural-science instruction in our educational institutions.

Mineralogy is the natural handmaid of geology. In studying the composition of the matter that makes up the crust of the earth, to learn its useful properties for man's comfort and progress, the student of mineralogy necessarily has to learn the practical part of geology; the natural relative position of the primary rocks; the history, position, composition and useful properties of the sedimentary rocks; the phenomena and result of igneous action, and its metamorphic results in affecting the deposition of the useful minerals. This wide field in mineralogy takes in a good deal of what is useful in geology; and considering the practical utility of mineralogy, what an important factor it has been, is and will be for all time in civilized progress, it does seem to me that our educators would make themselves more useful if they would give more attention to this live, practical science. Take a little time off from their devotion to the Silurian, Devonian and Carboniferous ages, and get acquainted with the home habits of gold, silver, iron, lead, zinc, aluminum, silicon, carbon, sulphur, sodium, potassium, etc., and try to catch up with the twentieth century that now, like a great globe of light, is lifting its disk above the horizon to light us on to a future of wonderful possibilities.

WATER-SUPPLIES OF SOUTHEASTERN KANSAS.

By EDWARD BARTOW, of the University of Kansas, Lawrence.

An address delivered at Topeka, December 30, 1904, before the thirty-sixth annual meeting of the Kansas Academy of Science.

IN choosing the subject for the address this evening, I have taken occasion to glance over the subjects of the papers that have been used in similar addresses since the by-law was passed requiring an address by the retiring president.

These subjects have been of various natures; some dealing with the relation of science to everyday life, or to the schools, or to the nineteenth century, or to the state. Others are of a more special scientific nature, dealing with a chemical, an astronomical, a geological or a biological subject. Still others deal with scientific problems, the solution of which should be undertaken by the state. I would place mine this evening in the last class.

I might have chosen as a title for my address one analogous to that of President Brown, delivered in 1884. His title was, "Is a Geological Survey of the State a Necessity?" My title might be, "Is a Chemical Survey of the State a Necessity?" or, to speak boldly, "A Chemical Survey of the State is a Necessity."

The chemical work in the state has been limited. The work done, though very limited, has been very valuable in respect to the analyses of coal, gypsum, and mineral waters. Also, at the Experiment Station of the State Agricultural College at Manhattan, systematic work is being done in the examination of farm products and fertilizers. While I know that the state should provide a chemical survey of its minerals, including oil, gas, coal, salt, gypsum, lead and zinc ores, and should make provision for the chemical analysis to prevent food adulteration, I have chosen to confine myself in this address to the water-supplies of the state.

Owing to the size of the state, I have chosen to speak in detail of only the southeastern section; therefore my title, which appears on the program, "Water-supplies of Southeastern Kansas." I trust that, by a description of the conditions existing in that small section of the state, I may show you that a chemical survey of the water-supplies of the entire state will be of advantage, nay, will be or even is a necessity.

I will deal only with the watersheds of the Marais des Cygnes, Neosho and Verdigris rivers, because I have made some systematic examination of the water of these three rivers. These rivers drain all or part of twenty-two counties, having an area of 14,000 square miles, and a population of about 400,000. In area these counties equal in size the combined areas of the states of New Hampshire and Connecticut, and they were as thickly populated as either New Hampshire or Vermont at the time of the last census. Moreover the population has greatly increased since the last census, owing to the rapid development of the oil- and gas-fields.

The gas-fields had been drawn upon for several years for city gas supplies, and a small oil refinery was operated at Neodesha prior to 1901. It is from that date that the operations began to assume the colossal dimensions that in a few years will make the Kansas-Indian Territory-Oklahoma field the greatest in the United States, and probably the greatest in the world. The output of oil has increased one hundred fold in the last four years—from 200 barrels per day in 1900 to 20,000 barrels per day in 1904. The handling of this oil means a large increase in population, and, in addition, brick plants, cement works, zinc smelters and glass factories are using the gas and bringing thousands of people into this section.

It is necessary to provide an abundant supply of pure water for this increased and increasing population, and it is necessary to take proper care of the sewage from these enlarged and enlarging cities. The individual city will have a tendency to look out for itself, to the possible, even probable, detriment of neighboring cities. For example, a city may obtain its water-supply from one of these rivers and dispose of its sewage into the same river further down. This, however, cannot be done without detriment to other cities further down the stream. At certain seasons of the year the rivers in this southeastern section are so decreased in volume that they will not afford sufficient dilution to purify the organic matter which exists in these enlarged and enlarging cities. One such case suffices to show that the state should have a general oversight of the water-supplies and sewage systems throughout the state of Kansas.

In order to learn definitely the source of the water supplied to the cities of this southeastern section, I have addressed letters to the mayors of said cities. According to the United States Gazetteer for Kansas (1898), there are 119 cities and villages in this section of the state—thirty-five in the Marais des Cygnes watershed, fifty-six in the Neosho, and twenty-eight in the Verdigris. I have received replies from seventy-five of the cities, and find that twenty-seven have already a public water-supply, nineteen of which obtain their supply in whole or in part from these rivers. Only thirteen have public sewers, and, as far as my knowledge extends, these empty into these rivers. Thirty-nine from which replies were received obtain their supplies from wells and cisterns. A few obtain their supplies from springs and one from a lake.

PLATE V.—Kansas Academy of Science Museum, 1905 (looking west)—Capitol Building, Topeka.

We thus see by an examination of the reports that the source of the water used by these cities is either cisterns, wells, or rivers.

You may think it unnecessary for me to spend time in telling you things you already know in regard to the value of a good general supply of a good, pure water for cities and towns, but a review of the reasons for the necessity of an abundant supply of pure water may help to show you the necessity for a chemical survey of the water-supplies. It will also introduce what I have to say in regard to the advantages and disadvantages of the various sources of water-supply available in southeastern Kansas.

A good supply of pure water is of value to the household, to the manufactory, and to general public use. Most important of these three is the service to the household. Here, first of all, pure drinking-water is needed, on account of its relation to the health of the individual and therefore to the community. It is an established fact that many disease germs are carried by water, for such diseases as cholera and typhoid fever have been traced directly to the water-supply. A change in the source of the water-supply, by which a purer water is obtained, reduces the possibility of such diseases. This was shown in the city of Chicago, where the water intake was extended to four miles into the lake. The average death-rate from typhoid fever was reduced from 8.0 per 10.000 for seven years prior to 1892, when the extension was made, to 3.4 per 10,000 for the seven years following, a reduction of more than 50 per cent.

Again, the introduction of purification systems have reduced the death-rate from these germ diseases. As an example, the average annual death rate per 100,000 from typhoid fever in Zurich was reduced from 73.6 to 9.0 after the introduction of new filters. This is a reduction of more than 800 per cent.

A plentiful supply of water as soft as possible is needed in the household for bathing and for laundry purposes. Parkes in his book, "Hygiene and Public Health," says that the city of Glasgow saves annually $180,000 in the amount of soap used since the introduction of the soft Loch Katrine water. The most economical method for the proper disposal of household waste is by dilution with water, and the carrying of the same into a sewage system. For this household use we see that an abundant supply is needed.

Many branches of industry require large amounts of water, and these necessarily must choose their location on account of an abundant supply. Oil refineries, starch factories, chemical works, need large amounts of water, and in some cases a water of a high degree of purity. Every user of power depending on steam must have a good water for the boilers. Here the soft water—that is, a water free from scale-forming materials—has the preference. The saving in fuel consumption and in the durability of boilers will compare with the saving of soap in the household. Therefore, the location of many factories depends not only on the quantity of the water-supply, but also on the quality.

The most important general public use is for fire protection. For this purpose the primary need is an abundant supply. An abundant water-supply lowers the rates of insurance, and it is far better to pay a small tax for fire protection of this kind than to pay a heavy insurance rate.

Then, the water serves to sprinkle streets, to water lawns, to flush sewers, to give drinking and ornamental fountains. These uses add to the comfort of the people and to the attractiveness of a city, increasing the value of property.

With the cheap power available throughout the oil and gas region, an abundant supply can be easily obtained for general public use, and with care as to the quality, this supply will also serve the manufacturer and the household. It must be remembered that the first need is a pure water for drinking; the second, a water as soft as possible for laundry and boiler use; third, an abundant supply for flushing sewers and for fire protection.

The water available for water-supplies in southeastern Kansas may be classed as rain-water, ground-water, and surface-water. Let us consider each with reference to its advantages and disadvantages when applied to the various needs of the community. Rain-water—and by that I mean water collected on roofs and stored in cisterns, commonly termed cistern water—is seldom obtained pure. It washes from the air the dust that is blown from the highways and the gases that are present from the fumes of the chimneys of houses, factories, and furnaces. It washes from the collecting surface the dust, excrement of birds, and decayed leaves.

The cistern into which this water flows generally contains a filter of soft brick, which is supposed to remove all impurities. This filter will be effective at first, but it soon becomes saturated with the foul matter removed from the water and is then a breeding-place for bacteria, and serves to inoculate the water which passes through.

The rain which falls after the air is washed and the collecting surface is cleansed is quite pure. If care be taken to save only this part of the rain-water, water of a satisfactory quality for any purpose will be obtained. Most cisterns have an arrangement by which the first part of a shower can be diverted; but usually no attention is paid to it, and as Professor Palmer, who conducted the "Chemical Survey of the Waters of Illinois," has said, "It soon reaches a state of noxious desuetude."

It contains no mineral salts, and hence is soft, and is, therefore, good for laundry use and for boilers. Owing to the necessity for large storage to tide over a dry season, it is not suited to general public use, although cisterns are often built in small towns for fire protection.

From what has been said, one would conclude that, as a rule, cistern water is not well suited for drinking, and that its value for drinking or for fire protection is inversely proportional to the size of the city or town in which it is collected.

The second available source of water-supply in southeastern Kansas, namely, ground-waters, includes water of deep and shallow wells and water from springs. Deep wells are not possible in the greater portion of southeastern Kansas, as oil and salt water are found. The majority of the people rely on shallow wells for their drinking-water. In the country, with due care to prevent contamination, these are very satisfactory. They are liable to receive seepage and drainage from the surface down, and, therefore, in cities and villages are to be avoided. One may be careful of his own house, drainage, and sewage, but one cannot control the house drainage of a careless neighbor. That ground-waters are affected by the presence of people is shown by investigations in Massachusetts. These show that 100 persons to the square mile increase the normal chlorine of the district by 0.5 parts per million.

The users of wells rely on the powers of the earth as a filter. The earth is a good filter, but must not be used beyond its limits. It has been shown that sewage thrown continuously on the ground in the same place will very quickly saturate the earth with impurities, and then contamination will be carried long distances, especially if the seepage finds an underground passage. A case is on record of typhoid germs being carried a mile underground, then contaminating a spring, causing a serious outbreak of the fever. (Lausanne, Switzerland).

Intermittent additions of sewage to the same spot, allowing time for the air to come in contact with the earth, will be satisfactorily filtered, for the earth allows the growth of bacteria which, in the presence of air, destroy the organic matter and the harmful germs.

Wells that have been used a long time are usually considered safe. Again and again I have been told that a well under examination has been used for years, causing no illnesses. These wells sometimes contain diluted sewage from healthy sources as a result of small seepage. These sources may at any time become contaminated and dangerous. Diluted sewage containing no pathogenic germs may be drunk with impunity. Still more safely can a perfectly treated sewage be taken internally. When people are offered such sewage, though they are told that it is perfectly germ free, yet they hesitate to drink.

These same people will not hesitate to drink well-water that they know nothing about, which may contain diluted untreated sewage.

A soft well-water from a source free from contamination is excellent for any purpose. Wells in this section, on account of the limestone, would usually furnish a hard water that requires a large amount of soap and forms a boiler scale, making it an undesirable water for the laundry or for manufacturing purposes. For general public use, of course, the only requirement would be a high rate of flow, to furnish an abundant supply.

The third source of water-supply to be considered—surface-water—may be described as a combination of rain-water and ground-water. This water is usually from lakes, rivers, or impounding reservoirs. In southeastern Kansas there are no large lakes; hence the streams are the only source of surface-water to be considered.

To be entirely pure, a surface-water should be collected from an uninhabited region. New York city obtains its water-supply from surface-water. Considerable areas have been depopulated, farms have been condemned, and even whole villages have been removed from the watersheds of its reservoirs. It has become a great problem to furnish a sufficient supply of pure water, and at present they are contemplating still further operations of the same kind.

In southeastern Kansas the rivers necessarily receive the drainage, not only from houses but from streets and barn-yards. The organic matter in this drainage will be removed and destroyed, if there is sufficient dilution and if there is a sufficient lapse of time between the contamination and the use of the water. The greatest danger lies in contamination by disease germs. Some are nearly always present in the sewage of a city.

An illustration of the effect of such contamination is the typhoid epidemic that raged in the Hudson valley in 1890–'91. Prof. William P. Mason, of Rensselaer Polytechnic Institute (Water-supply, p. 33), investigated in person, and describes it somewhat as follows: "The epidemic began at Schenectady in July, 1890. The drainage of Schenectady passes into the Mohawk river. Typhoid fever broke out at Cohoes, farther down the river, in October, and at West Troy in November. These cities obtain their water-supply from the Mohawk, and return their sewage into the Mohawk and the Hudson. Typhoid fever broke out at Albany, six miles below West Troy, in December. Albany's water-supply is obtained from the Hudson, opposite the city. There was practically no typhoid in Waterford and Lansingburgh, cities connected to Cohoes by bridges, but cities that obtain their water-supply from the Hudson above the Mohawk junction and from the hills, respectively. There was also no fever in Troy proper, supplied with water from the Hudson above the Mohawk junction. Albany, at least, has since introduced a filtration plant."

Not only can a river be infected by sewage from a city but it may be infected by a single individual. The fecal discharges of a person suffering from typhoid fever thrown upon the ground have been known in well-authenticated cases to have been washed by rain or melting snow into a stream which serves as a water-supply. The outcome was a serious epidemic, with loss of life.

Cities are being built up so near each other on these Kansas rivers that it seems advisable to suggest and even to demand that no untreated sewage be allowed to flow into these streams, and that no unfiltered water be allowed to enter the service-pipes of any water system.

Special caution is needed in this section, for an abundance of water can only be obtained from these rivers. Think of the list of larger cities on the Neosho all taking their water-supply from this river and emptying their sewage directly or indirectly into it—Emporia, Burlington, Iola, Humboldt, Chanute, Erie, Oswego. The same statement may be made of the cities on the Verdigris, though a smaller list on a smaller stream—Fredonia, Neodesha, Independence, Coffeyville.

A chemical examination of the water of these three river systems was carried on in the laboratory for water analysis of the University of Kansas during 1903–'04. The expenses of collection were defrayed by the division of hydro-economics of the United States Geological Survey. The work was under my direction, and I was ably assisted by Mr. A. W. Sellards, K. S. U., in 1903, and by Mr. P. C. Jeans, K. S. U., in 1904. Collections of water were made principally during the college year at Ottawa, La Cygne, Emporia, Burlington, Chanute, Oswego, Benedict, Independence, and Fredonia. Turbidity readings have been made since July, 1904, at Ottawa, Emporia, Oswego, and Fall River. Results are to be published in full. The most important conclusion to be drawn is that these rivers, on account of the organic matter and turbidity, do not furnish a water that can be used as a household supply without treatment. Investigations should be undertaken to find the best method of treatment for rendering it serviceable, whether by filtration or by settling-basins, with or without a coagulant. Preliminary tests, when a treating plant is to be established, are almost a necessity, and have been shown to be of great value at Louisville and Cincinnati, where the Ohio river was tested.

As a rule, a turbid river-water contains organic matter and bacteria, but sometimes a turbid well-water may be practically germ free, when the water of a deep well contains a large amount of ferrous iron. Such water may be clear and bright when first drawn, but become turbid on standing. Most people do not like to drink a turbid water, and will drink instead any clear well-water, regardless of its source.

The waters of these rivers must be treated to render them clear and germ free for household use. And it is possible to treat them in such a way as to make them soft for laundry and manufacturing purposes. The question that occurs to many is, What is the use? or, in other words, Does it pay?

As an example of the use of filtration to obtain a germ-free water, I will mention the experience of the adjoining cities of Hamburg and Altona, in Germany, during the cholera epidemic of 1892. Hamburg used unfiltered Elbe water, while Altona used filtered Elbe water after it had received the sewage of over 800,000 people of Hamburg. The cases rate in Hamburg was 263 per 10,000 inhabitants, while in Altona it was only 38.1, and most of these cases had their origin in Hamburg. One part of Hamburg, supplied by water from Altona, did not have a single case, though surrounded by the disease.

As an example of the value of water treatment to soften it, I will refer to the work of the Santa Fe railroad in analyzing and treating waters throughout its system, from Chicago to California. In the *Journal of Locomotive Firemen*, Mr. Powers, the chief chemist for the Santa Fe, tells of the work done, and I take the liberty of reviewing his article. In 1902 the Santa Fe began the treatment to soften waters by means of soda ash and lime. In September, 1904, there were sixty-six plants in operation, capable of treating from 50,000 to 300,000 gallons of water per day, at a cost of from one cent to eight cents per 1000 gallons. Cost depends on the quality of the water. It is calculated that the treatment removes four and one-half tons of incrustants daily from 3,570,000 gallons of water used. From the only plant thus far erected in southeastern Kansas, at Neosho Rapids, 150 pounds of incrustants are removed from a daily consumption of 50,000 gallons. The results are highly satisfactory, and the life of flues and fire-boxes has been more than doubled.

The Kansas cities as individual cities are not large enough to undertake the necessary examinations advantageously. It is a task for the state. Other states and some large cities have established chemical surveys of their water-supplies. Considerable surveys of streams, watersheds and other possible sources of city supplies have been thoroughly examined. Several states have undertaken such work, sometimes from a chemical standpoint only, and in other cases bacteriological examinations have been included.

The most expensive work has been done by Massachusetts, carried on under the auspices of the State Board of Health. Their work was begun in 1887, and made possible by an act of the legislature, which is quoted elsewhere. Connecticut has made similar examinations.

New York city has carefully examined its watershed, and has recently extended its examinations to include sources of water-supply within fifty miles of the city. Ohio began such work in 1897; Illinois has been engaged on a chemical survey for a number of years; and considerable work has been done by the cities of Chicago and St. Louis. Other states have also made examinations, and in many cases have established a standard of purity for the state. All water intended for municipal use must conform to this standard. Michigan and Iowa are examples.

Since geological conditions vary, it is necessary for each state to deal with its own problems, and sometimes, as in Kansas, the problem must be worked out for different sections of the state. The chlorine standard for the watersheds of southeasterm Kansas will not answer for the valley of the Kansas river.

As I have said before, the control of the water-supply should be in the hands of the state, and since Massachusetts has done the most work and the best work in solving the problens discussed, I will quote the law passed in that state in 1888, entitled

AN ACT to protect the purity of inland waters, and to require consultation with the State Board of Health regarding the establishment of systems of water-supply, drainage, and sewerage.

SECTION 1. The State Board of Health shall have the general oversight and care of all inland waters, and shall be furnished with maps, plans and documents suitable for this purpose, and records of all its doings in relation thereto shall be kept. It may employ such engineers and clerks and other assistants as it may deem necessary; provided, that no contracts or other acts which involve the payment of money from the treasury of the commonwealth shall be made or done without an appropriation expressly made therefor by the general court. It shall annually, on or before the 10th day of January, report to the general court its doings in the preceding year, and at the same time submit estimates of the sums required to meet the expenses of said board in relation to the care and oversight of inland waters for the ensuing year, and it shall also recommend legislation and suitable plans for such systems of main sewers as it may deem necessary for the preservation of the public health, and for the purification and prevention of pollution of the ponds, streams and inland waters of the commonwealth.

SEC. 2. Said board shall, from time to time, as it may deem expedient, cause examinations of the said waters to be made for the purpose of ascertaining whether the same are adapted for use as sources of domestic water-supplies or are in a condition likely to impair the interests of the public or persons lawfully using the same or imperil the public health. It shall recommend measures for prevention of the pollution of such waters and for removal of substances and causes of every kind which may be liable to cause pollution thereof, in order to protect and develop the rights and property of the commonwealth therein and to protect the public health. It shall have authority to conduct experiments to determine the best practicable methods of purification of drainage and sewage or disposal of the same. For the purpose aforesaid, it may employ such expert assistance as may be necessary.

SEC. 3. It shall from time to time consult with and advise the authorities of cities and towns, or with corporations, firms or individuals either already having or intending to introduce systems of water-supply, drainage, or sewerage, as to the most appropriate source of supply, the best practicable method of assuring the purity thereof or of disposing of their drainage or sewage, having regard to the present and prospective needs and interests of other cities, towns, corporations, firms or individuals which may be affected thereby. It shall also from time to time consult with and advise persons or corporations engaged or intending to engage in any manufacturing or other business, drainage or sewage from which may tend to cause the pollution of any inland water, as to the best practicable method of preventing such pollution by the interception, disposal or purification of such drainage or sewage; provided, that no person shall be compelled to bear the expense of such consultation or advice, or of experiments made for the purpose of this act. All such authorities, corporations, firms and individuals are hereby required to give notice to said board of their intentions in the premises, and to submit for its advice outlines of their proposed plans or schemes in relation to water-supply and disposal of drainage and sewage; and all petitions to the legislature for authority to introduce a system of water-supply, drainage or sewage shall be accompanied by a copy of the recommendation and advice of the said board thereon. Such board shall bring to the notice of the attorney-general all instances which may come to its knowledge of omission to comply with existing laws respecting the pollution of water-supplies and inland waters, and shall annually report to the legislature any specific cases not covered by the provisions of existing laws which, in its opinion, call for further legislation.

SEC. 4. In this act the term "drainage" refers to rainfall, surface- and subsoil-water only, and "sewage" refers to domestic and manufacturing filth and refuse.

SEC. 5. Chapter 274 of the acts of the year 1886 is hereby repealed, but nothing in this act shall be construed to affect the expenditures authorized under chapter 30 of the resolves of the year 1888.

SEC. 6. This act shall take effect upon its passage. (Approved May 18, 1888.)

A similar law is entirely possible in Kansas. The water-supply from the rivers of Kansas can be rendered perfectly hygienic. It is my hope that the legislature will direct the State Board of Health to—

I. Have a general oversight of the water-supplies and sewage systems of the state;

II. Employ engineers, chemists and whatever expert assistance may be necessary to make a chemical examination of the water-supplies, who shall experiment as is necessary with sewage purification, who shall establish a standard of purity for the water to be served to cities and towns, and who shall advise cities and towns in regard to the care of supplies already in use, and to assist them in planning further supplies.

II.

CHEMICAL AND PHYSICAL PAPERS.

"Food Preservatives—How Far are they Injurious to Health?"
By L. E. Sayre, University of Kansas, Lawrence.

"Kansas Petroleum."
By Edward Bartow and Elmer V. McCollum, University of Kansas, Lawrence.

"Composition of Gas from a Well at Dexter, Kan."
By D. F. McFarland, University of Kansas, Lawrence.

"Native Zinc."
By J. T. Willard, Kansas State Agricultural College, Manhattan.

"Progress in the Production of High-protein Corn."
By J. T. Willard and R. H. Shaw, Kansas State Agricultural College, Manhattan.

"The Quality of Commercial Cream of Tartar."
By L. D. Havenhill, University of Kansas, Lawrence.

"A New Derivative of Diazo-amido benzene."
By Edward Bartow and H. C. Allen, University of Kansas, Lawrence.

"The Action of Ethyl Chlorsulfonate upon Aniline."
By F. W. Bushong, Kansas City University, Kansas City, Kan.

"Reactions in Liquid Ammonia."
By Edward Curtis Franklin, Leland Stanford Jr. University, California.

"Properties and Composition of Some Typical Flours."
By W. E. Matthewson, Kansas State Agricultural College, Manhattan.

"An Autographic Recording Instrument for Tension Tests."
By Geo. J. Hood, University of Kansas, Lawrence.

"The Effect of Clay and Loam on the Strengh of Portland Cement Mortar."
By W. C. Hoad, University of Kansas, Lawrence.

"Notes on Some Kansas Paving Brick."
By F. O. Marvin, University of Kansas, Lawrence."

FOOD PRESERVATIVES—HOW FAR ARE THEY INJURIOUS TO HEALTH?

By L. E. SAYRE, University of Kansas, Lawrence.

Read before the Academy, at Topeka, December 29, 1904.

IT is well known that we have now on our statute-books laws which prohibit the use of various substances as adulterants. Many of the substances may be classed as food preservatives. Outside the public, there is no class of people more interested in legislation in this direction than the pharmacist and physician.

Legislation in different countries and different parts of the United States concerning the employment of these substances has been of varying character, prohibiting in some parts what is allowed in others, and those local regulations, often contradictory, have emphasized the necessity of a bureau in Washington for an investigation which shall establish certain principles concerning the use or prohibition of these substances. This bureau not only analyzes chemically, microscopically and otherwise samples of food and drugs offered for sale, but by investigation determines how far the modern and other chemical preservatives are deleterious. In a recent bulletin of the Department of Agriculture, Bureau of Chemistry (Circular No. 15) the excellent work of this department is set forth. It may be said in passing that this circular shows the result of the physiological investigation regarding the use of borax and boric acid as a preservative upon digestion, etc.

The object of the present paper is to call attention to the possible undue antagonism against many of the new antiseptics furnished by organic chemistry, having, as they are used, little toxicity. We will cite but two, salicylic acid and benzoic acid. Doctor Biglow, of the Bureau of Food Investigation, at Washington, says of the former—salicylic acid:

"It has been used chiefly to preserve fruit and vegetable products. In following the directions of dealers in food preservatives, an ounce of salicylic acid or sodium salicylate is added to from 400 to 600 pounds (50 to 75 gallons) of liquids, and from two to three times that amount to pasty or semisolid substances. . . . Owing to the early exploitation of salicylic acid as a food preservative, and the well-known indifference which characterizes both legislative bodies and the general public regarding the wholesomeness of foods, the use of salicylic acid became so common at one time that chemists of many boards of health still test for no other preservative."

Some of the inorganic substances, such as boric acid, have also been found suitable as preservatives. Doctor Leffman calls attention to these as having the merits of cheapness, of not producing color in the amount needed, of having no odor or appreciable taste when added to the material to be preserved. Each substance has its preferable applications.

The common prejudice seems to be against all new antiseptics as being not only unwholesome but poisonous, but we are inclined to the belief that this is an exhibition of conservatism which may impede progress—a spirit that assumes all the preservatives of ancient origin to be safe and all of modern origin to be unsafe.

It cannot be said, says Doctor Leffman, that the prejudice existing against some of the new preservative agents is founded upon a scientific basis. The experimental data are not extensive, and are somewhat one-sided; the investigations have been made with the modern, or, as they have sometimes been called, chemical preservatives. If we accept freely the published results, we can say, I think, merely that a limited amount of disturbance of function may be attributed to most of the modern antiseptics.

The question, in my opinion, cannot be considered as placed on a scientific basis until all forms of preserved foods have been studied carefully in comparison. It is probable that all forms of preserved foods are less wholesome than fresh. Even the cooking of proteid foods diminishes their digestibility. Drying, salting, smoking and pickling have probably still more unfavorable effects. Experiences among those who make long journeys away from the comforts of civilization, who must rely on food preserved in any manner, show amply that fresh materials have some special nutritive quality that is not long retained. This fact is abundantly exemplified in the history of navigation and in recent experience of Alaskan pioneers.

Doctor Eccles (Am. Jour. Phar.) says: "Every intelligent man is an advocate of pure-food laws and of their enforcement; however, all do not agree as to what constitutes pure foods. There is an idea among people generally that food preservatives are as a rule deleterious to health; this prejudice is to be accounted for because it has been so widely proclaimed that any form of preservative added to food products is a poison. This, as every scientific man knows, is a false position to take. We see around us every day the evil effects of foods that do not contain preservatives. It is true preservatives may be somewhat harmful, but not to the same extent as decayed foods. Salicylic, benzoic and boric acids have been used for over twenty years, yet there cannot be found a single recorded case of any one having been injured by food containing them, while, on the other hand, thousands have been killed by using food that did not contain preservatives.

The pure-food laws controlling the use of these preservatives are in their infancy, and, so far as they aim to accomplish salutary effect, should be enforced. It is an undisputed question that there is no real harm done in the use or abuse of the preservative substances, but we question whether most of the real harm does not arise from the use in fraudulently manipulating inferior products so as to enable the seller to obtain a price of a much higher class of goods. These remarks especially apply to articles other than preservatives, such as aniline colors used in articles of food and drink; these colors being confined principally to the reds, yellows, and browns, and are somewhat easily detected by the well-known property of these colors to dye fat-free woolen goods. If the coloring matter be of fruit or vegetable origin, such material will be either uncolored or changed slightly; if coal-tar or aniline color be used, the woolen material will take color readily.

To any one who is interested in the subject of food control by the United States, it would be most profitable reading to take the report of 635 pages issued by the government relating to the "hearings before the committee of interstate and foreign commerce of the house of representatives on the pure-food bills." In this report it will be found that a great deal of the testimony in regard to the effects of many of the preservatives is based upon purely theoretical grounds: for example, it is stated that salicylic acid is injurious to the organs of secretion; if its use be continued, that it retards digestion. Many statements are made, and confessed not to be from any personal experimentation.

An American leader in the war against preservatives says: "There is no preservative that paralyzes the ferments which create decay that does not at the same time paralyze to the same extent the ferments that produce digestion. The very fact that any substance preserves food from decay shows that it is not fit to enter the stomach." It is this kind of reasoning that has led to the swearing in court that salicylic acid is dangerous to health and a poison. Salicylic acid has been chosen as the special target of attack because of one especial reason of its familiar antagonistic action to ferments; but let us remember its methyl ester is found in hundreds of plants from the most diverse botanical orders. Most fruits contain it. Nature has thus put it into our foods. In this respect it is like benzoic acid. Doctor Eccles says, in relation to toxicity of preservatives to be classed with salicylic acid: "I defy any one, if he dares to claim that vinegar is not a poison, to put the matter to the test of a public experiment with me. If vinegar is a poison, then the court's rulings, if consistent, make it a crime for any person to add vinegar to any kind of food. The acid of vinegar in its pure state is, according to the best authorities in therapeutics, eight times stronger than salicylic acid in its pure state. Is it just to punish the men who use the weaker substance and permit those who use the stronger to escape unscathed? In all standard works on therapeutics the acids of most all fruits are considered much stronger than salicylic acid; then if we consider the one a poison we must consider the other in the same degree. In their strongest condition, boric, benzoic and salicylic acids are much weaker than many of the substances used daily in our food, as in essences, spices, etc. No one will deny that salicylic acid when used in even small quantities will not only disturb digestion but may actually inflame the kidneys, and in very susceptible persons may produce delirium and convulsions; it also depresses the heart; but while we are aware of these effects regarding the use of the pure acids as a preservative in prescribed quantities similar to that of acetic acid, oil of smoke, etc., it would be harmful, our experience has been that salicylic acid is of much value in the preservation of the flavor of fruit juices, such as raspberry, strawberry, etc., from which the fruit syrups are frequently made for use at soda-fountains, and in other ways."

"Our results* tend to show that if 0.3 grams be added to a quart (twenty-seven fluid ounce) bottle of fruit juice, such as strawberry or raspberry, it will keep this fluid retaining its flavor, etc., very much better than if the fruit juice be bottled by the ordinary sterilizing process without the use of salicylic acid. Fruit juice bottled in each of the two ways has been kept for over a year, and then from this liquid syrups have been made; the one preserved with salicylic acid has a better flavor and is in every respect a better article. Now the question is, What harm may arise from the use of salicylic acid in this way? Let us estimate the quantity of salicylic acid that one would obtain in an ordinary tumbler of water flavored with raspberry syrup. To the half-pint tumbler let us say there would be added 50 cc. of raspberry syrup, not over one-third of this having been treated with salicylic acid. Therefore, as there was added to the original juice 0.3 grams to about 800 cc. of fluid, there would be contained about six milligrams of salicylic acid. The physiological dose of this acid is stated by our best authorities to be from 0.3 to 4 grams. So it would be seen that it would take a gallon, at least, of the syrup to make a respectable minimum dose of the preservative."

Doctor LeWall, speaking of salicylic acid as used in some of the jel-

* See "Use and Abuse of Food Preservatives," Year-book of Department of Agriculture, 1900, page 558. It should be stated in this connection that in his report Doctor Biglow gives an extensive list and the composition of commercial food preservatives.

lies as a preservative, says: "It would no doubt surprise many that an ordinary wintergreen lozenge contains as much salicylic acid (combined as methyl salicylate) as the average tumbler of jelly which has been preserved with this substance, but such is certainly the case, as any one who desires may verify for himself."

In this paper we have but briefly touched upon this very important question. The preservation of foods is now in many countries a gigantic industry; even the manufacture has reached such dimensions as to be too great for any one person to review. Our civilization has reached the point where it is absolutely necessary to protect the public against the harmful effects of decayed foods, and many things point to the great importance of the trade in preserved foods; hence, the importance of the study by the unprejudiced scientists of the exact value. What we are demonstrating as food preservatives have also a much wider and possibly more important application, viz., in the preservation of certain remedial agents; for example, in the antitoxic serums. In the anti-diphtheritic serums, a serum separated from the coagulated blood of a horse immunized through the inoculation of diphtheritic toxin must be preserved. The common preservative for the liquid is tricresol, which is a mixture of meta-, para- and ortho-cresol. Here we have a liquid which is injected hypodermically; fatal results would occur, perhaps, if this liquid were not preserved by antiseptic. The antiseptic employed is one which the food commissioners would say was dangerous, but in the quantities required it becomes entirely innocent, and a great protection to humanity.

We believe that all preservatives from a certain point of view must be more or less harmful. We are not prepared to believe that foods in general can be preserved without them. If there should be such a necessity, then the investigation concerning the relative toxicity of these preservatives is of far greater importance to the public than the unwarranted crusade against the use of them or the unqualified condemnation of them all. If it be found in any given case that a food preservative is necessary for a stored food, then the quantity and kind of preservative employed should be plainly stated on the package containing said preserved food.

KANSAS PETROLEUM.

By EDWARD BARTOW and ELMER V. McCOLLUM, University of Kansas, Lawrence.

Read before the Academy, at Manhattan, November 27, 1903.

SINCE our first report on Kansas Petroleum (Trans. Kan. Acad. Sci., vol. XVIII, p. 57), we have collected and examined twenty-five specimens of crude petroleum from Kansas and other fields, making thirty-three in all.

The oils from the Kansas field were obtained from the following localities; unless otherwise noted, they were obtained by one of us:

Sample No. 9 was from well No. 5 of the Illinois Valley Oil and Gas Company's property, about one and one-half miles northwest of Cherryvale, Montgomery county. The sample was pumped directly from the well.

Samples Nos. 10 and 11 were sent to me by the Independence Gas Company. No. 10 was described as coming from the Brownfield well, in the center of the southwest quarter of section 3–32–15, and No. 11 from the Giger well, in the southwest quarter of section 29–33–15.

Sample No. 19 was from well No. 3 of the Illinois Valley Oil and Gas Company, about one and one-half miles northwest of Cherryvale, and was collected directly from the well.

Sample No. 20 was from a well about one mile south of Neodesha, and was collected directly from the well.

Sample No. 21 was from a well about a mile west of Neodesha, Wilson county, and was collected from a tank at the well.

Sample No. 23 was from the Bolt well of the Independence Gas Company, near Bolton, Montgomery county, section 18–33–15. It was taken from a tank at the well.

Sample No. 24 was from the Fellows well of the Independence Gas Company, north of Bolton, Montgomery county, section 8–33–15. It was taken from a tank at the well.

Sample No. 25 was taken from the Brewster well of the Drum Creek Oil and Gas Company, four miles east of Independence, Montgomery county, section 3–33–16. This sample was collected as it was forced out between the casings by the gas pressure.

Sample No. 26 was from the Brownfield well of the Independence Gas Company, about four miles northwest of Independence, Montgomery county, section 3–32–15. It was collected directly from the flowing well.

Sample No. 27 was from the Mosher well of the Independence Gas Company, northwest of Independence, Montgomery county, section 35–31–15, and was collected from a tank.

Sample No. 28 was from the Brewster well of the Drum Creek Oil and Gas Company. This is the same well as No. 25, but this oil was pumped directly from the well.

Sample No. 29 was from the W. S. Gilliland well No. 1 of the Caney Gas, Oil and Mining Company, at Caney, Montgomery county, section 5–35–14. It was taken directly from the well.

Sample No. 30 was from the M. De Armond No. 2 of the Interstate Oil and Gas Company, at Peru, Chautauqua county, section 15–34–12. It was taken from the flowing well.

Sample No. 31 was from the T. L. De Armond well No. 1 of the Interstate Oil and Gas Company, at Peru, Chautauqua county, section 15–34–12. It was blown from the well by natural gas.

Oil No. 30 was said to come from the oil sand at a depth of from 920 to 960 feet, while that in No. 31 was said to come from a sand at 596 to 611 feet. These wells were only a few hundred feet apart.

Sample No. 32 was said to be from a well on the G. R. Wheeler farm, near Tyro, Montgomery county, section 30–34–15. This sample was furnished the writer by Mr. B. B. Canterbury, of Coffeyville.

Oils from outside the state of Kansas have been obtained as follows:

Sample No. 12 was from the Newcastle, Wyo., field, and was sent to us by Prof. E. E. Slossen, of the University of Wyoming.

Sample No. 18 was sent to us from Lima, Ohio, by Mr. C. J. Brotherton, of that city.

Sample No. 18 was from the Bartlesville, I. T., field, and was obtained by one of us from a tank-car.

Samples 33, 34 and 35 were obtained for us by Mr. Wesley Merritt, the industrial commissioner of the Santa Fe system.

Sample No. 33 was from Beaumont, Tex.

Sample No. 34 was from the Olinda district, California.

Sample No. 35 was from the Kern River district, California.

The table on next page shows a comparison of the specific gravity, flash and burning points of these samples.

From those analyses we would call attention to the following facts: The specific gravity varies greatly, from .845 to .949, a difference of about .100. In general, the oils of the higher specific gravity are found in the northeastern part of the field, although in the neighborhood of Humboldt, in the northeastern section, we find oils of a specific gravity of .860 and .940, a difference of .074. One sample sent to us from near Bolton has a specific gravity of .741. This is .200 below the heaviest oil that we collected personally. Exclusive of the very light sample, which seems phenomenal for Kansas, there is a greater variation than we have found recorded for any other field.

The flash points and burning points vary from below 10° C. in the

Number.	Specific gravity.	Baume.	Flash point.		Burning point.	
			Fahrenheit.	Centigrade.	Fahrenheit.	Centigrade.
9	0.857	33.5	Ordinary temperature.		Ordinary temperature.	
10	0.858	33.3	"	"	"	"
11	0.741	59.5	"	"	"	"
19	0.865	32.0	"	"	"	"
20	0.846	35.0	"	"	64°	18°
21	0.865	32.0	118°	48°	145	63
23	0.865	32.0	113	45	135	57
24	0.850	35.0	Below 50	Below 10	Below 50	Below 10
25	0.877	30.5	73	23	93	34
26	0.845	35.7	Below 50	Below 50	54	12
27	0.871	31 5	136	58	176	60
28	0.861	32.5	Below 50	Below 10	Below 50	Below 10
29	0.845	35.7	"	"	"	"
30	0.862	32.4	"	"	102	39
31	0.870	31.6	"	"	111	44
32	0.890	28.5	197	92	246	119
OILS FROM OTHER FIELDS.						
12	0.918	22.7	270°	132°	298°	148°
18	0.846	35.6	Ordinary temperature.		63	17
22	0.865	32.0	"	"	102	39
33	0.923	21.9	163°	73°	203	95
34	0.929	29.9	115	46	17	77
35	0.974	13.8	......	......	......	......

lighter oils to 143° C. in the heaviest sample, for the flash point, and to 172° C. for the burning point.

We have also made distillations according to the method of Engler of seventeen samples. We have determined the carbon and hydrogen of three representative samples, and have determined the sulfur in six samples. Prof. F. N. Peters, of the Kansas City central high school, has determined the bromin absorption of eight samples. These results will be published in detail in the Science Bulletin of the University of Kansas. The following is a summary of our results:

Distillation by Method of Engler.—300 cc. of the crude oil was distilled from a 500 cc. flask, and the fractions noted, as follows:

Naphthas	Boiling below 150° C	0.0 to 12.0% by volume.
Kerosenes	Boiling from 150° to 300° C	5.0 to 40.5% by volume.
Heavy oils	Boiling above 300° C	83.0 to 45.5% by volume.
Residue	Not distilling in glass	12.0 to 3.0% by weight.

The light oil from near Bolton gave 33 per cent. of naphthas and 63 per cent. of kerosenes, leaving practically no residue boiling above 217° C.

Determination of Carbon and Hydrogen.—For our determination of carbon and hydrogen we chose three representative samples of the lowest, medium and highest specific gravity, from oils that we collected direct from the wells. The results of average determinations follow:

Oil No.	Specific gravity.	Per cent. of carbon.	Per cent. of hydrogen.
3	.940	85.33	11.80
7	.912	85.63	12.44
19	.865	85.43	13.07

It will be noticed that the carbon is nearly constant in the samples examined, and that the hydrogen increases as the specific gravity decreases. This fact is usually accounted for by considering that the heavier oils have become oxidized and contain oxygen.

Determination of Sulfur.—Sulfur determinations have been made on the same samples, showing an average of 0.27 per cent. sulfur.

We have also made sulfur determinations in the oil from Lima, Ohio. This oil gave 0.84 per cent. sulfur. This may be compared with 0.81 reported by Mabery (Am. Chem. Jour., vol. 17, p. 727) for an oil of the same specific gravity and an average of 0.59 per cent. for the field.

An oil sent to us, said to be from the Lucas gusher, of the Beaumont, Tex., field, gave us 1.89 per cent. sulfur, compared with 1.75 reported by Clifford Richardson. (Jour. Soc. Chem. Ind., vol. XX, p. 691.)

The oil from Newcastle, Wyo., gave 0.38 per cent. sulfur.

The low percentage of sulfur in the Kansas oil is of great importance to the refiner, as the sulfur compounds can be removed from the refined oil without extra treatment.

COMPOSITION OF GAS FROM A WELL AT DEXTER, KAN.

By D. F. McFarland, University of Kansas, Lawrence.

Read before the Academy, at Topeka, December 30, 1904.

A GAS-WELL drilled at Dexter, in Cowley county, Kansas, has attracted a great deal of attention, owing to the fact that the gas which it yields will not burn. The well was drilled in 1903, and at a depth of about 400 feet a very strong flow of gas was encountered. According to measurements made by reliable parties at the well, and reported to Prof. E. Haworth, state geologist, the pressure of the gas was 120 pounds per square inch, and the rate of flow was estimated to be 7,000,000 feet per twenty-four hours.

Attempts were made to use the gas as a fuel, and it was soon found that the only way to make it burn was to turn it into a fire-box under a boiler where a good fire was already burning. Under these conditions the gas would burn and would generate enough heat to raise steam in the boiler, but as soon as the application of external heat ceased, it would no longer burn. No improvement in its combustibility was noticed after the well had been allowed to flow freely for fourteen days.

Professor Haworth, becoming interested in the gas, had a cylinder specially prepared with a valve at each end shipped to the well, where it was first filled with water, and this was then displaced by gas. By closing the lower valve and allowing the flow from the well to continue for a time the full pressure of the well was obtained in the cylinder, after which it was securely closed and sent to the University of Kansas, where it was turned over to the department of chemistry for analysis.

The results of the analysis have shown the gas to be of very unusual composition and totally different from gas from other Kansas gas-wells.

In the analysis, the methods of Hempel's gas analysis were used in the main, and these are so well known as to need no extended description. Oxygen was determined with a phosphorus pipette, carbon dioxide with strong potassium hydroxide solution, and carbon monoxide with ammoniacal cuprous chloride solution. Hydrogen was absorbed in a palladium tube, and methane was found by combustion with pure oxygen, and measurement of the resulting contraction and of the carbon dioxide formed.

The residual gas left after all of these operations, and constituting what is usually reported in a gas analysis as "nitrogen," was subjected to the treatment used by Ramsey and Rayleigh in the isolation of argon from atmospheric nitrogen. (Jour. London Chem. Soc., 1897, p. 181.) The residue was mixed with a large excess of pure oxygen, confined over mercury, and a small quantity of a strong solution of potassium hydroxide was introduced into the tube over the mercury. A spark from an induction coil was passed through the mixture for about sixty hours, and the nitrogen peroxide formed was absorbed in the potassium hydroxide solution. By means of the resulting contraction in volume the progress of the union between oxygen and nitrogen could be followed. The sparking was continued for several hours after all contraction had apparently ceased, and the residual gas was then passed into a freshly filled phosphorus pipette, where it was allowed to remain in contact with the phosphorus for several hours to insure the complete absorbtion of all excess oxygen. The residue, which measured 5.7 cc., represented 12.09 per cent. of the volume of original gas taken. It has not been further examined because of lack of time, so nothing can now be said as to its composition. As soon as time permits, the examination will be continued.

The results of the analysis are as follows:

Oxygen (O_2)	0.20	per cent.
Carbon dioxide (CO_2)	0.00	"
Carbon monoxide (CO)	0.00	"
Hydrogen (H_2)	0.80	"
Methane (CH_4)	15.02	"
Nitogren (N_2)	71.89	"
Inert residue	12.09	"
Total	100.00	per cent.

The large percentage of nitrogen and the small percentage of methane and hydrogen explain the relative incombustibility of the gas. The difference in composition between this gas and other representative Kansas gases is shown by comparison with some analyses published by Prof. E. H. S. Bailey (Kan. Univ. Quar., vol. 4, p. 10, 1895:

	Paola.	Osawatomie.	Iola.	Cherryvale.	Coffeyville.	Independence.	Neodesha.
Carbon dioxide	0.33	0.22	0.90	0.22	0.00	0.44	1.00
Olefiant gas, etc.	0.11	0.22	0.00	0.00	0.35	0.67	0.22
Oxygen	0.45	trace.	0.45	0.22	0.12	trace.	0.65
Carbon monoxide	1.57	1.33	1.23	1.16	0.91	0.33	0.50
Marsh-gas (methane)	95.20	97.63	89.56	92.46	96.41	95.28	90.56
Nitrogen	2.34	0.60	7.76	5.94	2.21	3.28	7.07
Hydrogen	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Totals	100.00	100.00	100.00	100.00	100.00	100.00	100.00

These analyses and many others published by various authors show that nitrogen is often found in small quantities in natural gases from various parts of the world. For example, three Ohio gases, from Findlay, Fostoria, and St. Mary's, analyzed by Howard (Redwood's Petroleum and its Products, vol. 1, p. 224), show, respectively, 3.41, 3.82 and 2.98 per cent. of nitrogen. Analyses by F. C. Phillips (Amer. Chem. Jour., vol. 16, p. 416) of a number of gases from points in Pennsylvania, Ohio, Indiana and New York show considerable quantities of nitrogen in almost every case, and in one case, that of a gas from Houston, near Canonsburg, Pa., 15.30 per cent. was found. In only one instance, however, have I noticed any report of a gas containing more nitrogen than that found in the Dexter well. Two samples of gas obtained by deep borings at Middleborough, England, were reported by Bedson (Jour. Soc. Chem. Ind., vol. 7, p. 662, 1888) to contain, respectively, 96.57 and 96.80 per cent. of nitrogen.

No attempt will be made in this paper to explain the formation of such enormous quantities of nitrogen as the Dexter well gives forth, this coming rather in the province of the geologist than in that of the chemist.

NATIVE ZINC.

By J. T. Willard, Kansas State Agricultural College, Manhattan.

Read before Academy, at Manhattan, November 27, 1903.

IN September, 1903, Mr. Frank A. Thackrey, superintendent of the United States Indian Training School. Shawnee, Okla., sent the writer a specimen of metal supposed to be native, and found in the banks of a new channel of a river. Upon examination, the metal proved to be zinc, and a request was made for further information concerning its occurrence and quantity. In reply, the following letter was received from Mr. Thackrey:

"Answering your letter of the 17th inst., I beg to advise that I have been unable as yet to personally investigate the allotment where the specimen of zinc, sent you some time ago, was found, as the allotment on which it was found is located a considerable distance from this office, and I have been unusually busy. I have ascertained, however, that it was found in a new channel made by the North Canadian river last spring during the high water, wherein it cut across a low, sandy bottom, and that several other smaller pieces were found along the same banks of this new channel in the river. I also learned that some years ago the allottee was digging a ditch to drain a pond into the same river on the same land, and in the bottom of this ditch, four or five feet underground, he found several similar specimens. However, he thinks the one sent you was the best he found, the others being smaller but of the same nature. I shall endeavor to look further into the matter as soon as possible, and shall be pleased to report the facts to you as soon as I can do so."

The specimen of metal sent is a flat, irregular mass, encrusted to a certain extent with earthy material, the whole weighing 43 grams. It has the coarse, crystalline texture common to zinc.

Native zinc is given by Dana as being reported from near Melbourne. Australia, from northeast Alabama, and from Shasta county, California. The comment is added, "Its existence in nature, however, needs confirmation." It is hoped that additional evidence may be secured in respect to the present instance, though there seems to be no reason to doubt the genuineness of the specimen.

PROGRESS IN THE PRODUCTION OF HIGH-PROTEIN CORN.

By J. T. WILLARD and R. H. SHAW, Kansas State Agricultural College, Manhattan.

Read before the Academy, at Manhattan, November 27, 1903.

IN previous papers the author has presented some of the results obtained at the Kansas State Agricultural College Experiment Station in analyses of corn incident to efforts to obtain varieties containing higher percentages of protein than the analyses known at present. This paper will include most of the analyses made of corn grown in 1902. The results previous to that year have been published in bulletin No. 107 of the Experiment Station, and the numbers given to the different samples are the same as those used in that bulletin.

The samples are the progeny of crosses made in 1898 among a considerable number of varieties supposed to be superior. The policy has been to reject each year all showing less than two per cent. of nitrogen. As average corn contains but 1.84 per cent. of nitrogen, the minimum in that which we have propagated would be about ten per cent. above the average. The following table shows the percentages of nitrogen in the corn from individual ears analyzed in all but one variety, which was unexpectedly inferior, and has not been included.

Cross No.	No. of ear and percentages.													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
76	2.10	2.30	1.85	1.69	1.83	2.14	1.88	1.88	2.23	2.09	.....	.....	.....	.....
92	1.99	2.15	2.34	2.22	2.02	2.53	1.87	2.07	2.22	2.38	.....	.....	.....	.....
138	2.11	2.60	.....	2.45	2.18	2.35	2.25	2.27	2.34	.....	.....	.....	.....	.....
322	1.69	1.77	2.39	1.93	1.99	2.23	1.99	2.13	2 17	2.16	.....	.....	.....	.....
401	2.11	2.33	2.15	2.14	1.87	2.00	2.04	2.25	2.18	2.01	.....	.....	.....	.....
417	2.16	2.05	2.23	2.13	.....	.....	2.23	1.82	2.18	.....	.....	.....	.....	.....
485	2.29	1.77	2.37	2.06	2.14	2.32	2.14	2.04	....	2.21	.....	.....	....	.....
487	2.08	2.08	2.14	1.62	1.76	2.10	1.78	....	1.78	1.82	.....	.....	....	.....
493	1.76	1.83	2.09	1.59	1.93	1.47	2.00	1.87	1.63	2.30	.....	.....	.....	.....
513	2.55	2.34	2.33	2.19	2.09	2.42	2.43	2.25	2.00	2.09	.....	.....	.....	.....
518	1.93	1.99	2.05	2.35	2.08	1.82	.....	...	...	...	.....	.....	.....	.....
519	1.86	2.02	2.01	2.30	2.14	2.30	2.20	2.26	2.12	1.96	....	....	.....	.....
535	2.14	1.67	2.26	2.12	2.29	1.80	1.77	2.00	2.07	2.11	.....	.....	.....	.....
547	2.26	2.35	2.09	2.29	1.88	2.21	1.59	2.06	2.07	2.34	.....	.....	.....	.....
554	2.15	2.18	2.25	2.32	1 94	1.94	2.33	2.21	2.44	2.24	.....	.....	.....	.....
545	1.90	1.92	1.97	1.58	2.04	2.08	1.85	2.18	1.74	1.63	....	.....	..	.....
541	....	2.05	1.61	2.12	1.19	1.82	2.60	2.09	2.07	2.21	1.78	2.15	2.03	1.96

The above table includes all of the analyses made in each case, and even a cursory examination will show the great superiority of many of the varieties over average corn. Of the 162 ears, only twenty were below 1.84 per cent. of nitrogen, and only fifty-one were below two per cent. of nitrogen. With a number of varieties none of the ears are of low nitrogen content; *e. g.*, Nos. 138, 92, 513, 519, and 554. The average percentage of nitrogen in all of them is 2.07.

It is generally conceded that an increase in the nitrogen content of corn would be a material addition to its value, yet with all the attention that corn breeding and corn judging are receiving at present, comparatively little weight is given to chemical composition. The tendency is altogether too much in the direction of judging upon merely fancy points. Last summer determinations were made of the nitrogen present in each of the ears of a bushel of Reid's Yellow Dent corn. This is one of the best known and longest bred varieties, and is without doubt an excellent corn in many respects.

The following figures show the percentages of nitrogen in each of the eighty-two ears analyzed: 1.26, 1.34, 1.45, 1.46, 1.48, 1.49, 1.51, 1.51, 1.52, 1.52, 1.54, 1.54, 1.55, 1.55, 1.55, 1.55, 1.56, 1.56, 1.57, 1.57, 1.57, 1.58, 1.58, 1.58, 1.59, 1.59, 1.60, 1.60, 1.60, 1.60, 1.60, 1.61, 1.61, 1.61, 1.63, 1.63, 1.64, 1.64, 1.64, 1.64, 1.65, 1.67, 1.68, 1.68, 1.69, 1.69, 1.70, 1.70, 1.73, 1.73, 1.74, 1.75, 1.75, 1.77, 1.77, 1.78, 1.81, 1.83, 1.84, 1.85, 1.85, 1.91, 1.92, 1.92, 1.94, 1.95, 1.96, 1.97, 1.97, 1.98, 1.98, 2.00, 2.01, 2.02, 2.05, 2.06, 2.07, 2.10, 2.13, 2.17.

The average per cent. of nitrogen in the Reid's Yellow Dent was but 1.71, or about seven per cent. less than that of average corn. The importance of giving more attention to the composition of a great staple product, which is grown for its feeding value and not for ornament, could scarcely be more methodically presented than by the above figures.

The plan adopted by the Experiment Station at the beginning of this experiment has been criticized by some, it being alleged that stable varieties can never be produced by crossing. It seems to the writer, however, that the results given above show that in respect to nitrogen content, the single quality that has thus far been made the criterion for selection, the plan adopted seems to be abundantly vindicated. It thus remains for us to select from among those of high protein content the specimens which possess the most desirable other qualities.

THE QUALITY OF COMMERCIAL CREAM OF TARTAR.

By L. D. HAVENHILL, University of Kansas, Lawrence.

Read before the Academy, at Topeka, December 30, 1904.

CREAM OF TARTAR, or potassium bitartrate, as it is scientifically termed, is derived wholly from the vegetable kingdom, and almost entirely from grapes. In this fruit it abounds, particularly in the vicinity of the seeds, and is the principal cause of the tart taste noticeable in that region. When the juice of the grape is expressed in wine-making, it carries with it the potassium bitartrate. This latter, since it is very much more soluble in the "must" than it is in the wine, is slowly precipitated, as the fermentation proceeds, along with large quantities of coloring matter and other substances.

From these precipitates, which are known, according to whether they collect on the sides or the bottoms of the fermenting tanks, as "argols" and "lees," respectively, the tartar is extracted with boiling water and purified by recrystallization. The chief natural impurity is calcium tartrate, which is present in the argols to the extent of from two per cent. to twenty per cent., but, owing to its very sparing solubility in water, should be practically all removed during the purification. Sometimes traces of the heavy metals are found, due to contamination from the vessels in which the argols are purified, but these are rigidly excluded by the tests of the United States Pharmacopœia, so that one per cent. of impurity which is allowed is practically calcium tartrate and moisture. According to the food and drug laws of Kansas (Gen. Stat. 1901, ch. 31, art. 11, page 487), the pure article of the United States Pharmacopœia is the only grade of cream of tartar that can be legally sold in the state.

As a drug, potassium bitartrate is classed with the saline cathartics and, owing to its hydragogue properties, is much used in dropsy. Aside from this, large quantities are used in combination with sodium bicarbonate as a leavening agent, or baking-powder. Its acid properties and sparing solubility in water render it peculiarly fitted for this purpose. The only drawback which, perhaps more than any other, keeps it from coming into universal use is that of price—a good cream of tartar baking-powder has for many years retailed at the uniform price of fifty cents per pound. It is, however, possible*, with pure

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* The following simple formula will be found to give satisfactory results, when pure chemicals are used:

Cream of tartar	2 parts.
Sodium bicarbonate	1 part.
Corn-starch or flour	1 part.

These ingredients must be dry, finely powdered, and free from lumps. Intimately mix, and pass several times through a fine sieve. Keep in a tightly closed can.

chemicals, for the housewife to prepare for herself this superior type of baking-powder at a cost of from twenty-five to thirty-five cents per pound—the usual price asked for the cheaper grades. No doubt many are prevented from availing themselves of this opportunity by the fact that cream of tartar is pretty generally believed to be grossly adulterated. To ascertain to what extent the facts bear out this belief has been the aim of this investigation. The work has been carried on in the laboratories of the University of Kansas School of Pharmacy during the past year, and special credit is due the members of the pharmacy class of 1904 for their valuable assistance in cooperating in the work.

The samples were all collected in one representative city in Kansas—one sample from each place of business. If the following statement of results does not represent the exact status of the quality of commercial cream of tartar in Kansas, it unquestionably does in one particular city.

In column I of the subjoined tabular statement of results will be found the number of samples analyzed; in column II, the source of the sample; in column III, the acidity in terms of pure potassium bitartrate, upon which its value as an agent for liberating carbon dioxide from carbonates depends; in column IV, the retail price per pound; in column V, the number of pounds calculated to equal, in efficiency, one pound of pure cream of tartar; the retail price of this is set opposite, in column VI; in column VII, the general observations.

I.	II.	III.	IV.	V.	VI.	VII.
		Per cent.				
6	Drug-store.........	99 +	$0.60	1.0	$0.60	Considered as up to standard.
2	"	99 +	.50	1.0	.50	" "
1	Grocery store......	99 +	1.25	1.0	1.25	" "
1	"	99 +	.80	1.0	.80	" "
1	"	99 +	.75	1.0	.75	" "
1	"	99 +	.60	1.0	.60	" "
4	"	99 +	.50	1.0	.50	" "
5	"	99 +	.40	1.0	.40	" "
2	"	99 +	.35	1.0	.35	" "
1	"	84	.50	1.2	.60	Calcium acid phosphate, etc.
1	"	84	.40	1.2	.48	Calcium acid phosphate, etc., with a trace of cream of tartar.
1	"	83	.60	1.2+	.72	Calcium acid phosphate, etc., with a trace of cream of tartar.
1	"	83	.50	1.2+	.60	Calcium acid phosphate, etc., with a trace of cream of tartar.
1	"	68	.40	1.5—	.59	Calcium acid phosphate, etc.
1	"	66	.40	1.5+	.61	" "
1	"	62	.75	1.6	1.20	" "
1	"	62	.40	1.6	.65	" "
1	"	62	.35	1.6	.56	" "
1	"	60	.60	1.6+	1.00	Calcium acid phosphate, etc., with a trace of cream of tartar.
1	"	14	.50	7.2	3.57	Calcium acid phosphate, etc.
1	"	14	.40	7.2	2.86	" "
1	"	12	.60	8.2+	5.00	" "

Thirty-six samples were examined; eight were obtained from druggists and twenty-eight from grocers. An inspection of the table brings out the following facts:

First. That all of the druggists were selling pure cream of tartar.

Second. That thirteen of the twenty-eight grocers were selling a substitute for cream of tartar, at a price equaling that asked for the pure article. Only four of these inferior samples contained any cream of tartar whatever, and this was more than likely accidental, since it existed in very small quantities.

Third. That seven of the fifteen grocers supplying pure cream of tartar were selling it at a price which was practically less than cost.

Fourth. That the adulteration, or more accurately speaking the substitution, was in every case calcium acid phosphate with its accompanying impurities, which in three of the samples was almost entirely impurity, calcium sulphate.

The calcium acid phosphate used for replacing the more expensive cream of tartar in leavening mixtures is a superior grade of superphosphate, a highly valued fertilizer, mixed with corn-starch. The better grades are pure white, and consist of the phosphates of calcium with about fifty per cent. of corn-starch and calcium sulphate, together with small quantities of iron and aluminum salts. As this complex mixture was the only impurity found, it is evident that any of these spurious samples would be condemned at once by their solubility, since a good sample of cream of tartar will be readily soluble in about fifty parts of hot water.

When such a simple test as this will serve to detect an adulteration, it does not seem that these dealers can be overly anxious to supply a pure article, and it is not necessary to look far for the motive for this high percentage of adulteration, since a much higher grade of this calcium acid phosphate than found in any of these samples masquerading under the guise of cream of tartar can be purchased for about one-fourth the price of pure cream of tartar. The public will, in many instances, be greatly imposed upon should it attempt an indiscriminate purchase of this article, and it is time that the attention of the wholesale as well as the retail grocers be called to paragraphs 2323 and 2327 of the Kansas statutes:

Paragraph 2323. *Adulteration of Food and Drugs.* No person shall within this state manufacture for sale, offer for sale, or sell, any drug or article of food which is adulterated within the meaning of this act.

Paragraph 2327. *Penalty.* . . . Whoever violates any of the provisions of this act shall be guilty of a misdemeanor, and upon conviction shall be fined not exceeding $100 nor less than $25, or imprisonment not exceeding 100 days nor less than 30 days, or both.

A NEW DERIVATIVE OF DIAZO-AMIDO-BENZENE.

(2, 2′ dibrom, 4, 4′ dimethyl diazo amido-benzene.)

By EDWARD BARTOW and H. C. ALLEN, University of Kansas, Lawrence.

Read before the Academy, at Topeka, December 31, 1904.

M-BROMTOLUENE may be prepared from *p*-acettoluid by bromination, elimination of the acetyl group, and submitting the amine thus formed to the Griess reaction,[1] thus replacing the amido group with hydrogen.

In following out the Griess reaction for the diazotizing of *m*-brom-*p*-toluidine by means of nitrous acid, we obtained well-defined bright yellow, needle-like crystals. Wroblevsky,[2] who prepared *m*-bromtoluene by the above-mentioned series of reactions, warms the alcoholic solution after diazotizing to effect reduction and makes no mention of an intermediate product. Sellards[3] mentions a crystal broth which is formed before the reduction takes place.

Our method of procedure was as follows: *P*-acettoluid was suspended in water and brominayed according to Wroblevsky[2] by adding bromine with occasional shaking, but without particular care to cool the reaction mixture. Under these circumstances *m*-brom-*p*-acettoluid is formed.

The acetyl group, which serves to protect the amine, is then removed by saponifying with either NaOH or KOH. Wroblevsky[2] claims that only KOH will act, while Grete[4] and Sellards[3] find that NaOH does equally well. Our experience was that either would react, but that the NaOH required longer heating, and also heating on the sand-bath. The *m*-brom-*p*-toluidine was then distilled with steam, dried with calcium chloride and diazotized by leading nitrous acid into a solution in absolute alcohol. The nitrous acid is best prepared by using arsenic trioxide having a specific gravity of 1.3 to 1.35. The nitrous acid was conducted through a reflux condenser, cooled by ice-water, and a Woulff's flask, surrounded by a freezing mixture, into the alcoholic solution. The condenser and flask serve as traps for nitric acid as well as for cooling the nitrous acid. The gas was absorbed until near the end of the reaction, and at the same time the bright yellow crystals mentioned above were formed.

If any acid is present in the alcoholic solution, the substance formed will be reduced to *m*-bromtoluene. Ten drops of sulfuric acid in ten grams of the substance completely reduced it in thirty minutes. When no acids are present, however, the crystals are very

1. A, 121-258. 2. A, 168-154. 3. Dissertation, U. of K., 1904. 4. A, 177-232.

stable and can be isolated. They are soluble in ether, but only slightly so in alcohol, and are purified by washing with alcohol and recrystallizing from a mixture of ether and alcohol.

A determination for bromine gave the following results:

0.2151 grams of the substance gave 0.2100 grams of AgBr.

Calculated for $C_{14}H_{13}N_3Br_2$.	Found.
41.77%	41.58%

A molecular weight determination, by lowering of the freezing-point of benzene, gave the following:

I. 0.2435 grams caused a depression of 0.223 degrees in the freezing-point of 14.13 grams of benzene.

II. 0.4459 grams caused a depression of 0.42 degrees in the freezing-point of 14.13 grams of benzene.

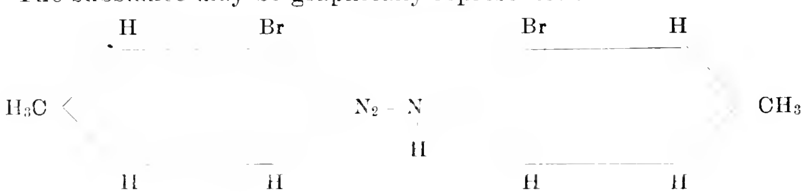
	Calculated for $C_{14}H_{13}N_3Br_2$.	Found.
I.........	382.13	378.66
II.........	.....	368.16

If, as claimed by Griess, aniline treated in this way gives diazo-amido-benzene, then our reaction may be represented as follows:

I. $C_6H_3CH_3BrNH_2 + HONO = C_6H_3CH_3BrN = NOH + H_2O$.
m-brom-*p*-toluidine nitrous acid = *m*-brom-*p*-diazotoluene.

II. $C_6H_3CH_3BrN = NOH + C_6H_3CH_3BrNH_2 =$
$C_6H_3CH_3BrN = N - NH - C_6H_3CH_3Br + H_2O$.
4, 4′ dimethyl 2, 2′ dibrom diazo-amido-benzene.

The substance may be graphically represented:



THE ACTION OF ETHYL CHLORSULFONATE UPON ANILINE.

By F. W. Bushong, Kansas City University, Kansas City, Kan.

Read before the Academy, at Topeka, December 31, 1904.

A STUDY of the action of sulfuryl chloride and of ethyl chlorsulfonate upon aniline, dimethylaniline and acetanilide was first undertaken by Wenghoffer,[1] who drew the following conclusions from the results of his experiments:

I. By the action of sulfuryl chloride upon aniline and upon anilides chlorine substitution products are obtained.

By the action of ethyl chlorsulfonate upon these bodies, products are formed which contain the $-SO_2OH$ group, bound directly to the benzene nucleus. With aniline, for example, he obtained sulfanilic acid.

J. Wagner[2] prepared a body from pyridine and chlorsulfonic acid which had the composition $C_5H_5NSO_3$, and which, with water or alcohol, decomposed, forming pyridine sulfate and sulfuric acid, or ethylsulfuric acid, respectively; and found that on dissolving it in aniline and adding ether, crystals of the aniline salt of phenylsulfaminic acid separate. He pointed out that Wenghoffer probably overlooked this salt, owing to the fact that he treated his crude reaction product with water.

W. Traube[3] isolated salts of aromatic sulfaminic acids, which he obtained by treating aromatic amines with chlorsulfonic acid, and Bamberger[4] has studied the transformation of phenylsulfaminic acid into sulfanilic acid.

It seemed desirable, therefore, to again take up the study of the action of ethyl chlorsulfonate upon aniline.

Ethyl chlorsulfonate (1 mol.) was dropped into an ice-cold ligroin solution of aniline (3 mols.) Each drop instantly produced a white crystalline precipitate. The crystals were thrown upon a filter and washed, first with ligroin, afterwards with absolute ether. The ligroin solution was found to contain ethyl aniline, which was identified by converting it into ethylphenylnitrosamine. No trace of an ester could be found in either the ligroin or ethereal solution. A portion of the crystalline precipitate, heated to 150°, gave off vapors re-

1. J. prakt. Chem., (2), 16, 448 (1877).
2. Ber. d. chem. Ges., 19, 1157 (1886).
3. Ber. d. chem. Ges., 23, 1653 (1890).
4. Ber. d. chem. Ges., 30, 2275 (1897).

sembling aniline, a property described by Laar[5] as belonging to the aniline salt of sulfanilic acid; although this salt was formed from the corresponding salt of phenylsulfaminic acid by heating, as the following work will show:

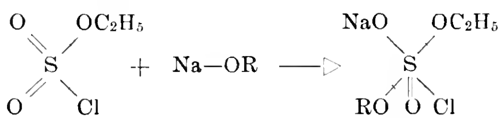
The crystalline precipitate, from which all free aniline and alkylated aniline had been removed. was treated with a solution of caustic potash, yielding an oil which was diazotized. No crystals of *p*-nitrosodiethylaniline were observed, but ethylphenylnitrosamine was obtained. The alkaline solution, which had been freed from aniline and alkylated aniline contained as a base in the salt, was acidified with hydrochloric acid and boiled about fifteen minutes. After cooling it was neutralized with caustic soda, and yielded aniline, which was converted into diazo-amido-benzene.

These experiments prove two points:

I. Aniline is alkylated by ethyl chlorsulfonate.

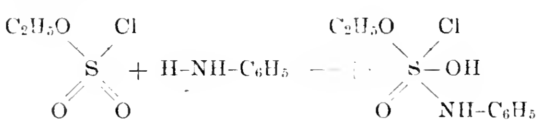
II. The ethylaniline salt of phenylsulfaminic acid is formed.

I have previously shown[6] that while sulfuryl chloride dissociates readily into SO_2 and Cl_2, forming with sodium alcoholates large quantities of sodium sulfite, ethyl chlorsulfonate does not thus dissociate, but unites quantitatively with sodium alcoholates to form addition products, thus:



which may be broken down in one way (by water), forming $RO-SO_2-OC_2H_5+NaCl$, and also in another way (by heat). forming $NaO-SO_2-OR+C_2H_5Cl$, no sulfite whatever being formed.

It is, therefore, quite evident that both sulfuryl chloride and ethyl chlorsulfonate behave in a perfectly analogous manner toward aniline; *i. e.*, sulfuryl chloride dissociates and acts upon aniline as a chlorinating agent, while ethyl chlorsulfonate is not dissociated, but reacts additively, thus:

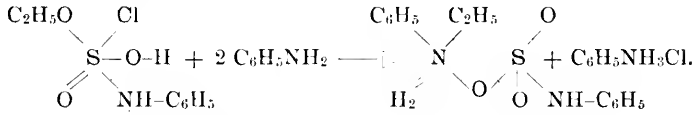


This addition product then reacts further with aniline, in a man-

5. J. prakt. Chem., (2), 20, 249 (1879).

6. Amer. Chem. Jour., XXX, 212-224 (1903).

ner analogous to that observed by Claesson and Lundvall,[7] in the case of the alkyl sulfates, forming a product which yields by loss of hydrochloric acid the ethylaniline salt of phenylsulfaminic acid:



7. Ber. d. chem. Ges., 13, 1703. Cf. Ullmann und Wenner, Ibid., 33, 2476 (1900).

REACTIONS IN LIQUID AMMONIA.

(Abstract.)

By EDWARD CURTIS FRANKLIN, Leland Stanford Jr. University, California.

Read (by title) before the Academy, at Topeka, December 31, 1904.

THE striking parallelism between the general properties of liquid ammonia and water has been emphasized by Franklin and his coworkers in previous papers. Water, among solvents, is characterized by its high boiling-point, its high specific heat, its high heat of volatilization, its high critical temperature and pressure, its high association in the liquid condition, its high dielectric constant, by its low boiling elevation constant, by its power to unite with salts as water of crystallization, by its wide solvent power, and by the fact that, with the possible exception of hydrocyanic acid, it is the most powerful ionizing solvent known. Aqueous solutions of salts are generally excellent conductors of electricity.

Of all well-known solvents ammonia most closely approaches water in all those properties which give the latter its unique position among solvents. While the boiling-point of liquid ammonia is thirty-three degrees below zero, it still appears abnormally high when compared with the boiling-points of such substances as methane, ethylene, hydrogen sulfide, phosphine, arsine, hydrochloric acid,[1] etc. The specific heat of liquid ammonia is greater than that of water, while its heat of volatilization, with the exception of water, is the highest of any known liquid. Its critical temperature is abnormally high, and especially the critical pressure, which is the more characteristic constant, is second only to water among solvents. Ammonia is an associated liquid, and its dielectric constant, while much below that of water, is still high. Its boiling-point elevation constant is the lowest of any known liquid, namely, 3.4, and it quite equals water in its power to unite with salts as ammonia of crystallization. As a solvent for salts it is inferior to water, though some salts, for example, silver iodide, dissolve much more abundantly in ammonia than they do in

1. The abnormally high boiling-point of liquid hydrofluoric acid, its evident association, even in the gaseous condition, its power of uniting with fluorides, and the fact that Moissan has found a hydrofluoric acid solution of potassium fluoride to be a good conductor of electricity, have led the writer to suspect that hydrofluoric acid is to be classed with water and liquid ammonia as an electrolytic solvent.

Some preliminary experiments on hydrofluoric acid have shown it to possess strong solvent powers. Potassium fluoride, sodium fluoride, potassium chloride, sodium bromide, nitrate, and chlorate, potassium bromate, acetamide, urea and potassium sulfate are abundantly soluble; silver cyanide, barium fluoride and copper chloride appear to dissolve to some extent; while calcium fluoride, copper sulfate, copper nitrate, ferrous chloride, mercuric oxide, lead fluoride and metallic magnesium are insoluble.

water, and it far surpasses this solvent in its power to dissolve the compounds of carbon. Finally, it exhibits very marked power as an ionizing solvent. The more dilute ammonia solutions are much better conductors than aqueous solutions of equal concentration.

Metallic Derivatives of the Acid Amides, Compounds Related to Ammonia as the Ordinary Metallic Salts are to Water. ("Ammonsalts," "Amidesalts," "Acidamidesalts." Suggest a good name.) In view of the close general resemblance between ammonia and water, the writer, collaborating with Mr. O. F. Stafford, was led to study the reactions between acid and basic amides in ammonia solution. The result of this work was to show that these substances behave in ammonia in a manner entirely analogous to the action of acids and bases in water. Franklin and Stafford have shown that the acid amides, which discharge the red color of a solution of phenolphthaleine in ammonia, react with the soluble basic amides, which give the characteristic red color with the same indicator, to form metallic derivatives of the acid amides, in accordance with the following general equations:

$$MNH_2 + AcNH_2 = AcNHM + NH_3$$

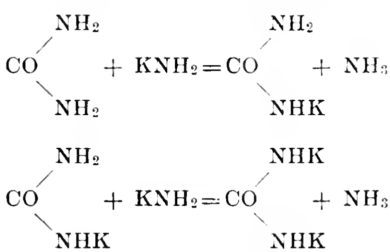
and

$$2MNH_2 + AcNH_2 = AcNM_2 + 2NH_3.$$

Acetamide and potassium amide, for example, react with each other as follows:

$$CH_3CONH_2 + KNH_2 = CH_3CONHK + NH_3$$
$$CH_3CONHK + KNH_2 = CH_3CONK_2 + NH_3$$

Carbamide and potassium amide, as follows:



Metallic Amides, Imides, and Nitrides. (Basic Amides, Basic Imides. "Ammon Bases.") Continuing in the direction suggested by the above-outlined analogy between water and ammonia, the writer now finds that the soluble basic amides react with the salts of the heavy metals in solution in ammonia to form amides, imides or nitrides of the heavy metals. For example, potassium amide reacts with silver nitrate to form silver amide, with lead nitrate to form lead imide, and with mercuric iodide and bismuth iodide to form mercury nitride and bismuth nitride, respectively. The reactions are represented by the following equations:

$$AgNO_3 + KNH_2 = AgNH_2 + KNO_3$$
$$Pb(NO_3)_2 + 2KNH_2 = PbNH + 2KNO_3 + NH_3$$
$$3HgI_2 + 6KNH_2 = Hg_3N_2 + 6KI + 4NH_3$$
$$BiI_3 + 3KNH_2 = BiN + 3KI + 2NH_3.$$

These substances are precipitated when potassium amide and the salts are brought together in ammonia solution. Silver amide is pure white, lead imide is orange, bismuth nitride is dark brown, and mercury nitride is chocolate brown. All of these compounds are very explosive. So sensitive, indeed, is silver amide that only with great difficulty was the analysis of the compound accomplished.

Compounds Related to Ammonia as the Ordinary Basic Salts Are to Water. ("Ammonbasic Salts," "Basic Amide Salts." Suggest a good name.) In some cases when the metallic salt is in excess, the result of the action of the alkali amide on the salt is a compound related to ammonia as the ordinary basic salts are to water. Examples of these compounds are $HgClNH_2$, $Hg = N - Hg - Br$ and $Hg = NHg - I$, which are formed when mercuric chloride, bromide, and iodide, respectively, are treated with potassium amide. The reactions take place in accordance with the equations:

$$HgCl_2 + NaNH_2 = HG{}^{Cl}_{NH_2} + NaCl$$
$$2HgI_2 + 3KNH_2 = Hg = N - Hg - I + 3KI + 2NH_3.$$

$HgClNH_2$ is the well-known infusible white precipitate, which is usually considered to be mercuriammonium chloride, $Hg = NH_2.Cl$, but by the writer looked upon as a compound related to ammonia as a basic salt is to water, with the formula given above. This formula, originally proposed for mercury chloramide by Kane some sixty years ago, has, in recent years, been discredited on the authority of Rammelsberg. The other two compounds are less well known. They are described in the literature as having been prepared from aqueous solutions, while their existence has also been denied. According to Rammelsberg, they are dimercurammonium salts; the iodide, for example, having the formula $Hg \equiv N.I$. The author's formulation is given above. These basic compounds dissolve in liquid ammonia solutions of ammonium salts, in a manner analogous to their solution in dilute aqueous acids, as indicated by the equation

$$Hg = N - Hg - I + 3NH_4I = 2HgI_2 + 4NH_3.$$

Phenomena in Liquid Ammonia Analogous to Hydrolysis in Water. ("Ammonolysis," "Amidolysis," "Ammolysis." Suggest a good name.) The salts of mercury, arsenic, antimony, tin, aluminum and probably salts of other metals react with pure dry liquid ammonia in a manner analogous to ordinary hydrolytic action in water.

For example, mercuric choride gives a small amount of mercury chlor-amide, and mercuric iodide gives $Hg = N - Hg - I$, both of which dissolve in excess of ammonium salts. Bismuth nitrate[1] and aluminum iodide give white precipitates of their respective basic salts, both of which are soluble in ammonium salts. The reversible equation representing the action of ammonia on mercury iodide is given.

$$2HgI_2 + 4NH_3 \rightleftharpoons Hg = N - Hg - I + 3NH_3.HI.$$

The Mercury Ammonium Bases. In the light of the above outlined relations, it would seem that certain of the so-called mercury ammonium bases are to be looked upon as mixed compounds containing residues basic to both ammonia and water, while others are simply mercury salts with ammonia of crystallization. For example, the fusible white precipitate is to be formulated $HgCl_2.2NH_3$, and not as a double salt of mercury ammonium iodide and ammonium iodide, $Hg = NH_2I.NH_4I$, nor as the double salt of dimercurammonium-iodide and ammonium iodide, $Hg_2NI.3NH_4I$, nor yet as mercury diammonium diodide, $Hg(NH_3)_2I_2$, although it may be that the latter formula represents the manner in which ammonia of crystallization associates itself with the salt.

The chloride of Millon's base, instead of being oxydimercurammonium chloride, $O\begin{smallmatrix}\diagup Hg \diagdown \\ \diagdown Hg \diagup\end{smallmatrix}NH_2.Cl$, or dimercurammonium chloride with water of crystallization, $N(Hg_2)Cl.H_2O$, is better formulated as a compound or mixture of salts basic to ammonia with salts basic to water. Of the half-dozen or more possible formulas, the following are given: $HgO.HgClNH_2$; $NH_2 - Hg - O - Hg - Cl$; $2HgO.Hg(NH_2)_2.HgCl_2$

Compounds Related to Ammonia, as the Plumbates, Aluminates, etc., are to Water. Certain metallic amides, the lead and aluminum derivatives, for example, dissolve in excess of potassium amide, just as metallic hydroxides and oxides dissolve in potassium hydroxide, forming compounds presumably of the type $PbNK$ or $Pb(NHK)_2$. Several amides have been found to dissolve in this way, but so far only in the case of the lead compound has the attempt been made to isolate and analyze the salt formed. The analysis indicates the compound $PbNK$, but the difficulty of separating the pure substance from the other products of the reaction has thus far rendered attempts to obtain concordant analyses futile.

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1. Not the ordinary salt with water of crystallization, but the salt formed electrolytically at a bismuth electrode in ammonia solution.

NOTE.—One further matter deserves mention, namely, a new instance of the catalytic action of platinum and certain metallic oxides. The potassium amide used in the above-described experiments is made by the action of liquid ammonia on metallic potassium. The action is a slow one, a fraction of a gram of metallic potassium, with large excess of ammonia, being completely converted into potassium amide only after the lapse of days. The writer finds that the presence of spongy platinum or of the oxide of iron greatly accelerates the reaction. The addition of a very small quantity of spongy platinum brings the action to completion in the course of about fifteen minutes.

PROPERTIES AND COMPOSITION OF SOME TYPICAL FLOURS.

By W. E. MATTHEWSON, Kansas Agricultural College, Manhattan.

Read before the Academy, at Topeka, December 30, 1904.

AN exact knowledge of the connection between the chemical composition of flour, as shown by our present methods of analysis, and its properties, judged from the bread-maker's standpoint, can hardly be said to have been approached. No argument is necessary to establish its importance; and while no great number of investigators have worked on the problem, this is, perhaps, due to the fact that one person has not usually the facilities to attack both aspects of it. The field is also rendered somewhat less inviting by a lack of exact analytical methods. Those adopted by the Association of Official Agricultural Chemists doubtless include most of the best ones known at present, but perhaps the best thing that can be said of the results obtained by them is that they are comparable with each other.

In the present experiment samples of eight brands of flour of different grades were taken and carefully analyzed. The samples were also submitted to bread-making tests in the department of domestic science by Prof. Henrietta W. Calvin and Miss Ula Dow. Considerable care was exercised, especially in the estimation of the different proteids, to carry out a series of determinations together, so that the effect of variations of temperature, etc., would be largely eliminated and the results be strictly comparable. The determinations of moisture. ash, ether extract, crude fiber, crude protein and nitrogen-free extract were made by the official methods; those of the nitrogenous substances, by the method of G. L. Teller, now of the Chicago Institute of Milling and Baking Technology, and published in bulletin No. 53 of the Arkansas Experiment Station. Some minor modifications were made in these, such as the substitution of Gooch filters for paper ones wherever practicable. In the determination of nitrogen, which forms the final step in all these separations, decinormal hydrochloric acid was used to collect the distillate and was titrated with decinormal ammonia, using a 10 cc. burette graduated in hundredths. Total nitrogen, however, was determined in the usual way, with seminormal acid and decinormal ammonia from an ordinary burette.

The flours taken were those of different grades from two well-known milling firms. The first four, Big 4, Golden Rod, Fortis, and Low Grade, were four grades of hard-wheat flour from the Page Milling Company, of Topeka. The others, Topeka High Patent, Topeka

Fancy Patent, Anchor, and Sea Foam, were different grades from the Shawnee Milling Company, of Topeka, the last being a soft-wheat flour. In the following tables the samples are numbered as follows:

1. Big 4 (high patent).
2. Golden Rod (fancy patent).
3. Fortis.
4. Low Grade.
5. Topeka High Patent.
6. Topeka Fancy Patent.
7. Anchor.
8. Sea Foam.

The regular food analysis was as follows:

Sample No.	Moisture.	Ash.	Crude protein.	Crude fat.	Crude fiber.	Nitrogen-free extract.
1	10.84	0.40	12.62	0.84	0.33	74.97
2	11.12	0.49	11.89	0.91	0.24	75.35
3	11.70	0.66	12.44	1.27	0.31	73.62
4	10.85	0.60	12.46	1.37	0.34	74.38
5	10.88	0.35	11.86	0.85	0.19	75.87
6	10.15	0.40	11.47	0.86	0.18	76.94
7	12.05	0.89	12.45	1.51	0.53	72.57
8	11.83	0.41	11.97	0.85	0.20	74.74

In the calculation of this table, the following analytical data were used:

Sample No.	Moisture.	Ash.	Total nitrogen.	Ether extract.	Crude fiber.
1	10.85 10.83	0.40 0.39	2.04 2.02	0.83 0.84	0.32 0.35
2	11.04 11.20	0.48 0.50	1.91 1.89	0.92 0.90	0.24 0.24
3	11.71 11.69	0.66 0.65	2.01 2.00	1.28 1.26	0.31 0.32
4	10.90 10.79	0.59 0.60	1.99 1.99	1.38 1.36	0.35 0.33
5	10.96 10.80	0.35 0.35	1.90 1.89	0.85 0.85	0.19 0.19
6	10.18 10.13	0.40 0.40	1.84 1.84	0.86 0.86	0.18 0.18
7	12.03 12.07	0.88 0.90	2.01 1.98	1.51 1.50	0.55 0.52
8	11.81 11.84	0.41 0.41	1.92 1.92	0.84 0.85	0.21 0.18

The estimation of proteids showed the following:

Sample No.	Total proteids.	Gluten.	Gliadin.	Glutenin.	"Edestin" and leucosin.	Amids as asparagin.
1	11.15	10.40	6.50	3.90	0.74	0.30
2	10.46	9.49	6.07	3.42	0.97	0.32
3	11.10	10.19	6.56	3.63	0.88	0.27
4	10.97	9.88	6.19	3.69	1.08	0.32
5	10.45	9.37	6.16	3.21	1.07	0.29
6	10.12	9.27	6.04	3.23	0.85	0.28
7	10.90	9.64	5.93	3,71	1.25	0.39
8	10.56	9.87	6.38	3.49	0.66	0.30

In calculating the proteids in the last table, the following nitrogen determinations were used:

Sample No.	Gliadin.	Leucosin and edestin.	Amid.
1	1.14 1.14	0.13 0.13	0.065 0.063
2	1.06 1.07	0.17 0.17	0.068 0.068
3	1.16 1.14	0.16 0.15	0.059 0.056
4	1.09 1.08	0.18 0.19	0.068 0.069
5	1.08 1.08	0.18 0.19	0.063 0.058
6	1.07 1.05	0.15 0.15	0.058 0.060
7	1.04 1.04	0.22 0.22	0.082 0.082
8	1.12 1.12	0.68 0.63	0.064 0.064

The above figures show that Teller's method gives results that are at least very concordant on the same sample. Most of the duplicate determinations do not differ from each other more than 0.01 per cent., and, except in the estimation of leucosin and edestin, almost no redeterminations were made. In all cases the duplicate determinations were entirely independent of each other.

The percentage of the gluten consisting of gliadin was found from the above data to be, for the different samples:

1.—62.5.	5.—65.7.
2 —64.0.	6.—65.2.
3.—64.4.	7.—61.5.
4.—62.7.	8.—64.6.

It was found in the baking tests that the soft-wheat flour yielded a more sticky dough than any of the others. This quality, which is more or less characteristic of soft-wheat flours, is considered to be connected with gluten rich in gliadin. While it is true that the gliadin-glutenin ratio on this flour is tolerably high, it is almost equaled by one of the low-grade flours, and is considerably exceeded by one of the high-patent flours, and neither of these showed this behavior. The lower grade flours (samples 3, 4, 2, and 7) all showed an inferior water-absorbing capacity. This is usually ascribed to an ill-balanced gluten, but the gliadin-glutenin ratios of two of the samples are intermediate between those of the two high-patent flours, and the third low-grade flour differs but slightly.

The results go to show, then, that however valuable the gliadin-glutenin ratio may be in certain cases, it is utterly inadequate to explain the difference in these. It must be left to further study to show its real value and to bring out other relationships, perhaps more important, between the composition and the bread-making qualities.

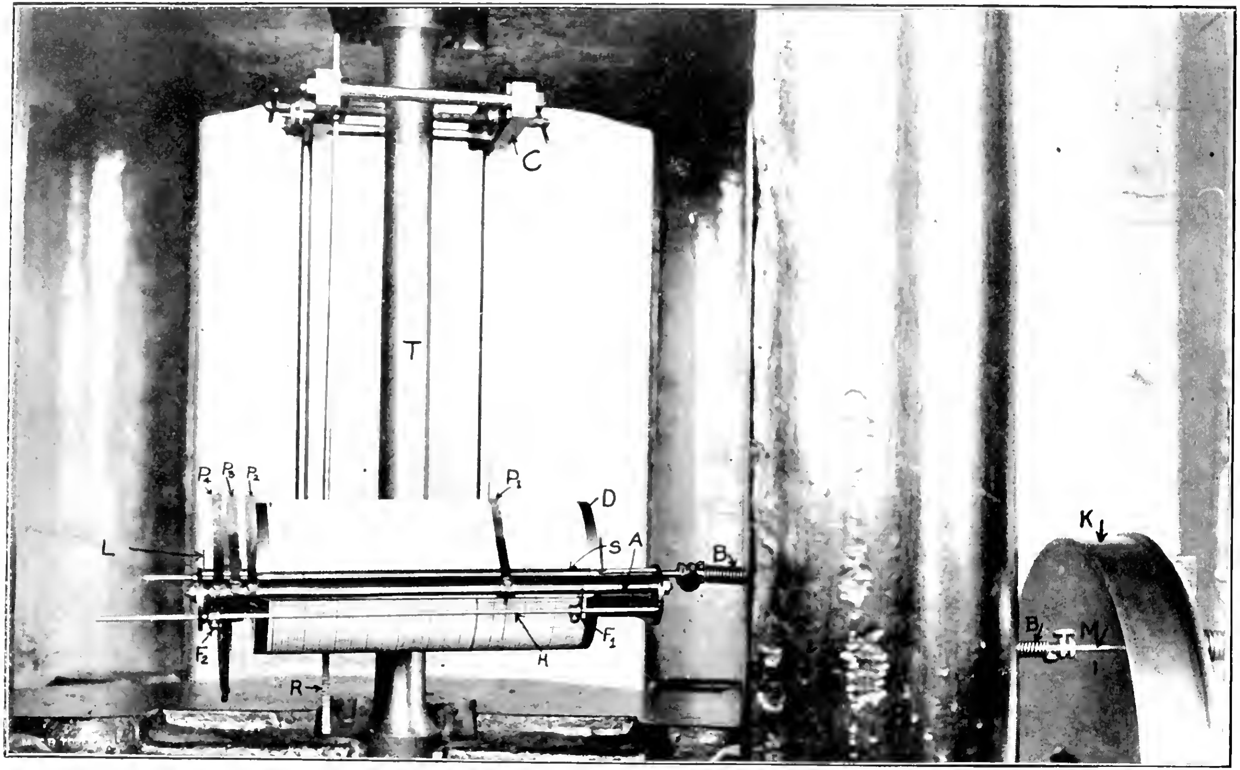

Plate VI.—An Autographic Recording Instrument for Tension Tests (front view).

THE EFFECT OF CLAY AND LOAM ON THE STRENGTH OF PORTLAND CEMENT MORTARS.

By W. C. HOAD, University of Kansas, Lawrence.

Read before the Academy, at Topeka, December 30, 1904.

IN constructive engineering, the use of cement mortar, both as a binding material for stone and brick masonry and as a matrix for concrete, is increasing every year by enormous strides. This cement mortar, made of hydraulic cement, sand, and water, is very much stronger, more convenient to handle and can be used in many more ways than the old lime mortar, whose place it has largely taken. It is also more costly. On account of both this greater cost and the greatly enlarged field of usefulness of cement mortar, the quality of the sand used in its manufacture is of greatly increased importance.

Frequently, on work involving concrete or masonry construction, dirty sand—that is, sand with a small admixture of clay or fine silt—is the only kind practically available, and the question as to whether such sand may be properly used as it is, or whether it must be washed before being used, is often a very troublesome one to the inspector in charge of the work, as well as to the engineer who draws up the specifications.

Under circumstances of this kind, there naturally arises the question, How much does this dirt in the sand detract from the strength of the resulting mortar? and until recently reliable data on this point were almost entirely lacking. There has been, it is true, a feeling among the users of mortar that perfectly clean sand was the best for this purpose, and that any adulterant, like dust or dirt, was injurious. Indeed, the idea has become so firmly rooted that the specification that "the sand used on this work shall be clean, sharp and coarse" has almost hardened into a formula. But, as the thorough washing of dirty sand is an expensive operation, the cost of structures where this specification is enforced is obviously increased, sometimes by a rather large percentage of the total cost.

Largely owing to the greatly increased use of concrete in engineering structures and the correspondingly increased importance of a thorough knowledge of the effect of dirt in the sand upon the strength of the mortar, an investigation into the subject was undertaken last winter, as a graduation thesis in the department of civil engineering at the University of Kansas, by Messrs. Ben. C. Hoefer and Earle Nelson. This investigation consisted for the most part of a series of tests of the tensile strength of mortar made of Portland cement and sand containing various proportions, from two to twenty per cent., of clay or loam.

The cement experimented with was the Iola brand of Portland cement, a cement much used in engineering construction in this part of the country. The sand used was the standard Ottawa sand adopted for cement testing by the American Society of Civil Engineers. The clay was the ordinary reddish clay commonly found on the hillsides west of the University campus and the loam was from the top soil of a corn-field.

In making the mortar briquettes for testing, the proportion of one part of cement to three parts of sand was used. When clay or loam was added, it was taken as a certain percentage of the sand, and thus the ratio of cement to sand, or of cement to clay or loam and sand, was maintained constant. All proportions were by weight.

At the end of three, seven, twenty-eight and ninety days sets of briquettes of the various proportions of clay and loam were broken in a late model Falkenau-Sinclair automatic cement-testing machine. The results for the clay mixtures are given in table 1 and shown graphically in diagram 1, while those for the loam mixtures are shown in table 2 and diagram 2. Each set consisted of six briquettes, the mean of the three strongest briquettes in each set being taken. Each number in the tables and each point in the diagrams represents one set. The small discrepancy between the results in the two columns headed "0 %" in the two tables is due to slight differences in manipulation by the two operators.

TABLE 1.—Showing strength of mortar with clay added.

Age, in days.	Percentage of clay.						
	0%	2%	4%	6%	10%	15%	20%
3..........	218	193	192	192	212	147	198
7..........	325	387	392	380	353	297	232
28..........	398	502	560	518	508	448	397
90.. ..	512	552	637	638	577	540	490

TABLE 2.—Showing strength of mortar with loam added.

Age, in days.	Percentage of loam.						
	0%	2%	4%	6%	10%	15%	20%
3..........	207	150	248	187	162	120	125
7..........	352	333	347	352	312	200	188
28..........	470	467	553	482	490	435	372
90..........	518	542	597	615	507	477	485

These tests indicate clearly that the presence of clay or loam in the small amounts usually found in dirty sand (say from two to ten per cent.) does not detract from the strength of the mortar, but rather

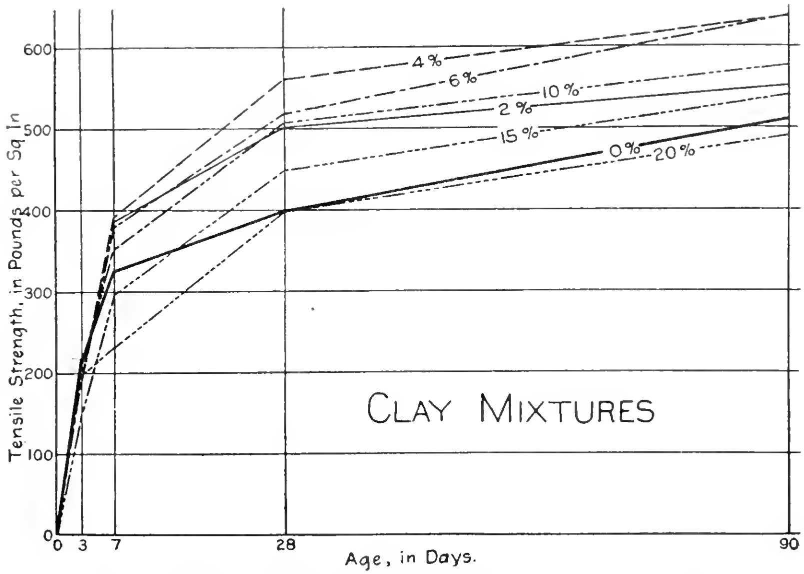

FIG. 1. Diagram showing tensile strength of mortar with clay added.

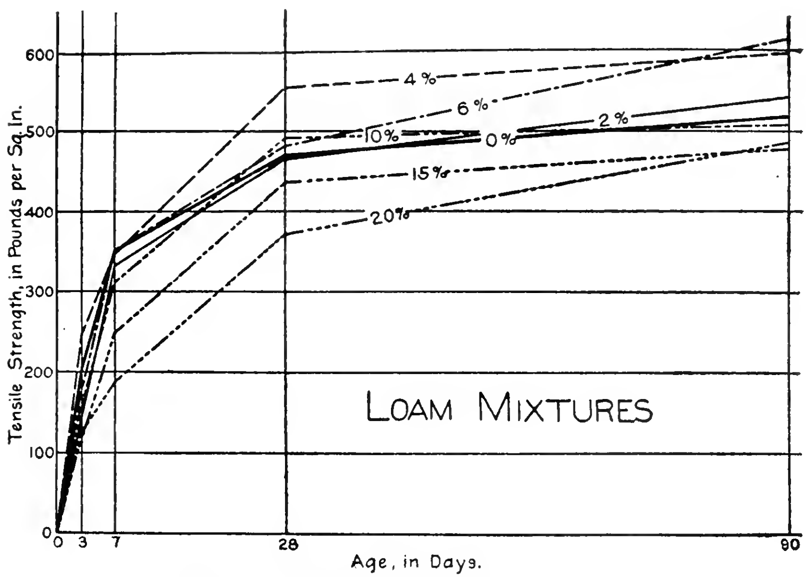

FIG. 2. Diagram showing tensile strength of mortar with loam added.

adds to it. There seems to be no important difference between the effect of clay and that of loam. It is also apparent from the diagrams that short-time tests of this nature are not of much value.

Table 3 gives the amounts of water absorbed by the briquettes in twenty-four hours, stated as percentages of the dry weights. These results, while not conclusive, point to the inference that one-to-three mortars made with sand containing up to five or six per cent. of clay or loam are at least as dense as those made with clean sand. With leaner mortars—that is, those with a smaller proportion of cement—the greater density of the dirty mortars would doubtless be more apparent. It will be noted that the effect of clay in increasing the density of mortar is noticeably greater than that of loam. This is doubtless due to the exceedingly small size of the clay grains, enabling them to fill the interstitial spaces of the cement.

TABLE 3.—Showing absorption of mortars with clay and loam added.

Per cent. of clay or loam.	Per cent. of water absorbed in twenty-four hours.	
	Clay.	Loam.
0	5.5	4.5
2	4.0	4.3
4	3.9	4.4
6	4.8	4.6
10	4.9	7.4
15	6.1	7.0
20	6.6	6.7

Some other experimental evidence bearing out the conclusions just stated may be briefly noted.

A number of years ago, Mr. E. C. Clark, of Boston, concluded, from tests* made with Rosendale cement, that an admixture of a small amount of loam or clay did not weaken mortar after six months or a year. His experiments were continued in part over two and one-half years.

About two years ago a series of tests was carried out at the Ohio State University† along the same line. These tests were quite similar in their nature to those just described, but were much more extended. Two Portland cements and three kinds of sand were experimented with, and the tests covered the period of a year. The results of these tests pointed strongly to the conclusion that the effect

* Trans. Am. Soc. of Civil Engineers, vol. 14, p. 163.

† *Engineering News*, vol. 50, p. 443.

of clay or loam in sand, up to about fifteen per cent., was to increase rather than to decrease the tensile strength of the mortar. This investigation, so far as the writer knows, is the most extended that has been made on this subject.

In view of the data above presented or referred to, it would seem to be a waste of money to require small amounts of earthy material to be washed out of sand that is to be used for Portland cement mortar, whether that mortar is to be used in ordinary masonry or in concrete. An exception to this conclusion might be taken if the mortar were to be placed under water, or if a quick-setting mortar were desired, but experimental evidence on these points is still lacking. For the general uses of cement mortar, the conclusions stated above would hold good.

AN AUTOGRAPHIC RECORDING INSTRUMENT FOR TENSION TESTS.

By GEO. J. HOOD, University of Kansas, Lawrence.

Read (by title) before the Academy, at Topeka, December 31, 1904.

THIS particular recording instrument, for tension tests of steel and iron, was designed and built by the author, for use with the Tinius-Olsen testing-machine, in the testing laboratory of the University of Kansas.

This testing-machine is of 100,000 pounds capacity, and is used for tension, compression and transverse tests of the strength of various materials.

The autographic recording instrument is shown in the photographs, plate VI and plate VII, in place, on a test piece. The instrument is usually left on the test piece until the curve begins to fall. This signifies that the maximum strength of the test piece has been reached; and the instrument is then removed, so that it may not be injured when the test piece is broken. Plates VI and VII are similarly lettered.

The drum, D, which holds the cross-section paper upon which the test is to be recorded, is revolved by the elongation of the test piece.

The pens, P_1, P_2, P_3, and P_4, move parallel to the axis of the drum, and proportionally to the load on the piece which is being tested.

The instrument is fastened to the test piece by the clamps, C; the distance between the upper and lower clamp screws being eight inches.

The rack, R, is connected by a rod to the upper clamp. This rack has sixteen teeth per inch, and meshes with a pinion of sixteen teeth. This pinion is pinned to the same shaft with the gear G_1, of 254 teeth. Gear G_1 meshes with gear G_2, of forty teeth. Gear G_2 is pinned to the shaft of the drum, D. The circumference of the drum is $7\frac{7}{8}$ inches.

If the piece under test is elongated one inch, the relative movement of the rack and pinion is one inch, and the pinion and the gear G_1 each make one revolution. At the same time the drum makes $\frac{254}{40}$ revolutions, and the length of the cross-section paper passing under the pens is $\frac{254}{40}$ by $7\frac{7}{8}$ inches, or 50.0006 inches, or, practically, 50 inches. Thus the elongation of the test piece is magnified fifty times.

Each of the pens, P_1–P_4, is mounted on a short barrel, which slides on the rod, A. Each barrel has a V projection, which reaches into the threads of the lead screw, S.

The lead screw, S, is connected by means of a flexible shaft, B, to

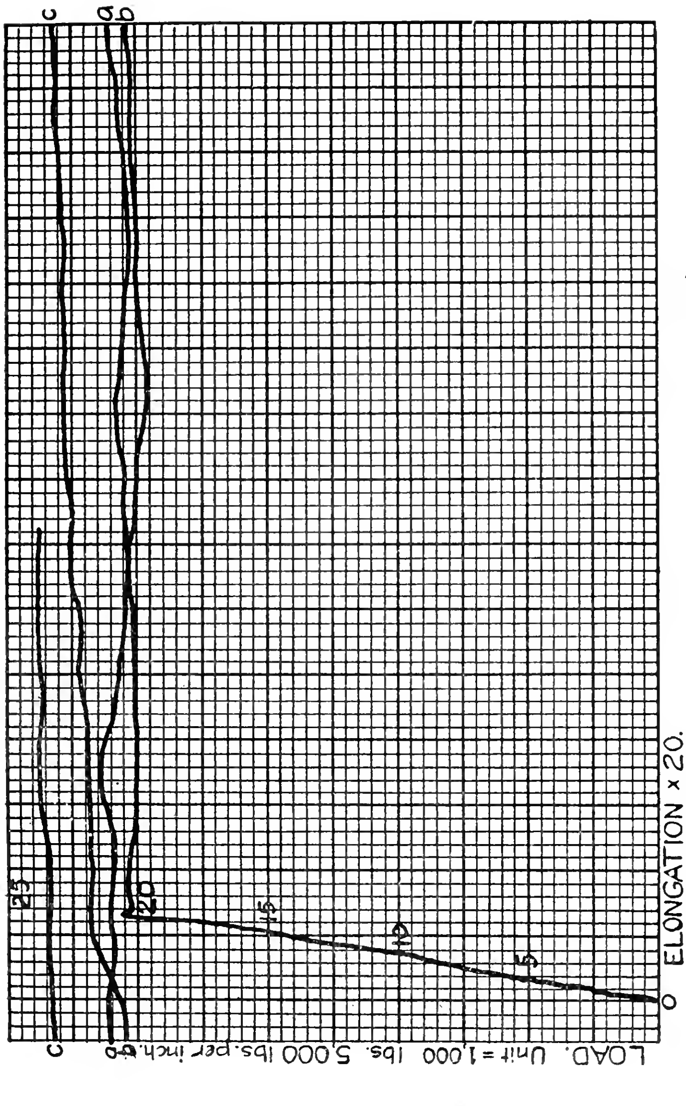

FIG. 3. Tension Test of MACHINERY STEEL. 3/4" dia. as rolled.

An Autographic Recording Instrument for Tension Tests, by Geo. J Hood

the shaft, M. The casing, K, surrounds a gear of 144 teeth, which makes one revolution for every 2000 pounds increase of load on the test piece. On the shaft, M, is mounted a gear of eighteen teeth, which meshes with the gear of 144 teeth, and thus makes one revolution for every 250 pounds change in load.

The screw, S, has twenty threads per inch, and the resulting load is, therefore, 250 x 20, or 5000 pounds per inch.

The capacity of the testing-machine being 100,000 pounds, and the suitable load scale being 5000 pounds per inch, it would require a drum twenty inches long. Instead of this, the drum is made five inches long, and four pens are arranged so as to have a total movement of twenty inches. The pens move from left to right with increase of load.

As pen P_1 reaches the end of its travel it presses against the finger F_1, which in turn moves the shifting-rod, H, causing finger F_2 to move the pens P_2, P_3 and P_4 to the right, until the pen P_2 is meshed with the lead screw, and takes up the curve five inches behind the pen P_1. In a similar manner the four pens supplement each other, either on increase or decrease of load.

The lever, L, operates a cam which releases the pens, so that the drum may be removed.

The rack, R, is held in mesh with its pinion by a spring, which allows the rack to slip in case the test piece should break with the recording instrument in place.

Figures 3 and 4 are two typical curves as drawn by the instrument.

The instrument is fairly satisfactory as it stands, but might, to advantage, have the lesser work of moving the pens accomplished by a mechanism actuated by the elongation of the test piece. The drum would then be rotated proportionally to the load. This would do away with the considerable strain between the upper and lower clamps caused by the high ratio of gearing and the inertia of the drum.

NOTES ON SOME KANSAS PAVING BRICK.

By F. O. MARVIN, University of Kansas, Lawrence.

Read before the Academy, at Topeka, December 30, 1904.

FOR the last four or five years, the writer has done considerable work in the University testing laboratories on Kansas paving brick from several plants, and, for the sake of comparison, on a few brands of established reputation from other states. The results of this work, in part, have been grouped and studied, and are presented in the tables and diagrams incorporated in this paper.

Good paving brick must be sound, homogeneous, little subject to weather action, strong enough to bear the loads that come upon them, tough enough not to chip or fracture under impact, and hard and cohesive enough to resist the abusive effect of traffic.

The tests that have been generally used are four: (1) Absorption; (2) crushing strength; (3) transverse strength; (4) the rattler test. Of these, the first is no longer used. It has been quite well established that any brick, whether porous or close grained, which will meet the requirements of the other tests, will have strength enough to withstand the action of freezing. It has also been found, through investigation on a large scale, by committees of the National Brick Manufacturers' Association, that the crucial test is the last named; and, also, that the tests for crushing and transverse strength are valuable through furnishing some knowledge of internal structure of brick.

The results of transverse tests are given in table I, and of crushing tests in table II. The Neodesha brick were samples made in Ohio from Neodesha shale, before any brick plant was located at this place, and are to be taken only as an indication of what the shale-bed might yield.

Back of the tests on Leavenworth brick lies a story of some months of experimentation in trying to improve the quality of the output and to meet a certain specification as to transverse strength required by the city engineer of Leavenworth.

The clay-bank at Leavenworth is one that is fat; that is, having too much alumina and too little silica. The brick made from it are too brittle and possess a bad structure. The auger machine that drives the clay through the dies gave a rotary motion to the clay stream, resulting in an internal series of concentric layers, which would separate to some degree during the burning process. The modification of machinery and dies and the mixture of sand with the clay to reduce its richness finally overcame the difficulty of structure and met the specified requirement as to transverse strength.

Transverse tests were made by placing the brick edgewise on knife edges, six inches apart, with the load applied at the center of top edge through a third knife edge. Crushing tests were made on half brick broken in the transverse tests, these being bedded edgewise in plaster of Paris on both the top and bottom. The specimen was placed in the machine, an Olsen of 100,000 pounds capacity, before the plaster was set; then under a light load of one to two thousand pounds it was allowed to rest for about ten minutes; then power was applied slowly till failure resulted. A few brick have been broken with strawboard or with soft pine cushions. Though more rapid, preference is given to the plaster bedding.

The rattler test is designed to furnish evidence of the ability of brick to withstand impact and abrasion — the blows from horses' feet that will chip off edges and corners and the wear from both horses and vehicles. The standard rattler is a cast-iron barrel with fourteen-sided polygons for ends and fourteen staves, set with small cracks between them. It is twenty inches long and twenty-eight inches in diameter, and is rotated with its axis horizontal at from twenty-seven to thirty-two revolutions per minute. Under the old method, enough brick to equal fifteen per cent. of the volume of the rattler, somewhere from twenty-two to twenty-six brick of common sizes, constituted the sole charge, and these were tumbled around for a maximum of 1800 revolutions.

Table III and figure 1 give the results of tests made by this method. Behind the Lawrence records there also is a story of many months' experimentation in modifying machinery, in mixing materials for different parts of the clay-bank, and in regulating the process of drying and burning. No. 39 was the first brick to come within the requirements set by the specifications for the first street paving in Lawrence. Tests of later brick are better still. Every manufacturer of paving brick has his own problem in adapting his methods to his materials. Clay-banks are not alike, and what will work in one place will not in another. Moreover, as the character of a shale-bed or clay-bank may change in a few feet of distance, the brickmaker must keep vigil if he is to maintain a high and uniform standard.

A rattler test, when platted as in figure 5, is significant in several ways. A curve that rises rapidly during the first 200 or 400 revolutions indicates a large loss due to the chipping off of edges and corners. This means brittleness. A flat curve here means relative greater toughness. If a curve continues to rise rapidly and the total loss is high, this is evidence that loss by abrasion chiefly has occurred. The flatter the curve, as a whole, the better will the brick wear in the street. Tests of brick giving high curves are invariably very dusty after 400 revolutions. A smooth curve indicates a brick of quite uniform structure and texture; an irregular one, like some shown in figure 8, for example, indicates some structural defect. In the case cited, the trouble was largely due to a curve and some separation of the concentric layers.

The method which puts brick only in the rattler has been abandoned for the shot method—partly because it was too severe, giving high percentage losses, and partly because it gave too much importance relatively to the impact side of the test. The present practice puts into the rattler twelve brick with 225 pounds of cast-iron cubes, one and one-half inches on each edge, and seventy-five pounds of larger cast-iron blocks, two and one-half by two and one-half by four and one-half inches. The results of tests by the shot method are shown in table IV and figure 6, and these will be self-explanatory.

In figure 7 are shown the results of tests made to determine the effect of water on the brick on the rattler losses. The Topeka and Galesburg brick absorbed but small quantities of water. For the Pittsburg, the wet weight of the soaked lot was about one pound in excess of dry weight. The Coffeyville, a gas-burned brick, and therefore more porous, had absorbed about a total of two pounds. During testing, dust began flying at 200 to 400 revolutions for the first two named, at 800 for Pittsburg, and 1100 for Coffeyville. The significant thing here is, that all brick should be rattled dry, if the results are to be compared.

In figure 8, the curves for Buffalo brick show in a marked way the effects of overburning—a loss of toughness and increased brittleness. The curves for Lawrence were chosen because they illustrate irregularities due to imperfect structure, and at the same time the effects of underburning—softness and little resistance to abrasion. These lines are not to be taken as characteristic of Lawrence brick, which now rank well and among the best made in the state.

In all of the tables, like laboratory numbers refer to the same lot of brick and received at the laboratory at the same time.

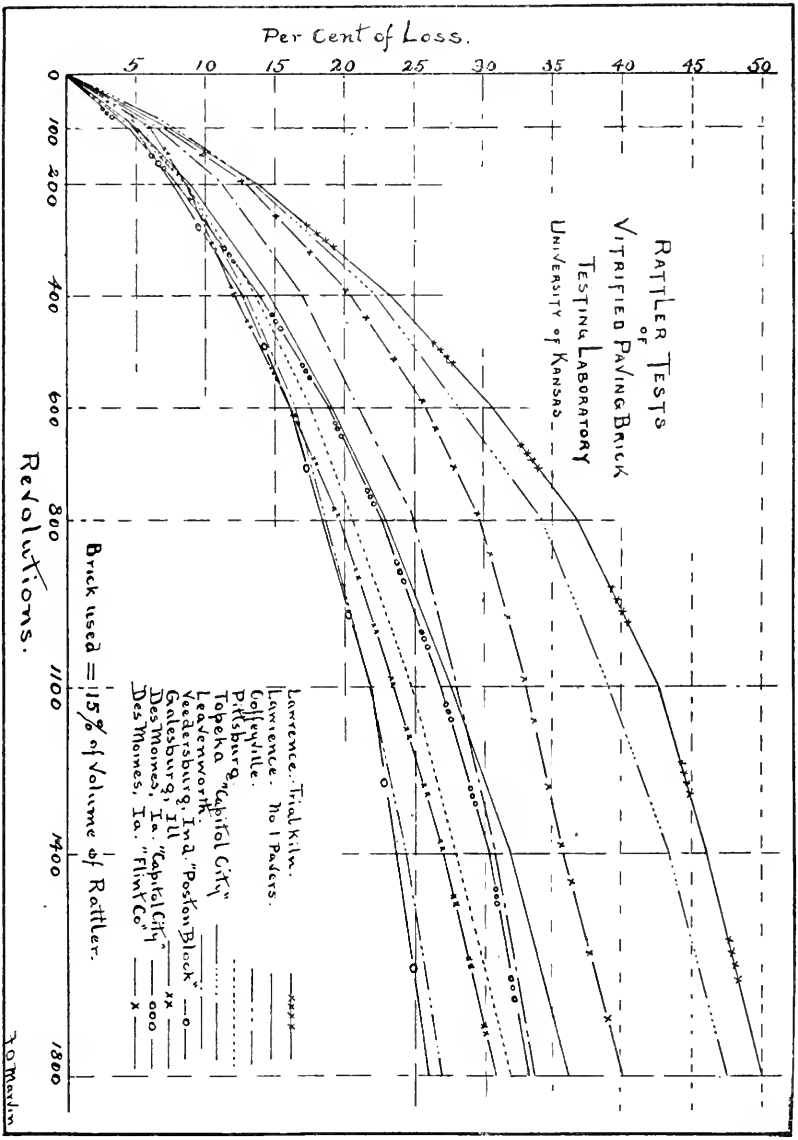

Fig. 5. Diagram of rattler tests on brick.

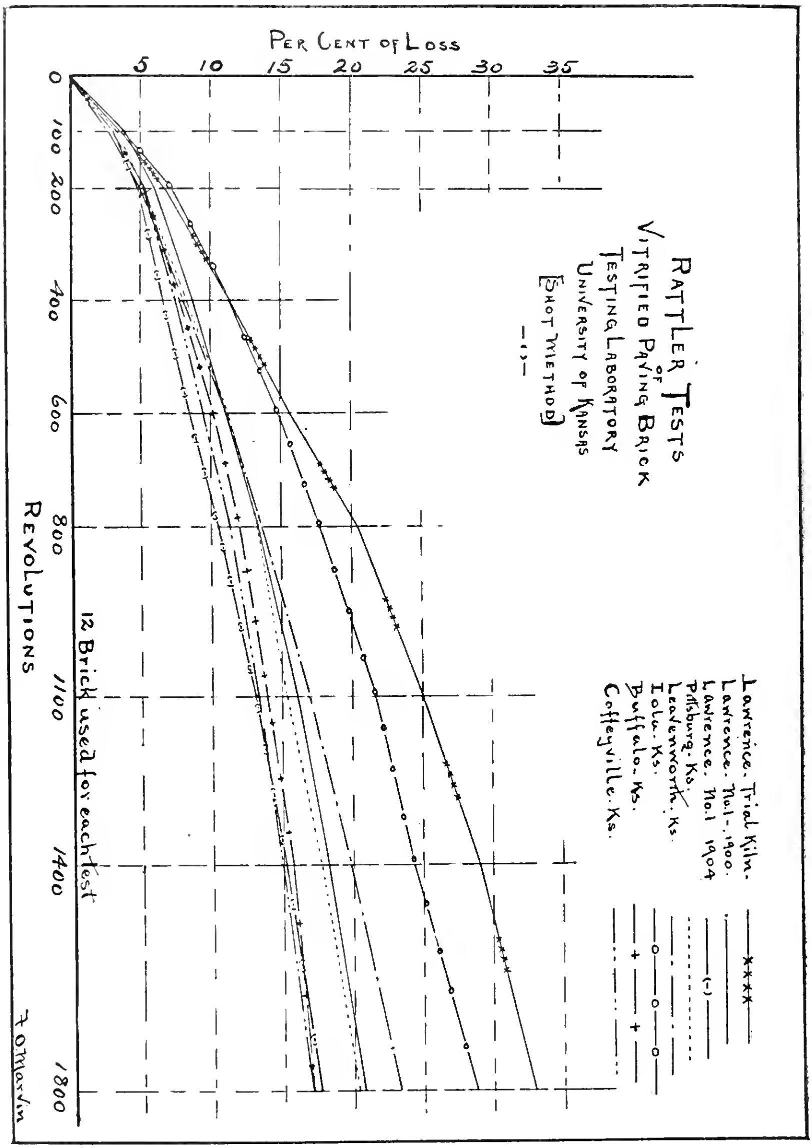

Fig. 6. Diagram of rattler tests on brick.

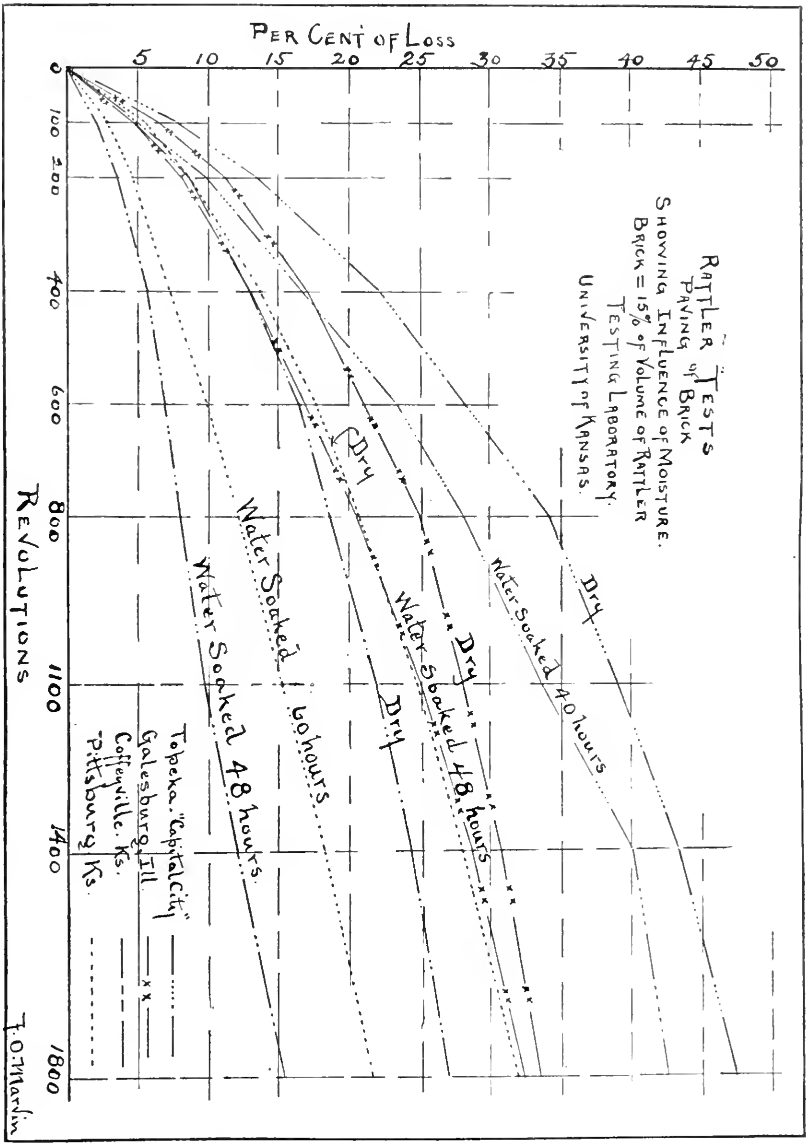

Fig. 7. Diagram of rattler tests on brick, showing effect of moisture on strength of brick.

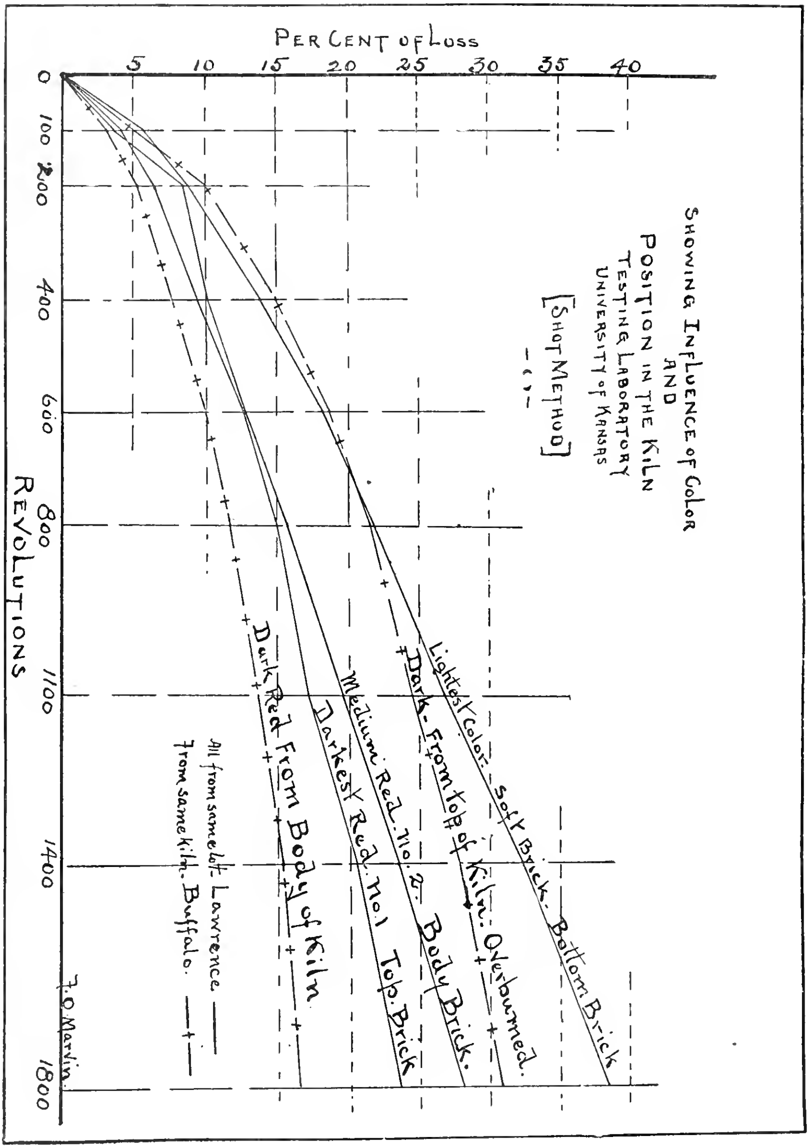

Fig. 8. Diagram of rattler tests on bricks, showing influence of color and position in kiln on strength of brick.

TABLE I.—Transverse tests of Kansas vitrified paving brick; testing laboratory, University of Kansas.

Lab. No.	Location and brand.	No. tested.	Average size of cross-section.	Average load at rupture.	Modulus of rupture $\frac{3wl}{26d^2}$
26	Lawrence, first kiln	12	2.39 x 3.83	12,516	3,220
27	" second kiln	12	2.38 x 3.81	8,128	2,106
9	Coffeyville, May, '97	4	2.28 x 4.07	9,244	2,201
10	" January, '00	10	2.28 x 4.07	11,185	2,649
7	Pittsburg	5	2.38 x 3.79	8,974	2,360
8	"	6	2.45 x 3.72	10,153	2,696
19	Topeka, "Capital City"	4	2.32 x 3.70	8,450	2,684
20	" "	12	2.20 x 3.63	8,069	2,680
21	" No. 2	4	2.34 x 3.88	6,802	1,749
11A	Leavenworth	6	2.56 x 3.72	9,432	2,207
11B	" "O," pure shale	5	2.70 x 4.17	10,032	1,928
12	" shale and river sand	5	2.72 x 4.10	10,919	2,143
13	" " "	9	2.52 x 3.86	10,677	2,548
14	" soft burned	4	2.69 x 3.99	7,890	1,656
15	" hard burned	6	2.48 x 3.67	8,940	2,409
16	" fine grained	6	2.51 x 3.77	9,253	2,324
17	" coarse grained	6	2.48 x 3.69	9,165	2,443
18	" beveled edges	11	2.43 x 3.55	7,590	2,331
22	Osage City, No. 1, May, '97	4	2.12 x 3.54	8,100	2,715
23	" No. 2, May, '97	4	2.15 x 3.61	4,692	1,567
24	" No. 3, May, '97	2	2.30 x 3.87	3,820	1,002
25	Atchison, May, '97	4	2.24 x 3.81	7,950	2,179
29	Iola, light color	6	2.36 x 3.83	6,220	1,633
30	" dark red	7	2.36 x 3.70	7,900	2,233
28	Neodesha	3	2.38 x 3.82	7,747	2,007
6	Galesburg, Ill	9	2.57 x 3.82	9,600	2,311
1	Des Moines, Iowa, "Capital City"	5	2.50 x 3.75	13,700	3,525
2	" " "	6	2.56 x 3.76	12,334	3,159
3	" " "T"	5	2.45 x 3.90	12,001	2,929
4	" " "Flint Co."	5	2.54 x 3.83	10,702	2,686
5	" " "Iowa"	6	2.60 x 3.94	13,580	3,038

TABLE II.—Crushing tests of Kansas vitrified paving brick; testing laboratory, University of Kansas. [Half-brick used.]

Lab. No.	Location and brand.	Number tested.	Average load at crushing.	Crushing load per sq. inch.
26	Lawrence, first kiln	10	87,537	9,550
27	" second kiln	9	51,457	5,759
9	Coffeyville	4	79,732	8,466
10	"	10	97,429	11,040
7	Pittsburg	5	94,746	10,447
8	"	6	95,722	10,082
19	Topeka, "Capital City," No. 1	4	95,080	11,464
21	" " No. 2	4	69,680	8,078
11 A	Leavenworth	6	57,562	5,736
11 B	" "O," pure shale	5	87,046	7,806
12	" shale and river sand	5	62,846	6,118
13	" " "	10	67,548	6,978
14	" soft burned	4	79,680	7,637
15	" hard burned	6	71,203	7,270
16	" fine grained	6	73,680	7,562
17	" coarse grained	6	50,000	5,151
18	" beveled edges	12	36,356	4,009
22	Osage City, No. 1	4	53,902	6,879
23	" No. 2	4	33,077	4,251
25	Atchison	4	59,340	6,852
20	Topeka, No. 1	12	49,503	6,273
29	Iola, light color	5	51,349	5,997
30	" dark red	5	59,148	6,790
28	Neodesha	3	36,472	4,832
6	Galesburg, Ill	10	90,640	9,516
1	Des Moines, "Capital City"	4	72,294	7,147
2	" "	5	60,392	6,959
3	" "T"	5	70,986	7,390
4	" "Flint Co."	4	74,442	7,783
5	" "Iowa"	5	58,446	5,607

TABLE III.—Rattler tests of Kansas vitrified paving brick; testing laboratory, University of Kansas. Tests by 15 per cent. volume method. Averages of two tests.

Lab. No....	Location and brand.	Date.	Number of brick to test	Revolutions per minute.	Per cent of loss at end of certain revolutions.							
					100	200	400	600	800	1,100	1,400	1,800
26	Lawrence, 1st kiln...	Dec. '99	24	28	6.0	10.8	17.5	22.1	26.2	31.4	35.7	39.8
27	Lawrence, 2d kiln...	Dec. '99	24	28	10.8	16.7	25.5	31.1	35.2	40.0	43.6	47.8
31	Lawrence	Jan. '00	23	28	7.0	12.2	20.0	26.0	30.4	35.6	39.1	43.4
32	Lawrence	Jan. '00	24	27.5	8.8	15.3	25.6	32.5	36.2	43.4	47.1	50.4
33	Lawrence, top of kiln, hardest.......	Feb. '00	26	28	5.5	9.4	18.5	24.8	29.5	36.7	41.8	47.3
34	Lawrence, body of kiln	Feb. '00	26	27	7.0	11.6	20.1	25.8	31.2	36.3	41.5	45.4
35	Lawrence, bottom of kiln, softest........	Feb. '00	24	28	7.6	13.8	23.4	30.7	36.7	42.6	45.9	50.7
36	Lawrence	Mar. '00	23	29	5.9	10.3	16.9	21.3	26.7	32.1	36.3	40.0
37	Lawrence	Mar. '00	25	28	6.6	12.5	21.2	26.8	30.8	35.4	39.5	43.2
38	Lawrence	Mar. '00	22	28	5.8	10.2	16.9	22.6	27.9	33.9	38.8	45.1
39	Lawrence, single stream	May '00	24	27.5	5.2	9.0	14.7	19.2	23.0	27.7	31.8	36.1
10	Coffeyville.	Jan. '00	23	28	5.5	8.6	13.6	17.6	20.2	23.5	27.0	29.0
10	Coffeyville...........	Jan. '00	23	28	4.9	8.6	13.0	16.5	18.6	21.8	24.3	27.0
10	Coffeyville, water-soaked 48 hours ...	July '00	23	27	2.1	3.6	5.7	6.9	8.0	9.6	12.0	15.3
8	Pittsburg	Jan. '00	25	28	5.1	8.6	13.7	17.6	20.6	24.8	27.9	31.9
8	Pittsburg, water-soaked 60 hours....	July '00	25	29	2.6	4.7	7.2	9.9	12.1	15.2	18.2	21.5
19	Topeka, "Capital City".	Jan. '00	29	28	7.9	13.6	22.2	28.2	34.2	39.0	43.3	47.4
19	Topeka, water-soaked 40 hours ...	July '00	29	29	5.1	10.0	16.7	23.4	28.0	33.6	40.1	42.7
15	Leavenworth	Jan. '00	23	28	4.6	7.9	13.2	17.7	21.2	25.1	29.5	34.7
17	Leavenworth	Jan. '00	22	28	5.6	9.6	15.2	19.1	22.1	26.4	30.6	33.7
18	Leavenworth, beveled edges...... ...	July '00	27	26	6.0	8.8	12.1	16.2	19.7	23.5	27.0	30.8
40	Veedersburg, Ind., "Poston block"...	July '00	14	28	5.0	7.7	12.6	16.1	18.5	21.9	23.7	26.0
6	Galesburg, Ill., Purington Co	Feb. '00	24	28	6.6	11.3	17.0	21.0	24.9	28.0	30.7	33.5
6	Galesburg, water-soaked 48 hours....	July '00	24	28	4.8	8.2	12.9	16.8	20.5	25.0	28.7	32.4
1	Des Moines, Iowa, "Capital City"....	Jan. '00	22	28	4.7	8.2	14.0	19.0	22.8	26.8	30.3	33.2
4	Des Moines, "Flint Co."	Jan. '00	23	28	7.2	13.1	20.4	25.9	29.6	33.0	35.6	39.9
5	Des Moines, "Iowa" and "Flint," mixed,	Jan. '00	21	28	5.5	9.5	15.5	20.1	24.1	28.2	31.5	34.9

TABLE IV.—Rattler tests of Kansas vitrified paving brick; testing laboratory, University of Kansas. Shot tests. Averages of two tests of twelve brick each.

Lab. No......	Location and brand.	Date.	Number of brick tested..	Revolutions per minute..	Per cent. of loss at end of certain revolutions.							
					100	200	400	600	800	1,100	1,400	1,800
8	Pittsburg	July '00	12	28.0	3.3	5.8	9.3	11.8	13.8	16.5	19.2	21.8
45	Pittsburg	Oct. '01	12	28.5	3.4	5.2	8.2	11.1	13.1	15.2	17.6	20.2
26	Lawrence	July '00	12	26.0	3.7	6.6	11.3	15.6	20.3	24.9	28.9	32.9
39	Lawrence, No. 1...	July '00	12	27.5	3.9	6.0	8.7	11.0	13.3	16.0	18.1	20.7
42	Lawrence, soft No. 2,	Dec. '00	12	27.0	5.7	9.0	14.0	18.3	22.0	27.0	32.7	39.0
43	Lawrence, medium No. 2..	Dec. '00	12	27.5	3.6	8.6	10.2	12.9	15.8	19.8	23.8	28.8
41	Lawrence, No. 1....	Dec. '00	12	28.0	4.1	6.5	9.7	12.8	15.1	17.4	20.9	24.3
49	Lawrence, No. 1....	Aug. '04	12	30.0	.....	4.2	6.6	8.5	10.4	13.0	15.1	17.5
30	Iola.	Nov. '00	12	27.5	3.8	7.2	11.3	14.7	17.6	21.5	24.2	28.6
48	Iola, Union Co.....	June '04	12	31.0	4.8	8.2	13.9	17.9	21.4	25.8	27.8	30.8
46	Buffalo.............	April '04	12	30.5	3.9	6.0	9.4	11.5	12.8	14.7	17.1	18.5
50	Buffalo, top of kiln...	Nov. '04	12	31.0	5.0	10.1	15.1	18.9	21.8	24.8	28.2	31.4
51	Buffalo, body of kiln..	Nov. '04	12	30.5	3.1	5.3	7.8	10.1	11.9	13.8	15.6	17.0
44	Leavenworth.......	Oct. '02	12	28.5	2.8	5.0	8.0	11.0	13.5	16.8	19.7	23.2
10	Coffeyville..	April '02	12	27.5	3.1	5.0	7.6	9.4	11.2	13.1	14.9	17.0

III.

GEOLOGICAL PAPERS.

"A Collecting Trip to Patagonia, South America."
By H. T. Martin, University of Kansas, Lawrence.

"Coal-mining in Atchison County."
By E. B. Knerr, Atchison.

"A Fossil Forest in Jackson County."
By C. H. Shattuck, Washburn College, Topeka.

"Origin of Gypsum, with Special Reference to the Origin of the Michigan Deposits."
By G. P. Grimsley, Assistant State Geologist, Morgantown, W. Va.

"Some Notes on Kansas Geology."
By L. C. Wooster, Kansas State Normal School, Emporia.

"The Fauna of the Mentor."
By Alfred W. Jones, Kansas Wesleyan University, Salina.

"Protostega gigas and other Cretaceous Reptiles and Fishes from the Kansas Chalk."
By Chas. H. Sternberg, Lawrence.

"The Kansas Mineral Exhibit at St. Louis."
By G. P. Grimsley, Assistant State Geologist, Morgantown, W. Va.

"The Flood of 1903 in Central Kansas."
By Alfred W. Jones, Kansas Wesleyan University, Salina.

"Notes on the Topography and Geology of New Mexico."
By J. J. Jewett, Los Angeles, Cal.

"Reading Blue Limestone."
By Alva J. Smith, Emporia.

A COLLECTING TRIP TO PATAGONIA, SOUTH AMERICA.

By H. T. Martin, University of Kansas, Lawrence.

Read (by title) before the Academy, at Topeka, December 31, 1904.

SINCE Darwin's description, in 1843, of the fossils discovered by Captain Sullivan in the Santa Cruz formation near Gallegos, Patagonia, very little has been known of the fossils of that country, until the publication of Doctor Ameghino's work, in 1889, fully describing and figuring the then known fossils from these beds. Unfortunately very little, if any, of this highly interesting and unique fossil fauna had reached this country, either for study or publication, until in 1896 my late lamented friend, Dr. J. B. Hatcher, then at Princeton University, determined on a trip to this far-off country in search of the hidden treasures deposited in the clay-banks and on the beach at the base of the bluffs forming the coast of the Atlantic. This was the first of a series of three trips made by him to this rich collecting ground, and the first sent out for systematic work by any institution from North America. The success of these trips is plainly to be seen in the valuable collections brought back by his party, and the geological and stratigraphical information obtained and published by Princeton University.

After carefully reading over the narrative of the above trips, I determined to make a trip to this Mecca of fossils; so, making all arrangements to this end, I left New York, on steamer "Afghan Prince," in September, 1903, accompanied by Mr. S. Adams, of Topeka, who went along to collect zoölogical material, and reached Buenos Ayres September 20, where we disembarked. While here we visited the National Museum, at this city, and were very courteously treated by its director, Doctor Ameghino. Leaving Buenos Ayres, we traveled overland *via* the Southern railroad to Bahia Blanca, a distance of some 500 miles, where we were unfortunately detained for two months awaiting our camping outfit. However, January 2, 1904, saw us again aboard ship, this time the steamer "Chubut," bound for Gallegos, Patagonia, which we reached the 23d of the same month.

Between Bahia Blanca and Gallegos we called at the following points of interest, from each of which a small collection of whatever material available was secured: San Blas, Port Madrin (port of entry for the Welsh colony), Caboroso, St. Elena, Camarones, Commodore Rivadavia (port of entry for the Boer colony), Cabo Blanco, Deseado (so graphically described by Darwin), San Julian (or Darwin station), Santa Cruz, and Rio Gallegos. After spending a few uncomfortable days at Gallegos, experiencing many difficulties getting our camping outfit together, and breaking our four South American horses to the use of the farm wagon which we shipped from New York, we at last proceeded happily on our way to our first collecting ground, which lay directly across the river from us. As we drove along the south side of the river for a distance of some fifteen miles, the bluffs of the north side were plainly to be seen. These are composed of the Santa Cruz formation, with a capping of the ever present shingle, as illustrated in plate IX. Crossing the river at Weir Aike, we reached, after a drive of fifteen miles, the estancia of Mr. H. S. Felton, where we were very hospitably received. Here we made our first camp in Patagonia (see plate VIII), and for two months collected in the remarkably rich but steep bluffs forming the south escarpment of the river. Here I secured a great number of the smaller mammals, a large part of which must be collected during low tide at the base of the cliffs and on the clayey bed of the river, which are continually being eroded away by the constant wash of the incoming and outgoing tides. In this latitude the tides reach the enormous rise and fall of over fifty feet. In the photograph, plate X, showing the bluffs at low tide, the high-tide mark can be plainly seen about twenty feet from the base of the cliff. These bluffs at high tide are shown in plate XI.

In March we moved our camp to the estancia of Mr. John Rudd, at Cape Fairweather, two days later moving to a point two miles north of Cape Fairweather, on the coast of the broad Atlantic. Here an interesting sight met our view. Away off to the southwest glistened the snow-capped tops of a high range of hills, while at the foot of the bluffs, which here attain the height of 400 to 450 feet, rolled the huge breakers of the ocean. The waves at each spring tide undermine the very hills we stood upon, while again at low tide the receding waters leave a beach of from three-fourths to one and one-half miles wide, at many points washed clear of loose sand, to the hard greensand and clay-beds of the Santa Cruz. This makes it one of the most unique collecting grounds imaginable, and in many instances beautiful little fossil skulls are left on a raised base of matrix, standing out like clear-cut cameo.

The mode of collecting in this locality differs greatly from the methods which must be used in the semi-arid region of western Kansas. Clad in oilskins and with the indispensable rubber boots on, one frequently has to dig out a fine fossil in some little pool of water formed by a slight depression in the surface. The contrast between this and the chalk of western Kansas can be better imagined than described, although I have very vivid recollections of many such occurrences. From Cape Fairweather north for thirty miles the beach afforded the best and most remunerative collecting ground. Each day, as the time-varying tide slowly receded, found me at my post, following up the water's edge, hunting up and digging out the fossils as fast as exposed to view, placing them on raised blocks of clay (dug up for the purpose) or on one of the many hard concretions left standing from a foot to five feet high to drain and partially dry. At the turn of the tide, driven back by the now incoming waves, one often finds himself knee-deep in the surf before the last fragment of bone belonging to some rare beast, left on the raised pedestal to dry, has been placed in safety in the collecting bag, then on to the next pile of bones, always in a hurry to beat the oncoming waves, and so on until all the fossils previously dug out are safely cared for. These are then carried to camp, perhaps ten miles away, on horseback, dried out, well soaked with a thin solution of gum arabic, again thoroughly dried, and lastly carefully packed, not forgetting to put a plenteous supply of cotton batting around the more exposed parts.

During the very high tides great care must be taken to have in view a place of safety for one's self and horse against the incoming tide. Several times I have had to lead my horse with great difficulty up the steep banks to some little ledge for safety, there to wait from two to three hours for the falling of the tide, which would allow us to pass along at the foot of the cliffs to one of the very few places, often miles apart, where it is possible for a horse to climb to the pampas above.

Twenty miles north of Cape Fairweather, as illustrated in plate IX, the uppermost formation is the so-called shingle, composed of water-worn pebbles, intermixed with sand and clay, forming a layer of varying thickness of from 2 to 100 feet, which covers nearly the whole of Patagonia. Beneath this are the Cape Fairweather beds, of Pliocene age. These are of marine origin, composed of a reddish sandstone, thirty to thirty-five feet in thickness, literally packed in places with a rich and varied collection of invertebrate remains—brachiopods, gastropods, and oysters of giant size, of which a good series was secured. Below these lie the Santa Cruz beds, composed of many different colored stratified clay sand sandstones, of fresh-water origin, the colors varying from blue to brown and gray, the grayish white predominating.

The period of the explorations was unfortunately cut much shorter than anticipated, owing to our being two months later in the field than intended, and on account of the severe winter setting in, making it impossible to collect on the cold, wet beach. Consequently, in June, everything was packed, and shipped *via* Punta Arenas to New York. The first week in June we bade farewell to this land of strange living and fossil mammals and birds, and sailed away on our home-ward voyage, not, however, without a lingering regret that time and circumstances had not allowed us to accomplish more for the advancement of science.

The specimens now placed in the University Museum are entirely new to the collection. These, when cleaned, will be described and figured in the *University Quarterly*. The following is a partial list of these new acquisitions:

VERTEBRATES.

Santa Cruz beds:

Astrapotherium.
Toxodon.
Diadaphoreus.
Nesodon.
Protypotherium.
Typotherium.
Hegetotherium.
Pachyrucose.
Lagastomus.
Planops.
Hapalops.
Hoplophoreus.
Scelidotherium.
And several other edentates.

INVERTEBRATES.

Cape Fairweather beds:

Balanus cævis.
" varians.
Cardeta elegantoides.
Cancellaria gracilis.
Crepidula dilatata.
Pecten giminatus.
Terebratella patagonica.
" gigantea.

Patagonia beds, San Julian:

Terebratella patagonica.
Scutella patagonensis.
Pecten prænuncius.
Scalaria rugulosa.
Turritella patagonica.
With many others not yet identified.

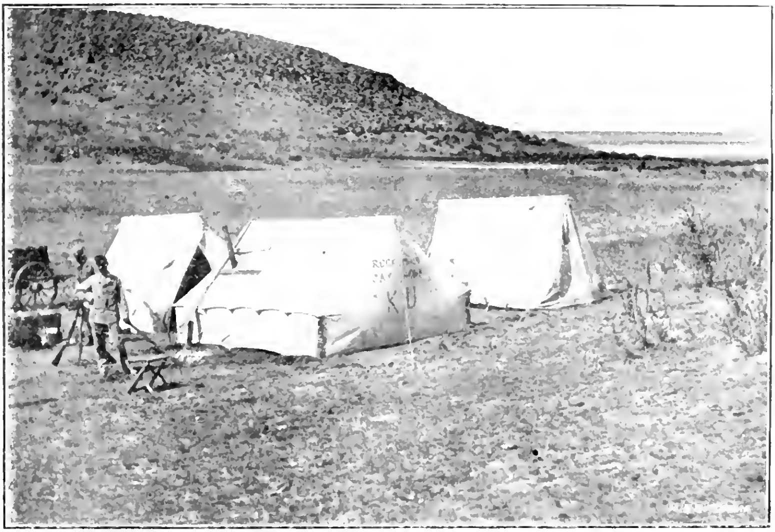

Plate VIII.—First Camp in Patagonia of University of Kansas Expedition.

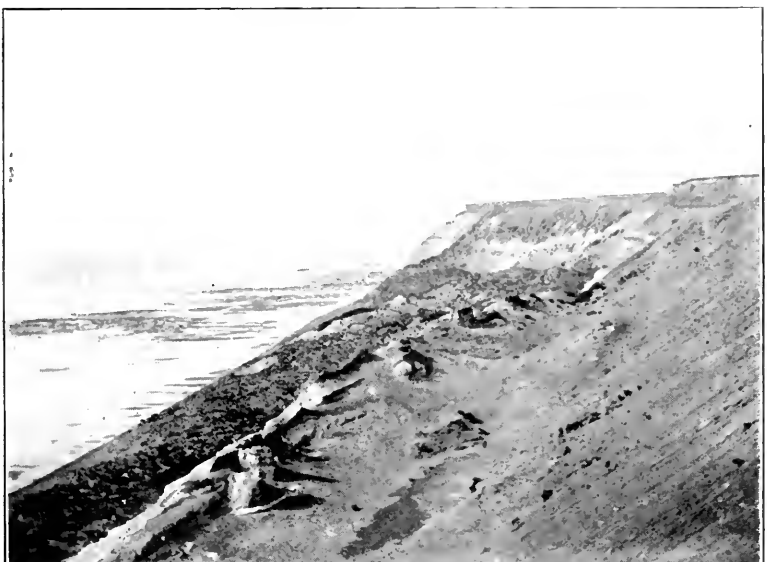

Plate IX.—Cliffs on Atlantic Coast of Patagonia Twenty-five Miles North of Cape Fairweather.

(The thin dark layer on top is shingle; then thirty to thirty-five feet of the Cape Fairweather beds, sandy in character; from this down to base of cliff is the Santa Cruz formation. To the left is the beach at low tide, where the fossils of the Santa Cruz beds were found.)

COAL-MINING IN ATCHISON COUNTY.

By E. B. Knerr, Atchison, Kan.

Read (by title) before the Academy, at Manhattan, November 28, 1903.

SINCE the discovery in 1893 of the sixteen-inch vein of coal about a mile and a half south of Atchison, a report of which is given in volume XIV of this Academy's Transactions, that vein has been worked to some extent almost every winter, though mostly in a small way. One quite elaborate effort, however, at putting this coal on the market was made by Mr. W. T. F. Donald, of Atchison, for four years, from 1894 to 1898. In that time Mr. Donald removed about twenty-three acres of the coal stratum from his mine, in an area of a square about 1000 feet on a side, and amounting to nearly 50,000 tons.

To work the vein, an electric plant was installed, at an expense of $12,000. Boilers, engines, tracks, etc., raised the item of expense for equipment to $15,000. The coal first entered the market at $2.50 per ton delivered, but as its excellent quality became known to the public, the price gradually rose to $4 per ton.

The difficulties of mining this coal by machinery are such, however, that after four years of experimenting, attended by considerable financial loss, Mr. Donald abandoned the enterprise. The method employed was the "long-wall" system, and the machine used was a toothed wheel about five feet in diameter, which was made to revolve in a horizontal position by a sprocket chain, and undercut the seam of coal to a depth of two and a half feet. The machine was propelled by an electric motor, and was run along the face of the exposed vein, making a daily undercut sometimes of 100 feet or more. During the night the coal would break down of its own weight, frequently in continuous lengths of twenty or thirty feet, when it required only to be broken up and hauled from the mine the next day. However the "horses" and faults encountered were so numerous as to occasion much dead-work and delay the progress of profitable mining; but the coal found a ready market, and was all disposed of in Atchison and Doniphan counties.

At the present time a new colony of four laboring men are at work opening up a new entry in the property immediately north of Mr. Donald's land. Indeed, the lay of the vein is so advantageous that men of but little experience can readily handle it, and nearly every winter parties of such men work it in a small way. They wagon the coal to Atchison or sell it to the farmers, getting about four dollars per ton for it.

But the coal-mining enterprise which is now commanding most attention at Atchison is that of the Atchison Coal Mining Company, which is sinking a shaft to the three-foot vein discovered by prospect drilling in October, 1900. This shaft is now down to a depth of about a thousand feet, and has only about 130 feet yet to go till the coal is reached. The work of sinking progressed rapidly and smoothly until the bed of sandstone at about 900 feet was reached, when there was such a greatly increased flow of water as to necessitate suspension of operations until air-compressors and pumps could be installed. These are being put in at the present time, and when they are in service it is hoped that the work of sinking will be pushed to completion in a few weeks.

The waterflow at present is about 70,000 gallons in twenty-four hours, which under continuous lifting reduces to 40,000 gallons, but after each shot the flow is increased again.

The engines, machinery and equipment are all of the very best type. The shaft is sixteen by eight feet, and is timbered into two compartments by four-by-twelve-inch curbing, laid flat. The derrick, or tower, is seventy feet high, and is provided with two sheave wheels around which the inch-and-a-quarter steel cables pass from the ten-foot drum in the engine-house to the two cages of the shaft, carrying one up as the other descends.

This shaft and equipment have cost the company to date about $70,000, including recent expenditures for pumps and air-compressor. All the work is of a permanent order; for even if the three-foot vein for any reason should prove unworkable, it is the purpose to back up, and work the Leavenworth vein, which at the shaft was found to measure fully twenty-three inches.

A FOSSIL FOREST IN JACKSON COUNTY.

By C. H. SHATTUCK, Washburn College, Topeka, Kan.

Read before the Academy, at Topeka, December 30, 1904.

DURING the month of June, 1900, while making a study of the geology of the northwestern part of Jackson county, I was asked to visit a well which was being dug on the Channel farm about two miles south of America City. The workmen had discovered a layer of some twenty inches of a soft, white stone which they were unable to name. This proved to be a very good grade of massive gypsum.

While at this place one of the workmen brought me a large fragment of petrified wood. He informed me that it came from the Laban Brenner farm, about one mile southeast of America City, and that great quantities of this material had been found here and carried away by any who cared for it.

He also said that stumps could be found at this place projecting above the surface of the earth, giving the appearance of a recently cleared field. I later found this last statement to be somewhat overdrawn. However, it so far aroused my interest as to cause me to visit Mr. Brenner at once. I found in his yard numerous fragments of petrified trees, and one large stump which he had used for a number of years as a stile-block. It was about two and one-half feet in height by one and one-half feet in diameter at the base, and at a distance might easily be taken for an old, partially decayed stump of the present time which had been dug up by the roots, as these extended on each side some two feet. Mr. Brenner told me that there had formerly been many of these on his place, but only one was now left, and this only because it was too large to be easily handled, and was surrounded by about eight inches of limestone, and is illustrated in plate XII.

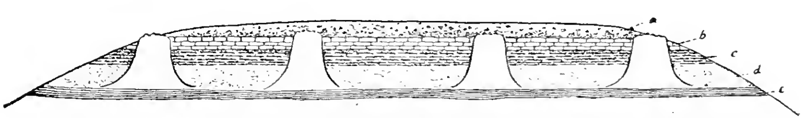

FIG. 9. Diagram showing location of stumps in the fossil forest in Jackson county. (*a*) Soil and gravel; (*b*) limestone; (*c*) shaly limestone; (*d*) soil and clay; (*e*) shale.

I found this fossil located on the south bank of Wolf creek, on top of a high knoll, probably the highest point in the county, as it easily overtops the high ground along the western edge known as English Ridge. On examining the locality, I found that all the stumps removed had come from just beneath this layer of limestone (fig. 9, *b*), which outcropped around the rim of the knoll. I also found many fragments of petrified wood below this level which had evidently weathered out of this same stratum. A close search along this outcrop revealed two other fair-sized stumps within fifty yards of the former one; their tops were just level with the surface of the ground.

Permission having been obtained from Mr. Brenner to remove these, as well as any others which I might find, I again visited this place in November of the same year, with my geology class. A further search brought to light two more fine specimens of stumps. These, with the three formerly discovered, were sufficient to constitute a heavy load for transportation to Holton, and as our time was limited we were compelled to give up further search.

The work of excavating was comparatively easy, as the limestone had been very much fractured. Below this was about eight inches of a soft, shaly limestone mingled with clay (figure 9, *c*). This rested on ten inches of dark brown soil and clay (figure 9, *d*), in which the roots of the stumps were embedded as they grew. A careful search in this soil failed to reveal any of the leaves or fruit of these trees.

The stumps were, with one exception, found as they grew, their larger roots still unbroken. All the wood at this place appears to have partly decayed before petrifaction took place, no remnant of bark remaining. This would indicate that the trees were partially or wholly submerged, as logs and stumps of the present time decay in much the same manner when exposed in the water.

I am indebted to Mr. E. H. Sellards for the identification of these trees. He has found them to belong to the ancient group of plants, linking the conifers with the cycads, known as Cordaites. The strata belong to the Upper Carboniferous, Wabaunsee formation.

The stumps found vary in diameter from eight inches to two feet, and, as our examination of this locality was only superficial and very hasty, I feel sure that extended search would reveal many others, possibly some larger, though two feet is the maximum size, so far as I know, yet reported for Cordaites.

The present extent of these trees, which I have made bold to designate as a fossil forest, is limited to the top of this single knoll, an area of perhaps ten acres. However, it must in times past have been very much more extensive, as evidence of their existence in the form of loose fragments and occasionally stumps and logs have been found in both Jackson and Pottawatomie counties, even extending southward across the Kaw to seven miles west of Alma, in Wabaunsee county.

The most important points in this discovery may be briefly noted in the following:

SUMMARY.

1. The stumps are found in place as they grew.

2. They are probably the last remnant of what was formerly a forest of considerable extent.

3. The soil upon which these trees grew can still be found much the same to-day as when they flourished.

4. The trees represent the highest type of plants to be found on the earth at that time.

ORIGIN OF GYPSUM, WITH SPECIAL REFERENCE TO THE ORIGIN OF THE MICHIGAN DEPOSITS.[1]

By G. P. Grimsley, Assistant State Geologist, Morgantown, W. Va.

Read before the Academy, at Topeka, December 31, 1904.

A VARIETY of theories have been advanced at various times to explain the origin of gypsum in various parts of the world. In order to arrive at a satisfactory explanation of the gypsum deposits in the state of Michigan, it may be well to give a résumé of these different theories.

DEPOSITION OF GYPSUM BY ACTION OF SULFUR SPRINGS.

Gypsum is deposited directly by some thermal springs, as in Iceland,[2] where the mineral is formed by the decomposition of volcanic tufa by acids dissolved in the water. The sulfurous acids become oxidized to sulfuric acid, and thus convert the carbonates, especially of lime and magnesia, into sulfates. Then, through evaporation, the sulfate of lime is deposited, forming layers of fibrous and selenitic gypsum.

Small gypsum deposits are found about the fumaroles of craters and lava streams[3] in Hawaii, where sulfurous acid (SO_3) is converted into sulfuric, and attacks rocks which contain lime. The gypsum concretions in the Harz mountains are regarded as due to action of sulfur vapors on lime. Dana explains the origin of part of the New York gypsum as a secondary mineral, formed by the alteration of limestone by action of sulfuric acid; the sulfuric acid coming from sulfur springs by oxidation of the sulfuretted hydrogen. Such springs are to be found in New York, especially about Salina and Syracuse.

According to the French geologist Lapparent, the large deposits of gypsum and anhydrite at Montiers, Bourg, and Saint Maurice, in the western Alps and Switzerland, are due to a similar transformation of lime. According to Lyell, the thermal waters of Aix, in Savoy, in passing through the strata of Jurassic limestone, turn them into gypsum. The springs of Baden, near Vienna, deposit a fine powder composed of a mixture of gypsum, sulfur, and muriate of lime.

Mr. R. S. Sherwin presented a paper before this Academy in 1901 in which he gave a series of arguments for this mode of origin of the Oklahoma gypsum deposits.

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1. Published with permission of the director of the Michigan Geological Survey.
2. Annalen der Chem. 1847, Bunsen.
3. Iowa Geological Survey, vol. 12, p. 116, 1902.

DEPOSITION OF GYPSUM THROUGH VOLCANIC AGENCIES.

Dawson, following Lyell, explained the origin of the gypsum in Nova Scotia as due to an accumulation of these layers of limestone which were later acted upon by sulfuric acid in solution or in vapor produced by volcanic action. The limestone and calcareous matter were thus changed to the sulfate, and gypsum of good quality accumulated in considerable thickness.

HUNT'S CHEMICAL THEORY OF GYPSUM FORMATION.

T. Sterry Hunt many years ago proposed a very complex theory of chemical interactions whereby gypsum was formed. The bicarbonate of soda acting upon sea-water separated the lime in the form of carbonate, which gave rise to a solution of bicarbonate of magnesia. The action of this solution on the sulfates of soda and magnesia formed bicarbonates of these bases and sulfate of lime (gypsum).

This theory was applied by Logan, in 1863, to explain the origin of the Canadian gypsum by the reaction between solutions of bicarbonate of lime and water containing sulfate of magnesia, forming the sulfate of lime, or gypsum.

GYPSUM DEPOSITED IN RIVERS.

Rivers may in some instances carry high percentages of sulfate of lime, and so deposit gypsum at their mouths or in the basins into which they empty. Lyell cites the river in Sicily known as the La Frume Salso as an example of a river forming such gypsum deposits.

SECRETION OF GYPSUM BY ANIMALS.

In the cruise of the "Challenger," M. Buchanan found that the bathybius formed a sulfate of lime deposit. This form is an unicellular animal belonging to the lowest group of animal life, the Protozoa, and it forms slimy masses on the floor of the ocean. Many scientists maintain that it is not an animal, but merely a deposition of lime salts in the depths of the ocean.

GYPSUM FORMED FROM ANHYDRITE.

Anhydrite, which is the sulfate of lime without water, on taking up two molecules of water becomes gypsum. In this process there is an increase in volume of thirty-three per cent. According to Lapparent, the force exerted by this change is four times as great as that of water in process of freezing. Such a change on a small scale is found in many places, but in the Harz mountains, according to Gary, the large gypsum deposits are formed from anhydrite through the entrance of water. Near Ellrich this change has formed mounds of gypsum in concentric shells fifty-two feet high, often hollow at the interior. The force of the resulting expansion has been sufficient to break crystals of quartz and the dolomite in the layers above.

DEPOSITION OF GYPSUM FROM BODIES OF SALT WATER.

The most generally accepted theory of origin of the large deposits of gypsum and salt has been the evaporation of salt-water lakes, bays, and seas, cut off from the main ocean. This theory has been given for the Iowa, New York and Kansas deposits in the reports on salt and gypsum in those states. In the Kansas report the writer endeavored to picture the history of the changes resulting in the deposition of gypsum in a bay whose waters retreated to the southwest in Permian time.

Examples of these changes can be found in the salt lakes, ocean gulfs and bordering seas at the present day. In southern Europe are excellent examples of the evaporation of salt lakes; and in this country the best examples are to be seen in the Great Salt Lake and neighboring salt lakes of Utah and Nevada.

Lake Bonneville, in the Quaternary geological time, covered an area of 19,750 square miles, with a depth of 1050 feet, and its waters were fresh. Through evaporation, its level was lowered below the place of outlet at the north, and its waters in course of time became more and more saline. This evaporation has continued until the present remnant, Salt Lake, has less than 2400 square miles of area, with an extreme depth of fifty feet, and its waters almost a concentrated brine, with specific gravity of 1.1. The total amount of salts in this lake water is 15 per cent., of which 11.8 per cent. is common salt (sodium chloride).

The waters of the Dead Sea afford another example of concentrated brine due to evaporation. In this water there is 26 per cent. of salts, but differing in composition from the American lake. There is only 3.6 per cent. of common salt and over 15 per cent. of magnesium chloride, as compared with 1.5 per cent. in Great Salt Lake. The amount of gypsum (lime sulfate) in the two basins is nearly the same, 0.086 per cent. Geikie, in his text-book (page 383), gives the chemical composition of these waters as follows:

	Great Salt Lake.	*Dead Sea.*
Chloride of sodium (common salt)	11.8628	3.6372
Chloride of magnesium	1.4908	15.9774
Chloride of calcium	......	4.7197
Chloride of potassium	0.0862	0.8379
Bromide of magnesium	......	0.8157
Sulfate of lime (gypsum)	0.0858	0.0889
Sulfate of potassium	0 5363	......
Sulfate of magnesium	0.9321	......
Water	85.0060	73.9232
	100.	100.

Ocean water, according to the analyses of the "Challenger" reports, contains 3.5 per cent. of mineral salts, of which three-fourths is com-

PLATE X.—Bluffs of Rio Gallegos, Patagonia, at Low Tide—University of Kansas Expedition.

PLATE XI.—Bluffs of Rio Gallegos, Patagonia, at High Tide—University of Kansas Expedition.

mon salt. The waters of the Atlantic show the following varieties and proportion of salts:

Chloride of sodium (common salt)	77.758
Chloride of magnesium	10.878
Sulfate of magnesia	4.737
Sulfate of lime (gypsum)	3.600
Sulfate of potassium	2.465
Carbonate of lime	0.345
Bromide of magnesium	0.217
	100.

When such a body of water is cut off and evaporated, the gypsum is deposited after 37 per cent. of water is removed, and common salt only after the removal of 93 per cent. The normal order of these formations would be a deposit of gypsum, and then a much heavier deposit of salt. But since 93 per cent. of the water must be evaporated before the salt would be thrown down, the evaporation might go far enough for the deposition of gypsum, but not far enough for salt; or the salt might be deposited and subsequently removed by solution. The first condition apparently took place in the Kansas gypsum area, and both conditions probably occurred in Michigan. Gypsum deposits are more wide-spread in nature than salt, but they usually occur in thinner beds.

In most areas, the amount of gypsum found is far greater than the amount that would be found in a body of ocean water sufficient to cover the gypsum area at reasonable depths. The present conditions in the Mediterranean sea seem to aid in explaining the formation of such deposits, and it has been cited for this purpose in the discussion of the Kansas and Iowa deposits, and also in the older reports of the Michigan gypsum.

The most complete study of the composition and currents of the Mediterranean sea has been made by Captain Nares and Doctor Carpenter, in charge of H. M. S. "Shearwater" in 1871.[1] They found the basin of this sea to be 6000 feet in depth, separated from the ocean at the Straits of Gibraltar by a ridge 1200 feet high. The water of the Atlantic outside this ridge had a specific gravity of 1.026; at the western end of the basin the gravity was 1.027, and at the eastern end, 1.03. The proportion of salts in the ocean was 3.6 per cent., and in the Mediterranean it was 3.9. Passing over the dividing ridge were two currents, one over the other. The upper was inflowing and the lower outflowing. The water of the basin is not concentrated enough to deposit salt and gypsum, but it is gaining in quantity of salt held in solution.

1. Published in Proc. Royal Soc., XX, pp. 97, 414, 1872; quoted also in Encycl. Britannica, vol. XV, p. 821.

So it is thought the water in the old seas and gulfs of Kansas and Iowa received additions of salt and gypsum by inflowing waters, thus increasing the thickness of the deposits. The same theory is used to explain the great thickness of salt at Stassfurt (1000 feet) and at Sperenberg (3000 feet), in Germany.

QUANTITY OF GYPSUM IN THE ANCIENT MICHIGAN SEA COMPARED WITH THE PRESENT SUPPLY.

The area of rocks in Michigan after the Marshall or Kinderhook series is approximately circular in outline, with a radius of eighty-five miles, giving an area of 22,686 square miles. As will be shown later, the sea covering this area in Osage times was approximately 700 feet in depth, and assuming an average depth of 326 feet, based on well records, there would have been about 1,280,000 billion gallons of water.

The analysis of Atlantic ocean water given above shows 93.3 grains of gypsum to the gallon. If this Michigan sea had this same proportion, it would have yielded 8,500,000,000 tons of gypsum.

The thickness of gypsum at Grand Rapids is eighteen feet and at Alabaster twenty feet. The gypsum in the Grand Rapids quarries is shown in plates XIII and XIV. The approximate area at Grand Rapids is twenty-four square miles and at Alabaster ten square miles; and while the gypsum does not by any means keep the thickness given over the entire area, and is even absent in places, it has probably been removed by solution since its deposition.

These figures would give a total quantity of 1,237,764,000 tons of gypsum. Where gypsum is found in the deep wells it is usually in thin beds, and in many of them it is entirely absent. It is thus evident that the quantity of gypsum held in this old Michigan salt sea is sufficient to explain the quantity of gypsum actually in existence to-day in its basin.

If the assumption is made, and there is no basis for it, that the gypsum covered all the interior sea area with a thickness of twenty feet, then it would require 917 billion tons of lime sulfate in the sea, more than a hundred times the quantity probably in the basin.

CASPIAN SEA AS AN ILLUSTRATION OF THE MICHIGAN SEA.

The gypsum deposits in Michigan do not occur uniformly distributed through all parts of this old sea basin, but they appear concentrated in certain areas of comparatively small size. For the cause of this localization of the deposits we may look for a modern illustration of the conditions in the Caspian sea.

Into the northern part of the Caspian sea empty the Volga, Ural and Terek rivers, bringing in a large quantity of fresh water, so that in this portion of the sea the water is nearly pure, with a specific gravity of 1.009. This small percentage of salt is, according to Van

Baer, due to the number of shallow lagoons surrounding the basin, each being a sort of natural salt pan. At Novo Petrovsk, a former bay of the main sea is now divided into a number of basins, showing all degrees of saline concentration. One of these has deposited on its banks only a thin layer of salt, a second is a compact mass of salt, and a third has lost all the water and is a mass of salt covered with sand.

The concentration is seen on the greatest scale in the Karaboghay (Black Gulf) of the Caspian, where the nearly circular shallow basin is about ninety miles across and almost entirely cut off from the sea by a long, narrow spit of land, so that the gulf and sea are only connected by a channel not over 150 yards broad and five feet deep. Through this channel there passes into the gulf a current with an average velocity of three miles an hour, but which is accelerated by the western winds.

This current is due to the indraught produced by excessive evaporation from the surface of the basin, due to the heat and winds. The shallow depth of the bar prevents a counter-current of highly saline water into the Caspian. This current carries into the Black Gulf, according to Van Baer, 350,000 tons of salt daily. If this dividing bar of land should be elevated and cut off the basin from the sea, the gulf would rapidly diminish and become a salt marsh, which, later, drying up, would leave a large salt deposit.

With a greater depth of water over the dividing ridge, the counter-current would come in as at the straits of Gibraltar, and the evaporation could go far enough for the deposition of gypsum, while the concentrated salt brine would pass back into the larger sea. This was more probably the condition in the Michigan gypsum basins, as will now be shown from a study of geological conditions and well records.

MICHIGAN INTERIOR SALT SEA.

The Kinderhook sea of the American continent was an interior sea with a bay extending northeast into Michigan. In this bay were deposited the Marshall sandstones. The close of the period was marked by uplift in this area, causing a retreat of the sea southwestward, finally exposing a wide area of land in southern Michigan and northern Indiana. At Lafayette, Ind., the floor of this sea was at least 563 feet above sea-level. North of this barrier was a large interior sea, with its floor 375 feet above sea-level near Grand Rapids, lower by nearly 200 feet than the ocean to the southwest. This sea was surrounded by the Marshall series, at this time dry land, 777 (Kalamazoo), 983 (Coldwater) and 1000 (Hillsdale) feet above sea-level on the south; 700 (Huron county) feet on the east; and 755 (Grayling) feet at the north—a sea like the Caspian, with a depth at first of probably 700 feet or more and an area of 22,686 square miles.

In this sea were elevations and depressions; a ridge at Lansing 500 feet above sea-level and a depression east of Saginaw 380 feet below sea-level, separated from the main basin by a ridge 187 feet above the sea floor.

This sea probably had its tributary streams coming from the high land at the north and northeast, flowing down across the recently emerged flats of the Waverly and Marshall land, bringing a supply of sediment and doubtless salt from the Salina beds at the north. The lake basins of Michigan and Huron were not in existence at this time, but belong to a much later chapter in the geological history of our continent. The irregular clay seams and the clay-dividing planes in the gypsum represent an influx of sediment, wind-blown material, or tidal currents.

As the evaporation of these waters went on, the first deposit would be carbonate of lime, thrown down when the specific gravity was raised to between 1.0506 and 1.1304. By further concentration the gravity would reach 1.22, and in this interval the gypsum would be deposited. At this period 37 per cent. of the water must have been evaporated. If the sea was 700 feet in depth, it would now be 440 feet, still covering the Saginaw ridge but exposing the Lansing ridge. Further well records might give a clue to other basins separated by ridges of land. The sea would gradually become like the Caspian, with smaller basins around it, in which all degrees of concentration would be found.

In the deep basin near Saginaw the dividing ridge would be exposed before salt was deposited. In such an evaporating basin the deposit of salts would occur around the borders of the basin first, and by the influx of water across the Saginaw ridge the water in the concentrating basin was probably renewed, resulting in the twenty to twenty-five feet of gypsum now found in that area.

The normal order of deposits should be lime carbonate, on which would be a deposit of gypsum, covered by layers of salt. In the present developed areas the gypsum rests on a limestone floor, but with no traces of salt over it. The rock-salt deposits are below the gypsum series, in the Monroe or Salina series. Further, in the salt series of Saginaw, Grand Rapids and other places there are no traces of rock salt, but the salt-wells secure the salt from natural brines.

If the Michigan interior sea evaporated completely, there would have been, on the assumption its waters were like those of the presen Atlantic, 17.9 times as much salt as gypsum, and the salt over the gypsum, or in the lower part of the basins toward the interior, where the waters, deprived of their gypsum content, had retreated.

If these conditions were true, the salt might later have been removed by solution in downward percolating waters which dissolved the more soluble sodium chloride. The gypsum now remaining does show marked effects of solution, the surface being rounded and furrowed by solution, and in places it is entirely removed. These effects would have been far greater in the common salt. The salt-laden waters or brines would flow downward along the slope of the rocks and through them, finally remaining at rest in the lower porous formations, where it is now found. Further, the salt seems to be found in greater amounts toward the interior of the basin than near the edges; more at Saginaw, Ann Arbor, Lansing, etc., than at Tawas and Grand Rapids, though it is found in all these places.

Another possible explanation of the final history of this sea is to be found in the great extension of the sea in the next epoch, when the St. Louis limestone was found. The sea in the St. Louis epoch extended its borders north and south, and passed across the interior basin of Michigan to Grand Rapids on the west and to Huron county on the east. Possibly this renewal of the waters took place before the Michigan sea had disappeared by evaporation, or before it had evaporated enough to deposit a large quantity of salt, except in certain smaller basins separated by the dividing ridges.

From the evidence of sandstones and shales of the Michigan series found in the well borings of the interior, it would seem that the ocean flowed over the southern barrier into the interior basin a number of times before the greater St. Louis inundation, and at these times deposited the sediments which are lacking in gypsum and salt contents. At these times the water would be diluted, its specific gravity lowered, so that precipitation of the salts would not take place. These overflowing waters, local in their occurrence, cannot be correlated with other sections, unless with those of the Logan series of Ohio, whose origin may be similar.

In the deeper Michigan borings, gypsum appears to be replaced by anhydrite; but where the depth of concentrated waters is 325 feet, giving a pressure of ten atmospheres, anhydrite is formed instead of gypsum.

This theory, as outlined for the Michigan gypsum deposits, is based on the study of a few well borings and a comparative study of the conditions in the Caspian sea of to-day and those of the Michigan area as far as they can be determined. There is a wide range of probability involved, and while the theory is advanced as a theory resting on limited data, it may be taken as representing approximately the conditions of origin of these deposits.

SOME NOTES ON KANSAS GEOLOGY.

By L. C. WOOSTER, State Normal School, Emporia.

Read before the Academy, at Manhattan, November 27, 1903.

IN the beginnings of every science, the chief work done by the workers in the several departments consists in collecting and accumulating facts of observation and representative forms of the minerals, plants or animals in which the collector has become interested. The embryo scientist, or, more properly, naturalist, soon becomes possessed with a fever or craze for collecting. As his collection grows, his fever or craze increases in intensity or virulence till it possesses the whole man or woman. The several members of this Academy illustrate to a greater or less degree the truthfulness of this generalization.

As the collection grows, as the number of objects and observations become so great as to be burdensome, the collector is forced to arrange his collection after some plan, original or borrowed. The classification, at first rude, soon becomes more systematic, and a new craze possesses him. He loves to classify every thing within his reach, and exhausts his Greek vocabulary in securing a supply of names for his species, genera, orders, and classes. The naturalist next adds method to his madness and collects more systematically, hunting most zealously for missing links in his collection. He readily pays twenty-five or fifty dollars, as did Doctor Horn, of Berlin, for a single beetle, or he travels a thousand miles to identify a single bird.

The scientist, as he should next be called, becomes increasingly mathematical as he becomes more methodical, and time and form or space values receive his earnest attention. In geology he constructs beautiful chronologies, and tries to make his time and rock groupings conform to the mathematical terms in use in common speech. The scientist-geologist talks very confidently of the millions of years covered by his eons and eras, and, as his vision becomes more microscopic and less telescopic, with more exact data at hand, he speaks with equal assurance of the years covered by his periods, epochs, and hemeras. Unfortunately, as one scientist becomes more exact in his estimates and names his subdivisions of geological time to suit his individual plan, other scientists insist on being exact in their way, and use those names for the subdivisions of time which suit their own convenience, and a variety of chronologies results. Here, as in other fields, the fittest should survive, regardless of priority. The priority fad is certainly being overworked at the present time.

I present in the table which follows, as an introduction to my paper, the chronologies of Dana and Scott. Dana's chronology has been used for many years by the great majority of American geologists; Scott's chronology is, in its essential features, the scheme proposed by a congress of European and a few American geologists. Like most unnecessary compromises, this has failed to bring harmony, and is not accepted to this day by many eminent American geologists. I shall follow Dana's chronology in my paper, for I believe it suits the conditions here in America better than any other; and the few who need to do so can run parallels between it and any other chronology with which they wish to make an adjustment.

In the following table, I have given in the first column the formations found in central Kansas; in the second column will be found Dana's time and rock groupings; in the third column is Williams's classification, based on the dominant life forms, modified to suit Kansas conditions; and in the fourth column I have given the time and rock divisions given in Scott's Geology:

Formations.	Dana's.		Williams's.		Scott's.	
	Time.	Rocks.	In part, life.	Time.	Time.	Rocks.
Paleozoic	Eon.	Series.	Trilobiteon.	Eon.	Era.	Group.
Carbonic	Era.	System.	Phillipsian.	Era.	Period.	System.
Coal Measures	Period.	Group.	Cameratus.	Period.	Epoch.	Series.
Upper Coal Measures	Epoch.	Stage.	Myalina.	Epoch.	Age.	Stage.
Emporia limestones	Hemera.	Substage.	Coral knot.	Hemera.		Substage.

While the geological formations of Kansas are flexed less than most of the neighboring states, these formations are sufficiently tilted to make their study interesting. The slow rise of the Ozarks, due in part to denudation, has given the strata of eastern Kansas a westerly dip; and the rise of the Rocky Mountains in the Tertiary era has given the strata of western Kansas their eastward dip. In addition to these tiltings of the strata of the state from their original horizontal position, due to the rise of mountain ranges, there have been other movements nearly as potent. The first of these is the great downward flexure of the strata of Indian Territory during the Lower Coal Measure epoch. This flexure amounts, if reported correctly, to 9000 or 12,000 feet. The second disturbance of the strata of Kansas has been due to the rising, sinking and partial recovery of the northern portion of North America during the Glacial, Champlain and recent periods.

Unfortunately for the geologist, these crustal movements have not been sufficiently great to induce great and rapid changes in the life of the Kansas seas, and he is accordingly plagued, if he is a systematic geologist, or blessed, if he is an evolutionist, with transitional strata and mixed faunas and floras. It would seem in one instance, however, that these crustal movements may be used in eastern Kansas to separate the rock stages of two epochs, those of the Lower and Upper Coal Measures.

Using the thicknesses of the formations given in the University Geological Survey reports and in Adams's recent bulletin on the Upper Carboniferous rocks of Kansas, we shall find that most of the shales below the Iola limestone thicken as we proceed southward, and that the shales above the Iola limestone thicken as we go northward.

I quote the following statements from the authorities just mentioned:

"Cherokee shales—thickness of the equivalent is twenty times greater in the Indian Territory."

(The thickness of the Cherokee shales substage in Kansas is 450 feet; in Indian Territory the thickness of the equivalent deposits, those between the Missisipian limestone below and the Fort Scott limestone above, is 9000 feet.)

"Labette shales thicken southward."

"Parsons limestone thickens southward, where it includes a shale-bed."

"Galesburg shales thicken southward."

"Cherryvale shales thicken southward."

"Chanute shales thicken southward, where the substage includes more and more sandstone."

The limestones lying between these shales thin out as they are traced into the Indian Territory and these substages contain more shale and even sandstone. These peculiarities of deposition might be caused by a shore-line on the borders of the Ozark and Wichita mountains being the source of the clay and sand, and by deep, muddy seas occupying northern Indian Territory and making incursions northward into Kansas. The limestones may have been deposited in the clearer seas beyond, and in the clear water at intervals between the incursions.

With the deposition of the Iola limestone the conditions were markedly changed. After that time the shales were thicker in northern Kansas and sandstones more largely predominated in the southern part of the state. I quote again from the authorities previously mentioned:

"Lane shales thicken northward."

"Garnett limestone thickens north and west."

"Lawrence shales thicken northward and are replaced by the Chautauqua sandstone in the southern part of the state."

"Kanwaka shales become more arenaceous in southern Kansas."

"Tecumseh shales become more arenaceous southward."

"Calhoun shales thin southward."

"Burlingame shales thicken northward."

The warping of the crust of the earth, attended by the rise of the

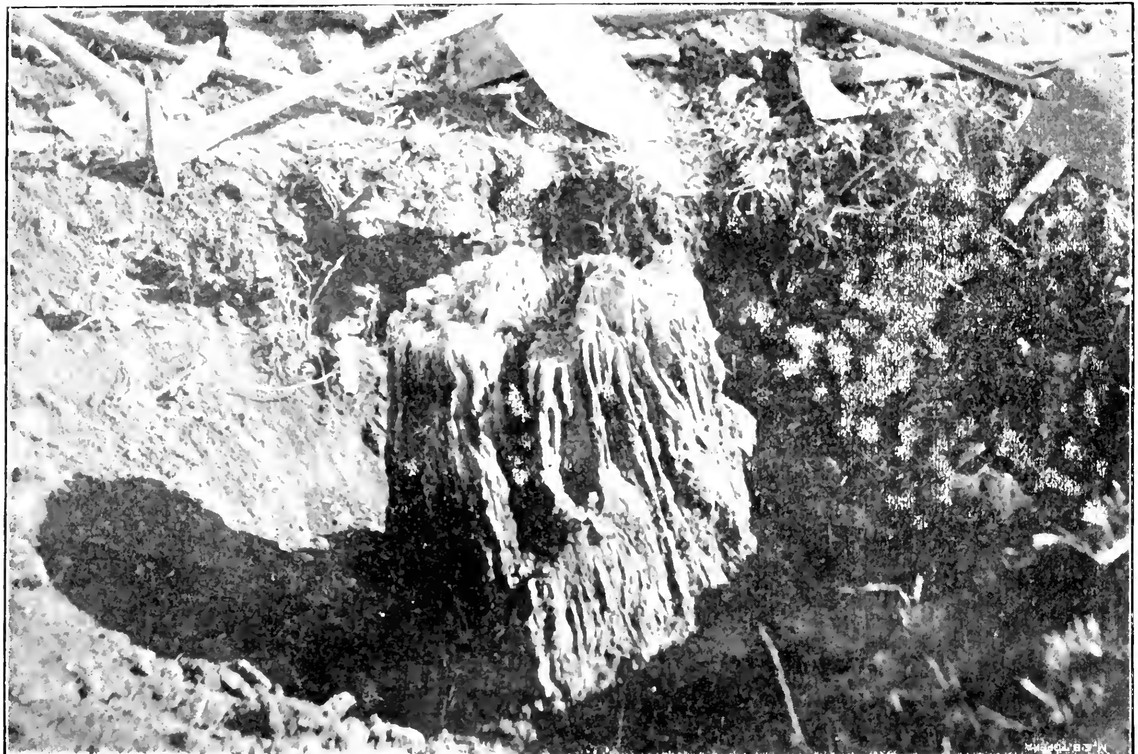

PLATE XII.—Petrified Tree Trunk in Jackson County, Exposed by Artificial Excavation.

seabottom at the south and the sinking of the seabottom at the north, which must have occurred at about the time of the deposition of the Iola limestone makes this hemera a natural break in the Coal Measure period, and gives abundant warrant for dividing the Coal Measures into the Lower and Upper epochs at the Iola limestone.

In Lyon county, the Americus limestone is not much lighter colored than the limestones below it, and is far darker than the Cottonwood limestone above. Hence the clearing of the seas of ferruginous material would, in Lyon county at least, make the time of deposition of the Cottonwood limestone a better hemera for separating the Coal Measure period from the Permian period than the Americus limestone hemera, should we make the clearing of the seas of iron the natural feature for making such division, as Adams suggests. The most marked changes in the fauna occur, too, at about the horizon of the Cottonwood limestone, and hence this hemera may well be used to mark the upper limit of the Coal Measure period.

The foldings of the crust of the earth which attended the Appalachian revolution, some crustal movements of about the same time in Indian Territory, Oklahoma, and Kansas, and possibly also some crustal movements which attended the development of the Glacial period, have thrown the strata of eastern Kansas into folds trending in Lyon county to the northeast and southwest. A careful mapping of these anticlines and synclines is work that should be done in the near future, for until this work is completed much difficulty must attend the proper correlation of the strata.

Near Neosho Rapids, in Lyon county, these movements of the crust of the earth have been accompanied by fissurings, faultings and wave-action. Fissuring attended with vertical cleavage planes may be seen in the sandstone beneath the Eureka limestone near Neosho Rapids and in a sandstone beneath the Emporia limestones at Emporia. The faulting is shown by a heavy displacement of strata about two miles northwest of Neosho Rapids, along the Neosho river. The wave-action is best seen in a railroad cut about one mile west of Neosho Rapids. At this point is a section forty feet in thickness of a rock composed of limestone fragments, but with the cross-bedding and peculiar weathering of sandstone. This sandstone-limestone thins out rapidly, and two miles to the northward is only a few inches thick. To the southwestward it holds its thickness better, so far as traced. Fossils are not common in this rock. The few that were collected were entire. The source of the material of this sandstone-limestone can only be conjectured. Possibly it was derived from a concretionary limestone which belongs at the same horizon and may be seen beneath its northern margin.

THE FAUNA OF THE MENTOR.

By Alfred W. Jones, Kansas Wesleyan University, Salina.

Read (by title) before the Academy, at Topeka, December 31, 1904.

THE following list of species I have collected in Saline, Ellsworth and McPherson counties; unless particular localities are noted, the species is common to the Mentor wherever marine forms occur:

Ostrea franklina Coq. Frequent.
Ostrea quadruplicata Shum. Brookville, Bavaria, and Marquette.
Ostrea kansasense Logan. Brookville; not abundant.
Inoceramus comancheanus Crag. Brookville; rare.
Avicula salinaensis White. Not common.
Pteria salinaensis White. Brookville; rare.
Gervillia mudgeana White. Brookville and Bavaria.
Gervillia, n. sp. Brookville; rare.
Trigonia emoryi Conrad. Common.
Nucula catherina Crag. Common.
Tapes belvederensis Crag. Frequent.
Roudaria quadrans Crag. Rare.
Cardium kansasense Crag. Abundant.
Protocardia salinaensis Meek. Common.
Cyprimeria texana Roem. Rare.
Linearia, n. sp. Not common.
Corbula sp. Abundant in fresh-water locality five miles northeast of Salina.
Unio (belliplicata ?). Five miles southeast of Kanopolis.
Unio, n. sp. Frequent in fresh-water locality near Salina.
Pholcdomya sancti-sabæ Roem. Brookville; rare.
Mactra (?) sp. Marquette; frequent.
Pyrgulifera sp. Common in fresh-water locality near Salina.
Pyrgulifera humerosa (?) Meek. Near Salina; not common.
Mesalia kansasensis Meek. Common.
Turritella belviderei Crag. Common.
Glauconia, n. sp. Brookville and Marquette; rare.
Anchuria, n. sp. Brookville and Marquette; frequent.
Turbo sp. Marquette; rare.
Sphenodiscus sp. Three poorly preserved specimens from Brookville and one from Marquette. A much better specimen was obtained a short time ago from Thompson creek, in southern Ellsworth county, and a species of Exogyra added to the list from this locality.

PROTOSTEGA GIGAS AND OTHER CRETACEOUS REPTILES AND FISHES FROM THE KANSAS CHALK.

By CHARLES H. STERNBERG, Lawrence, Kan.

Read before the Academy, at Manhattan, November 27, 1903.

IN his report to the United States Geological Survey of the Territories, volume II, 1875, Prof. E. D. Cope fully describes the material on which he founded the new genus *Protostega*. To me, after all these years, having collected many specimens of this large tortoise, it has been a wonder how he was able, from the bones he collected himself and restored with infinite care and patience, to make such a nondescript of the animal, especially as in volume IV he gives, as the most important law that governs paleontology, "the persistence of type." But this creature, as he created it, is an exception to the rule. He makes the total length 12.83 feet, with width of carapace three feet and length seven feet, or twice as long as wide. One mistake leads to another. The professor thought the skeleton he discovered lay on its back. The loose ribs doubtless did, as their heads were pointed upward. During the time it was being buried in the soft sediment they could easily have been turned over. I have found hundreds of specimens where the elements have been macerated free from their fellows, and lying in every conceivable position; in fact, it is rare indeed to find them in their natural position. With this idea firmly fixed, he proceeds to put the great radiated bones of the plastron in the skin of the back as "lateral dermal plates," along with some of the bones that cover the top of the skull. In describing the plates, he notices they were concave on the under surface, yet the ribs were flat and straight. It is useless to try and understand how he could have made such mistakes when he had so much of the skeleton present. For many years his description remained uncorrected, though in 1876 my party sent him a nearly complete skeleton.

Prof. E. C. Case, in his paper on the "Osteology and Relationships of *Protostega*," published in 1897, is so fortunate as to have for description an almost complete plastron with marginal plates. Of course, Cope's "lateral dermal plates" are no more, as Case finds them in the plastron. He is therefore able to give the correct proportions of the under part of the body. The carapace and limbs in correct position are unknown to him. I was so fortunate as to discover a nearly complete skeleton of this tortoise last summer in Logan county, Kansas. The arches, limbs, and most of the column and ribs, I have the pleasure of exhibiting to you. It has taken me over a month to get them in their present condition, and though I was very anxious to show you the whole skeleton, it was a physical impossibility. It will take another month to scrub off the tenacious blue shale in which they were buried. The whole animal was originally present. It lay on its back, every bone in its natural position, though sadly broken by the disintegration of the shale; one fore limb, from the humerus outward, and the end of the skull were cut off by the wash. It therefore gives me great pleasure to introduce you to the fellow who has been so cruelly misrepresented during his absence. He will tell you the truth, and as I hope will be a warning to paleontologists to know what they are talking about before they rush into print and give a false representation of one of God's creatures, as it may turn up, as this has done, to make their labor vain, and give young paleontologists a chance to rise in the world on the mistakes of their predecessors.

You will find this turtle very unlike the one Professor Cope's imagination pictured; and though it boasts of lying in its rocky tomb undisturbed while more recent history was being made—in fact, before and since the vast sediments in ocean and lake were laid down that make up half the strata that compose the bulk of the Rocky Mountains; before this material was elevated in mighty ranges and towering peaks, or the Colorado river had with its tools of sand and gravel carved out of the solid rock the Grand Canyon, 300 miles long and 6000 feet deep—yet in spite of the vast lapse of time since it lived it is still a tortoise, resembling in many particulars the Mediterranean genus *Thallassocheyles*, fully carrying out the law of the "persistence of type."

So after these many years of doubt and uncertainty as to his structure Mr. *Protostega* comes before you in his own person to prove to you that scientific literature is full of "science falsely so called." My discoveries have often proved that when men of science guess on the structure of an animal which they only know in part they usually guess wrong. Our works on paleontology are full of such errors as Cope made, proving that the ablest minds, when they draw on their imagination for scientific material, drop into the same class to which Professor Hicks belongs. When they try to force facts to carry out some preconceived theory of their own, as to how nature should do things, the unexpected is likely to happen; the animals themselves may come forward to prove that man cannot describe correctly an animal he never has seen. It is said the Japanese can take our most complicated machinery to pieces and build as many exact duplicates as they wish, but they cannot invent. So all a paleontologist can do is to give a description of what he has seen. To go beyond this is guesswork and of little or no value.

Knight has given, in the frontispiece of the University Geological Survey of Kansas, volume IV, a restoration of this turtle as he supposed it to be, from the study of Cope and others. He makes the flippers three times as long as the hind paddles. With a completely ossified carapace, you may therefore be surprised to find that the hand in the turtle before you (see plate XVIII), by actual measurement, is only three and an eighth inches longer than the feet. The third finger is the longest—sixteen and a half inches long; the fourth, fifteen and a half; the second, fourteen; the first, nine a half, and the fifth, eight and a half inches long. The second and third toes are twelve and five-eighths; the fourth, twelve and an eighth; the fifth, eight and an eighth; the first, seven and a half inches long. Professor Williston has restored a limb of this species in the University of Kansas from a lot of loose and scattered bones I collected some years ago; in the presence of this animal he was mistaken. The professor assumed the position of a land turtle feigning death; his limbs were drawn within the marginal plates as far as the hands and feet, yet in this position the distance between the ungual phalanges of the hands is over eight feet. When stretched out at full length, with the great horn claws added, the span would be nearly ten feet; so that Cope was about right in his estimate of this part of the skeleton. In the neck and carapace there are twenty-three vertebræ, three feet and nine inches long. There are also present three caudals, measuring five inches more (see plate XIX).

The first vertebra in the preserved series is the fourth cervical, according to Case, as it is convex at each end. The others are concave towards the head and convex towards the tail. The length of the rib attached to the seventh and eighth vertebræ is twenty and a half inches. As this is the only one at right angles to the column, it represents, with the vertebræ and ends of the marginal plates that extend beyond their distal ends, the widest part of the carapace. In this individual it is forty-five and a half inches between these plates. The ribs radiate from the right and left of this rib, like the spokes of a wheel, giving a round outline to the carapace, as Case suggested, though I think it was a few inches longer than broad. The carapace consists only of the ribs, vertebræ, and neurals, Case to the contrary notwithstanding. They are quite small, shaped like diamonds, with rounded angles, and unite by suture to the expanded portion of the ribs, that rises above, and reaches beyond the rib heads. The ribs are also expanded laterally and unite with each other to form the peak of this "first great roof." They soon separate, though still expanded for a third or half their length, according to the age of the animal. They do not join the marginals, but lie in shallow depressions, that in very old animals are arched over. So the carapace can be taken up entire, resembling a hub and spokes with the felloes taken off. Only, in this case, the hub would be represented by the string of anchycolosed vertebræ.

I have a much older individual that I described in *Popular Science*, June, 1899. The specimen was so badly broken that I did some guessing myself, and figured an oval carapace with only sixteen ribs. In this specimen the neurals are beautifully sculptured, rising in the center in rounded prominences like inverted wedges, with blunt apexes, divided by narrow valleys. The carapace is, in this specimen exhibited, about four and a half feet long and forty-five inches wide. Compared to the enormous pectoral and pelvic arches and powerful limbs, the body cavity was remarkably small. I suppose these huge limbs were developed more as a means of defense, offense, and rapid swimming, than to enable him to appease his appetite. The sharp elongated claws and horn-armed jaws would likely meet with the respect they were entitled to by his neighbors, the mosasaurs and large predaceous fishes. After a few more months of labor I hope to be able to restore the remaining parts of this specimen. When a correct description is made, paleontologists will be able to get a true idea of one more of the ancient inhabitants of Kansas.

Mr. Branson, of Doctor Williston's party, collecting for the University of Chicago, was so fortunate as to find a complete skeleton of a new form of *Platecarpus*. The skeleton is twenty feet long. This was found in Mr. Switzer's pasture, on Hell creek, about twenty miles northeast of Scott City, in Logan county. I made a camp in the same pasture three miles north, at the spring on Hay creek. Science as well as myself are under obligations to Mr. Switzer, for, though his fields were full of wild cattle, he allowed me to remain at this camp from the 20th of June, until the 27th of August, 1903. I made some rich discoveries here. Among other things, were five more or less complete skeletons of *Platecarpus* which I think are of the same species discovered by Mr. Branson. All had complete heads. One very interesting specimen lies on the top of the head with a palatine exposure, with sixty-six continuous vertebræ, ribs, and other bones, twelve feet long. Another has a frontal exposure, with lower jaws lying horizontal, near their natural position, the quadrates also flat. So in these two heads their complete anatomy can be made out without removing them from their native bed. I secured fourteen fine skulls of mosasaurs, with much of their skeletons, including the great ram-nosed *Tylosaurus*, with skull three feet nine inches long. Also a very fine head of *Clidastes*, exposing the right side of the face, every bone and tooth in position, even to the complete ring of sclerotic plates. The coronoid does not overlap the presphenial, as Williston believes. So I am led to think Cope was right when he suggested that this animal had the power to spread his mandibles laterally, to force food down a loose, baggy throat. Then, I have a nearly complete skeleton of the large *Platecarpus coryphæus*.

I never get tired of talking about these old Kansas mosasaurs. But as they are so well known, I will tell you of a skeleton I was able to secure of the great predaceous fish, Cope's *Portheus mollosus*. This was discovered several years ago by my friend, Mr. W. O'Bourne, of Scott City. He entertained me every time I came to town in his pleasant home, surrounded by beautiful trees. His estimable wife and he did all in their power to make me forget the hardships of the fossil fields, and I returned to them with fresh courage. My son George rediscovered the specimen, with several tons of loose dirt on top. I consider this specimen better than the one I sold the American museum, Central Park, New York, in 1900. Professor Osborn had it mounted by his skilful assistant, Mr. Adam Herman, and I take great pleasure in showing you a fine photograph of this specimen. *Public Opinion*, page 896, December, 1902, says: "It is the most striking specimen of a fossil fish to be found anywhere in any museum in the world." In this photograph the dark shades represent the bones I collected, the light shades the parts restored, using the skeleton of a living tarpon for comparison. And it would seem that this restoration could be safely made when so much of the skeleton is present. Yet my more complete specimen shows that there were no additional spines in the dorsal line They were V-shaped. The proximal ends of the limbs were provided with rounded heads, that fit in bowl-like depressions in the centrum of the vertebra. The distal end was sharp—no room for extra spines. Further, some of the spines in the caudal region were double.

This individual of mine occupies three large panels of its native chalk. The complete head, gill bones and pectoral arches are the most perfect of any I have collected. The distal ends of the pectoral fins are cut off by the wash, with a few of the ends of the ribs in this region. All the proximal ends and many complete ribs are present, with all the spines of the vertebræ. Both the pelvic and dorsal fins are present, but unfortunately the tail fins are missing. I hope the museum that procures this specimen will be able to get a cast of the tail fins in the New York museum, as that individual seems to have been of the same size as this one. I have twelve feet of the skeleton, but the one in New York is sixteen feet long. So I am truly delighted that in these two specimens men of science will at last get correct ideas for the first time of this great fish.

I wish, in this connection, to give credit to my son George F., who was my chief assistant in the field. He discovered many of the best specimens we collected, and his skill in handling the large panels we took up showed great forethought. He loaded my large collection on the car and stayed with it until it was safely delivered in my workshop at Lawrence. Mr. W. A. Anderson, whom I hired in the field, proved an efficient helper. I close with an invitation to you all to visit me in my laboratories and examine some of the ancient inhabitants of Kansas.

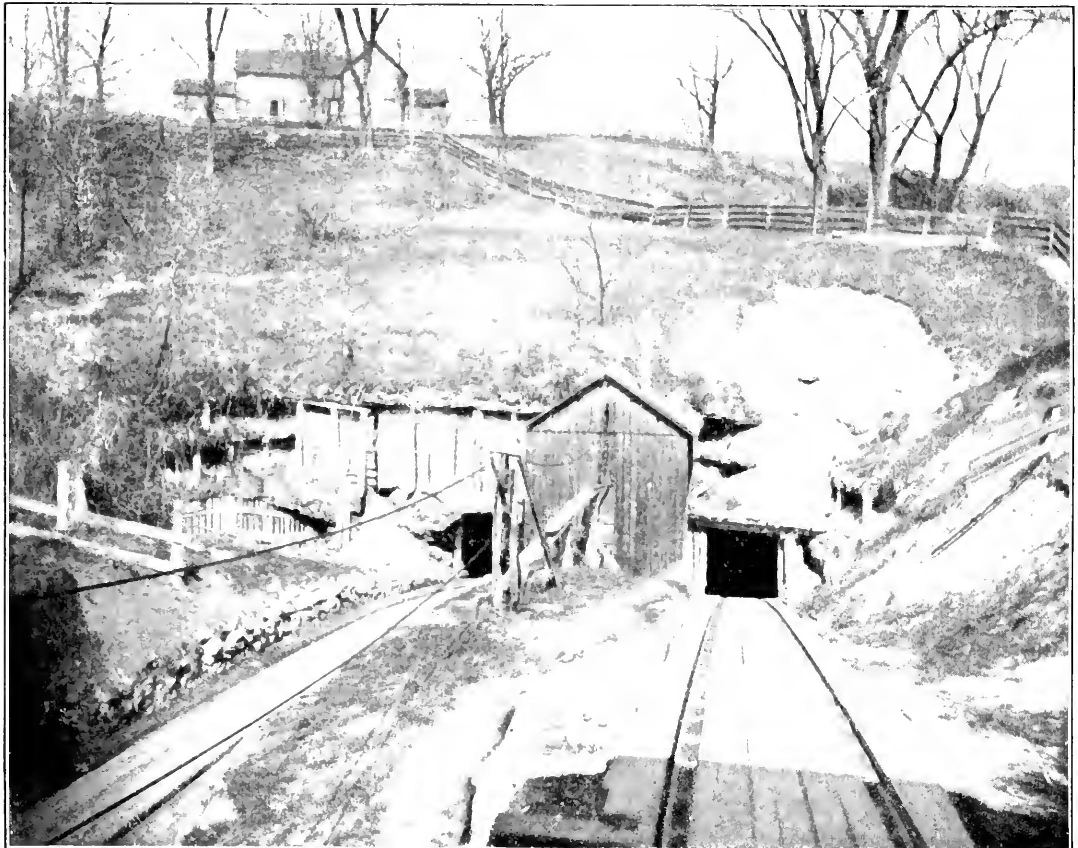

PLATE XIII.—Entrance to Gypsum Mine at Grand Rapids, Mich.

THE KANSAS MINERAL EXHIBIT AT ST. LOUIS.

By G. P. Grimsley, Assistant State Geologist, Morgantown, W. Va.

Read before the Academy, at Topeka, December 31, 1904.

THE chief of the mining department of the Louisiana Purchase Exposition insisted from the beginning of the work of preparation that the mineral exhibits should have an educational value, and that it should be an exhibit of processes, as far as possible. It was hoped that the exhibits of states and foreign countries would not be wholly of the nature of mineral curiosities and unique specimens, but should be practical, so that here in the compass of a single building the people might see the steps in manufacture, from the crude ores up to the finished product adapted to its various uses.

PLAN OF ARRANGEMENT.

Realizing the value of this wise plan, the Kansas exhibit was planned and erected with these ends in view. That we succeeded in approximating this ideal of arrangement is proved by the many favorable comments made by the visitors from other states and countries and by the awards given us by impartial juries.

Several months before the fair opened we made detailed plans for the Kansas mineral exhibit and submitted them to the mines department. These plans called for a space of 3000 square feet, and were later adapted to 2000 square feet, which we felt sure would be awarded to us. The demand for space was so great that the chief of the mines department, though expressing his deep interest in our display and his satisfaction with our plans, was compelled to cut our allotment of space to 1588 square feet. This space was in the form of a rectangle fifty-nine feet long and twenty-seven feet wide, situated in block 51, in the southeastern section of the building. We had for our neighbors on either side Nebraska and Oklahoma, with Wyoming back of us and Montana in front, across the aisle.

This space was enclosed by building a partition fifty-nine feet long and twelve feet high at the back of the booth. This partition was covered with green fire-proof burlap, and it was used for a large display of pictures, maps and charts of the Kansas mineral industries. The maps on a large scale, three in number, showed in colors the geology of the state, the mineral belts of the eastern third of the state, giving the location of the oil and gas territory, the lead and zinc area, and the important coal areas. A third map showed vertical sections of the rocks of the state, a log of one of the gas-wells, and a section of the Lyons rock-salt shaft. Photographs of the zinc smelters and mines, coal-mines, brick plants, oil- and gas-wells, etc., were exhibited in neat frames, covered with glass made in Kansas factories. The charts gave the production of oil, from the first year to 1904, the number of wells, statistics of the different mineral products, purity of Kansas gas compared with that from other states, which showed the Kansas article equal and in a few cases superior to that of Eastern states.

Oklahoma on one side of our space having large fields of gypsum, it seemed fitting to make the dividing wall of blocks of gypsum from our own quarries. This wall was built thirty inches high in a checker work of gypsum stone blocks two feet long, one foot wide, and ten inches thick, the material coming from the Great Western Plaster Company mines, at Blue Rapids. The Nebraska exhibit, on the other side, was separated by a line of show-cases.

GYPSUM INDUSTRY.

Since Kansas held first rank for many years in the gypsum industry and to-day has large developed fields of this important building material, the prominent aisle front of the Kansas exhibit was made in a gypsum facade, as shown in plates XXI and XXII. The plaster came from Blue Rapids, and was modeled into an open balustrade, surmounted at the corners with plaster urns. The central approach was an arch eighteen feet high, supported by fluted columns and capped by a large seal of state, with the word "Kansas" in raised gold letters on the cornice. This brought prominently into view one of our prominent industries and made an artistic and imposing approach to the exhibits. The facade was broken by two other open doors four feet wide.

In order that there could be no trouble in identifying our exhibits, we had the word "Kansas" prominent in all corners and places on printed signs, and a large eight-foot sign suspended above was visible from all parts of the building, showing the people that Kansas was here.

The gypsum products were also shown in the crude material and in the finished products by the United States Gypsum Company, which took the interest to build an attractive exhibit in one corner of our space. They showed polished blocks of gypsum from their various Kansas mines, the white and colored finishing plasters, small pyramids covered with different kinds of plaster, and ornaments molded out of plaster. Another very instructive exhibit was erected by the J. B. Ehrsam Machine Company, of Enterprise, Kan. This consisted of two gypsum calcining kettles for the manufacture of gypsum plaster, made one twenty-fifth natural size and enclosed in brick-work, showing the arrangement of the flues and drafts, method of stirring the plaster, fire arches, vapor- and smoke-stacks. This exhibit, enclosed by a brass rail, made one of the most instructive exhibits in the building, because the beauty of the architecture and sculpture of the entire fair was wrought in plaster made from gypsum rock. Here in the Kansas space was the only exhibit on the fair-grounds which showed how the marble halls, sculptured urn and statue were made possible; how the soft, white gypsum rock could be converted by heat in properly constructed kettles into plaster for this temporary city of palaces. It was fitting that the Kansas display should include such an exhibit, since a large percentage of the material for these buildings came from Kansas. This was, perhaps, for the reasons given above, one of the most valuable displays in the Kansas space, and while it was a very expensive exhibit, it was well worth the cost, and the expense was met by the Ehrsam company, which deserves the appreciation of the state for their interest in our display.

OIL.

When the great fair was held in Chicago, and Kansas came to the front with good displays, there was one mineral industry which belonged to the lesser products, and no one dreamed that by the time of the next great exposition this small industry would be attracting the attention of the world. The developed oil-fields of Kansas at that day, and even two years ago, were small, but to-day the oil men of the country are looking to Kansas for the future supply.

Realizing the great importance of this industry, it was hoped that we could make our greatest exhibit that of oil. In this we were disappointed; vain efforts were made time and time again to interest the oil companies in making the finest oil exhibit at St. Louis. The golden opportunity was ours, and with our rapidly growing fields we should have made easily a gold-medal exhibit. Our oil companies were too busy drilling new wells to stop and take an interest in a St. Louis oil exhibit. It was a great loss to our fine exhibit and to our oil centers not to have an exhibit commensurate with our oil resources. Yet, with this drawback, Kansas had an oil exhibit which attracted more attention than any other in the building excepting that of the Standard Oil Company.

The oil exhibit consisted of ornamental glass jars filled with samples of crude oils from the different fields arranged in a pyramid, surmounted by a large pitcher of oil. Samples of oil- and gas-well sands were placed with the samples of oil. In this exhibit the following localities were represented: Humboldt, Chanute, Neodesha, Thayer, Cherryvale, Peru, Buffalo, Coffeyville, La Harpe, Independence, Longton, Le Roy, Erie.

A pamphlet describing the history of the oil-fields, the origin and description of the different areas was distributed in connection with this exhibit. The Commercial Club of Chanute, late in the summer, m de a special exhibit of crude oils and photographs of the wells.

LEAD AND ZINC.

Kansas at the present time holds first rank in the production of metallic zinc, or spelter. The producing area of lead and zinc is not large, and is found around Galena, in Cherokee county. The lead is smelted at Galena by the Galena Smelting and Manufacturing Company, which made an exhibit of pigs of lead piled up in a pyramid containing one and one-half tons. The fumes and dust from this smelter are caught in large cylinders and then fused in a furnace, giving a variety of lead known as "lead smoke." This "smoke" has a prismatic structure, and the process of its manufacture at this plant is superior to any other used. The exhibit of this material in the Kansas space attracted attention on account of its value and peculiar appearance, as well as from its name of "lead smoke."

The metallic zinc was shown in our exhibit by fifty-pound plates of spelter loaned by the Granby Mining and Smelting Company from their smelter at Neodesha. The main metallic zinc exhibit from Kansas was made by the Lanyon Zinc Company, from its works at Iola, Gas City, and Lanyonville, in a separate space of 2000 square feet under their own name and control. This exhibit showed all the varied uses of metallic zinc—for rods, roof-tile, wash-boards, stair work, inside metallic finish, etc. This booth had the name "Kansas" prominent; and while in no way connected with the state display, it was still an advertisement of the Kansas resources, and was so intended by the company. Mr. Drake, president of this company, took great interest in our work and tried to secure space near us, so as to bring these displays together. This exhibit received the grand prize.

On the Kansas space a pyramid was constructed of choice lead and zinc ores, with plates of metallic zinc at the base, and the whole capped by an eagle and ball made of the sheet zinc. This pyramid thus showed in one column the ores, the metal, and the metal rolled into sheet zinc worked over into a patriotic emblem. Some of the finest cubes of zinc in the building were in our exhibit. Two show-cases were filled with choice specimens of lead and zinc ores from Galena. A pyramid case was filled with zinc silicate ores and lead and zinc sulfide ores. There was one mass of lead crystals weighing 700 pounds and another weighing 300 pounds, both from Galena, and the former, known as the Carney specimen, received a special award.

The ornamental minerals associated with the lead and zinc in the mines, celebrated for their beauty rather than for their utility, were exhibited in two cases. These consisted of the golden lime or calcite crystals, the rarer and more choice crystals of ruby zinc, and yellow, cadmium-coated crystals. These made a brilliant and beautiful display, and were loaned from the Cooper collection, of Washburn College, at Topeka. This collection attracted much attention from visitors and was a source of surprise to many, who did not know before that crystals of such beauty could be found in mines of lead and zinc.

The Kansas lead and zinc display in its own space, combined with the Lanyon exhibit, was one of the features of the mines building.

COAL.

Coal was shown in the central space of the exhibit, in the form of a symmetrical pyramid eight feet square at the base and fourteen feet high, containing some sixteen tons of coal from Frontenac, mined and erected at St. Louis by the Mt. Carmel Coal Company without any cost to the state. This coal pyramid was one of the massive displays, and one of the conspicuous exhibits in a group of coal columns and pyramids from the various states in this part of the building, which was sometimes designated as the coal-mines of the fair. With all these coal exhibits, some of which secured the grand prize, Kansas people had no cause to feel ashamed of their coal pyramid.

This coal shows by analysis the following composition:

Moisture	1.14	per cent.
Volatile matter	64.71	"
Fixed carbon	24.26	"
Ash	6.59	"
Sulfur	3.30	"

COKE.

The coke made from Kansas coal was shown in a small exhibit from the Eastern Coal and Coke Company, from their ovens at Cokedale. The Standard Oil Company gave the state much valuable assistance in the collection of the crude oils from the different fields, and also made an exhibit of coke made from the residue from the oil in the course of refining at the Neodesha refinery. This fairly compact coke made in this interesting way was the only oil coke exhibited and, being a new and but little-known product, attracted much attention.

SALT.

Kansas holds third rank in salt production; so one of the prominent displays made by Kansas was that of salt. The rock salt from the Lyons shaft was shown in a massive display by the Western Rock-salt Company. This exhibit consisted of three heavy blocks, the largest shown in the building. This display interested the government experts, and, at their urgent request, was given to them for a permanent exhibit at the new Washington museum. In addition, this company exhibited jars of the different grades of salt, and a collection of very clear, pure crystals, ranging in size from a half-inch to several feet across. There are only six rock-salt mines in this country, and three of these are found in Kansas. The only rock-salt exhibit that compared with Kansas was that of Louisiana.

The solar evaporated salt and brine used by the Solomon Salt Company were exhibited. These were from the oldest salt-works in the state, and the only one that uses the direct heat of the sun to evaporate the brine. The salt from brines evaporated by artificial heat filled two large show-cases, one from the Sterling Salt Company and the other from the Hutchinson-Kansas Salt Company. These exhibits consisted of packages of table salt piled several courses high, and the spaces between filled in with small sample packages. Both the table and dairy salts were shown. The high character of these pure-white table salts was apparent in open dishes, and proved a valuable advertisement for the companies and for the state.

MINERAL WATERS.

Mineral waters were shown from the Phillips well, at Topeka, and a large case filled with bottles of the famous Abilena natural cathartic water gave the public a good idea of the health-giving qualities of Kansas waters. The Abilena water became a well-known brand at St. Louis. The water from these springs at Abilene contains the following ingredients, in grains, per United States gallon:

Sodium bicarbonate	8.909
Lime bicarbonate	10.7333
Iron bicarbonate	0.917
Sodium nitrate	0.568
Sodium sulfate	3229.288
Magnesium sulfate	71.966
Lime sulfate	44.966
Sodium chloride (common salt)	65.176
Silica	0.293
Ammonia	No trace.
Total solids	3432.195

It is without doubt the best natural cathartic mineral water in the country. In another part of the building, the United States Geological Survey had a mineral-water exhibit, and in this exhibit were mineral waters from the Waconda and other mineral springs of Kansas.

BLUE VITRIOL AND CEMENT.

Another show-case contained the blue-vitriol exhibit from the old Argentine smelter. This represents one of the lost arts of Kansas. This company supplied over half the vitriol used by the Western

Union Telegraph Company, and was prepared to ship vitriol on a larger scale and of the highest quality, but the consolidation of the smelter interests of the country resulted in the closing down of the Argentine smelter with its interesting by-product of vitriol.

In the upper part of the case, the Iola Portland Cement Company had a small exhibit, showing the materials from which the cement was made, the finished cement, the briquettes of cement broken, to show the high tensile strength. This was only a small exhibit, as the main exhibit was made in the cement building outside, in the mining gulch. The cement industry has developed very rapidly in the past few years in Kansas, and it was a source of regret that we could not persuade the companies to make a united exhibit in the Kansas space. Elaborate plans had been made with this end in view, but they failed to materialize at the last moment.

BUILDING STONE.

Kansas building stone was shown in eight- and ten-inch cubes from the quarries of the state. Very few quarries were willing to contribute to this exhibit; so we collected the stone and had it cut at the expense of the state. From a number of the quarries we had the stone donated and even cut into the desired form. This stone exhibit, while incomplete, was large enough to attract attention. The blocks were arranged on white enameled supports, set on a sloping series of shelves five feet in height and ten feet in length. The top shelf contained ornamental jars of white silica or tripoli from Burr Oak, and concentrates of lead and zinc. The sandstone and limestone blocks of different colors were exhibited from the following quarries:

Americus.	Fort Scott limestone.	Lyndon.
Atchison.	Fort Scott sandstone.	Manhattan.
Blue Rapids.	Galena.	Neodesha.
Caldwell.	Great Bend.	Norton.
Cherryvale.	Greeley.	Oswego.
Coffeyville.	Hays City.	Ottawa.
Cottonwood Falls.	Holton.	Russell.
Ellis chalk.	Iola.	Salina.
Ellis limestone.	Jefferson county.	Sedan.
Florena.	Junction City.	Topeka.
Frankfort.	Leavenworth.	Wilson.
Fort Scott cement rock.	Lecompton.	Winfield.

GLASS.

Our great glass industry was brought to the attention of visitors by a fine exhibit of table glassware from the Cherryvale Glass Company, bottles from the Coffeyville Bottle Glass Company, and the crude materials for glass manufacture from within the state's limits. There was an exhibit of the glass sand from Fredonia, contributed by Long

Brothers Real Estate Company; soda ash and lime from the New Jersey United Zinc and Chemical Company, whose works are located at Argentine, Kan. The state has not only the large glass factories, located at Coffeyville, Cherryvale, Independence, Caney, etc., but all the materials necessary for this work within the state.

CLAY PRODUCTS.

Over a large area of the state of Kansas the clay shales form a characteristic and thick formation. In the past ten years these have been utilized in brick manufacture to a very considerable extent. The brick industry is now prominent in the state, and at St. Louis the brick and the shales were exhibited from the various brick-yards of the state on a long pyramidal table. On one side were shown the brick burned with coal fuel, and on the other side the brick burned with natural-gas fuel. On account of the high quality of both grades, the exhibit attracted much attention from brick manufacturers and from the general public. The exhibit was thus carefully studied to try and determine whether gas- or coal-burned brick were better. Many compliments were given on the quality of the Kansas paving-brick in this exhibit.

Samples of the brick were taken by the representative of the War Department, at Washington, to be tested at the United States arsenal at Watertown, Mass., but these results will not be available for some months. The brick for the Kansas exhibit were contributed by the following firms:

Atchison Vitrified Brick Company.
Capital City Vitrified Brick Company, Topeka.
Caney Brick Company.
Cherryvale Brick Company.
Clay Center Brick Company.
Coffeyville Vitrified Brick and Tile Company; plants at Chanute, Cherryvale, Coffeyville, and Independence.
Columbus Brick Company.
Federal Betterment Brick Company.
Fredonia Brick Company.
Fort Scott Vitrified Paving-brick Company.
Humboldt Vitrified Brick Company.
La Harpe Brick Company.
Lawrence Vitrified Paving-brick Company.
Missouri Valley Brick Company, Leavenworth.
Neodesha Brick Company.
Ottawa Brick Company.
Paola Brick Company.
Pittsburg Paving-brick Company, Sycamore plant.
Salina Brick Company.

The Coffeyville Vitrified Paving-brick and Tile Company made a special exhibit of their ornamental hand-molded brick in a mantel

PLATE XIV.—Alabastine Plaster Company's Gypsum Quarry, near Grand Rapids, Mich.
(Upper gypsum ledge, six feet; lower ledge, twelve feet. Seventeen feet of shale forms the cover.)

eight feet wide and ten and one-half feet high. In this mantel were placed their various types of red and buff brick, making an artistic exhibit, which was said by experts to be the finest mantel erected at the fair. This exhibit was made by the company at their own expense.

The new Coffeyville Roofing-tile Factory made an exhibit of roofing-tile, with a picture of their plant placed above it. In color, finish and strength these tile had no superior in this building. This industry was started after the fair opened and is building up a large business.

CONCLUSION.

Kansas, through her mining exhibits, established a reputation as a mineral state in the minds of the visitors from home and abroad. The question, "What has Kansas to show in mineral lines?" was answered by this display. This phase of the state's resources is one not as well known nor as well advertised as it should be, and the results of this complete advertisement of the mineral resources is bound to bring rich returns in the future.

It certainly will repay the state for its money expenditure, the commission for its time and anxiety involved in its preparation and installation, and the people of the state who have aided in the collection of the materials.

At the close of this great exposition our exhibit of the Kansas mineral products was appreciated so highly that it was sought after by some of the leading museums of the country. The National Museum, at Washington, wished to take it entire and set it up in the new government museum. Some of these demands, with the honor involved, were hard to refuse, but it seemed best to the chief of this department and to the commission that this collection, so nearly complete, and collected at the expense of the state, ought to be preserved at home as a permanent memorial of the exposition and as a standing advertisement of our mineral wealth. It was deemed best to send it to Topeka, to be set up in the museum room of the Kansas Academy of Science, in the state-house, open to public inspection. Thus in one room the stranger and citizen can see what Kansas has in mineral wealth. It will there prove an educational force, and will be worth more than its money value to the state. The exhibit is now installed in Topeka, in the Academy of Science museum, open to the public.

This exhibit received two gold medals, twenty-two silver medals, and fourteen bronze medals.

THE FLOOD OF 1903 IN CENTRAL KANSAS.

By ALFRED W. JONES, Kansas Wesleyan University, Salina.

Read before the Academy, at Manhattan, November 26, 1903.

IN the spring of 1903 an unusual pressure of cold air from the Northwest seems to have prevailed, causing weeks of terrific wind-, hail- and rain-storms over the Central West, and precipitating all its moisture, apparently, over this region, causing the Northeastern states an unprecedented drought.

The sleet-storm and freeze of April 29, that ruined a magnificent fruit prospect, seem to have precipitated the period of calamity. Following in rapid succession came tornadoes, hail-storms, and deluges of rain, and the elements appeared to have been warring with all their fury. Tornadoes occurred in Saline county May 20, 21, and 22, three days in succession, killing one person and injuring several others, doing much damage to stock and buildings. Hail occurred on several dates, but the hail that fell in the vicinity of Salina on May 22 was remarkable for the enormous size of the hailstones. Hailstones fell weighing from eight to sixteen ounces, and measuring as much as fourteen inches in circumference. Fortunately, during the fall of hail, there was very little wind, reducing the damage to a minimum.

But to return to the subject. The rainfall for May was as follows:

May 4	0.93 in.	May 22	1.02 in.
" 7	0.16 "	" 25	2.97 "
" 11	0.76 "	" 26	1.62 "
" 13	0.06 "	" 28	5.25 "
" 14	0.50 "	" 29	1.54 "
" 16	0.08 "	" 30	0.45 "
" 18	0.11 "	" 31	0.31 "
" 20	0.93 "		
" 21	0.60 "	**Total for month**	17.33 in.

This is almost equal to the entire rainfall of the year 1901. The rainfall from May 20 to 29 was 13.93 inches, and while this was a great surplus of water, there was unquestionably much heavier local downpours at various places up the streams from here. Tuesday, May 26, Dry creek and Mulberry creek began overflowing all the bottom lands west of Salina and began to invade the northwest portion of the city of Salina. The Saline also began rising, which retarded the drainage of the Mulberry system. Wednesday the Smoky began to rise rapidly and the Solomon was already overflowing below. Thursday torrents of rain fell, filling all the creeks to overflowing. The Smoky was already overflowing and the waters spread over the bottom lands in every direction, and Friday and Saturday witnessed the greatest flood ever seen by white men in the valleys of Saline county. Probably two-thirds of the ground level of Salina was covered with water, and from roofs of high buildings or the hills one could look out over miles and miles of glistening, swirling water.

According to observations made by the first settlers of Salina, backed by Indian traditions, a flood probably even greater swept through the valley in 1844.

From the information gleaned from A. M. Campbell, of Salina, and other pioneers, old drift marks could still be seen in 1859 along the base of the bluffs and in timber that indicated a flood even higher than the recent one. But I am of the opinion that had the surface of central and western Kansas been covered with the hard buffalo-grass sod of forty years ago the water would have run off into the drainage channels with such rapidity that the same conditions existing last May would have produced a flood fully as great as the traditional flood of 1844.

Geologists and others have indulged in much speculation concerning the origin of the broad alluvial plains forming the valleys of the Smoky Hill and other streams, and said surely these insignificant streams never did this work. But I think in this year of 1903 the Smoky arose in its might to claim its own and demonstrate its right. Peculiar depressions that seemed to have no special functions as drainage channels became roaring torrents. The terrible havoc wrought by the flood in the valleys below Salina is too well known to be given space here, but I think a little consideration of the work of this one flood will convince any one that two or three such occurrences in a century would not require many thousand years to build up vast flood-plains, and I wish to call especial attention to the changes produced in the uplands. I have made collecting trips into certain regions of Ellsworth, Saline and McPherson counties almost every summer during the last ten years, and in revisiting several of these localities since the middle of July I have been astonished at the work of destruction among the hills.

The clays and shales became so softened by the long-continued saturation that landslides are in evidence everywhere among the hills with steep slopes and along the little canyons of the Dakota, and here and there great gullies are cut down the slopes. Flowing springs now exist where springs were unknown before; wells that had furnished but a scanty supply of water for years are now filled to a depth of many feet; dry creeks are now running streams; for example, Dry creek, by name, a tributary of Mulberry creek, west and southwest of Salina, has only carried water at seasons of heavy rains, but at this date is carrying a good running stream of clear water.

For weeks, and in some cases even months, water would seep into the cellars in the north part of Salina from the saturated soil, even where the surface seemed comparatively dry. Certain it is that we have had a great object-lesson on the power of water as a geological agent, and a few repetitions of the flood of 1903 would bring about vast changes in the topographical features of the state.

NOTES ON THE TOPOGRAPHY AND GEOLOGY OF NEW MEXICO.

By J. J. JEWETT, Los Angeles, Cal.

Read (by title) before the Academy, at Topeka, December 31, 1904.

ON the parallel of 37 degrees north, New Mexico is but fifty-four miles from southwest Kansas. The distance is measured by one degree of longitude between meridians 102 deg. and 103 deg. west. The geological formations bridging the interval are, no doubt, identical with those of western Kansas and eastern New Mexico. The Cimarron river, deriving its waters from the territorial slope of the Raton mountains, is the only river entering Kansas, except the Arkansas, having its sources in the Cordilleran region. The area of New Mexico is more than once and a half that of Kansas, and is about measured by that of Great Britain and Ireland. Its average altitude is at least 3000 feet above the average of Kansas, and its lowest parts are above the mean of Kansas.

The geology of New Mexico is less certainly known than that of any other political division of the geographically connected United States. The present paper will only call attention to certain picturesque features of topographic and geologic interest.

Unlike Kansas, the Paleozoic formations in the territory would be a matter of inference only, except for its mountains and the canyons, their derivatives, for those early deposits are deeply covered with Mesozoic and Cenozoic strata elsewhere than in the vicinity of these elevations and trenches. Fortunately, Kansas, without mountains within her boundaries to destroy the vastness of her agricultural capacities, revels in the successive disclosures of her strata, from early Carboniferous to late Alluvial, giving almost unexampled access to the geological benefactions of all time. This condition to human advantage, however, is to be credited to the slow uplifting agency of the Ozarkian region to the east and southeast of her present borders.

The territory is ridged and cross-ridged with mountain segments, which together constitute geographic ranges for hundreds of miles, but continuous sierras end in the middle of the north half, in the Sangre de Cristo range, apparently the oldest orographic monument. The range culminates in an altitude of over 13,000 feet, seventy-five miles south of the Colorado line and thirty miles east of the central meridian of the territory, the 106th. From this point it broadens and splits into three sharply crested, nearly parallel ranges, of which the eastern is longest, and which extends fifty-five miles further south.

These ranges average from 9000 to 11,000 feet in height, in order from east to west, the longest having least altitude and the shortest, or western, the greatest. The intervening troughs have few, if any, intrusives, and are occupied by tributaries of the Pecos river, deeply canyoned in their upper courses, and with narrow, fertile valleys near their points of issue. The ranges vary somewhat in the character of their granitic masses. The eastern is fine-grained, the middle syenitic, and the western with large crystals of red feldspar.

To indulge a somewhat grotesque but instructive imagination, one may picture a huge book, so bound that its pages lie flat when opened, with its back on the Kansas-Colorado line, its top to the south, and the right and left outer edges of its leaves resting on the Rocky Mountains and the Kansas-Missouri boundary. The outer edges on the left will be imbricated like the shingles on a roof; they will represent the Kansas stratigraphic exposition. Let the outer edges on the right be somewhat crumpled and turned up; they will represent the stratigraphic exposition of eastern Colorado. Imagine the Sangre de Cristo to be the right arm of the titanic book reader, with his wrist and hand resting on the breast of New Mexico from the top of the sternum to the xyphoid cartilage. The Raton mountains represent an enlarged inner condyle of the radius; the Cimarron mountains will represent the thumb; the Mora spur the forefinger, and the tripartite main range the remaining digits. East of these latter is Las Vegas, west is Santa Fe, and the A. T. & S. F. railroad skirts the finger tips to reach the Rio Grande valley. Fancy these enormous fingers of a titan thrust into the leaves of another volume, upturning their leaves, tearing, crushing and crumpling them; the torn and jagged edges will in part typify New Mexican sedimentary strata.

In a general way the granitic mountains of the territory are ranged in north and south lines. A series of short ranges begins just a little southwest of the Sangre de Cristo and extends on the east side of the Rio Grande into Texas, and, crossing the river, continues into Mexico. The crests of its interrupted segments are from 8000 to 10,600 feet above sea-level. The ranges have but little breadth, but overlap each other in places, and their linear directions often differ by considerable angles. One flank of each mountain is an escarpment and the other strata blanketed. The average distance of this line of short ranges from the Rio Grande is about thirty miles. On the other side of the valley, at a distance averaging seventy-five miles from the stream, is the drainage axis of the continent, the "continental divide," so called. This is not a mountain range, in its northern part, but a tract of high mesas of stratified rock, Cretaceous. Granite hills protrude in places, giving evidence that at the base the axis is of that nature. Further south, and crossing the line of the Santa Fe railroad, western division, the divide is capped with lava sheets. Still further south the granite base rises into a mountain range, the Black range. Mountains on either side of the divide rise to altitudes above the divide, but streams have cut canyons through them or have passed around their extremities. Detached ranges not far from the Rio Grande rise to heights of 8000 to nearly 11,000 thousand feet. The Ladrone, Magdalena and Caballo are the principal. But there are three groups or clusters of ranges prominent in situation, magnitude, general elevation and mining importance, namely, the Sangre de Cristo, or Red mountains (from the red feldspar of the granite), in the north-central part, the Black mountains in the southwest (from the black clothing of pine forests), and the White mountains in the southeast. They form a right-angled triangle, of which the hypotenuse is the line from the Sangre de Cristo to the Black mountains.

New Mexican orology well illustrates the principle that, in crust-wrinkling, horizontal thrust is from all directions and not from one or two, as in the action of a vise. However, the lines of weakness may not run in all directions; but it appears that, in New Mexico, the strata were too evenly laid to allow any great differential of resistance. Perhaps the absence of those enormously thick and rigid barriers to compression, the Cambrian, Silurian and Devonian rocks, may have had an influence in directing a distribution of effects to various points of the compass.

Mountain evolution did not cease in New Mexico until late Tertiary, if it has yet ceased. Extensive local faulting, totaling, in cases, 1000 feet or more, accompanied or followed elevation. This movement is still probably progressing, as is indicated by frequent slight earthquakes, local in perceptible effects. About the center of the territory a good number of seismic agitations occurred the present year (1904). Whether dislocation progresses by elevation of mountain masses, and corresponding slipping of strata in contact about the bases, or by extension of old faults further removed, is a question the solution of which may come by observing if changes of position occur in mining tunnels intersecting faults. Some suppose the faults increase without elevation, which is not probable unless a reason can be given for cavernous conditions. From the traditions of the Pueblo Indians and descendants of the early Spanish settlers, and from the evidences of former successful agriculture and large population where neither of these conditions exist to-day, the inference has been drawn that there is a general subsidence of the plateaus, but such data do not seem to warrant the conclusion. It is true that certain altitudes are necessary to cause aqueous precipitation, but these altitudes are not the same in all sections. Some high mountains secure very little;

others not so high get good supplies. Breadth of ranges seems to figure a good deal in the rainfall.

New Mexico is dotted and overspread with later intrusions than her granitic wrinkles, and of a different character. Basaltic cones and lava-beds intermingle in all parts of the territory, west of the Llano Estacado, with her mountain ranges and her park-like plateaus. Rhyolite often caps the summits of the higher peaks; but they were not the higher peaks when the molten rock was spread over them. Subsequent erosion has left them to tower above the crumbling granite masses by which they are surrounded, and which once looked down upon the sites now occupied by the cold vomit of Pluto. Young isolated cones of basalt rival in altitude the porphyritic monarchs of many geological ages. A line of these in a southwest direction begins near Colorado, between the Sangre de Cristo range and the Rio Grande river, and extends 200 miles. Among these peaks, Ute, San Antonio, Abiquiu, Hemas and Mt. Taylor are between 10,000 and 12,000 feet high. Mt. Capulin, in the northeast quarter of the territory, a noted landmark, 8000 feet high, has a crater a mile in diameter. Ten miles west of Albuquerque are five cinder cones, from 6000 to 8000 feet above sea, in a line, and visible from the city. The central one has an open crater and a secondary cone. Some of the basalts are vesicular or amygdaloid, and some massive and dark-purple basalt weathers to a white kaolin. Some rhyolites are pumiceous and some glassy and massive. Of course there are other varieties. The lava overflows are extensively spread on the plains or parks. A region of lava overflow, 300 miles in length and averaging twenty miles in width, in the midst of which the plutonic peaks above named and many others lift their heads above the desolation they have wrought, runs through northwestern New Mexico. In its northern part it is basaltic, and lies on both sides of the Rio Grande, which cuts through it in long, black chasms, in places 800 feet deep. It leaves the eastern side of the river about the parallel of Santa Fe, but, on the western side, is still a visible object from the city of Albuquerque, presenting the appearance of a perpendicular, high, black wall. A bed of black obsidian covers about 300 square miles a little southeast of the territorial center. It is known as the Malpais. Many sheets with local names might be mentioned in other sections of the territory.

As might be inferred, dikes and sills are numerous, and have effected important economic conditions, among which is the conversion of bituminous coal into anthracite, and the introduction of some metallic ores of profitable mining value. It is, however, a question whether the extrusive and intrusive plutonics have made New Mexico more fitted than it would otherwise have been for the production of

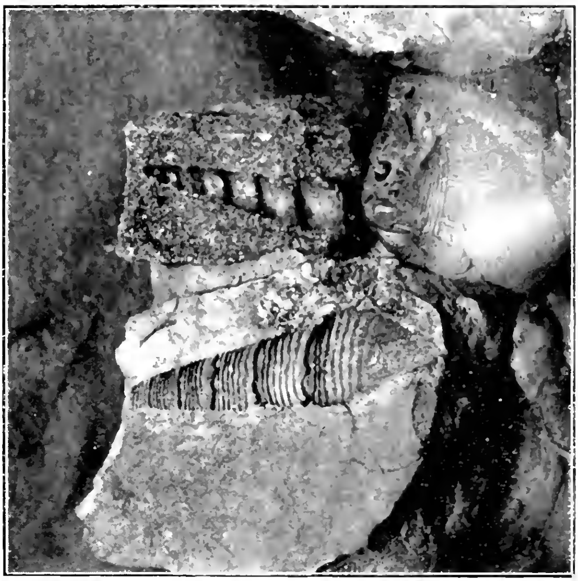

PLATE XV.—Mentor Fossils—*Turritella belvederei* Cragin.

wealth and for permanent civilized, prosperous and increasing population. They have restricted the formation of wide alluvial valleys and covered large areas of possible agricultural surfaces, converting them into sterile deserts. By damming the Rio Grande in late Tertiary times, it made the valley of that stream a great longitudinal lake or a series of linear lakes for several hundred miles of its course, which became filled with the detritus of basaltic and granitic masses to the depth of nearly 1000 feet. Thick layers of basalt run into its bed and spread on both sides of it, the stream finally cutting deep canyons to deliver itself. Much of the drift and sediments yet remain, as well as most of the broad, barren lava tables. The remains of the old lake deposit are seen to be stratified and sometimes feebly consolidated with calcium carbonate. The layers consist of silicious sand alternating with fine to very coarse conglomerate. The water-worn pebbles of the latter are often six to eight inches in diameter. Every description of color and composition of plutonics is found in the smooth stones that cover the mammillary faces of the low hills bordering the lower levels of the valley. One may sometimes find gold, which the naked eye can detect in the specimens he gathers, and many are colored by ores of copper or other metals. The cutting of the Rio Grande canyons resulted in several debacles, according to the evidence of distinct benches along the boundaries of the lake basin, especially marked in Colorado, but also manifest in New Mexico.

The granite of the mountains is mainly a feldspar porphyry, with the feldspar ingredient in rather large crystals. In the Sangre de Cristo this component is reddish, also in the Nacimiento and some other ranges, but further south it is oftener a white orthoclase. The granite passes into gneiss or *vice versa* in places, and where schists are in contact it is often that the junction is not a *locus* that can be identified. Quartz and granite dikes are frequently found cutting into the great axial masses. About fifty-five miles straight north of Santa Fe, near the Denver & Rio Grande railroad, is a granite dike carrying reddish feldspar in masses of four to five cubic feet, quartz masses as large or larger, and white mica plates several inches thick. The probability is that this dike was not thrust up to the surface, but cooled very slowly under great pressure, and is exposed through denudation by erosion of thick strata.

The gneisses, schists and granites show more or less lamination in the vertical direction, and some schists under the lens exhibit clastic structures. Apparently they do not conform with the layers of conglomerate and quartzites that rest upon them on the sloping flanks of the ranges, when viewed from the escarpment faces. They are below the Carboniferous and are supposed to be Algonkian metamorphics. No remains of Cambrian, Silurian or Devonian strata are recognized. If any of these systems were ever deposited, they appear to have been completely removed, unless the metamorphics are remnants. The upper surfaces of these Azoic masses are scored into bosses and fosses, and the latter are filled with conglomerates and quartzites on which limestones of the Carboniferous period lie conformably, the first clearly defined Paleozoic strata in the territory. The whole series of the Carboniferous, except coal seams, is displayed,

New Mexico appears to have been immersed in the sea when the ferns and club-mosses of eastern Kansas formed dense cryptogamic forests, for millions of years, flourishing upon hundreds of feet of the dead bodies of their species. Most of the mountains have carried upon their summits extensive and thick beds of Carboniferous limestone, sometimes in nearly horizontal attitudes. On the summit of the Sandia range, opposite Albuquerque, at an altitude of 10,000 feet, are two vast tables of Carboniferous limestone several hundred feet thick, lying one above the other and separated by a bed of sandstone. Viewed from the city these beds appear horizontal, but in reality they have a small dip to the east. They extend miles along the crest, and their conspicuous light-colored and uniform borders present a strong contrast to the darker, serried, granite pyramids that stud the steep slope below. They attract the attention of the traveler as a remarkable sight. No better illustration can be had of the slow, non-impulsive elevation of granite ranges than the attitude of these extensive tables 5000 feet above the base of their upheaved support. The writer has seen masses of the debris of these strata composed almost wholly of small brachiopod shells loosely cemented by calcium carbonate. Near to and opposite the escarpment sides of the mountains the Carboniferous and other strata are usually canted up at high angles.

The Triassic and Jurassic are extensively displayed in northern New Mexico, and probably in the southern part, west of the Pecos valley, in all their colors. In various places the Jurassic is capped with gysum fifty feet or more in thickness, which would represent more than 25,000 feet of sea-water evaporated. The southern part of the Gallinas and northern part of the Nacimiento mountains, about eighty miles northwest of Santa Fe, have their summits covered for many miles with gypsum, above Jurassic sandstones and shales, at a height of 10,000 feet. Gypsum is found in various connections, but most often with the Jurassic. West of the Sacramento mountains, in the southeastern part of the territory, is an area of 600 miles covered with gypsum sands heaped into white dunes by the wind. It is dangerous to attempt a penetration of this dazzling desert. In places gypsum beds are found upturned at an angle of 90 degrees. The Trias and Jura beds do not fall short of 1000 feet, or one-half that of the Carboniferous, in thickness.

The system most frequently exposed is the Cretaceous. All the formations from the Dakota to the Laramie are represented. There is much of interest in connection with each, but space in this paper does not allow details of those below the last named. It is the Laramie that is the most interesting, and that has the greatest economic value. Its thickness is one-third that of the entire Cretaceous. It is also widely developed. It seems to be wholly a fresh-water deposit, lacustrine or estuarine, and paludine. Its beds are sandstone, shale or clay, and coal, with later intervening plutonic intrusives. The Laramie period was a long one, and its climate was temperate. The scarcity of limestone precludes deep seas; the absence of gypsum indicates that no wide marine, littoral basins were overflowed by the tides, and their waters left to be evaporated by the sun. But the flora is sufficient evidence of the character of the aqueous depository. Little of sulfur or iron is found, which argues a period of plutonic inactivity and a drainage area devoid of extensive volcanic products. A series of great lakes, probably, extended from Mexico, or perhaps the City of Mexico, to southern Alaska, perhaps the longest chain of lakes in geological history. Their outflow was probably into the Pacific, principally through the Columbia and Colorado rivers. The area of erosion was largely one of granitic and metamorphic rocks, with much quartzite. Under continued deposits, mostly silicious sands and fine clays, the lakes became fens, or their marshy margins were greatly broadened and became the habitat of dense coniferous forests, the origin of the Laramie coal-beds; a vegetation entirely different from that which produced the coal-beds of Kansas. Through progressive elevation, the outlets of the lakes were raised by degrees exceeding the erosive effects of the clear lake water, and the flat forest-covered lands about the lakes became overflowed, and the forests were drowned out. The sand and silt which had heretofore been carried into the lakes through drainage channels now began to be dropped in the overflowed flats; more of them than heretofore were carried through the outlets, scouring these more rapidly.

The sandy flats were once again but moist or swampy grounds. Between raising the surface of the lowlands by sediment, and deepening the lake outlets by increased corrading material, the equilibrium was restored and passed. Perhaps pauses in the elevating forces may also have aided the effects. Resinous, rank conifers once more occupied the drained surfaces and the material for coal-beds accumulated. Alternately the conditions described succeeded each other, until scores of thick or thin coal-beds were laid, with intervening layers of sandstone and shale. As sea saurians and marine mollusks have been found in supposed Laramie, it is probable that at times the outlets may have been so lowered as to admit the influx of tides or currents, producing brackish conditions, but the exclusive fresh-water view is intended to apply only to New Mexico. In the disintegration of granitic rock, the feldspar and mica and other basic constituents yield and are washed away before the quartz is reduced to sand; hence the shale in the Laramie is generally overlaid by sandstone, and the coal-beds have mostly a sandstone roof. This enables them to be operated with greater security and less labor and expense than in many other coal-fields.

The workable coal-seams vary in thickness from three and one-half to forty feet; where the latter extreme is found want of transportation facilities renders the seam unavailable. It lies in the northwest part of the territory, between the western division of the Atchison, Topeka & Santa Fe railroad on the south and the Denver & Rio Grande railroad on the north. The field embraces more than a million acres, and is 125 miles in length. The southern exposure of this coal-field is exploited about Gallup, near Arizona territory. The coal is a lignite, in two series of seams, with 400 feet of rock between them; but it borders on the bituminous, and is sometimes strictly of that grade. In these coals resinous gum is found distributed in small masses about the size of a pea. It crumbles easily and is difficult to collect. It was first discovered in 1873, and was then new to science, and was given the name "wheelerite," in honor of Lieut. George M. Wheeler, engineer in charge of the exploring expedition. From these mines are also obtained sections of trunks or limbs of exogenous trees, with the concentric rings plainly visible. One of these sections is in the rooms of the chamber of commerce at Los Angeles, Cal.

The Coal Measures in the region of Santa Fe are much broken by intrusive dikes and sills of porphyritic lava; so, also, in the northeast and in the southeast parts of the territory. The interesting consequence is the change of whole seams, or only portions, from bituminous to anthracite, or to semi-anthracite; the best anthracite being equal in quality to the Pennsylvania product. In one instance, near Cerrillos, a plutonic sheet, 350 feet deep, lifted the upper end of an inclined coal-bed and its floor of sandstone and floated them over another part of the same, metamorphosing both the transported and the *in situ* portions. Coal is found on the tops of some mountains in small patches, whether of Laramie age is doubtful, but Laramie coal is found in each of the four quarters of the territory, which seem to have been wooded, then as now, with large areas of coniferous trees; but, very differently from the present, they were also spotted with extensive swamps for conserving the dead generations of their arborescent giants, or it may be pigmies.

Eocene deposits are found both east and west of the Sangre de Cristo, and probably exist in other parts of the territory. West and north of the Gallinas mountains is a *mauvais terres*, rivaling in aspect the similar region of Wyoming, Dakota, and Nebraska. Silicified tree trunks, some several feet in diameter, are abundant. Many reptile and some mammal remains have been removed from its marl beds The marl beds are bordered by sandstone of the same age and interstratified with it. This region was the site of a large fresh-water lake in Eocene times, and its sediments aggregate 1000 feet in thickness. The marl when wet becomes very slimy, and the wash from it adds greatly to the turbidity of the Rio Grande waters.

The Middle and Late Tertiary are represented in the Rio Grande valley extensively. It was during this period that it was the bed of a lake, or a series of linear lakes, extending for hundreds of miles, and probably due to lava flows. The Llano Estacado upper strata are considered of this age for 100 feet in depth, perhaps more. The remains of an immense dog, as large as a bear, the three-toed horse, the mastodon, the rhinoceros and the camel have been taken from the marls.

During the Glacial period New Mexico doubtless received cataclysmic rains with great frequency, and her canyons and mountain slopes were deeply eroded by rock fragments, carried with torrential force against granitic and basaltic ramparts, while Pluto and Vulcan joined forces to flood with fiery streams her watercourses and to plaster some of her valleys and park like plateaus with a coat of netherworld cement. It was probably in this age that the Rio Grande freed its channel from the natural bars of the Pliocene eruptions.

In conclusion, it may be said the succession of formations in New Mexico and Kansas are not very different, except as regards the Coal Measures, but the physical features of surface are widely in contrast.

READING BLUE LIMESTONE.

By ALVA J. SMITH, Emporia.

Read before the Academy, at Topeka, December 30, 1904.

THIS name is proposed for a hard blue limestone which extends across Greenwood, Lyon and Osage counties, and probably much further.

The outcropping margin of the stone is broken by the frost into irregular fragments, which weather into more or less rounded forms on the upper surface. A freshly broken surface of the stone is blue, the color gradually changing by the action of the weather to a brown, and finally to a buff.

The results of an analysis are as follows:

Hardness, 4; specific gravity 2.70.

Insoluble portion	9.50	per cent.
Aluminates and ferric carbonate ($FeCO_3$)	10.00	"
Calcium carbonate ($CaCO_3$)	78.50	"
Magnesium carbonate ($MgCO_3$)	2.00	"
Total	100.00	per cent.

Well-water taken from the shale below the blue stone is saline and yields on analysis from 25 to 300 parts per million of chlorine as sodium chloride.

At Humphrey's ford, six miles southeast of Emporia, the following section is found (beginning at the bottom):

	1. Barclay limestone, about	12
Humphrey shales,	2. Yellow and blue shale	9
	3. Limestone	1
	4. Shale	15
	5. Limestone, friable (*Streptorhynchus crenistria*)	6
	6. Blue and yellow shale	13½
	7. Reading blue limestone	3

The following fossils have been taken from the blue stone near Emporia:

Crinoid columns.
Fusulina cylindrica.
Chonetes granulifera.
Productus cora.
Rhomboporia lepidodendroides.
Setopora biserialis.
Enteletes hemiplacata.
Seminula argentea.

DEFINITION AND SYNONYMY.

The first reference made to the Emporia limestone is found in volume 1 of the University Geological Survey of Kansas, page 80, in Kirk's Neosho river section, where it is mentioned as being first seen in Chicago mound, near Wyckoff. This system he says disappears under the Neosho river near the Emporia water-works.

The same author, on page 82, refers to a stone quarried in section 28, township 19, range 11, as the Emporia limestone. Careful observation has proven that the formations at the locations mentioned are three different strata, the first being separated from the later by about sixty feet of shale, and the later from the one found at the water-works by ten feet, making in all, including the limestones, a thickness of eighty-six feet included within the formation he calls the Emporia limestone.

In a paper read before this Academy previously, I suggested the name "Emporia blue limestone" for the lower stone mentioned by Kirk, and that the name "Emporia" be retained for the system of five limestones, sixty feet above. The name "Emporia limestone" would thus include the formation quarried in section 28 and the one found at the Emporia water-works.

It was thought at that time that the word "blue" added to "Emporia" in the former instance would be a sufficient distinction to prevent confusion, but on more careful study the blue stone is found to be the more important of the two, being more persistent stratigraphically and much more valuable commercially. As the blue color of the stone under discussion is a very prominent characteristic, it seems desirable to retain that portion of the name. But to avoid any possibility of confusion in the future, I now propose the name "Reading blue limestone" to be applied to the formation.

As this stone lies within the Olpe shales as defined by George I. Adams on page 52 of the United States Geological Survey Bulletin No. 211, it seems necessary to either supply new names for the shales above and below this stone or restrict the extent of the Olpe shales to one portion or the other. I will therefore propose the name "Humphrey shales" for the beds of shales and limestone forty to forty-five feet in thickness between the Burlingame or Barclay limestone and the Reading blue; and that the name "Olpe shales" be applied to the sixty feet of arenaceous and carbonaceous shale overlying the blue stone and extending up to the Emporia system of five stones.

This leaves the upper limit and the thickness of the Olpe shales the same as originally given by Adams, but the lower limit is changed from the Barclay to the Reading blue stone.

OUTCROP.

The outcrop of the blue limestone, as shown in plate XXIII, enters Lyon county from the south in section 32, township 21, range 11, and extends northwesterly along the sides of the hills and bluffs on the west side of Rock creek about one and one-half miles, to a point where it passes under the stream; thence easterly it skirts the hills and bluffs of Moon creek, Tate's branch and Smith creek and numerous small streams and ravines, creating in most places a well-defined escarpment for a distance of about nine miles. In several places it extends south in the high ridges into Greenwood county.

In sections 25 and 26, in township 21, range 12, near the head waters of Smith and Four Mile creeks, is an outlier a mile or more in length by one-half mile in width.

There is a quarry located near the center of section 33, township 21, range 12, and another in the southeast quarter of section 22, same township and range.

From the last-mentioned quarry the outcrop extends nearly north along the west side of Hoosier creek three miles. It then angles to the northwest, skirting the south branches of Eagle creek, to section 31, township 20, range 12. A good quarry is located near the north-east corner of the southeast quarter of said section, in a bluff about fifty feet above the creek.

The stratum passes under the creek one mile farther up. Thence it trends northeasterly five miles, where it crosses the divide between Eagle creek and the Neosho river, in section 16, township 20, range 12. A good quarry is situated on an outlier, near the southeast corner of section 14, from which stone has been taken for a number of bridge abutments.

Another outlier, one-half mile or more in length, is found in sections 3 and 4, and another smaller one at the summit of Chicago mound, in section 34, township 19, range 12, where a quarry has been extensively worked. This is the exposure that Kirk erroneously called the Emporia limestone.[1]

The stratum referred to on the same page as the Wyckoff limestone is equivalent to the one termed "Burlingame" by Haworth and "Barkley" by Adams.[2]

From the south side of section 10, township 20, range 12, the general trend of the outcrop is west, flanking the ravines that flow into Coal creek from the south six miles to a point four miles north of Olpe, where it passes under the creek. Thence it extends northeast five miles to a bluff on the south bank of the Cottonwood river. Thence west, passing through sections 31, township 19, range 12, and section 36, township 19, range 11, where the most extensive quarries on the outcrop are located. Many thousand cords of dimension stone have been taken from these quarries for use in Emporia and vicinity. The ledge passes under the flood-plain of Coal creek three miles south and one-half mile west of Emporia. The footing of the dam at Soden's mill, on the Cottonwood river, rests on this stone. It is also found in wells at Emporia from twenty to forty feet deep, but

1. Univ. Geol. Surv., vol. 1, p. 83.

2. U. S. Geol. Surv. Bulletin No. 211.

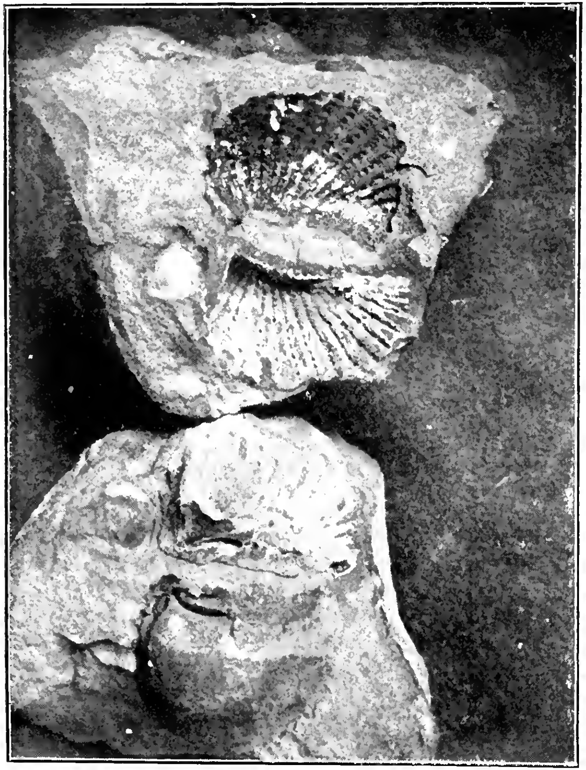

Plate XVI.—Mentor Fossils—*Trigonia emoryi* Conrad.

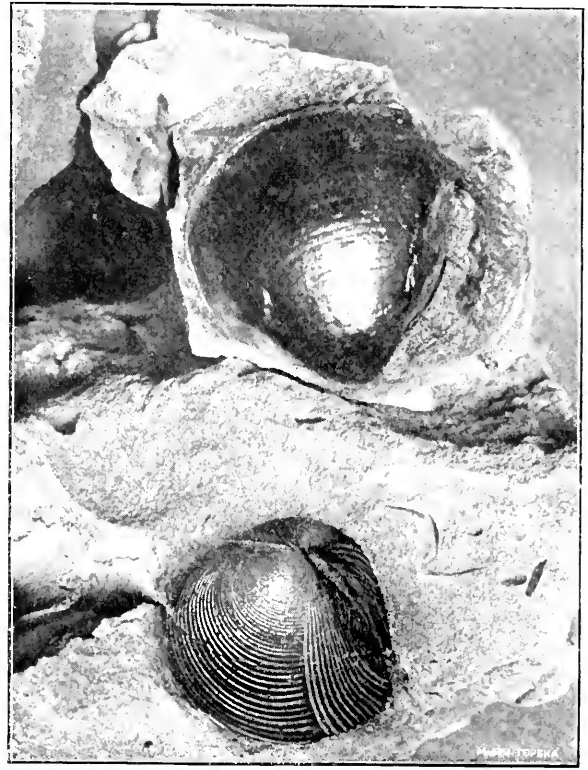

Plate XVII.—Mentor Fossils—*Protocardia salinaensis* Meek.

no exposures occur till a point one mile east and one-fourth mile north is reached, where the closest quarry to Emporia is situated, in the southeast quarter of section 11. This quarry has been in operation three years, and has produced about 1000 cords of stone. At this quarry the cap rock is seven to eight inches thick and is very rough on the lower side. A seam of buff clay separates this from the main stratum, which is twenty-six inches in thickness. Along the margin of the outcrop a bottom layer five inches thick separates readily from the main ledge, but after working the quarry back twenty feet or more they are found to adhere together in a solid stratum. Parallel seams from six to eight feet apart extend through the stone in a general course north fifty-five degrees east, while irregular transverse seams intersect these at approximately right angles, cutting the surface of the stone into rough parallelograms. A heavy bed of gravel overlays the stone in this quarry and adds materially to the cost of stripping.

The blue limestone is next seen in the Neosho river at Rinker's bridge. From there the stone is covered to a point two miles east, where a quarry is located. From this quarry southeast three miles the country is hilly, and the outcrop may be traced readily around the hills four miles. Thence it extends in a general course north fifteen degrees east along the slopes on the west of Badger creek five and one-half miles, to the south line of section 13, township 18, range 12. From this point there is a long extension of the outcrop southward four miles, with an outlier on the top of Wooster mound, one mile beyond.

The formation leaves Lyon county and enters Osage in section 22, township 18, range 13, and reenters near the northeast corner of the same section, and, bearing northwesterly, flanks the hills at the head of Duck creek, and returns to a point one and one-half miles northwest of Reading, where it has been extensively quarried. Other quarries are located on the west lines of sections 21 and 29, township 17, range 13.

The outcrop is very prominent on both sides of Marais des Cygnes river, and may readily be traced along the west side of the valley of Elm creek to Miller station, where it creates a waterfall in that stream at a ford one-fourth mile west of the depot. It leaves the county at points from three to five miles southeast of Miller, and reenters farther north on Salt creek, about twenty feet above the water, and extends up that stream a mile. I have identified this formation as far south as Eureka, in Greenwood county, and north to a point in Osage county two miles east of Harveyville.

The accompanying map, plate XXIII, shows the line of outcrop of the Reading blue limestone, together with other formations in Lyon county.

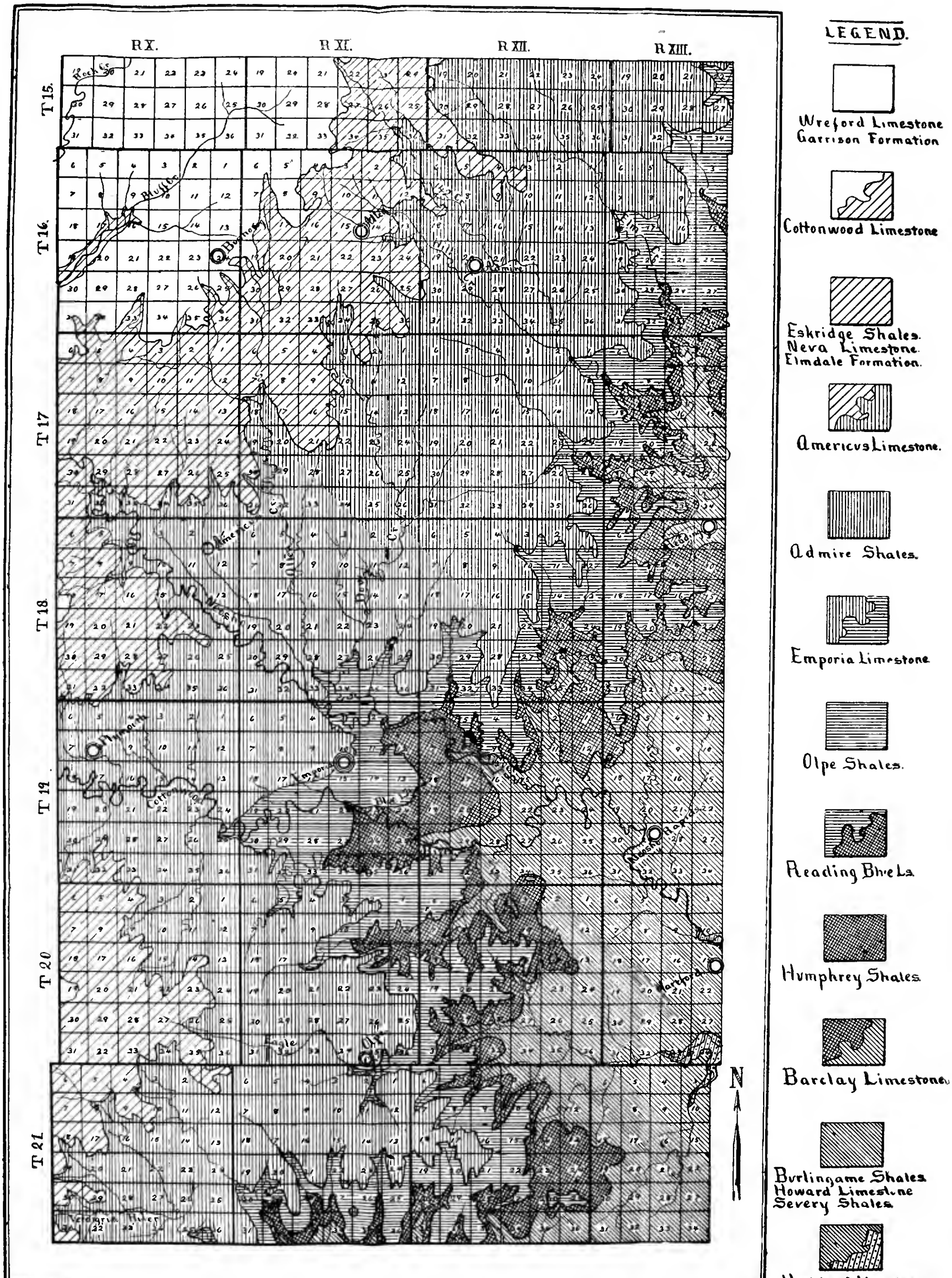

PLATE XXIII.—Map showing Area of Reading Blue Limestone. (One-fourth inch equals one mile.)

IV.

BIOLOGICAL PAPERS.

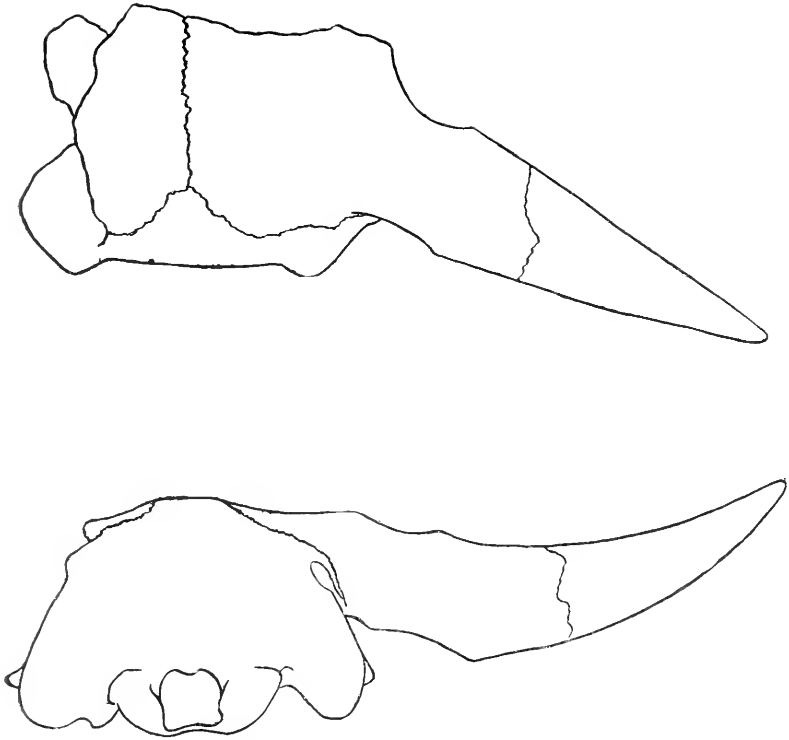

FIG. 10.—Skull of Fossil Bison.

THE FOSSIL BISON OF KANSAS.

By C. E. McClung, University of Kansas, Lawrence.

Read before the Academy, at Topeka, December 30, 1904.

THE heavy floods of the spring of 1903 excavated in the valley of the Kaw river numerous washouts of considerable size and extent. In one of these near North Lawrence several bison crania were exposed. So far as I am aware, these all belong to the common species, *Bison bison*, with the exception of one, which was secured by Mr. C. H. Sternberg, and sold to the University. This specimen differs from the remainder also in being completely fossilized. Unfortunately only a portion of the cranium is preserved, but sufficient remains to indicate the main structural characters, and these are such as to point to the existence of a new species of bison. Since Kansas was the home of the bison in such a large measure, it seems eminently fitting that the name of the two should be associated together, and I have accordingly called the new form *Bison kansensis*.

Bison remains are often found throughout the state, and, in order to make the determination of these possible by those who have not access to the literature, I append a key to the species so far described. It is based upon the work of Allen and of Lucas, and specific characters are given in relation to the horn cores. Doubtless there are valid objections to making one character the basis of specific determinations, but since this portion of the animal is the one with which we have oftenest to deal, necessity and common sense make the classification the most useful and effective. Since there is frequently confusion of the two genera, *Bison* and *Bos*, the generic characters of the former are given:

Genus Bison Smith. Forehead convex, with vertical and lateral diameters in the ratio of 2:3; horns attached some distance in front of occipital angle; outline of occipital region semicircular and forming an obtuse angle with fore head; intermaxillaries short, triangular, acute behind, and not reaching to the nasals; orbital, lachrymal and malar processes forming a projecting cylinder for the eyes; ribs in fourteen pairs. Limbs slenderer than in *Bos*, and dorsal spines much longer; cannon bones longer in the hind limbs than in fore limbs. Body covered with short, crisp, woolly hair, becoming long and bushy upon the head. The fore legs are fringed with long, coarse hair.

The species of bison may be classified according to the following key, in which the characters of the horn cores are used for differentiation, according to Lucas.

(*A*) Horn cores placed at right angles to the longitudinal axis of skull . . . . *antiquus*.

(*B*) Horn cores placed at an acute, posteriorly directed angle, with longitudinal axis of skull.

(*a*) Circumference of horn cores at base as great as, or *greater* than, length along upper curve. Transverse and vertical diameters about the same.

1. Horn cores short, recurved, not anywhere arising much above occipital crest .... *bison.*
2. Horn cores moderate, strongly and regularly curved upward and backward.......................... *occidentalis.*
3. Horn cores moderate, curve regular and moderate, raking strongly backward .... *kansensis.*

(*b*) Circumference of horn cores at base *much less* than length along upper curve. Transverse diameter much exceeding the vertical.

1. Horn cores moderately curved, stout, strongly elliptical in cross section.................................. *crassicornis.*
2. Horn cores strongly curved, elliptical in cross section, moderately stout .... *alleni.*

(*c*) Circumference of horn cores at base *much less* than length upon upper curve. Transverse diameter slightly exceeding the vertical. Curve regular but slight.

1. Size medium, flattened above........................... *ferox.*
2. Size large, subcircular in section..................... *latifrons.*

The measurements include only the portion of the core covered by horn in the living condition. Transverse diameter is measured parallel to the longitudinal axis of skull; vertical diameter at right angles to this.

It must of course be remembered that there is no little individual variation in the form and structure of the horn cores, and also that these organs differ in the two sexes. These facts introduce real faults in the scheme of classification proposed above, but they appear to be unavoidable. It is a fair question whether any one character offers a more reliable diagnostic value. At any rate, we have to make the best use of available data, and it is unnecessary to point out that due caution should be employed in this particular case. In *Bison bison*, the form with which we are most familiar, there are marked sexual differences, the horn cores of the bull being much heavier and, as a rule, less curved than in the cow. Probably similar conditions prevail among the other species in some measure. It would appear that the specimens upon which species have been founded are generally males, and this fact must be borne in mind.

The above key contains all the known species of bison found in North America. Of these, there have been found in Kansas the following: *B. bison*, *B. occidentalis*, *B. alleni*, *B. latifrons*, *B. kansensis.* The type specimen of *B. alleni* was obtained at the Blue river, of this state, and probably the best specimen of *B. occidentalis* so far secured was obtained from Gove county, and is now in the museum of the University of Kansas. An exceptionally fine pair of horns of *B. latifrons* was unearthed in Sheridan county. This specimen measures some eight feet from tip to tip of the horn cores.

A brief description of the new species will be sufficient. As will be seen from figure 10, the horn core descends rapidly from the level of the forehead and barely attains it again at the upcurved tip. Viewed from above, the core is observed to rake strongly and persistently backward, so that it has passed the level of the occipital region a short distance out from the line indicating the limit of the horn attachment. In section the core is subcircular in outline, and the circumference at the base exceeds the estimated length along the upper curve. The specimen thus falls within the group containing *B. bison* and *B. occidentalis.* It may be distinguished from *B. bison* by the greater size of the horns and by their rapid backward extension beyond the line of the occipital crest. It is separated from *B. occidentalis* by the strong downward sweep of the horns. A comparison of the measurements of the horn cores from specimens of the three species of this group is shown in the following table:

	B. bison. mm.	B. occident. mm.	B. kansensis. mm.
Vertical diameter	76	108	90
Transverse diameter	81	108	97
Circumference at base	253	343	290
Length along upper curve	180	318	250 (est.)
Length along lower curve	235	372	265 (est.)
Distance between tips	650	875	840 (est.)

These measurements are taken from specimens in the museum of the University of Kansas.

THE PUMA OR AMERICAN LION.

(*Felis concolor.* Linnæus.)

By L. L. Dyche, University of Kansas, Lawrence.

Read before the Academy, at Topeka, December 31, 1904.

IT appears that the first mention of the American lion was made by Christopher Columbus. He speaks of *leones* (lions) among other things that he saw on the coast of Honduras and Nicaragua during his fourth voyage, in 1502.[1]

The first mention I have been able to find of the animal being in Kansas is in Zebulon Pike's notes on his journey from St. Louis through the interior of Louisiana[2] and the northwest provinces of Spain.

I find the following in Pike's journal for Friday, September 12, 1806: "Commenced our march at seven o'clock, and passed some very rough flint hills; my feet blistered, and were very sore. Standing on a hill, I beheld in one view below me buffaloes, elk, deer, cabrie (antelope), and panthers."

When this was written Lieutenant Pike was camped, as near as it is possible for me to make it out by comparison of maps, on the head waters of the Walnut river, in the northern part of Butler county. He continues to speak of the great quantities of game seen in this locality. The "Indians," he continues, "alleging it was the Kansas hunting-ground, said they would destroy all the game they possibly could."[3]

From this point Lieutenant Pike continued his journey northwest through Marion and Saline counties, passing through or very near the localities where Florence, Marion and Salina are located.

While making this journey, Lieutenant Pike says: "On the march we are continually passing through herds of buffaloes, elks, and cabrie (antelopes). I prevented the men shooting at the game, not merely because of scarcity of ammunition, but, as I conceived, the laws of morality also forbade it."

In volume XVI, page 278, of the reports of this society, Mr. J. R. Mead says: "In the fall of 1859 the writer noticed skeletons of buffalo calves, some recently killed and partly eaten, in the heavily timbered bend of the Solomon river a few miles above its mouth.

1. See True's article on the puma in National Museum Report, 1888-'89, p. 600.

2. Kansas was then a part of the district of Louisiana.

3. These Indians who accompanied Lieutenant Pike were from Missouri

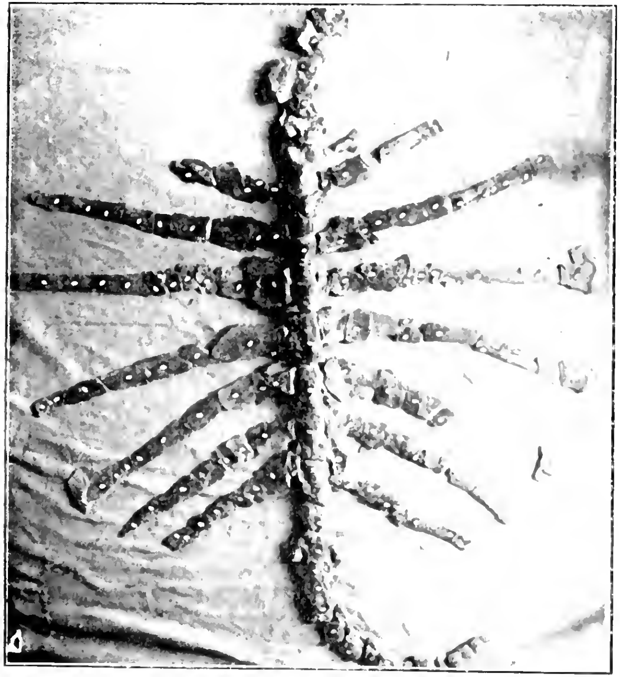

PLATE XVIII.—*Protostega gigas* Cope, showing the Spinal Column and Ribs.

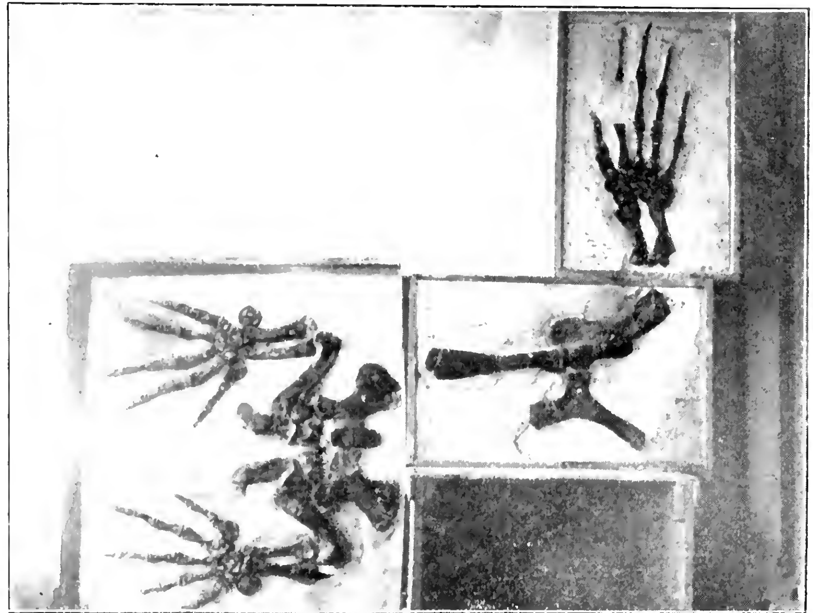

PLATE XIX.—*Protostega gigas* Cope, showing the Arches and Limbs.

Later the Sac and Fox Indians on their annual fall hunt camped in that bend, and with the aid of their dogs killed an immense panther."

A little farther on, Mr. Mead says: "In 1865 I saw one on the White Water, in Butler county, close to the Means ranch, where Towanda now stands." This is only a few miles, apparently not more than fifteen or twenty, from the place where Lieutenant Pike saw a panther some sixty years before.

In volume IV of the Transactions of this society, bearing the date of a meeting held October 12 to 13., Prof. M. V. B. Knox, of Baker University, reported a "specimen taken about nine years ago at Valley Falls,[4] by Mr. Whitman, and identified by him."

In the Bulletin of the Washburn College Laboratory of Natural History, volume I, No. 2, page 42, Professor Cragin, in his notes on some Kansas mammals, says: "Seven specimens (referring to American lions) are known to the writer to have been observed (three of them killed and the fourth, a cub, captured alive) in Harper, Barber and Comanche counties during the prolonged cold of December[5] and three of these have come under his personal observation." No definite date or locality is given for any of these specimens.

In volume VI, page 56, of the proceedings of this Academy, Mr. A. B. Baker, of Wa Keeney, Kan., published a list of the mammals of western Kansas, but does not mention the American lion.

On Monday afternoon, August 15, 1904, Mr. William Applebaugh and Mr. J. H. Spratt, of Hays City, Ellis county, Kansas, killed an American lion while out hunting near that city. This lucky find was made in a ravine about one-half mile east of John Roth's place and just north of Catherine.

This latter-named place is a small town located on Victoria creek, and about seven miles northeast of Hays City. The animal, when first discovered by Mr. Applebaugh and his bird-dog in a thicket of bushes and vines, was thought to be a coyote. However, the mistake was soon discovered when a real American lion emerged from the underbrush. Mr. Applebaugh and Mr. Spratt succeeded in killing the animal at a few yards distance, by shooting it in the side with No. 8 bird-shot.

Twenty years have passed since Professor Cragin reported the animals from the southern counties of the state. I know of no record of an animal being killed during this intervening period.

The question naturally suggests itself, Where did it come from? The animal was not seen or heard of in the neighborhood of Hays City until it was found and killed. Though a young animal, only

4. In Jefferson county, Kansas.

5. This would be December, 1884, as the report was submitted to the printer in January, 1885.

about half-grown, it can scarcely be considered as a native-born Kansan; it must rather be looked upon as a mere straggler. It may have come from the south. Ellis county is over a hundred miles directly north of Comanche county, where animals were reported twenty years ago. It may have come from the west—even as far west as the Rocky Mountains. In either case, it would find an abundance of food on the plains, as jack-rabbits and prairie-dogs could be found in plenty almost anywhere. The animal was fat and had its stomach well filled with jack-rabbit meat.

The lion was sent to the writer in the flesh. This made it possible for me to make a careful study, not only of its general contour, but its anatomy as well.

It weighed, soon after being killed, eighty-eight pounds, and eighty-six a day later, when received at Lawrence by express. It was a young male, apparently not much over a year old.

I submit the following, which will not only show the measurements taken of this lion, but will show how any large animal is measured when it is desired to preserve a record of its size. Such a record is not only of value to general natural history, but it is of especial value to the person who expects to have an animal mounted, or to the person who expects to mount it for museum purposes. Measurements taken before the animal is skinned.

LENGTHS.

1. Total length, 78.50 inches. Measured from end of nose to end of tail bone in a straight line, when animal is stretched straight at full length.

2. Length of tail, 28.50 inches. Which means the length of the tail bone and does not include length of hair on the tail. To take this measurement, bend the tail up towards the back and hold it straight, at right angles to the body, and measure from point where tail and body meet to end of tail bone.

3. Length of body, 50 inches. This is the distance in a straight line from the end of the nose to the root of the tail.

4. Standing height, 22.50 inches. This measurement is taken by placing the fore leg of the animal in natural position at right angles to the body, and in this particular case with elbow two inches above the bottom of the body or binket. Place the animal's foot at right angles to its legs, and measure from the bottom of the foot in a straight line with a straight stick or rule to a point on the top of the back between the shoulder-blades. This is not an easy measurement to make; it should be taken with great care. The object of the measurement is to get what would be the standing height of the animal when alive, as nearly as it can possibly be determined from the dead body.

5. Head of femur to head of humerus, —— inches. This is the distance from the head of the femur (upper end of upper long bone of the hind leg) to the head of the humerus (upper end of upper long bone of the arm). It is frequently necessary to press the muscles of the animal with the fingers in order to locate the heads of their bones in the joints. Before this measurement is taken the operator should be sure that the shoulder is in natural position. When an animal is dead and lying upon one side, the upper shoulder naturally slips down

and forward. It should be pushed up and back and put in a natural (standing) position as nearly as possible before the measurement is taken.

6. Length from elbow to end of longest toe, 16 inches. Should be measured in a straight line, when the leg is straight.

WIDTHS AND DIAMETERS.

7. Width of hind quarter, 7.25 inches. This measurement was made from a point two inches above the flank skin straight back to the back part of the hind quarter.

8. Width of hind leg at knee, —— inches. Measured from the front to the back part of the leg at the knee-joint.

9. Width of shoulder, —— inches. Measured from front part to back part of shoulder at a point half-way up from the elbow to the head of the humerus. This measurement can only be taken approximately.

10. Width of neck (transverse diameter), 4.75 inches. This measurement is made at the middle of the neck with calipers.

11. Width (transverse diameter) of the shoulders, 9.50 inches. From head of humerus on right side to head of humerus on left side.

12. Width (transverse diameter) of hind quarters, 9.50 inches. This measurement is taken by placing the calipers so that the points will rest over the heads of the two femur bones.

13. Width (transverse diameter) of abdomen, 6 inches. This measurement was taken while the animal was lying flat on the floor. It might be a little greater in life.

14. Depth of chest, 10.25 inches (the distance from top of back to bottom of chest). This measurement is taken just behind the shoulder-blades. It can be made with a straight stick or rule, but large calipers are better.

15. Depth of body, 11.75 inches. This is the distance from the top of the back to the bottom of the dupert part of the abdomen.

CIRCUMFERENCES.

These measurements are usually made with a good stout cord that does not stretch, or with a stout rope. An ordinary cloth tape is easily spoiled by the blood of the animals measured. Cheap cloth tape lines are usually of very uncertain length. The cord or tape should go straight around the animal, or part to be measured, and should be pulled tight, but not tight enough to make a crease or depression in the flesh of the animal. I usually refer to these measurements, when speaking to my students, as light-line measurements.

16. Circumference of head half-way between ear and eye, 18 inches.
17. Circumference of neck half-way between ear and shoulder, 16 inches.
18. Circumference of body just behind fore leg, 27 inches.
19. Circumference of body around longest part of abdomen, 30 inches.
20. Circumference of hind leg at patella or knee-joint, 13.50 inches.
21. Circumference of tail at base, 7 inches.
22. Circumference of tail taken at middle, 4.50 inches.

SPECIAL MEASUREMENTS.

23. Anterior corner of eye, measured from the bone to end of nose, 3 inches.
24. Anterior corner of eye to the center of hole in ear, 4.50 inches.

In making the above measurements three pairs of calipers, large, small, and those of medium size, were used. No account was taken of the hair in any measurements. The measurements should represent the animal without any hair on it.

THE MOUND-BUILDING PRAIRIE ANT.

(*Pogonomyrmex occidentalis.*)

By GEO. A. DEAN, Kansas Agricultural College, Manhattan.

Read before the Academy, at Manhattan, November 28, 1903.

OF all the insects none are more familiar to us than ants. They are found in all countries; they establish their communities in the immediate vicinity of many dwellings, and some of them even invade the habitations of man. Their intelligence, industry and perseverance have attracted the attention and admiration of the most serious men. Even in remote ages such men as Solomon did not hesitate to state that these little creatures were worthy of imitation. In Proverbs 6: 6–8, we find the following familiar words: "Go to the ant, thou sluggard; consider her ways, and be wise: which having no guide, overseer, or ruler, provideth her meat in the summer, and gathereth her food in the harvest."

Structurally they rank among the highest of the insects. In efficiency they are second to none. They have acquired the art of living together in societies more perfectly than our own species. Their time and labor are devoted to the welfare of the colony, rather than to that of the individual.

Crossing the prairies of central and western Kansas, the traveler's interest and attention are attracted to the gravel-covered cones which skirt the railroad on either side. Located in the center of a circular cleared space, they stand out very prominently to break the monotony of the grass-covered plains. The industry of these little workers has dotted the prairies with their formicaries. Their mounds are conspicuous along the slopes of a ravine. Their domiciles are located in the little nooks and flats between cliffs and ridges and along the streams. The ants are found persistently clinging to their home in the traveled street and along the crowded sidewalk. They assert their presence in the front yard, at the doorstep, and in the trodden path. They adapt themselves to the abnormal environments of a barn-yard. They cling to their nest, and establish their clearing in the wheat- and alfalfa-fields, regardless of the plowing, disking, and cultivation. The farmer hates them; animals avoid their formicaries; birds and fowls do not molest them. On the other hand, the naturalist admires their industry, wonders at their pertinacity, and enjoys studying their habits.

The form of the mound is usually that of an elliptical cone, although several of them are symmetrical. The cones are of various sizes and heights, depending on the age, size and location of the colony. Of those measured in the grass on the prairies, the prevailing height was about nine inches, while those located in an alfalfa-field, in Ellis county, Kansas (see plate XXIV), were about four inches in height. The mound is made very prominent by the cleared space, by which it is surrounded. This clearing is usually circular in form, although it may be somewhat elliptical. The mound is usually located in the center of the clearing, which is always absolutely void of vegetation. The size of this clearing depends on the size of the mound and the nature of the surrounding vegetation. Those found in the buffalo-grass are much smaller than those in a cultivated field. A large nest may be found with a comparatively small clearing; however, this is not common. The clearings surrounding the nests located in the buffalo-grass averaged nine feet; those in the Russian thistles, eleven feet; those in an alfalfa-field, thirteen to fourteen feet. This clearing is usually smooth and level. These ants, like most mound-building specimens of ants, have a dislike to the presence of vegetation in the immediate vicinity of their mound.

EXTERIOR MEASUREMENTS OF NEST, IN INCHES.

umber.	Height........	Long slope	Short slope	Major diameter at base	Minor diameter at base	Diameter of cleared space..	Location of mound in cleared space.
1..................	13	27	24	44	40	126	Center.
2..................	11	24	24	42	36	90	Center.
3..................	12	36	24	66	44	168	Center.
4..................	9	20	20	39	39	132 x 108	West side of clearing.
5..................	8	36	22	66	43	144	West side of clearing.
6..................	10	24	24	48	36	108	Center.
7..................	16	46	34	78	78	144	Center.
8	9	28	16	45	36	120 x 96	Center.
9..................	9	24	24	44	44	180	Center.
10	8	15	15	24	24	132	Center.
11..................	9	23	18	44	36	90	Center.
12..................	9.5	27	27	48	48	132 x 144	Center.
13..................	11	22	22	52	34	132	Center.
14..................	11	30	20	51	40	120	Center.
15	9	29	17	48	36	144 x 84	Center.
16	9	27	17	48	38	120 x 96	One foot from edge of clearing.
17	9	21	21	41	41	114 x 96	West side of clearing.

The clearing away of the vegetation is accomplished by the workers cutting it away with their mandibles, which are well adapted for the purpose of such work. We may assume several reasons why the ants wish to have a cleared space, The plants too near the nest would be a hindrance to their going and coming. They would afford a shelter or hiding-place for any enemy or intruder. Vegetation would endanger the nest by the retention of moisture after a rain. The nest would be seriously damaged by the roots of any plants growing near, as the roots would penetrate the underground galleries and chambers. Water, after a rain, would follow down the roots and destroy the nest.

The mounds are covered with any surrounding available material, such as pebbles, gravel, cinders, and dirt pellets. Along the railroads they are covered with cinders, bits of coal and ballast. Many of the mounds on the town site at Wallace, Kan., as illustrated in plates XXV and XXVII, were covered with bits of glass, mortar, nails, etc., this material being available on account of many of the houses having been torn down. True, some of the covering is brought up from below, as they are excavating for the underground galleries and chambers. However, the most of it is gathered out around the nest, as it is of the nature of the surrounding material. The purpose of this gravelly covering is to protect the mound from the outside elements, such as rain and wind. The slope of the mound is usually as steep as the gravelly covering will permit. This covering is from one-half to one inch thick.

It is surprising with what ease these ants will handle the pebbles, which they seize with their outstretched mandibles, and carry over the rough pebbles, to the very summit of the mound without once stopping to rest. Some of the pebbles are at least eight times the weight of the ant carrying them. Yet, with the head elevated, and holding the pebble well to the front, the little worker carries the burden to the desired place, somewhere on the surface of the mound. They work entirely without the assistance of another. Many times a worker, after working hard and long to carry a pebble, finds, on reaching the mound, that the load is too heavy with which to ascend. While she is working away with the pebble at the base of the mound, other ants pass within touching distance, but never stop to assist, or even to ascertain what the trouble is. And thus the disappointed ant must leave the precious pebble at the base of the mound.

Many of the cones have just the single opening, while others have two and three. One exceptionally large one had as many as eight. The position of the gates is usually about one-third of the distance from the base of the mound to the summit. There is no uniformity in regard to the direction of the gates. However, the tendency seems to be to the east, southeast, and south. These gates, which are funnel-shaped openings through the gravelly covering, extend downward a short distance and communicate with the galleries and chambers found in the interior of the mound, and even several feet beneath the mound. The gates are opened and closed every morning and evening, the time varying with the season of the year. In the summer they are usually opened between eight and nine o'clock. They begin closing them a short time before sunset, usually having them closed before darkness comes on. There seems to be only a small force engaged in this work. The material used for closing is the same as that used for the covering of the mound. So perfectly are they closed that even close observation does not detect the place. The gates are also closed if a storm is threatening, the force at work being larger and more active. Especially is this true if the storm is fast approaching. As soon as the gates are opened the working force is out and soon busily engaged with the work. However, they again return to the formicary for their nooning, not coming out to resume their work until the midday fervor of the sun has passed. If the day is a cool, cloudy one, they do not stop for the noon. It does not follow that the ants are not working because the field-work has ceased at the noon hour. The interior work of the nest certainly requires very much time and labor, and this work is probably in operation during the noon hours, and especially in the morning before the gates are opened.

NUMBER, DIRECTION AND POSITION OF GATES.

Number.	No. of gates.	Direction.	Distance from base, inches.
1	1	S.	12
2	1	E.	11
3	1	E.	8
4	1	NE.	7
5	5	N., E., SE., SW., S.	2, 3, 4, 3, 6
6	3	SW., E., N.	6, 4,
7	8	N., NW., SW., S., S., SE., E., NE.	8, 6, 14, 16, 16, 14, 12, 8
8	3	S., W., SE.	2, 2, 2
9	1	E.	13
10	1	S.	5
11	1	E.	8
12	2	SE., SW.	6, 12
13	2	NE., S.	7, 12
14	2	N., SE.	6, 4
15	1	SE.	8
16	1	E.	9
17	2	N., S.	6, 6

Beneath the gravelly roofing of the mound is the natural soil, of which the remainder of the mound is composed. The most of this has been brought from below, being the soil removed for the underground galleries. This soil is firmly cemented together, forming a hard and almost rain-proof covering. The galleries, into which the gates open, communicate with the galleries, storerooms and living-rooms within the mound and directly beneath the mound. The subterranean galleries and chambers are so numerous in many of the mounds that they are simply honeycombed. This is particularly true in that half of the mound next to the external opening, which is illustrated in plates XXVI and XXVIII. The chambers, with their low, arched ceilings and level floors, are of various sizes, being from one to three inches long, and from one-half to one inch high. The chambers are connected by galleries of various lengths, about three-eighths of an inch in diameter, and, beyond the first three or four inches below the base of the mound, they are not so numerous or close together, many of them here being six inches or more apart. I found these galleries and chambers penetrating the earth to the distance of nine feet. Throughout the entire nest are granaries stored with seeds, many of these storerooms being sealed. Many of the other chambers are nurseries, in which are found the larvæ, pupæ, and young ants. These are probably shifted from one room to another as the surrounding conditions require. The other chambers seem to be merely working-rooms and living-rooms.

Seed of various kinds are gathered upon the field and carried within the nest. The husks or hulls are torn off and carried out, to be deposited to one side of the clearing, while the plump, sound seeds are stored away in the storerooms or granaries. The seeds found in the chambers are those of the surrounding vegetation, excepting, of course, those that are too large for them to handle. The seeds of the common pigweed (*Amaranthus albus*) were found in abundance in nearly all the nests examined. Seeds of the genus *Helianthus* were common in several of the nests. In a millet-field, the ants were busily engaged harvesting the seeds of the millet which surrounded their nest.

Three classes of ants are found within the formicary—the queens, the males, and the working caste (Fig. 11). The queens and males are winged and much larger than the workers. In the nests examined there seemed to be about an equal number of the queens and males. The females are about seven-sixteenths of an inch in length. The color throughout is a yellow brown. They have one pair of small compound eyes and three very small ocelli. The large, black mandibles are armed with seven teeth. All females are provided with a sting.

The males are about three-eighths of an inch in length, being somewhat smaller than the females. The head and thorax are nearly black. The abdomen is brown and more pointed than that of the females. The head, which is small, bears two large compound eyes and three small ocelli, the middle one being much larger than the other two. As with all hymenopterous stinging insects, the males have no sting.

The workers vary from three-sixteenths to five-sixteenths of an inch in length. Their color is a rich chestnut brown throughout. The head is very large, being from two to three times the width of the prothorax. The large, curved mandibles, armed with seven teeth, are well fitted for the purpose of general work, such as seizing, cutting, crushing, and sawing. The head bears no ocelli. The compound

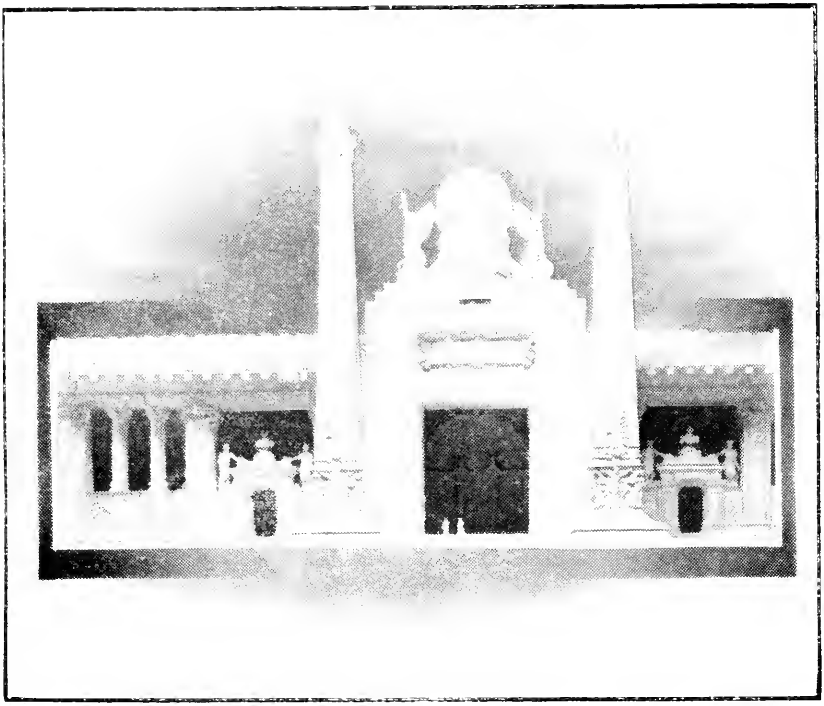

PLATE XX.—Entrance to Mines and Metallurgy Palace, Louisiana Purchase Exposition, St. Louis.

(The Kansas mineral exhibit was installed in this building.)

eyes are small, or about the size of those of the females. The workers are armed with a sting. The workers are very numerous, there being in some of the large nests at least 10,000.

As with other ants, the workers vary in size, and are termed by many writers as the large-headed and the small-headed individuals, the former being called the worker major and the later the worker minor. However, with the *Pogonomyrmex occidentalis* it should be distinctly understood that there is no definite distinction between these. One may select eight or ten of the ants and so place them as to have a gradation from the smaller or worker minor to the larger or worker major. But it certainly is not right to select the two extremes and give them an individual name, when the other eight, coming in between, deserve an equal distinction. There are no characters or division of labor to justify such a distinction.

Although this ant has been endowed by nature with two of the most formidable offensive and defensive weapons known in the insect world—large pointed mandibles for seizing, tearing, and crushing, and a sting that is most painful—and although she is larger than most specimens of ants, yet she is not quarrelsome nor warlike, but on the other hand she is a peaceful and good-natured insect in many respects. This ant permits other species of ants to come on the

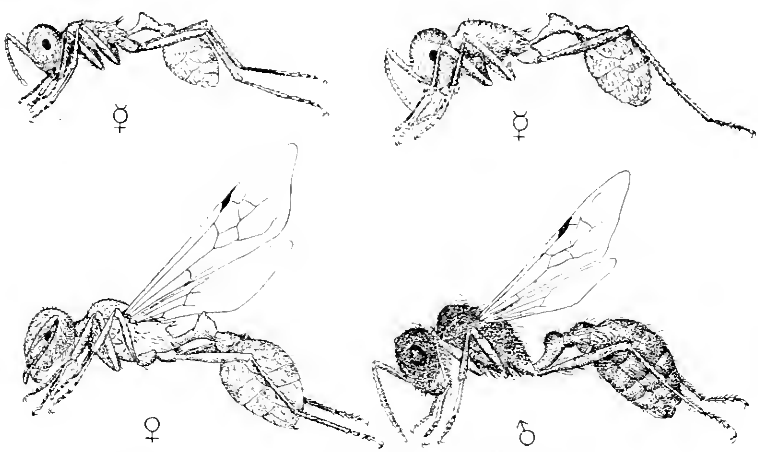

Fig. 11. *Pogonomyrmex occidentalis.* Upper two, workers, minor and major; lower two, female and male. (*Drawn by Ella Weeks.*)

clearing and establish their nests or erect their little crescent-shaped piles of loose dirt within a few inches of the base of the mound. I have observed as many as ten of these little nests on one clearing. Neither the nests nor the little ants are molested by the occident ant. But, on the other hand, the Occident ant is chased and attacked by these intruders, if she should happen to pass too near the little one or her nest. Again, I have found our common termites and a species of another ant living within the chambers of the occupied nest. These intruders or parasites were not disturbed or molested by the rightful occupants of the nest. However, when their formicary is molested or seriously endangered by an enemy, they skilfully put to use the warlike weapons with which they are armed, and, if they are fortunate enough to make a landing on a person, and they usually are if you are disturbing them, they bow the head, seize the skin with the mandibles, bow the back, curve the abdomen, and thrust the sting into the tissue.

A LIST OF KANSAS MAMMALS.

By D. E. LANTZ, U. S. Department of Agriculture, Washington, D. C.

Read (by title) before the Academy, at Topeka, December 31, 1904.

THE following list of Kansas mammals is the result of several efforts on my part to bring the subject of mammalian fauna up to date. Several years ago I announced a historical list of our mammals on one of the programs of the Kansas Academy of Science. When the Academy met the article was incomplete, and was accordingly read by title. I now confess that in preparing it I met with difficulties which I then believed to be insuperable, and abandoned the task. Twice afterward I took up the bibliographic notes I had collected and tried to bring order out of their chaotic condition without accomplishing anything of a satisfactory nature.

My difficulties were of a complex kind. My opportunities for collecting materials were confined to a limited part of the state. The materials to which I had access were poorly labeled, often with doubtful localities. There was especial liability to error in listing forms that are either rare or recently extinct when proper authenticated specimens are entirely lacking to confirm the records. The records themselves are meager in quantity, and are much confused by constant changes in nomenclature, and by the creation of subspecies whose range has not yet been determined.

These difficulties have not disappeared and the last one named has become more formidable in recent years. I believe, however, that the list of wild mammals found in Kansas within recent times, now presented, is as nearly correct as the present state of investigation of the subject will permit. I present it as a tentative list, subject to correction. No doubt further exploration, especially along the southern counties of the state, will result in a number of additions to the list. The scattered areas of sand-hills all over the western half of Kansas also present unusual faunal possibilities, because but little has been done in their exploration.

Very little of a systematic nature concerning Kansas mammals has been published. Prof. M. V. B. Knox, formerly connected with Baker University, Baldwin, Kan., published a list of Kansas mammals in the Transactions of the Kansas Academy of Science, volume IV. A few additions to this list, based on Coues's and Allen's monograph of the North American *Rodentia*, appeared in volume V of the Transactions.

Professor Knox's list was only partially based on personal captures, and it undoubtedly contains a few untenable records and some names which have been changed by the discovery of earlier synonyms and of varietal forms. But on the whole it was a work of honest effort and real merit.

Another worker, Mr. A. B. Baker, now of the National Zoological Park, Washington, D. C., but formerly of Trego county, presented before the Academy a list of mammals taken or observed by him in the vicinity of Wa Keeney, Kan. This was published in volume II of the Transactions of the Academy, and is of much value as a local list. Some changes in nomenclature have been made since its publication.

Professor Cragin, formerly of Washburn College, in the natural-history bulletins of that institution, presented a few scattered notes on the mammals of the state. Mr. J. R. Mead, of Wichita, has given us some interesting notes of his recollections of our larger mammals, as he found them in hunting and trapping expeditions to the plains in the fifties.

Professor Dyche, of our University, has been too busy as a worker to do much writing, but has given us some valuable notes on the food of some of our animals. I learn that he is preparing a list of our mammals, intending to publish it as soon as some problems of distribution shall be settled. When it is ready, it will undoubtedly be a notable contribution to our knowledge of the Kansas mammalia.

The present list embraces representatives of twenty families and forty-eight genera of mammals, and includes eighty-one species and subspecies.

ORDER I.—*MARSUPIALIA*. Marsupials.

Family DIDELPHYIDÆ. Opossums.

1. Didelphis virginiana Kerr. Virginia Opossum.
   Common in the wooded parts of the state and along the streams westward. It is possible that the dark form, Didelphis californicus, may occur in the southern part of the state.

ORDER II.—*UNGULATA*. Hoofed mammals.

Family CERVIDÆ. Deer.

2. Cervus canadensis Erxl. American Elk.
   Formerly common throughout the state. Now extinct.

3. Odocoileus americanus macrourus Rafin. Long-tailed deer.
   Rafinesque's type of this animal was from the plains of the Kansas river. It is uncertain whether the animal really differs from the Eastern White-tailed deer. It is now probably extinct in the state.

4. Odocoileus hemionus Rafin. Black-tailed Deer, Mule Deer.
   This deer was still found in western Kansas in 1884, but has now probably entirely disappeared.

Family ARTILOCAPRIDÆ. Prong-horned Antelopes.

5. Antilocapra americana Ord. Antelope.
Fast disappearing. A recent law protects these animals, but the law is ignored by many of the settlers in western Kansas. A few small herds have been reported to me within the last year as occurring in the extreme western counties of the state.

Family BOVIDÆ. Cattle, Sheep, etc.

6. Bison bison Linn.
Extinct, except in private preserves.

ORDER III.—*RODENTIA*. Rodents.

Family SCIURIDÆ. Squirrels, Marmots, etc.

7. Sciurus rufiventer E. Geoffroy. Western Fox-squirrel.
Common in the wooded parts of the state. While not protected by law, it does not seem to be decreasing greatly in numbers. Melanistic forms are common.

8. Sciurus carolinensis Gmel. Gray Squirrel.
Found in eastern and southeastern Kansas.

9. Tamias striatus Linn. Chipmunk.
The chipmunk was reported by Professor Knox, and undoubtedly is rarely found in eastern Kansas. The form may be one of the subspecies recently described, probably T. S. griseus Mearns, but until specimens from the state can be obtained for examination the matter will be in doubt.

10. Citellus spilosoma major Merr.
Taken by me at Kinsley, in October, 1904. Probably common in the sandhills of the Arkansas valley.

11. Citellus tridecemlineatus Mitch. Striped Spermophile.
Common in the eastern half of the state.

12. Citellus tridecemlineatus pallidus Allen. Pale Striped Spermophile.
Replaces the last in west Kansas; abundant.

13. Citellus franklini Sabine. Franklin's Spermophile.
Found in most parts of the state ; not common.

14. Cynomys ludovicianus Ord. Prairie-dog.
Fast disappearing in some sections of western Kansas, but still sufficiently numerous in others.

15. Marmotta monax Linn. Woodchuck, Groundhog.
Found in northeastern Kansas; not very common.

16. Sciuropterus volans Linn. Southern Flying Squirrel.
Found only in wooded parts of eastern Kansas. Rarely seen because of its nocturnal habits.

Family CASTORIDÆ. Beavers.

17. Castor canadensis Kuhl. American Beaver.
Once abundant on our streams; now rare.

Family Muridæ. Rats, Mice, Voles.

18. Mus norvegicus Erxleben. Brown Rat.
Common everywhere in the state, and a great pest.

19. Mus musculus Linn. House Mouse.
Common throughout the state.

20. Onychomys leucogaster Weid. Missouri Grasshopper Mouse.
Found in many parts of the state, but not common. I captured a specimen at Kinsley in November, 1904.

21. Onychomys torridus Coues. Arizona Scorpion Mouse.
Probably rare in the state. It is included here on the authority of Doctor Coues, in "Rodentia of North America."

22. Peromyscus taxanus Woodh. Texas White-footed Mouse.
Included on the authority of specimens taken at Pendennis and Long Island by Mr. Granger. They may be the same as the next—the Fulvous White-footed Mouse.

23. Peromyscus texanus nebrascensis Mearns. Fulvous White-footed Mouse.
Rather common in western Kansas.

24. Peromyscus michiganensis Aud. and Bach. Michigan White-footed Mouse.
Abundant in eastern Kansas. The genus Peromyscus is in great confufusion. While it is probable that a revision of it will greatly reduce the number of forms now recognized, it is probable that explorations in Kansas will add from one to five varieties to our present known list.

25. Sigmodon hispidus texianus Aud. and Bach. Cotton Rat.
Taken at Cairo, Kan., by the United States Biological Survey.

26. Oryzomys palustris Harlan. Rice-field Mouse.
Taken at Neosho Falls by Captain Goss.

27. Reithrodontomys dychei Allen. Dyche Harvest Mouse.
Type from Lawrence, Kan. Rather common in the eastern half of the state and probably farther west.

28. Reithrodontomys dychei nebrascensis Allen. Nebraska Harvest Mouse.
Reported from Pendennis, Lane county. Taken by Mr. Granger. Regarding the Lane county specimens, I may say that good authorities insist that they are identical with R. dychei. However, specimens from Onaga in the collections of the Biological Survey, prove to be specifically distinct from R. dychei. Whether they will be described as a new species or referred to any other form now recognized I am not now able to say. It is very desirable that series of specimens of this genus from many parts of Kansas shall be collected.

29. Neotoma campestris Allen. Prairie Wood Rat.
Type from Pendennis, Kan.

30. Neotoma baileyi Merr. Bailey's Wood Rat.
Common in eastern Kansas. It is now supposed that the above two forms are identical. Should this prove correct the latter would have priority. It is probable that Neotoma micropus surberi Elliot may occur in southwestern Kansas.

31. Microtus pennsylvanicus Ord. Meadow Vole.
Found in marshy lands in eastern Kansas.

32. Microtus austerus Le Conte. Prairie Vole.
Abundant in eastern and central Kansas. Does much damage to fruit-trees.

33. Microtus nemoralis Bailey. Woodland Vole.
Common in suitable localities in eastern Kansas. One taken by me at Manhattan November 19, 1904.

34. Microtus haydenii Baird. Hayden Vole.
Common in western and northwestern Kansas.

35. Synaptomys helaletes gossii Merr. Goss's False Lemming.
Taken at Neosho Falls by Capt. B. F. Goss. Has been found at Topeka by Charles Popenoe.

36. Fiber zibethicus Linn. Musk Rat.
Common along streams over the whole state, unless the streams are shallow.

Family GEOMYIDÆ. Pocket-gophers.

37. Geomys bursarius Shaw. Prairie Pocket-gopher.
Abundant over the eastern half of the state, except in the southern counties outside the Arkansas valley. The most formidable rodent pest in the state.

38. Geomys lutescens Merr. Plains Pocket Gopher.
Abundant in sandy parts of western Kansas.

39. Geomys breviceps Baird.
While it is possible that the specimens referred to this species by Professor Baird and taken at Fort Riley by Dr. A. W. Hammond were of the preceding form, there are other specimens extant taken in southern Kansas which, while not typical breviceps, may be referred to this species. Further investigation will no doubt result in the finding of typical specimens within the state.
Cratogeomys castanops Baird will probably be found in the southwestern corner of the state, as the type came from Las Animas, Colo.

Family HETEROMYIDÆ. Kangaroo Rats, Pocket Mice.

40. Perodipus richardsoni Allen. Richardson's Kangaroo Rat.
Well distributed in the state, especially in the western part, but most abundant in the sand-hills of the southwest. Perodipus ordii Woodh., on Baker's and Knox's lists, probably does not occur in the state.

41. Perognathus flavescens Merr. Plains Pocket Mouse.
Found in north-central part of the state.

42. Perognathus hispidus paradoxus Merr. Kansas Pocket Mouse.
Abundant. Type from Trego county. Specimens from the extreme southern part of the state are brighter in color and smaller than those from farther north, and may approach typical hispidus.
Perognathus flavus Baird may occur in northwestern Kansas, but no specimens are known to me. On Knox's list.

Family ZAPODIDÆ. Jumping Mice.

43. Zapus hudsonius campestris Preble. Prairie Jumping Mouse.
Not common. I have seen a few specimens in the state.

Family ERETHIZONTIDÆ. Porcupines.

44. Erethizon epixanthum Brandt. Yellow-haired Porcupine.
Found in rough canyons of western Kansas; not common.

Family LEPORIDÆ. Hares.

45. Lepus campestris Bach. White-tailed Jack-rabbit.
Found over the northern half of the state, but is not abundant.

46. Lepus floridanus mearnsi Allen. Mearns's Hare.
Abundant in northeastern Kansas. Its range southward not fully known.

47. Lepus floridanus alacer Bangs.
Abundant in southeastern Kansas. The question as to whether this form is distinct from the eastern cottontail, Lepus floridanus mallurus Thomas is not fully determined.

48. Lepus arizonæ minor Mearns. Prairie-dog Hare.
This pale form of the cottontail is common in the western part of the state.

49. Lepus melanotis Mearns. Black-eared Jack-rabbit.
Abundant in the state. Type from Indpendence, Kan.

50. Lepus texianus Waterh. Texas Jack-rabbit.
This form, if distinct from the last named, is found in southwestern Kansas.

ORDER IV.—*CARNIVORA*. Flesh-eaters.

Family FELIDÆ. Cats.

51. Felis oregonensis hippolestes Merr.
At one time not uncommon in the territory now covered by Kansas. Records at Valley Falls, in Comanche county, in Trego county, have been made within the last thirty years. The most recent record is the killing of a specimen nine miles north of Hays City on August 15, 1904, by Messrs. Applebaugh and Spratt, who were hunting prairie-chickens at the time, and were armed only with No. 8 chilled shot.

52. Lynx rufus Guld. Bay Lynx, Wild Cat.
Found well distributed in the state, but not common anywhere at the present time.

Family CANIDÆ. Wolves.

53. Canis ater Richardson, Gray Wolf.
Once abundant. Still found in a few scattered sections of the state. There is a bounty of five dollars on the large wolves in most of the counties. Last year only three counties were called upon to pay such bounties—Chautauqua, Republic, and Sherman.

54. Canis griseus Sabine. Dusky Wolf. Lobo Wolf.
This animal, still found in western Kansas in small numbers, may be Canis nubilus of Say, now called Canis mexicanus nubilus. I find that there is great confusion on the identity of the lobo wolf, and that specimens are lacking to decide the matter.

55. Canis latrans Say. Coyote.
Probably rare in the northeastern part of the state.

PLATE XXI.—Kansas Mineral Exhibit at Louisiana Purchase Exposition, St. Louis (looking east).

56. Canis nebrascensis Merr. Prairie Coyote.
This seems to be the form commonly found in Kansas. During the year ending June 30, 1904, 18,425 were killed in the state, and six counties are missing from the total.

57. Vulpes fulvus Desmarest. Red Fox.
Found in the eastern counties of the state. Probably descendants of both indigenous and introduced parents.

58. Vulpes velox Say. Swift Fox.
Formerly common in western Kansas; now rare.

59. Urocyon cinereoargenteus Schreber. Gray Fox.
Found in the eastern part of the state; rare.

Family URSIDÆ. Bears.

60 Ursus americanus Pallas. Black Bear.
Reported by all the early explorers. Now extinct in the state.

Family PROCYONIDÆ. Raccoons.

61. Procyon lotor Linn.
Common in the wooded parts of the state and westward along streams where there is scattered timber.
Bassariscus astutus Licht., the Northern Civet Cat, is found on Professor Knox's list of Kansas mammals, but I am unable to verify his statement that it occurs in the state.

Family MUSTELIDÆ. Weasels, Otters, etc.

62. Taxidea taxus Schreber. American Badger.
Found throughout the state, but rarely in the eastern part. Abundant on the plains.

63. Taxidea taxus berlandieri Baird. Berlandier's Badger.
A specimen in confinement at Kinsley has all or nearly all the external characters of this southwestern form. The specimen is a young animal of the year and may change in color as it becomes more mature.

64. Mephitis mesomelas varians Gray. Texas Skunk.
Abundant throughout the state, though the northern Plains skunk, Mephitis hudsonica, may partly replace it in the extreme northeastern counties.

65. Spilogale interrupta Rafin. Little Striped Skunk.
Abundant in eastern Kansas.

66. Putorius vison lutreocephalus Harlan. Southern Mink.
Rather common in eastern Kansas and along streams westward.

67. Putorius nigripes Aud. and Bach. Black-footed Ferret.
Found on the plains in western Kansas. Lives in prairie-dog burrows, feeding almost entirely upon that pest. Not common and decreasing in numbers.

68. Putorius longicauda Bonaparte. Long-tailed Weasel.
In eastern Kansas; not very common.

69. Putorius frenatus neomexicanus Bart. and Cockerell. New Mexican Bridled Weasel.
   Included because of a specimen in the collection of the State University—apparently from Liberal, Kan. The color and locality both indicate this northern form, and the only reason for hesitation about including it as a Kansas record is that it may have been taken south of the Kansas line.

70. Lutra canadensis sonora Rhoads. Otter.
   Formerly common, but now rare. One was captured near Manhattan in September, 1904.

Order V.—*INSECTIVORA*. Insectivores.

Family Soricidæ. Shrews.

71. Blarina brevicauda Say. Large Blarina.
   Rather common in northern Kansas and may occur throughout the state.

72. Blarina parva Say. Small Blarina.
   Found in the eastern part of the state; not rare.

Family Talpidæ. Moles.

73. Scalops aquaticus machrinus Rafin. Garden Mole.
   Common in wooded and cultivated parts of the state.

Order VI.—*CHIROPTERA*. Bats.

Family Vespertilionidæ. Common Bats.

74. Myotis lucifugus Le Conte. Little Brown Bat.
   Found throughout the state.

75. Myotis californicus ciliolabrum Merr. Little Pale Bat.
   Type from Trego county; range not known.

76. Myotis subulatus Say. Say's Bat.
   Occurs in western Kansas; probably rare.

77. Lasionycteris noctivagans Le Conte. Silver-haired Bat.
   Rather common over eastern Kansas.

78. Pipistrellus subflavus F. Cuvier. Georgian Bat.
   Undoubtedly occurs, but no specimens have been seen by me. Southern Kansas.

79. Vespertilio fuscus Beauvois. Brown Bat.
   Common in the eastern half of the state.

80. Lasiurus borealis Müller.
   Southeastern Kansas; not common.

81. Lasiurus cinereus Beauvois. Hoary Bat.
   Eastern Kansas; common.

THE GOLDEN EAGLE.

(*Aquila chrysaetus.*)

By L. L. DYCHE, University of Kansas, Lawrence.

Read before the Academy, at Topeka, December 30, 1904.

THE Golden Eagle is a rare resident of the state of Kansas. A pair of birds were reported to me in 1901 as having reared their young on a high, rocky ledge in Trego county. In fall and winter the birds may be considered as not uncommon. If I should judge from my own experience, during the past fifteen or twenty years, I should say that the birds had increased as winter sojourners rather than decreased. During the fall and winter of 1901 and 1902, not less than twenty-one Golden eagles were reported to me at the University of Kansas as having been killed or trapped in the state of Kansas. Many were undoubtedly taken that I had no knowledge of. However, very few eagles are thrown away without first being offered to a museum or taxidermist.

A dozen were reported last winter, and the record is up to nine specimens already for this winter. It has been possible to see them almost any pleasant day this fall soaring in the neighborhood of Lawrence, especially in the valley of the Wakarusa, a few miles east or west of the city.

The Golden eagle is, by most writers, considered a grander, nobler and more courageous bird than his near cousin, the Bald eagle. One specimen of Golden eagle, a female from western Kansas, received in the laboratory in 1901, had a spread of wings of eighty-seven inches, and the bird weighed twelve pounds and five ounces. However, there was a full pound of jack-rabbit meat in the bird's crop.

The object of this paper, however, is not to give general information about the bird, but to give notes upon its food habits, based upon the examination of specimens that have happened to fall into my hands.

The record of observations extends over a period of twenty-two years, during which time over forty birds were examined. Some specimens had nothing of consequence in their crops, while others had been kept in captivity and fed, rendering them of no value for food-habit observations.

The notes which follow are based upon the examination of thirty stomachs that had more or less food in them.

In order to get a better idea of the field covered, I have prepared a chart. By reference to this chart, the date, locality and nature of food found in each bird's stomach can be ascertained.

Twenty-three of the thirty birds were taken in Kansas. No birds were taken in April, June, July, August, or September, and but one in May.

Eleven of the thirty birds had eaten common Cottontail rabbit.

Seven had eaten jack-rabbit.

Nine had eaten prairie-dogs. Five of these had eaten more or less of two different animals, as was shown by the food mass containing more than two fore or hind feet, two tails, or two pairs of ears.

One which was sent from Riley county in May, 1883, had in its crop a mass of partly digested stuff that contained feet, some bones and hair that seemed to belong to a young coyote wolf.

One taken in October, 1889, in the northern part of the state of Washington, had been feeding upon a woodchuck, presumably *Arctomys pruinosus*, as this species lives in that locality.

One specimen, taken near Lawrence, October 7, 1891, had eaten a Franklin's gopher-squirrel (*Spermophilus franklini*). This specimen also had some hair and bones of a rabbit in its food contents.

One bird, taken March 11, 1894, had the feet, some bones, feathers and meat of a Short-eared owl (*Asio accipitrinus*) in its crop. This bird had also some rabbit bones and hair in its food mass.

A specimen taken in Wabaunsee county, Kansas, November, 1885, had eaten part of an opossum. Another, taken in Franklin county, Kansas, January 25, 1902, had eaten a fox-squirrel.

The last bird studied was taken November 17, 1904. It had parts of a Cottontail rabbit and the foot and leg of a Red-tail hawk in its crop.

As a rule but one kind of food was found in the crop of each bird. When more than one kind was present, it was usually some hard, undigestible material, as ears or feet, which had been left over from a former meal.

Twenty-three of the birds had fed upon rabbits or prairie-dogs, the animals most common in the localities where the birds were taken.

One hawk and one owl constitute the only traces of bird food found in the stomachs of the thirty eagles examined.

However, but one bird was taken during the months of April, May, June, July, August, and September, the season of the year when birds would perhaps be more likely to be taken for food.

NOTES ON THE FOOD HABITS OF THE GOLDEN EAGLE (*Aquila chrysaetus*).

Date.	Locality.	Kinds and per cent. of food found in stomachs.							
		Common rabbit.	Per cent.	Jack-rabbit.	Per cent.	Prairie-dog.	Per cent.	Kinds of food rarely found.	Per cent.
Dec. 29, 1882	West Indian Territory					Whole animal	100		
Mar. —, 1883	Trinidad, Colo.			Parts of	80	Foot and pieces	20		
May —, 1883	Riley Co., Kan.							Two partly digested feet, some bones and mass of hair that seemed to belong to a young coyote wolf [1]	100
Dec. —, 1883	West Indian Territory					Parts of two	100		
Jan. —, 1884	" "					Parts of one	100		
Jan. —, 1884	Harvey Co., Kan.					Parts of two	100		
Jan. 5, 1886	Jefferson Co., Kan.	One animal	100						
Dec. —, 1886	Stevens Co., Kan.					One animal	100		
Feb. 8, 1888	Logan Co., Kan.			Parts of one	100				
Mar. 1, 1889	Neutral Strip, Okla.			" "	100				
Oct. —, 1889	Washington							Parts of woodchuck	100
Oct. 7, 1891	Douglas Co., Kan.	Hair and bones	10					Franklin's gopher-squirrel [2]	90
Dec. 22, 1890	Las Vegas, N. M.			Parts of one	100				
Feb. —, 1891	Leavenworth Co., Kan.	Parts of two	100						
Mar. 11, 1894	Franklin Co., Kan.	Hair and bones	10					Feet, meat, bones, etc., of Short-eared owl	90
Jan. —, 1895	Reno Co., Kan.			Parts of	100				
Nov. —, 1895	Wabaunsee Co., Kan.							Parts of an opossum	100
Mar. —, 1896	Ford Co., Kan.					Parts of two	100		
Feb. —, 1898	Osage Co., Kan.	Gorged with	100						
Oct. 28, 1900	Republic Co., Kan.	Parts of two	100						
Nov. —, 1900	Harper Co., Kan.					Parts of two	100		
Oct. 22, 1901	Elk Co., Kan.	Parts of one	100						
Oct. 28, 1901	Douglas Co., Kan.	" "	100						
Nov. 14, 1901	Republic Co., Kan.			Parts of one	100				
Nov. 19, 1901	Bourbon Co., Kan.	Parts of one	100						
Mar. 27, 1901	Wallace Co., Kan.			Parts of one	100				
Jan. 25, 1902	Franklin Co., Kan.							One fox-squirrel	100
Mar. —, 1902	Trego Co., Kan.					Parts of two	100		
Nov. 17, 1903	Chase Co., Kan.	Parts of one	100						
Nov. 17, 1904	Johnson Co., Kan.	" "	50					Foot and leg of Red-tail hawk [3]	

1. *Arctomys pruinosus.* 2. *Spermophilus franklini.* 3. Foot and leg exhibited to members of society.

Twenty-four of these eagles were females, one was a male, and five had no sex marks recorded.

A PRELIMINARY LIST OF KANSAS SPIDERS.

By THEO. H. SCHEFFER, Kansas State Agricultural College, Manhattan.

Read before the Academy, at Manhattan, November 27, 1903.

THE following list of 100 species represents the results of a season's collecting in the central and western parts of the state. It includes also a half-dozen species taken in the vicinity of Lawrence by the department of entomology of the State University. As the title implies, the list is only preliminary, and the author hopes to double it within the year, if opportunity offers for visiting the southern and eastern parts of the state, and for more extended collecting in the territory already covered.

The spider fauna of the prairies is not as rich in number of species as the well-watered and timbered regions of the East, but individuals are abundant in several of the more prominent families, particularly the Lycosidæ, Salticidæ, and Thomisidæ. In number of individuals, the first-named family undoubtedly leads all the others, the open, grassy plains being especially suited to the habits of these roving ground spiders. Second in point of abundance come either the crab spiders (Thomisidæ), or the jumping spiders (Salticidæ), perhaps the former. The great variety of prairie flowers blooming in early summer and teeming with insect life afford the proper environment for the lurking habits of the one family or the stalking habits of the other. Then, too, the prevalence of these two types, as well as the abundance of the ground spiders, are no doubt directly related to the fact that they do not build webs—frail structures which would not stand long before the wild, free sweep of our prairie winds. Although the orb weavers (Argiopidæ) exceed any one of the three families mentioned in number of species, the individuals are fewer, and mostly confined to sheltered localities, the smaller Tetragnathæ alone braving any sort of situation.

In all, the list of 100 species includes representatives of thirteen families and fifty genera. Twelve families accredited to temperate North America by Simon are not represented, but these families have very scant representation anywhere, and taken together include probably not more than a score or two of species on the continent. Types of the four new species described are in the collection of the Kansas State Agricultural College. Duplicates have been sent to the National Museum, at Washington, section of Arachnida.

Family AVICULARIIDÆ.

Eurypelma hentzi Girard.

Mygale hentzii Girard. Marcy's Expl. Red Riv. of La., 1852, p. 251.

Not uncommon in the southern part of the state. One specimen from Barber county, December 7.

Family DICTYNIDÆ.

Dictyna foliacea Hentz.

Theridion foliaceum Hentz. Jour. Bost. Soc. Nat. Hist., VI, 1850, p. 277.

Several specimens from Wild Cat creek, May 9. Common in the woods during the spring and early summer. Cocoons found in May.

Dictyna volucripes Keyserling.

Dictyna volucripes Keyser. Neu. Spin. aus Am., III, 1881, p. 286.

Specimens from Delphos, June 30; Hays, July 11; Waconda, August 25 Very common on bushes and grass in midsummer.

Amaurobius americanus Emerton.

Titanœca americana Emerton. Trans. Conn. Acad., VII, 1888, p. 453.

One specimen from Manhattan, March 30, and three from Wallace, July 16.

Family THOMISIDÆ.

Misumena aleatoria Hentz.

Thomisus aleatorius Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 441.

A half dozen males and females from Manhattan, August 17. Not so common as M. asperata.

Misumena asperata Hentz.

Thomisus asperatus Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 447.

Taken at Manhattan, Hays, Stockton, and Wallace. Common on flowers everywhere throughout the summer. The color varies with that of the flower, ranging from whitish to red or yellow.

Synæma parvula Hentz.

Thomisus parvulus Hentz. Journ. Bost. Soc. Nat. Hist., V, 1845, p. 447.

This species was taken in considerable number at Manhattan, September 25.

Tibellus oblongus Walck.

Philodromus oblongus Walck. Ins. Apt., I, 1837-'47, p. 558.

Common on grass in late summer. Specimens collected at Manhattan, September 25.

Philodromus vulgaris Hentz.

Thomisus vulgaris Hentz. Journ. Bost. Soc. Nat. Hist., V, 1845, p. 444.

Plentiful under bark in winter. Specimens taken also on August 28 at Stockton and at Manhattan in September.

Tmarus angulatus Walck.

Thomisus angulatus Walck. Ins. Apt., I, 1837-'47, p. 537.

A single immature female from Manhattan, October 3.

Xysticus stomachosus Keyser.

Xysticus stomachosus Keyserling. Die Spin. Am., I, 1880, p. 7.

Two females from Manhattan, April 18.

Xysticus versicolor Keyser.

Coriarachne versicolor Keyser. Die Spin. Am., I, 1880, p. 53.

Two females from Manhattan, May 25.

Xysticus triguttatus Keyser.

Xysticus triguttatus Keyser. Die Spin. Am., I, 1880, p. 12.

Several males collected on Wild Cat creek, June 15.

Xysticus nervosus Banks.

Xysticus nervosus Banks. Proc. Phila. Acad., 1892, p. 55.

A number of specimens taken under dead leaves at Manhattan, April 20. Not uncommon on foliage in autumn and under leaves or trash in winter.

Xysticus gulosus Keyser.

Xysticus gulosus Keyser. Die Spin. Am., I, 1880, p. 43.

One specimen, a male, from St. George, September 20.

Oxyptila modesta, sp. nov. (plate XXIX, fig. 1).

Xysticus modesta Scheffer. *The Industrialist*, vol. 30, No. 24, 1904.

This is a modest little crab spider, smaller than any of the species ordinarily considered as common.

Female.—Length, 4-5 mm.; width of cephalothorox, 2 mm.; width of abdomen, 3 mm. First and second pairs of legs stout, the tibiæ and metatarsi armed with two rows of spines set along the anterior margin. The corresponding joints in the legs of the third and fourth pairs show a few weak spines on the under surface. The middle area of the cephalothorax is yellow, brightest near the base. In the central longitudinal line is a narrowing streak of brown running back from a point between the posterior median eyes. On either side of this streak is a broader stripe of brown, ending, a short distance in front of the posterior margin, in an enlarged portion curved slightly outward. Still farther out, conforming to the outward curve of the cephalothorax, is a broad stripe of brown bordered laterally by a narrow line of yellow. On the extreme lateral margin is a hair-line of brown. The ground color of the abdomen is dark brown. There is a narrow central stripe of dirty yellow and three broad transverse bands of about the same color. The portion of the dorsal region not occupied by these bands is punctate with yellow. The legs are yellowish brown, the former color predominating on the proximal joints, the latter on the tibiæ, metatarsi, and tarsi. The third and fourth pairs of legs are lighter in general than the first and second pairs. Scattered over the abdomen and also on the front of the head and on the pedipalps are numerous stubby hairs, some of them enlarged at the end so as to be almost clavate. This spider is a pronounced type, but not common. Several females were taken under rocks near Manhattan, in June. In this situation they were guarding their egg sacks.

Family Clubionidæ.

Anyphæna rubra Emerton.

Anyphæna rubra Emerton. Trans. Conn. Acad., VIII, 1892, p. 22.

Female from Manhattan, April 20. Immature specimens rather common in early autumn.

Corinna ornata Hentz.

Herpyllus ornatus Hentz. Jour. Bost. Soc. Nat. Hist. V, 1845, p. 456.

A number of specimens taken on limestone hills, near Manhattan, July 4. A species with bright colors.

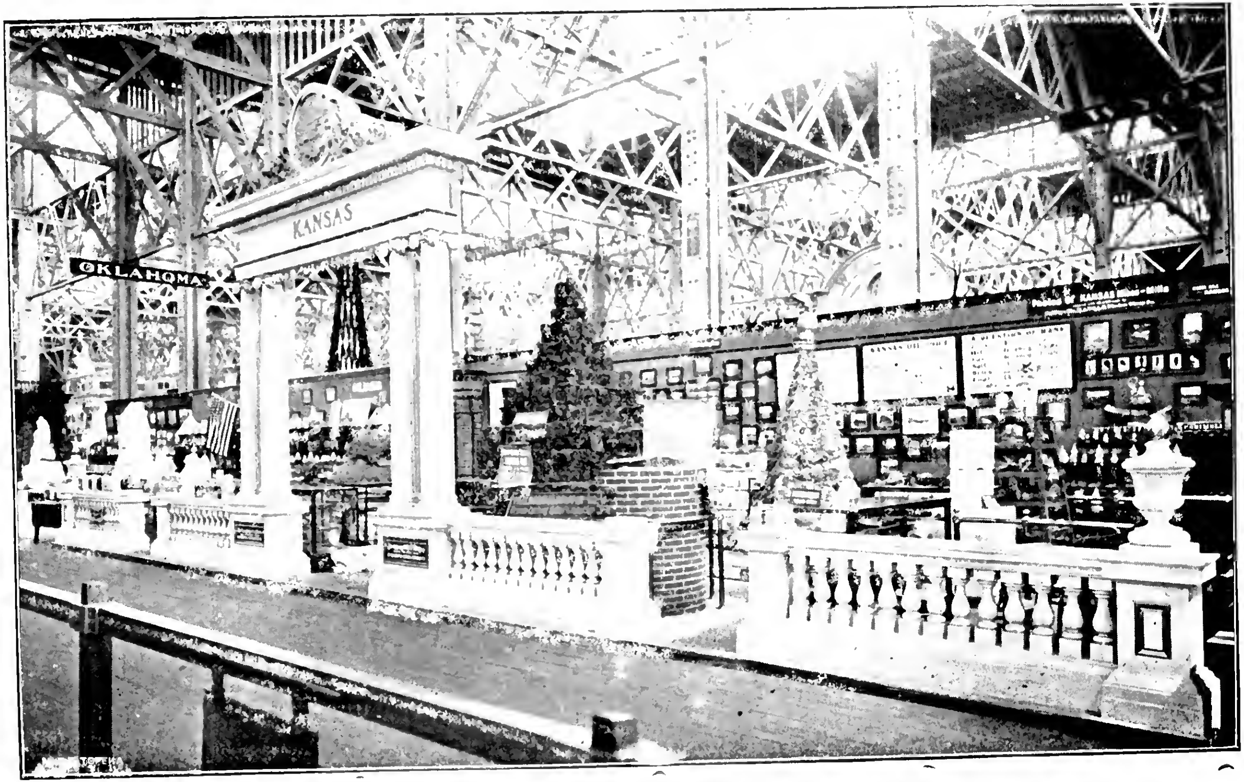

PLATE XXII.—Kansas Mineral Exhibit at Louisiana Purchase Exposition, St. Louis (looking west).

Castaneira bivittata Keyser.

Castaneira bivittata Keyser. Ver. d. bot. zool. Ges. Wien, 1887, p. 442.

One female from Manhattan, July 6.

Castaneira pinnata Emerton.

Geotrecha pinnata Emerton. Trans. Conn. Acad., VIII, 1890, p. 6.

One specimen from Manhattan, September 18.

Micaria aurata Hentz.

Herpyllus auratus Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 459.

A female of this species was collected in Clark county in June.

Family Drassidæ.

Sergiolus variegatus Hentz.

Herpyllus variegatus Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 458.

Two or three females collected under rocks at Manhattan, June 10.

Cesonia bilineata Hentz.

Herpyllus bilineatus Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 456.

A specimen from Delphos, June 30, and a female with cocoon from Manhattan, August 19. Cocoon contained twenty-seven young spiders.

Drassodes neglectus Keyser.

Drassodes neglectus Keyser. Ver. d. bot. zool. Ges. Wien, 1887, p. 434.

Common under rocks in spring, the male and female in mating sacks. Specimens from Manhattan, May 8. Females with cocoons June 16.

Herpyllus vasifer Walck.

Drassus vasifer Welck. Ins. Apt., II, 1837–'47, p. 620.

Immature spiders of this species fairly common under bark in winter. Mature females from Wallace, September 1, and from Manhattan, September 18.

Family Salticidæ.

Marptusa familiaris Hentz.

Attus familiaris Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 354.

Half-grown specimens common under bark in winter. Mature forms taken in May.

Phidippus comatus Peckham.

Phidippus comatus Peckham. Trans. Wis. Acad., XIII, p. 291.

Two males from Wild Cat creek, June 13.

Phidippus cardinalis Hentz.

Attus cardinalis Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 200.

Males and females very common in mating sacks at Stockton, August 26, and at Wallace, September 1. The females did not undergo last molt until a week or ten days later.

Phidippus rufus Hentz.

Attus rufus Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 536.

A number of males of this species taken in Clark county in June.

Phidippus ardens Peckham.

Phidippus ardens Peckham. Trans. Wis. Acad. Sci., XIII, p. 288.

Two females with cocoons from Wallace, July 17.

Phidippus obscurus Peckham.

Phidippus obscurus, Peckham. Trans. Wis. Acad. Sci., XIII, p. 294.

Three specimens from Hays, July 14, and one female with cocoons, from Stockton, August 17.

Phidippus ferrugineus, sp. nov. (plate XXIX, figs. 2, 3).

This is a large species, with two dominant colors—black and reddish brown.

FEMALE.—Length, 14-15 mm. Length of abdomen, 10 mm; width of abdomen, 7 mm.; height of abdomen, 6 mm. Width of cephalothorax, 4 mm.; height of cephalothorax, 4 mm.

LEGS.—Relative length, 4, 1, 2, 3. Absolute length, 9.5, 9, 8.5, 10.5 mm., respectively.

COLORS.—The abdomen is black beneath and on the sides, with sometimes faint indications of lighter spots or streaks. Above it is reddish brown except in the central longitudinal region, which is occupied by a black stripe extending from the anterior pair of muscle depressions to the spinnerets. This stripe broadens just back of the posterior muscle depressions until it is nearly 3 mm. in width, when it narrows again gradually toward the tip of the abdomen. In some specimens the red projects into the stripe so as to form two pairs of spots. Often these spots are entirely isolated from the red of the dorsum. Occasionally a spider has scarcely any indication of the stripe, being of a uniform reddish brown color above. Usually a lighter red or yellowish streak extends along the front border of the abdomen and runs diagonally down the sides, Back of the diagonal portion of this stripe may be one or two more yellowish stripes running down from the red-brown of the dorsum. The cephalothorax is black beneath, on the sides, and on that portion of the dorsal aspect that slopes toward the abdomen. The higher portion is reddish brown above, like the abdomen. The cheliceræ are iridescent green and purplish. The pedipalps and the first two pairs of legs have yellowish scales scattered here and there, and rings of like color near some of the joints. The presence of some long whitish hairs on these appendages is also common. The second and third pair of legs are almost always uniformly black, though some specimens have the proximal half of the tarsus lighter. This spider spends the winter under loose stones in large oval dwelling sacks of closely woven silk, protected in some cases by the addition of leaves or trash. I have found the species only in the vicinity of Manhattan, on the summit of higher slopes of hills capped with the Permian limestone. I have not been able to identify the male.

Phidippus morsitans Walck.

Attus morsitans Walck. Ins. Apt., I, 1837-'47, p. 432.

Our commonest representative of the family. Specimens from various parts of the state. The species passes the winter half-grown. Mature males first taken April 20; mature females, May 8.

Hyctia pikei Peckham.

Hyctia pikei Peckham. Trans. Wis. Acad., VII, 1888, p. 79.

Two mature females taken at Manhattan, June 12. A few young collected in sweeping during October.

Saitis pulex Hentz.

Attus pulex Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 361.

A number of specimens taken in sweeping, June 13. Fairly common for a few weeks.

Ballus immaculatus Peckham.

Attus albo-immaculatus Peck. Desc. New Att. of U. S., 1883, p. 5.

One specimen from Delphos, June 30.

Dendryphantes capitatus Hentz.
Attus capitatus Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 200.
Females common at Manhattan in June. Males very abundant in September and October.

Phlegra leopardus Hentz.
Attus leopardus Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 359.
A number of females with cocoons of eggs taken under rocks near Manhattan, May 25.

Synemosyna formica Hentz.
Synemosyna formica Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 368.
A few specimens taken in two or three localities near Manhattan, September 30; not quite mature.

Icius vitis Cockerell.
Icius vitis Cockerell. *The Entomologist*, London, 1894, p. 207.
Males and females abundant at Manhattan, June 13; at Hays, July 14; and at Wallace, July 18.

Philæus chrysis Walck.
Attus chrysis Walck. Ins. Apt., I, 1837, p. 451.
One specimen from Manhattan, July 13.

Pellenes elegans Peckham.
Pellenes elegans Peck. Bull. Wis. Nat. Hist. Soc., V, No. 4, 1900, p. 212.
One male from Clark county, June 15.

Thiodina puerpera Hentz.
Attus puerperus Hentz. Jour. Bos. Soc. Nat. Hist., V, 1845, p. 360.
One specimen, a male, taken on Wakarusa creek in June.

Family Pholcidæ.

Psilochorus cornutus Keyser.
Pholcus cornutus Keyser. Ver. d. zool. botan. Ges. Wien., 1887, p. 457.
Specimens from Manhattan, April 13; Delphos, June 30; Hays City and Wallace, July 14, 15. The females taken at Delphos were carrying balls of eggs in their cheliceræ.

Family Argiopidæ.

Linyphia communis Hentz.
Lynphia communis Hentz. Jour. Bost. Soc. Nat. Hist., VI, 1850, p. 28.
Very common, as the specific name implies. Mature specimens about Manhattan in May and June. Bushes full of webs of young in autumn.

Linyphia marginata Koch.
Linyphia marginata Koch. Die Arach., XII, 1836–'48, p. 118.
About as common as the preceding species. Specimens taken from April 6 to November 1.

Linyphia phrygiana Koch.
Linyphia phrygiana Koch. Die Arach., III, 1836–'48, p. 83.
Rarely taken. One specimen from Wild Cat creek, March 9, and a few more from the same locality in September.

Araneus frondosus Walck.
Epeira frondosa Walck. Ins. Apt., II, 1837–'47, p. 65.
A single specimen from the Kaw river bridge at Manhattan, May 23.

Araneus ocellatus Clerck.
Araneus patagiatus Clerck. Sv. Spindl., 1757, p. 38.
One specimen, a female, from the Blue river valley, near Manhattan.

Araneus sericatus Clerck.

Araneus sclopetarius Clerck. Sv. Spindl., 1757, p. 43.

A male and a female from Wild Cat creek, October 19.

Araneus aranatus Walck.

Epeira aranata Walck. Ins. Apt., II, 1837–'47, p. 133.

Common in the woods about Manhattan in the midsummer months.

Araneus stellatus Walck.

Plectana stellata Walck. Ins. Apt., II, 1837–'47, p. 171.

Common in the grass and low bushes in August. Specimens, from Manhattan, Stockton, and Wallace. Young taken in sweeping until late in the fall.

Araneus labyrintheus Hentz.

Epeira labyrinthea Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 471.

Apparently rare. Two females taken in one locality near Manhattan, August 13.

Araneus pratensis Hentz.

Epeira pratensis Hentz. Journ. Bost. Soc. Nat. Hist., V, 1845, p. 475.

Several females collected from webs on tall grass at Manhattan, October 13.

Araneus conspicellatus Walck.

Epeira conspicellata Walck. Ins. Apt., II, 1837–'47, p. 58.

One female, not fully grown, taken near Manhattan, September 21.

Araneus benjamini Walck.

Araneus benjamini Walck. Ins. Apt., II, 1837–'47, p. 42.

Our most conspicuous orb weaver. Found in the woods and about houses. Varies considerable in color and size. Mature specimens from several localities, in August.

Araneus eustalus Walck.

Epeira eustala Walck. Ins. Apt., II, 1837–'47, p. 37.

A common species. Specimens from Hays, Stockton, and Manhattan, in July and August.

Araneus gibberosus, Hentz.

Epeira gibberosa Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 457.

A considerable number of specimens from Manhattan, August 17, and from Stockton, August 28.

Araneus thaddeus Hentz.

Epeira thaddeus Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 473.

Two females collected on Prospect hill, near Manhattan, September 21.

Araneus pegnia Walck.

Araneus pegnia Walck. Ins. Apt., II, 1837–'47, p. 80.

But a single specimen, female, collected near Lawrence, in July.

Araneus trivittatus, Keyser.

Epeira trivittata Keyser. Beschr. n. Orbit., Sitz. d. Isis in Dresden, p. 95.

Fairly common in the eastern part of the state. Mature females taken at Lawrence in June and September.

Araneus singæformis, sp. nov. (plate XXIX, figs. 4, 5, 6).

This small orb weaver is of the type usually referred to the genus Singa, a group whose species Simon includes in the genus Araneus.

FEMALE.—Length, 4–5 mm. The abdomen is oval, moderately high and symmetrical in outline. It projects some distance over the cephalothorax.

The latter is broad back of the head region, which is much narrower and distinctly set off by lateral grooves. The head itself is considerably elevated. The median ocular area is nearly or quite square. The lateral eyes are contiguous. The legs are short and show very few spines.

COLORATION.—The cephalothorax, legs and cheliceræ are various shades of dull yellow. The head is usually brightest and the thoracic region darkest, in some cases tinged with brown. The legs are unmarked, except in an occasional specimen which shows traces of longitudinal stripes, particularly on the femora. The ocular quadrangle, as well as a small area about the lateral eyes, is black. The abdomen above and on the sides is whitish tinged with a fine network of brown. The muscle depressions are marked by brownish spots, and down the center of the abdomen in most specimens is a more or less branched, scar-like stripe. A broad border of black nearly or quite encircles the dorsum near the margin. Sometimes it is interrupted at the anterior end and occasionally also at the posterior end. The central portion of the abdomen beneath is occupied by a broad black band running back from the epigynum and enclosing the spinnerets. On either side of this is a narrow stripe of white, and between this stripe and the margin another band of black. The sternum is also black. These black areas, above and below, are more or less dotted over with light spots. I have taken but one specimen of this spider in sweeping, but secured over 100 mature females from the provision stores of some of the mud-dauber wasps in Wallace county, July 16.

Argiope aurantia Lucas.

Argiope aurantia Lucas. Anals. Ent. Soc. France, 1833, p. 480.

The Golden garden spider is pretty well distributed over the localities in which I have collected. Specimens from Manhattan, August 17, and from Wallace, September 1.

Argiope trifasciata Forsk.

Argiope trifasciata Forsk. Descrip. Animal., 1775, p. 86.

Less frequently met with than A. aurantia. One mature female from Manhattan, October 3. Undergrown specimens from Stockton, August 28, and from Wallace, September 21.

Argyroepeira hortorum Hentz.

Epeira hortorum Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 477.

Not uncommon in the scrubby timber. Specimens collected at Manhattan, July 4, and at Stockton, August 28.

Tetragnatha extensa Linn.

Aranea extensa Linn. Syst. Nat. etc., Ed. XI, 1758–'67, p. 621.

Abundant in timber and on the prairies, especially in the spring and early summer. Specimens from various parts of the state.

Tetragnatha elongata Walck.

Tetragnatha elongata Walck. Tabl. d' Aran., 1805, p. 69.

Taken frequently along the streams. Spiders of this species from Manhattan, August 14, and from Stockton, August 28.

Micrathena gracilis Walck.

Plectana gracile Walck. Ins. Apt., II, 1837–'47, p. 193.

Common in the woods at Manhattan and St. George in July and August. Not taken farther west.

Micrathena reduviana Walck.

Plectana reduviana Walck. Ins. Apt., II, 1837–'47, p. 201.

Only three specimens taken during the season — two at Manhattan, August 17, and one at St. George, October 6.

Micrathena sagittata Walck.

Plectana sagittata Walck. Ins. Apt., II, 1837–'47, p. 174.

One specimen, a male, taken at Lawrence in June.

Cyclosa conica Pallas.

Aranea conica Pallas. Spicilegia Zool., I, 1772, p. 48.

Three specimens from Manhattan, August 13.

Larinia directa Hentz.

Epeira directa Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 478.

Webs of this species are frequently encountered in the tall grass during the late summer and early autumn. A few specimens from Stockton, August 28; a large number from Manhattan, October 1.

Family Lycosidæ.

Lycosa ocreata Hentz.

Lycosa ocreata Hentz. Jour. Bost. Soc. Nat. Hist., IV, 1842, p. 391.

A number of males collected along the small streams near Manhattan in May.

Lycosa polita Emerton.

Lycosa polita Emerton. Trans. Conn. Acad., VI, 1885, p. 484.

Only one specimen, a female, from Delphos, May 26.

Lycosa nidicola Emerton.

Lycosa nidicola Emerton. Trans. Conn. Acad., VI, 1885, p. 482.

One of our common burrowing spiders. Both sexes taken in considerable numbers at Manhattan in May and at Delphos in July and August. Females observed with cocoons in May.

Lycosa kochii Keyser.

Tarentula kochii Keyser. Ver. d. zool. botan. Ges. Wien., 1877, p. 636.

Taken frequently in the region about Manhattan, especially in the fall and spring. Females carrying cocoons as early as April 6.

Lycosa scutulata Hentz.

Lycosa scutulata Hentz. Jour. Bost. Soc. Nat. Hist., IV., 1842, p. 390.

Specimens from Hays, July 11; Wallace, July 18; and Manhattan, August 12. Matures in midsummer. Not common.

Lycosa carolinensis Walck.

Lycosa carolinensis Walck. Ins. Apt., I, 1837–'47, p. 285.

Taken in various parts of the state the year round. It has burrowing habits very similar to those of L. nidicola and L. fatifera. Females with cocoons in May.

Lycosa communis Emerton.

Lycosa communis Emerton. Trans. Conn. Acad., VI, 1885, p. 489.

Matures in June. Common in all parts of the state visited. The "horse-shoe curve," a color pattern on the under side of the abdomen, is, in nearly all cases, closed by a transverse bar of black behind the epigynum.

Lycosa cinerea Fabricius.

Araneus cinereus Fabricus. Ent. Syst., II, 1793, p. 423.

Specimens of both sexes taken on the sandy margins of creeks in Wallace county.

Lycosa pratensis Emerton.

Lycosa pratensis Emerton. Trans. Conn. Acad., VI, 1885, p. 483.

Taken occasionally in the fall and spring about Manhattan.

Lycosa fatifera Hentz.

Lycosa fatifera Hentz. Jour. Bost. Soc. Nat. Hist., IV, 1842, p. 229.

Specimens taken from burrows at Delphos, June 30. Not so common as the other two burrowing species, L. carolinensis and L. nidicola. This is undoubtedly the same species as Banks's L. missouriensis.

Lycosa coloradensis Banks.

Lycosa coloradensis Banks. Jour. N. Y. Ento. Soc., II, 1894, p. 50.

One specimen from Dodge City, September 10, and one from Wa Keeney, November 1.

Pirata wacondana, sp. nov. (plate XXIX, fig. 7).

Lycosa wacondana Scheffer. *The Industrialist*, Vol. 30, No. 24, 1904.

A small species, found about springs or creeks on the prairies.

Female.—Length, 7-8 mm.; width of cephalothorax, 3 mm. The abdomen is slightly longer than the cephalothorax, which is narrow in front and widens rapidly back of the head, the thoracic region proper being as broad as it is long. The posterior margin of the cephalothorax is very noticeably procurved above the peduncle. The legs are rather long and slender. The fourth pair is longest, measuring about 13 mm. The front pair measures 10 mm. They are sparsely covered with fine dark hairs and beset with black spines. The ground color of the legs is dull yellow, but they are darker towards the ends, and some of the joints, particularly the femora, are banded near the middle and at their extremities by the darker shade. The coxæ are lighter above and below than the general ground color of the legs. At the proximal end of the trochanters, anteriorly, is a slight roughened prominence or two, much darker in color. The brownish cephalothorax presents a dull yellow middle stripe, widest back of the eyes, and two somewhat undulating lateral stripes of the same color. The dorsal groove is marked by a fine dark line. From its anterior end a forked stripe of brown runs forward to the eyes. In the brown area between the central and lateral stripes of the cephalothorax are several darker streaks arranged radially from the dorsal groove. The ground color of the abdomen is a darker brown than that of the cephalothorax. It is finely punctate with dull yellow. On the front half is a pointed yellow stripe running back to the region of the muscle depressions, and there are faint indications of transverse streaks on the hinder half. The sternum is light in the middle and darker around the edges. The under side of the abdomen is similarly colored, except that in the central line of the lighter area is a darker streak running from the epigynum to the spinnerets. I do not know the male of this species. Have taken the female in June about Manhattan, and in August at Waconda Springs. On the latter occasion nearly all the females were carrying cocoons of eggs.

Pardosa nigropalpis Emerton.

Pardosa nigropalpis Emerton. Trans. Conn. Acad., VI, 1885, p. 497.

Females carrying cocoons taken at Manhattan, September 26.

Pardosa lapidicina Emerton.

Pardosa lapidicina Emerton. Trans. Conn. Acad., VI, 1885, p. 494.

Very common in all parts of the state visited. Specimens carrying cocoons taken as early as April.

Pardosa sternalis Thorell.

Lycosa sternalis Thor. Bull. U. S. Geol. Surv. Terr., III, No. 2, 1877, p. 504.

Two specimens taken at Wallace, July 16.

Pardosa albopatella Emerton.

Pardosa albopatella Emerton. Trans. Conn. Acad., VI, 1885, p. 497.

One male taken at Lawrence in May.

Family Oxyopidæ.

Oxyopes salticus Hentz.

Oxyopes salticus Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 196.

Specimens from Manhattan, Waconda and Stockton in August.

Family Agelenidæ.

Tegenaria domestica Clerck.

Araneus domesticus Clerck. Sv. Spindl., 1757, p. 76.

Common in basements and cellars.

Coras medicinalis Hentz.

Tegenaria medicinalis Hentz. Jour. Acad. Nat. Sci. Phila., II, p. 53.

Common. Mature specimens taken under rocks or trash in the winter and spring. Cocoons observed in webs May 4.

Agelena nævia Walck.

Agelena nævia Walck. Ins. Apt., II, 1837–'47, p. 24.

Abundant over the state. Mature males and females first taken August 13.

Family Theridiidæ.

Steatoda borealis Hentz.

Steatoda borealis Hentz. Jour. Bost. Soc. Nat. Hist., VI, 1850, p. 274.

Common about Manhattan. Females in webs with cocoons, May 9.

Teutana triangulosa Walck.

Teutana triangulosa Walck. Faune Paris, II, p. 207.

This species observed only in the basement of buildings on the State Agricultural College grounds.

Theridion tepidariorum Koch.

Theridium tepidariorum Koch. Die Arach., 1836–'48, VIII, p. 75.

A common cobweb weaver in all parts of the state.

Theridion murarium Emerton.

Theridium murarium Emerton. Trans. Conn. Acad., VI, 1882, p. 11.

A male and a female from Wild Cat creek, June 15.

Latrodectus mactans Fabricius.

Latrodectus mactans Fabricius. Entom. Syst., II, 1775, p. 410.

One male from Hays, July 12, two from Wallace, September 1, and one from Manhattan, September 20. Cocoons in webs in each case.

Family Pisauridæ.

Dolomedes rufus De Geer.

Aranea rufa De Geer. Hist. Insect., 1776, VII, p. 319.

A number of specimens from Manhattan and Delphos during the spring and summer. Also taken under bark in the winter. Nests containing cocoons observed in June.

Dolomedes sexpunctatus Hentz.

Dolomedes sexpunctatus Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 191.

Young spiders of this species from the glacial swamps about St. George, October 15.

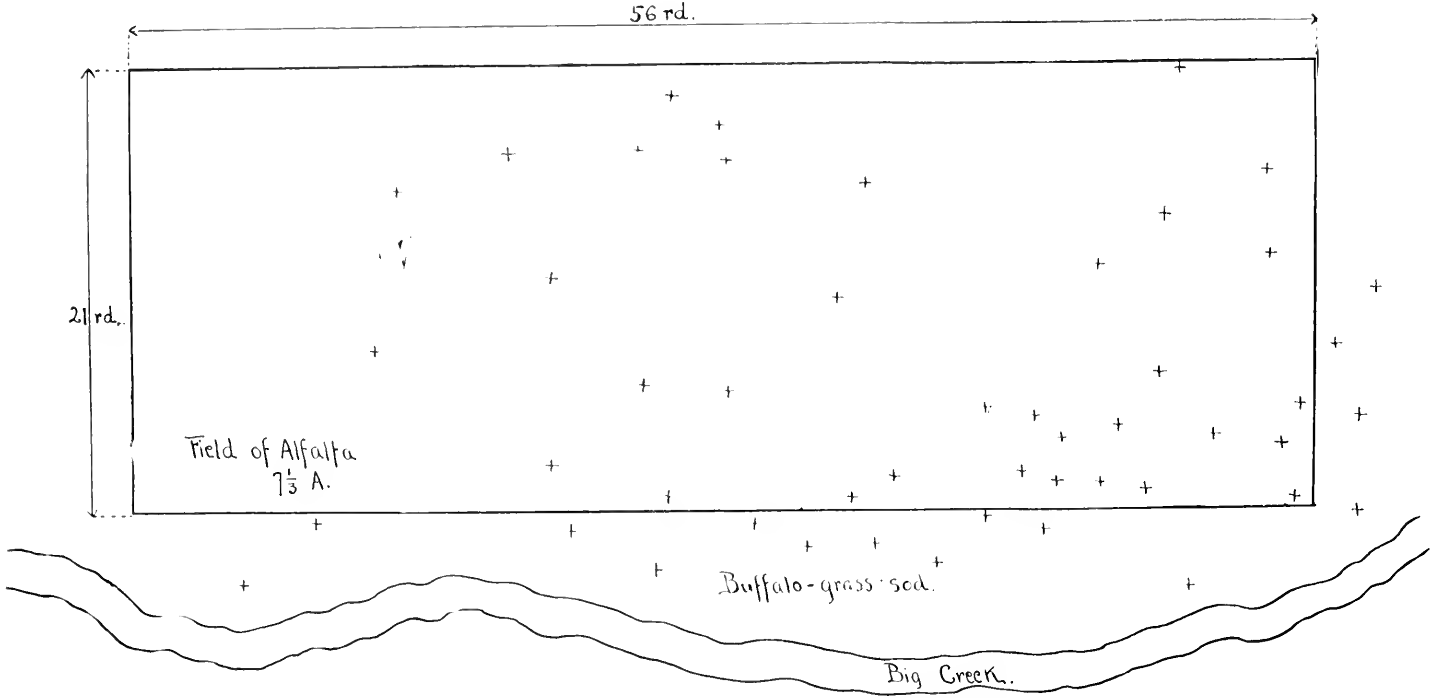

Plate XXIV.—Map of Alfalfa-field, showing Location of Ant Mounds, in Ellis County.

Pisaurina mira Walck.

Dolomedes mira Walck. Ins. Apt. I, 1837-'47, p. 357.

Undergrown specimens from Wild Cat creek, September 26.

SUMMARY OF GENERA AND SPECIES.

Family AVICULARIIDÆ:	
Eurypelma	1
Family DICTYNIDÆ:	
Dictyna	2
Amaurobius	1
Family THOMISIDÆ:	
Misumena	2
Synæma	1
Tibellus	1
Philodromus	1
Tmarus	1
Xysticus	6
Family CLUBIONIDÆ:	
Anyphæna	1
Corinna	1
Castaneira	2
Micaria	1
Family DRASSIDÆ:	
Sergiolus	1
Cesonia	1
Drassodes	1
Herpyllus	1
Family SALTICIDÆ:	
Marptusa	1
Phidippus	7
Hyctia	1
Saitis	1
Ballus	1
Dendryphantes	1
Phlegra	1
Synemosyna	1
Icius	1
Philæus	1
Pellenes	1
Thiodina	1
Family PHOLCIDÆ:	
Psilochorus	1
Family ARGIOPIDÆ:	
Linyphia	3
Araneus	15
Argiope	2
Argyroepeira	1
Tetragnatha	2
Micrathena	3
Cyclosa	1
Larinia	1
Family LYCOSIDÆ:	
Lycosa	12
Pardosa	4
Family OXYOPIDÆ:	
Oxyopes	1
Family AGELENIDÆ:	
Tegenaria	1
Coras	1
Agelena	1
Family THERIDIDÆ:	
Steatoda	1
Teutana	1
Theridion	2
Latrodectus	1
Family PISAURIDÆ:	
Dolomedes	2
Pisaurina	1
Total number of species	100
Total number of genera	50

EXPLANATION OF PLATE XXIX.

Fig. 1.—Oxptila modesta. Dorsal view of female.
Fig. 2—Phidippus ferrugineus. Dorsal view of female.
Fig. 3.—Phidippus ferrugineus. Side view.
Fig. 4.—Araneus singæformis. Dorsal view of female.
Fig. 5.—Araneus singæformis. Ventral view.
Fig. 6.—Araneus singæformis. Epigynum.
Fig. 7.—Pirata wacondana. Dorsal view of female.

BILIOGRAPHY OF THE LOCO WEED.

By L. E. SAYRE, University of Kansas, Lawrence.

Read before the Academy, at Manhattan, November 26, 1903.

THERE are perhaps few plants of the vegetable kingdom that have excited more interest of a general character than that of the *Astragalus mollissimus.* This is due to its alleged property of producing, when eaten by animals, a condition which is known as "locoism"; this term being derived from the Spanish word *loco*, meaning crazy, hence the common name of "crazy weed." We have been interested in compiling the various papers concerning this weed, and present herewith to the Academy a bibliography, so far as we have been able to obtain data, original papers, etc.

We desire to state in this connection that during the past year we have endeavored to ascertain the food value of loco. Our own laboratory results pointed to the fact that if the plant was not poisonous it would not be a bad stock food, but for confirmation of our results we had authentic material collected, such as the animal feeds upon, derived from the *Astragalus mollissimus* (loco) and sent to the department of agriculture at Manhattan, and through the kindness of J. T. Willard, of the chemical laboratory, we have the following report of the analysis:

Crude protein	14.73 per cent.
Ether extract	2.31 "
Nitrogen-free extract	40.22 "
Crude fiber	30.39 "
Moisture	6.51 "
Ash	5.84 "

For the purpose of comparison, we tabulate the analyses of well-known foodstuffs. These analyses were taken from the reports of the Experimental Station of Kansas and those of the Department of Agriculture, at Washington. The figures represent average composition.

	Per cent. water	Per cent. crude protein	Per cent. ether extract	Per cent. nitrogen-free extract	Per cent. crude fiber	Per cent. ash
Loco	6.51	14.73	2.31	40.22	30.39	5.40
Alfalfa, dry	8.40	14.30	2.20	31.40	25.00	7.90
Clover, Alsike	9.70	3.90	0.90	40.70	7.40	8.30
Clover, Red	15.30	4.40	1.10	31.80	8.10	6.24
Clover, White	9.70	15.70	2.90	39.30	....	8.30
Clover, Crimson	9.60	3.10	0.70	36.60	5.20	8.60
Clover, Japan	11.00	13.80	3.70	39.00	24.00	8.50
Timothy	13.20	5.90	2.50	45.00	29.00	4.40
Corn-fodder	42.20	4.50	1.60	34.70	14.30	2.70
Sorghum	12.80	9.10	3.60	69.80	2.60	2.10
Kafir-corn (field cured)	19.20	4.80	1.60	39.60	26.80	8.00
Oats	16.00	7.40	2.70	40.60	27.20	6.10
Bran, wheat	11.90	15.40	4.00	53.90	9.00	5.80

If we take the view that loco weed is non-poisonous, and that the peculiar symptoms which follow the ingestion of the weed in large quantities for a long-continued period be due to a malnutrition or a disturbed condition of the digestive tract, we naturally look to a possible mechanical disturbance brought about by one or more of the elements making up the structure of the leaf. This we find in innumerable unicellular hairs which cause the characteristic pubescence of the leaf. These hairs seem to constitute about one-third of the weight and over one-half of the bulk of the powder.

We append below the bibliography relating to this interesting subject:

LOCO WEED.

Description of: L. H. Pammel, professor botany, Iowa Agricultural College. *The Vis Medicatrix*, June, 1891, p. 40 (journal of the Iowa State Medical Society). The article contains figure of rattle-box (Crotalaria sagittalis).

WOOLLY LOCO WEED; STEMLESS LOCO WEED; RATTLE-BOX.

Description of: V. K. Chestnut, U. S. Dept. of Agriculture, division of botany. Principal Poisonous Plants of the United States. Bulletin No. 20, 1898, p. 29.

Fig. 12.—Woolly loco weed (Astragalus mollissimus).
" 13.—Stemless loco weed (Argallus lambertii).
" 14.—Rattle-box (Crotalaria sagittalis).

Description of: V. K. Chestnut, assistant botanist, U. S. Dept. of Agriculture. Thirty Poisonous Plants of the United States. Farmers' Bulletin, No. 86, 1898, p. 14.

Fig. 8.—Woolly loco weed (Astragalus mollissimus).
" 9.—Stemless loco weed (Argallus lambertii).
" 10.—Rattle-box (Crotalaria sagittalis).

WHITE LOCO WEED.

Description of: V. K. Chestnut and E. V. Wilcox, department of botany, U. S. Dept. of Agriculture. The Stock-poisoning Plants of Montana. Bulletin No. 36, 1901, p. 86.

Plate 9.—White loco weed (Argallus spicatus) in flower.
" 10.—White loco weed (Argallus spicatus) in fruit.

SILVERY LOCO WEED; PURPLE LOCO WEED.

Description of: V. K. Chestnut and E. V. Wilcox, division of botany, U. S. Dept. of Agriculture. The Stock-poisoning Plants of Montana. Bulletin No. 36, 1901, pp. 99, 100.

Plate 11.—Silvery loco weed (Argallus splendens).
" 12.—Purple loco weed (Argallus besseye).
" 13.—Purple loco weed (Argallus lagopus).

LOCO, OR CRAZY WEED.

Description of: J. U. Lloyd, Cincinnati, Ohio. *The Eclectic Medical Journal*, Oct., 1893, Art. XCI.

LOCO WEED.

Description of: Dr. F. B. Power and J. Cambier. The Pharmaceutical Rundschau, 1889, p. 134.

Fig.—Crotalaria sagittalis.

YERBA LOCO.
The Druggists' Bulletin, May, 1889, p. 134.

LOCO WEEDS.
Description of: V. K. Chestnut, B. S., assistant, division of botany, U. S. Dept. of Agriculture. Preliminary Catalogue of Plants Poisonous to Stock, p. 404.
Fig. 50.—Woolly loco weed (Astragalus mollissimus).

LOCO.
Some Observations upon Loco, Bulletin No. 35, Dec., 1892.
Experiment Station, Kansas State Agricultural College.
Plate XV.—Loco weed (Astragalus mollissimus).
Description of: David O'Brien, chemist, State Agricultural College, Fort Collins, Colo. Progress Bulletin on Loco and Larkspur, Oct., 1893.

LOCO WEED.
The Importance of Scientific Investigation. L. E. Sayre, Ph. G. Proceedings of the American Pharmaceutical Association, Sept., 1888, p. 107.
L. E. Sayre, Ph. G. Proceedings of the American Pharmaceutical Association, vol. 38, 1890, p. 107.
Description of: L. E. Sayre, University of Kansas, Lawrence. The Transactions of the Kansas Academy of Science, XVIII, p. 141.
Fig. 5, Astragalus mollissimus, p. 195.
Description of: L. E. Sayre, Ph. G., Kansas State University, department of pharmacy. The Transactions of the Kansas Academy of Science, vol. X.
Paper by L. E. Sayre. *The Druggists' Circular and Chemical Gazette*, Feb., 1903, p. 27.
Description by L. E. Sayre, Ph. G., department of pharmacy, University of Kansas. The Biennial Report of the Kansas State Board of Agriculture, vol. X, 1885–'86, p. 209, part II.
By L. E. Sayre, Ph. G., University of Kansas, school of pharmacy. The Biennial Report of the Kansas State Board of Agriculture, vol. XII, 1889–'90, p. 97, part II.
By L. E. Sayre, Ph. G., department of pharmacy, University of Kansas. The Biennial Report of the Kansas State Board of Agriculture, vol. XI. 1887–'88, p. 147, part II.
By L. E. Sayre, Ph. G., school of pharmacy, University of Kansas, The Biennial Report of the Kansas State Board of Agriculture, vol. XIII, 1891–'92, p. 163, part II.
Description of: The Proceedings of the American Pharmaceutical Association, 1879, p. 611.

ASTRAGALUS MOLLISSIMUS ("LOCO").
By L. E. Sayre, Ph. G. *Western Drug Record*, Nov., 1886, p. 18.
Fig.—Astragalus mollissimus.

LOCO WEED.
By L. E. Sayre, Ph. G., department of pharmacy, University of Kansas. *The Druggists' Bulletin* 1889, p. 145.
Fig. I.—Osytropus lambertii.
Fig. II.—Astragalus mollissimus.
Fig. III.—Astragalus tridactylicus.
The Active Principles of Loco Weed. L. E. Sayre, Ph. G., Kansas State University, Lawrence, Kan. *The Pharmaceutical Era*, 1890, p. 251.

The Poisonous Principle of Loco Weed. H. C. Oatman, University of Kansas. Notes on New Remedies, 1891, p. 14.

Report on Loco Weed. L. E. Sayre, Ph. G., department of pharmacy, Kansas State University. Notes on New Remedies, 1891, p. 79.

Paper. L. E. Sayre, Ph. G. Proceedings of the Kansas Pharmaceutical Association, May, 1888, p. 43.

Problem of. *Western Drug Record*, Jan., 1889.

The Active Principles of Loco Weed. L. E. Sayre, Ph. G., department of pharmacy, Kansas State University. *Western Drug Record*, vol. 5, p. 109.

Loco.

Special theses on loco, from school of pharmacy, University of Kansas (unpublished).

By A. J. Noble. June, 1902.

By R. J. McClure. June, 1888.

By L. W. Snepp. June, 1889.

By W. E. Henry. 1900.

WHAT IS INSANITY IN LOWER ANIMALS?

By L. E. Sayre. *Kansas Medical Journal*, Feb., 1904.

THE LOCO DIVISION.

By L. E. Sayre. *Kansas Medical Journal*, March, 1904.

DISSEMINATION AND GERMINATION OF SEEDS.

By WESLEY N. SPECKMANN, Kansas Wesleyan University, Salina.

Read (by title) before the Academy, at Topeka, December 31, 1904.

ONE of the most important subjects in the study of botany, as well as one of extraordinary interest, is that of the dispersal and germination of seeds. It is one that has received the attention of interested students for ages, and one of which a passing notice will not suffice. If we take, for example, a common morning-glory (*Ipomœa purpurea* Lam.), which is only a moderately prolific plant, and which is said to have some 3000 seeds in a single season, we will find that in seven years, at this rate, the enormous number of 729,000,000,000,000,000,000,000 seeds will be produced. If nature intended that each of these seeds should germinate and develop into a plant, there would need be some wonderful means of dissemination of the seeds over a wide range of territory, which would soon comprise the entire surface of the globe. It is, therefore, clear that the manner in which seeds are distributed is one of vital importance to the maintenance of plant life upon the earth.

An omniscient creator has provided various devices for transporting seeds; not only is this true of dehiscent but of indehiscent fruits as well.

The important means of transportation comprise the following: (*a*) Wind, (*b*) water, (*c*) man, (*d*) lower animals, and (*e*) hygroscopism.

The dispersion of seeds by means of winds is an interesting subject. In cases of this kind the seed or fruit is light and buoyant, as in the dandelion (*Taraxacum officinale* Linn.) When the akene of this plant matures "the beak lengthens and elevates the pappus; then the involucre is reflexed, the pappus spreads and, with the fruit, is blown away by the wind,"[1] closely resembling a parachute, except that it rises instead of descending.

Another example is that of the sow-thistle (*Sonchus asper* Vill.), which has a pappus of delicate downy hairs. In the virgin's bower (*Clematis* L.) the akene retains the feathered style, which aids in dissemination; so, also, in the milkweed.

Among the many other examples of dispersion of seeds found in the family of Compositæ, suffice it to mention further the common thistle (*Cnicus lanceolatus* Hoffm.) and the Canada thistle (*C. arvensis* Hoffm.), the latter being the plant that makes life miserable

1. Gray's School and Field Book of Botany.

to many a Northern farmer, on account of its dissemination of seeds by means of the wind as well as its spreading by deep-running roots.

But not only are single seeds carried by the winds, but whole flower clusters at times, when ripe. The "Russian thistle" (*Salsola kali* var. *tragus*)—saltwort—which, in reality, is not a thistle at all, but an "immigrant" without which we would be much better off, has wings on the back of the fruiting calyx. It sometimes forms large, bushy masses which, when dry, are driven by the wind in such quantities that they form ridges as high as fences. One such plant has been estimated to carry with it as many as 200,000 seeds. It "was first introduced into South Dakota in flaxseed brought from Russia and planted in 1873 or 1874. In twenty years from that time the plant had become one of the most formidable weeds known over an area of about 25,000 square miles."[2]

Other seeds are supplied with wings for flying, as the smara of the maple (*Acer* Tourn.), White ash (*Fraxinus americana* L.), elm (*Ulmus* L.), etc. Of the American linden (*Tilia americana* L.), the fruit is attached to a foliaceous bract which carries it through the air. The maple seeds fall from the trees with a twirling motion, which is especially designed to help carry them a greater distance. In some species of the *Pinus* (pine) the multiple fruit is in the form of a cone or strobile, the scales of which, when ripe and dry, turn back or separate, and the seed, with a lining of the scale, is dispersed by the wind. The pine-cones are sometimes opened by frosts. In damp weather they are seen to be closed.

A second mode of transportation is by water. Many seeds are provided with an impervious outer coat and a light, porous one. An example is the cocoanut. In the formation of coral islands, after the polyps and waves have done their wonderful work, floating wood lodges among the coral fragments, which decays and forms mold. Seeds, such as cocoanuts, which are not injured by the salt-water, are carried thousands of miles by the waves and deposited on the islet, and soon produce the cocoa-palm (*Cocos nucifera*). Rivers and creeks carry walnuts, hickory-nuts, cockle-burs and the catkins of birch with them and deposit these seeds along their banks.

Man has been an active agent in the dissemination of seeds; more especially was this the case in the years of the settlement of America. The immigrants brought cereals with them to this country, and took back the "Irish" potato (*Solanum tuberosum*), from Chili, South America; the tomato (*Lycopersicum esculentum*), from tropical America; tobacco (*Nicotina tabacum* L.), which is named for John Nicot, one of the introducers of tobacco into Europe; and Indian corn or maize (*Zea mays*), from Paraguay.

2. Bergen, Elements of Botany, pp. 201 and 205.

But not only have the seeds been taken to foreign countries, but there has been a great exchange within our own borders. Plants not known in one section of the land have been introduced and have become acclimated. Railroads have been important agents in the dissemination of seeds. It is said that travelers have thrown seeds from car-windows that have caused farmers untold inconvenience.

Another means of transportation is by the lower animals. Sometimes the outer part of the fruit is fleshy and palatable, at times even bright-colored and odorous, which attracts animals. The seeds themselves may be bitter and unsavory, or they are rendered indigestible and are protected against the action of digestive juices by being enclosed in a hard shell, or stone. In this way they are transported but not destroyed. Examples of seeds of this sort are cherries, berries of different kinds, grapes, currants, mountain-ash, and mistletoe. It is from the glutinous berry of the last named that birdlime is made.[3] "The berries are a favorite food of thrushes; and it has been supposed that the mistletoe was propagated by the seeds deposited by the birds; the propagation is really by the wiping off of the seeds from the bird's beak, which it rubs against the bark." "'Mistel' (the 'mistletoe') is a diminutive of German 'mist' (dung), probably in reference to the seeds deposited by the birds who eat the berries, or it may refer to the slime of the berries."[4]

Trees are annually planted by blue jays and other birds, as well as by squirrels, which bury nuts and acorns in the ground, intending to get them later, but fail to do so.

Again, seeds are furnished with hooks or spines by which they adhere to the fleece or plumage of animals or to the clothing of man. An example is *Xanthium strumarium* (common cockle-bur), which is the well-known bur with two strong beaks at the apex that attaches itself to the manes and tails of horses and mules, the wool of sheep, and the hair of cattle, and is thereby transported to different places. It is almost impossible to remove the burs without cutting off the hair to which they are attached. We also see a wise provision of the creator in allowing the bur-bearing plants to carry their fruit until late in the season, thereby increasing their chances of dissemination.

Other examples are the burdock (*Arctium lappa* L.), cleavers (*Galium verum* L.), hound's-tongue (*Cynoglossum officinale* L.), beggar's-lice (*Echinospermum virginicum* Lehm), and beggar-ticks (*Bidens frondosa* L.), or Spanish needles (*B. bipinnata* L.), all of which have the fruit enclosed in burs except *Bidens frondosa* L., which has wedge-obovate akenes ciliate with upturned bristles, and is two-awned, adhering to clothing only too readily.

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3. Gray's Structural and Systematic Botany, p. 469.

4. Columbian Cyclopedia, art. "Mistletoe."

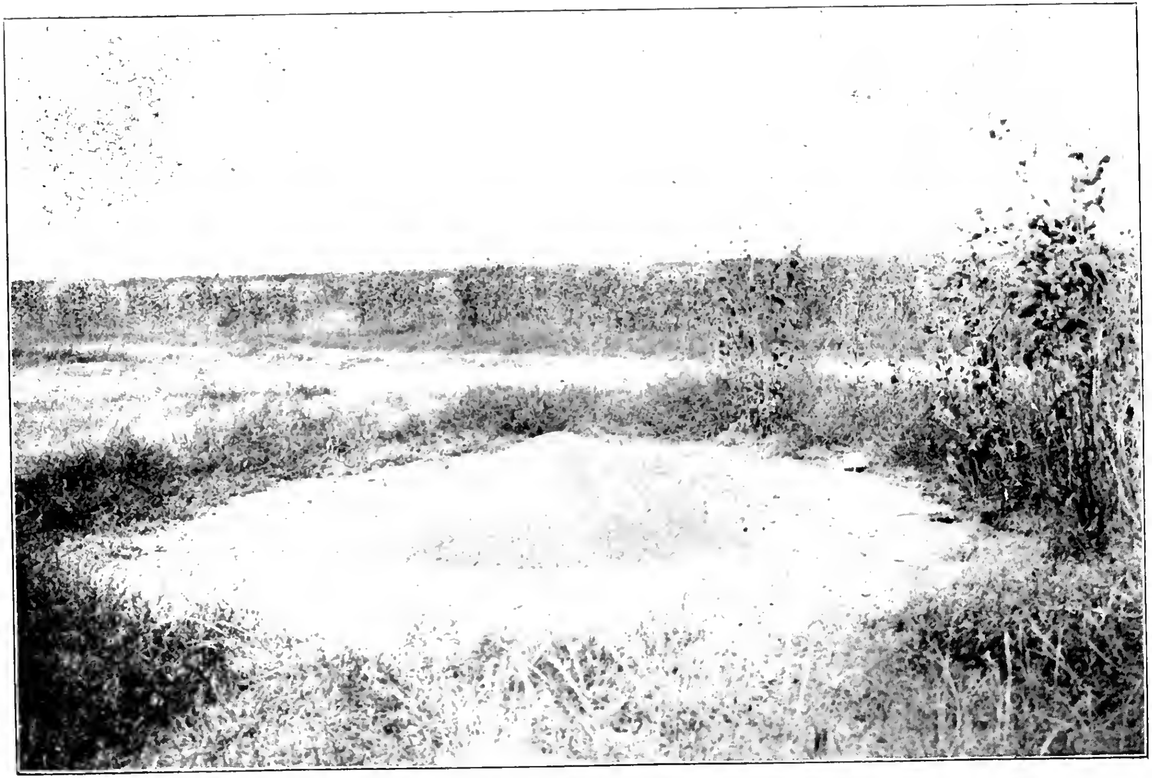

Plate XXV.—Ant Mound (No. 7 of table), Wallace, Kan.

Finally, seeds are projected by hygroscopicity, causing the explosive action of the capsules. Certain fruits, which have warped or dried unequally, will burst suddenly and scatter the seeds. Many examples of this are found, as the common blue violet, the pansy, balsam, witch-hazel, cranesbill, and herb-robert; the last two being species of geranium, whose ovaries separate when ripe into five carpels, which split off from below upwards, from a long central axis, throwing the seeds at times a distance of ten feet. "The capsule of the South American sand-box tree bursts open when thoroughly dry with a noise like that of a pistol-shot."[5] There is said to be a plant in Canada whose capsule when bursting pops like a gun.

But seeds are also covered with a coriaceous pod beset with prickly points, in order to prevent their being eaten by animals. Examples are species of *Castanea* (chestnut and chinquapin) and the *Æsculus* (horse-chestnut or buckeye). The seeds of the latter contain a bitter narcotic principle which renders the otherwise farinaceous interior more or less noxious. Those of the *Æsculus pavia* (Red buckeye) are used to stupefy fish, especially by the colored people of the South. The root of the plant is said to be used as a substitute for soap.

After the seeds have been disseminated it is necessary that a certain time elapse before they will germinate. The vegetable kingdom has been likened unto the fall and redemption of man. As it is necessary that our bodies remain in the grave until the last resurrection, so with seeds there must be a time of rest before the process of germination commences.

On the other hand, seeds do not retain their vitality *ad infinitum* There is great diversity along this line. Some perish almost immediately after they are disseminated if they are not planted at once, while others have been known to germinate when fifty or sixty years old, and it is claimed by some that seeds that have been buried several feet beneath the surface of the earth for many hundred years have sprouted when planted, but this is considered not well established.[6]

Germination has been defined [7] as "the process by which an embryo unfolds its parts," and "is complete when the plantlet can lead an independent existence." There are, therefore, "two stages in the process of germination: (1) That marked by the protusion of the first rootlet; (2) the subsequent development of the embryo into an independent plant."

Dr. J. M. Coulter says: "This 'awakening' of the seed is spoken of as its 'germination', but this must not be confused with the germination of a spore, which is real germination. In the case of the seed

5. Bergen's Elements of Botany, p. 191.

6. Gray's Structural Botany, p. 328.

7. Goodale, Physiological Botany, p. 462.

an oospore has germinated and formed an embryo, which stops growing for a time, and then resumes it. This resumption of growth is not germination, but is what happens when a seed is said to 'germinate.' This second period of development is known as the extra-seminal for it is inaugurated by the escape of the sporophyte from the seed."[8] It is this latter process that we are considering in this paper.

Experiment shows us that certain conditions are requisite for germination, viz.: (1) moisture, (2) heat, (3) free oxygen. Light, although essential to subsequent growth, is not requisite for germination. It is thought by some to impede or prevent it at the beginning.

Germination is to a certain extent a tearing-down process (katabolism); therefore a portion of organized matter is destroyed and carbonic acid is evolved. This acid is formed by the oxygen taken into the seed uniting with the carbon which it contained. This is most effective when one part of oxygen is diluted with three of nitrogen.[9]

The popular belief is that water is the only requisite for germination. This is incorrect. The amount of water differs also. As a rule sufficient moisture to saturate and soften the seed is required, but in certain cases germination takes place when only the radicle and the albumen surrounding it have become soaked. The seeds of the Leguminosæ require much more water than the cereals.

An easy experiment to prove the relation of water to germination is to arrange seeds in several vessels. In one, place dry seeds on blotting-paper that has been slightly moistened. In a second, on moist blotting-paper, place seeds that have been soaked for twenty-four hours. In a third, put soaked seed on saturated blotting-paper; while in a fourth put sufficient water to half cover the seeds. By placing the vessels where the conditions of heat and air will be the same, it will be noted that although water is a prerequisite for germination yet the quantity must not be too great.

The temperature to which seeds are subjected is an important item in germination. Although the seeds of *Acer platanoides* (Norway maple) and *Triticum vulgare* (wheat) have been known to sprout on ice (*i. e.*, at 0° C.),[10] and those of certain Alpine plants at from 0° to 2° C., yet there must be some heat evolved in every case. The highest temperature has been found to be 50° C. Between these minimum and maximum temperatures there is, according to Sachs[11] an *optimum*, one at which germination takes place most speedily, that of

8. Coulter, Plant Structures, p. 187.

9. American Encyclopedic Dictionary, "Germination."

10. Goodale, Physiological Botany, pp. 464, 465.

11. Ibid., pp. 465, 466.

barley and wheat being 29° C., and of scarlet runner, Indian corn and squash 33° C.

A third requisite is atmospheric air or, more strictly, free oxygen. In order to prove this conclusively, three bottles were used, in each of which moist blotting-paper was placed, and upon this seeds of *Phaseolus vulgaris* (common bean) and of *Zea mays* (Indian corn) that had been soaked for twenty-four hours. In one bottle we placed a perforated rubber stopper through which a glass tube bent once at right angles had been passed. This was attached to an air-pump and as much air as possible exhausted. While this process was going on we hermetically sealed the glass tube by means of an alcohol-lamp flame, leaving the bottle air-tight. In a second bottle seeds of the same kind and condition were placed and the bottle was tightly stoppered, thereby retaining what air there was within, but preventing the admission of more. In a third bottle of like condition we placed soaked seeds of the same kind, but affixed a stopper through which the air could readily pass. The result was that the seeds in the bottle without air never germinated; some of those in the one containing air, but stoppered tightly, began to sprout, but soon ceased growing. The seeds in the bottle to which air was constantly admitted germinated and produced good-sized plants. When the second bottle was opened a very disagreeable odor escaped, showing that the oxygen of the air had been consumed, carbon dioxide and organic gases formed. This oxidation which takes place is proof of chemical changes going on in germinating seeds.

Another chemical change caused by germination is shown in malt, which is barley which has been sprouted until the radicle protudes and the process then stopped by applying heat.

But there are other changes that take place in germinating seeds, as seen in the structure of kernels of corn, etc., when sprouting.

The seed when germinated contains the embryo, which is an axis, one end of which invariably lengthens and grows towards the light, while at the other end cell multiplication takes place—but always in the direction of dark and moist soil. It is remarkable that these tendencies of ascending and descending axes are irreversible, showing that a superhuman creator causes every individual of the vegetable kingdom to develop according to His immutable laws.

MYXOMYCETES OF CLAY COUNTY, KANSAS.

By JOHN H. SCHAFFNER, Ohio State University, Columbus, Ohio.

Read (by title) before the Academy, at Topeka, December 31, 1904.

IN recent years the writer has been collecting myxomycetes in various localities, and those from Clay county, so far as determined, are listed below. Thanks are due to Mr. A. P. Morgan, of Harrison, Ohio, and Prof. H. C. Beardslee, of Ashville, N. C., for assistance in identifying the species. The nomenclature is that of Macbride in "The North American Slime-molds."

CERATIOMYXACEÆ.

1. Ceratiomyxa fruticulosa (Muell.) Macbr.

PHYSARACEÆ.

2. Fuligo ovata (Schaeff.) Macbr.
3. Physarum cinereum (Batsch) Pers.
4. Physarum nefroideum Rost.
5. Tilmadoche polycephala (Schw.) Macbr.
6. Tilmadoche viridis (Bull.) Sacc.
7. Badhamia orbiculata Rex.
8. Physarella oblonga (B. & C.) Morg.
9. Craterium minimum B. & C.

DIDYMIACEÆ.

10. Didymium minus List.
11. Diderma crustaceum Peck.

STEMONITACEÆ.

12. Stemonitis fusca (Roth.) Rost.
13. Stemonitis morgani Peck.
14. Stemonitis smithii Macbr.
15. Comatricha stemonitis (Scop.) Sheld.
16. Diachea leucopoda (Bull.) Rost.

CRIBRARIACEÆ.

17. Dictydiæthalium plumbeum (Schum.) Rost.
18. Tubifera ferruginosa (Batsch.) Macbr.
19. Dictydium cancellatum (Batsch.) Macbr.

LYCOGALACEÆ.

20. Lycogala epidendrum (Buxb.) Fr.
21. Lycogala flavo-fuscum (Ehr.) Rost.

TRICHIACEÆ.

22. Perichæna depressa Lib.
23. Perichæna quadrata Macbr.
24. Perichæna corticalis (Batsch.) Rost.
25. Arcyria incarnata Pers.
26. Arcyria denudato (L.) Sheld.
27. Arcyria cinerea (Bull.) Pers.
28. Hemitrichia vesparium (Batsch) Macbr.
29. Trichia iowensis Macbr.
30. Trichia persimilis Karst.

SOME VARIATIONS AMONG SOME KANSAS WILD FLOWERS.

By F. F. Crevecœur, Onaga.

Read before the Academy at Topeka, December 29, 1904.

THERE is a growing disposition on the part of individuals and institutions to attempt the preservation and propagation of our useful, or otherwise desirable, native plants, in view of the almost certain extermination of many of the innocuous species due to the enlarged area brought under cultivation or put to use as pasture on account of the increase of our population.

Mrs. Oliver, at Belmont, N. Y., has set aside a tract of land for a plant preserve in that state, where the heart-endearing flowers that are rapidly disappearing may be preserved; and the United States government, through its Department of Agriculture, has taken the matter in hand and established plant-propagating gardens in connection with its Pacific coast laboratory, at Santa Ana, Cal., where all useful, beautiful or otherwise desirable plants, from all parts of the world, may be preserved and propagated. Nearer home we have a number of individuals interested in floriculture who have taken upon themselves the preservation of rare or beautiful species of our native flora. It is to these latter, more especially, that this article is dedicated, and it is hoped it may suggest search for rare specimens that occasionally may be found, but that are not known to exist, or are rarely seen.

Most people would think, on looking over a field of any of our common wild flowers, that the prevailing color, form or other quality usually seen at first glance are the only ones peculiar to each species, but on looking closer one will occasionally discover a plant differing in color or form of flower, shape or size of leaf, or height or habit of growth from the bulk of the species. Notes used in the preparation of this paper have been kindly contributed by B. B. Smyth and by Grace R. Meeker, to whom grateful acknowledgments are due. Some of the variations seen by Professor Smyth have been recorded in his "Check-list of Kansas Plants," August, 1892, and are again recorded here.

Anemone caroliniana Walter. Professor Smyth has seen plants of this species bearing flowers of all shades of color from pure white to deep purplish.

Oxalis violacea L. Miss Meeker reports having a plant of this pretty species in her garden bearing white flowers instead of the purplish-pink, the color usually seen. A white-blooming variety is also mentioned in Professor Castle's list of Franklin county plants, and Professor Smyth records the finding of the same by Miss Minnie Blake, at Highland.

Schrankia uncinata Willd. Miss Meeker reports that Professor Carleton had told her he had seen a white-flowering form of the sensitive brier in Oklahoma.

Platanus occidentalis L. Professor Smyth has seen trees of this species bearing leaves varying from the normal so as to resemble in shape those of the sweet gum, to which he has given the designation "forma styracifluifolia."

Amorpha canescens N. This shrub usually grows with several ascending stems from one root, but Professor Smyth has seen plants of this species in the southwestern part of the state that had a distinct diminutive trunk, graced with a perfect crown.

Astragalus caryocarpus Ker. The writer has seen two plants of this species with creamy-white flowers.

Desmodium dillenii Darlington. It was the writer's good fortune several years ago to find a plant of this species with creamy-white flowers.

Petalostemon (Kuhnistera) gracilis N. W. K. Professor Smyth has found this species in Pratt county with a decumbent stem and bearing fruiting heads that resembled blackberries.

Psoralea tenuiflora (floribunda) Psh. Professor Smyth has recorded a white-flowering form of this blue-flowering plant.

Rosa arkansana Best. This pretty flowering plant presents us with blossoms of all shades of color, from a pale rosy white to a deep crimson, and a pure white form is reported to have been seen in Franklin county by Miss Meeker.

Opuntia rafinesquii Eng. Professor Smyth has found specimens of this plant with cylindrical joints instead of the usually flattened ones.

Liatris pictostachya Mx., L. scariosa Willd., L. squarrosa Willd. Professor Smyth records white-flowering forms of these three species of purple-flowering plants.

Achillea millefolia L. Professor Smyth records plants with rose-colored and others with red-colored flowers, instead of the white, the form usually seen.

Actinomeris squarrosa N. The writer last summer found a plant of this species that bore on the lower part of the stem leaves beautifully variegated with pale yellow.

Helianthus annuus L. It is a fairly common sight to see flowers of this common weed that are partly or fully double. These flowers usually bloom some time before the others on the same plant, or before any are seen anywhere else. The change from a single flower to a double is supposed to be caused by some insect working in the flower-head. The past summer the writer saw a plant that bore pale sulfur-yellow flowers, and also found two plants with variegated leaves, the variegation consisting of a portion of the leaf being a pale yellow while the remainder was of the normal green.

Helianthus maximiliani Schrader, H. tracheliifolius Willd. These near relatives to the common sunflower also often bear partly to fully double flowers.

Helianthus tuberosus L. Professor Smyth records plants of this species as bearing double flowers, like its cousins above.

Lepachys tagates L. Professor Smyth records a yellow-rayed form of this plant.

Polypteris hookeriana Gr. Professor Smyth has found plants of this species in the soutwestern part of the state bearing rayless flowers.

Silphium integrifolium Mx. Professor Smyth has seen plants of this species which, instead of bearing opposite leaves—the normal form—bore leaves in whorls of three, the leaves of the whorl above being directly above the spaces between the leaves of the next whorl below. The stem of the plant in this case was six-angled.

Thelesperma gracile Gr. Professor Smyth has found throughout its range within the state plants of this species with rayless flowers.

Cnicus altissimus Willd. Miss Meeker reports having seen white-flowering thistles, but does not say of what species, but it is supposed it is this.

Cichorium intybus L. The writer found a plant the past summer in a meadow of tame grasses, where the plant has been established for a number of years, which had pale pink flowers instead of blue.

Asclepias tuberosa L. The writer found a plant of this beautiful species last summer that bore its blossoms in small umbels in racemes, there being three or four such umbels to each stem, instead of one large terminal umbel. It has not been the writer's fortune to find other than the common orange-scarlet flowering variety of this plant, but Professor Smyth told him he had met with all shades of color, from a bright scarlet to a rich golden yellow.

Gentiana puberula Mx. Miss Meeker reports the finding at Ottawa, by Prof. O. C. Carleton, of a specimen with white flowers of this pretty, late-flowering plant.

Convolvulus sepium L. The writer has several times met with plants of this vine bearing rosy-white flowers. Professor Smyth has found the same species with double flowers, the fulness being formed by the corolla being several times folded upon itself.

Phlox divaricata L. Both Professor Smyth and Miss Meeker report finding white-flowering plants of this early spring flower.

Phlox pilosa L. About twenty years ago the writer found a plant of this species, with pure white flowers. Last summer, while crossing a meadow where there were thousands of this pretty flower in bloom, a plant with white flowers with pink eye was found. Another plant had rosy-white flowers, while a third had blossoms of a lilac color with pink eyes. Several plants had blossoms of a deeper pink than the rest, verging on a crimson. Professor Smyth also records a white-flowering form of this plant.

Salvia pitcheri Torr. Both Professor Smyth and the writer have met with a white-flowering form of this blue flower.

Teucrium canadense L. Professor Smyth has found a pure white form of this plant, and the writer has found three shades of purple, from a light to a quite deep purple, among different clumps of this rather common weed.

Verbena aubletia L. Professor Smyth records a white-flowered form of this plant, and Miss Meeker says she had a plant with flowers of this color in her flower-garden.

Verbena stricta Vent. Both Professor Smyth and the writer have seen plants of this species with white flowers.

Verbena urticæfolia L. Professor Smyth reports finding plants of this species with purple-colored instead of the white flowers usually seen in this species. This is another case of the interesting variation from a lighter to a darker colored flower, a form of variation much less frequently met with than the more common one of the change from a darker to a lighter form.

Ruellia ciliosa Pursh. A white form of this purple-colored flower is recorded by Professor Smyth.

Oxybaphus angustifolius Sw. Professor Smyth records plants with linear leaves, and also a white-flowering form of this species.

Polygonum erectum L. A tall-growing form (three to six feet high) with a fastigiate habit of plant is recorded by Professor Smyth.

Polygonum pennsylvanicum L. The usual color of the flowering spikes of this weed is from a deep rosy to a deep red, but Professor Smyth reports a white-flowered form also.

Toxylon pomiferum Rafinesque. Last summer, while trimming hedge, the writer found trees of the Osage orange with leaves variegated with yellow; another tree had leaves of a glaucous green. The departure of these leaves from a normal color, as in the case of Helianthus annuus and of Actinomeris squarrosa, is supposed to have been caused by some disease or bacterial influence, and not the result of a true evolutional change.

Populus monilifera Ait. Professor Smyth has seen a tree of this species that had angular-shaped leaves instead of the cordate form.

Castalia odorata Woodw. & W. In this species we have another example of a change from a lighter to a darker colored form, a pink-flowered form of this water lily being recorded by Professor Smyth.

Sisyrinchium angustigolium Mill. The usual form of this pretty flowering grass has white blossoms, but a light blue form is often seen.

Tradescantia virginica L. The writer has seen flowers of this species from a deep bluish-purple to a deep pink, but Professor Smyth records a white-flowered form also. Miss Meeker also reports having a plant with white flowers in her flower border, where it ran riot among the grass.

Distichlis spicatea Greene. A trailing form of this grass is recorded by Professor Smyth.

Panicum crus-galli L. A dark-purple form of var. hispidum Gr. and a purple-variegated form of var. muticum are recorded by Professor Smyth.

Setaria glauca Beauvois. Professor Smyth has seen plants of this grass with red bristles instead of green.

Perhaps the writer's experience and methods for saving and transplanting rare specimens of wild plants may not come amiss. When a rare plant is found it may be transferred from its native habitat by carefully lifting it with a large ball of earth or sod so as to not disturb the roots. It may by this method be removed when in full bloom, and if it has been well done the plant will suffer no evil consequences. Some species of wild plants have long, deep-running perennial roots which do not permit of the plant's removal during the season of growth. Then it will be necessary to mark the location by planting a stake near it, or marking the spot where it is by any other method which will permit its being found during the late fall or early spring months, when it may usually be removed successfully. Such species as *Rosa blanda*, with its long underground stems, has not lent itself to a successful removal, in the writer's experience, but with proper care there is no reason why this may not be transplanted as well as other species of our wild flowers.

PLATE XXVI.—Vertical Section of Ant Mound (No. 7 of table), Wallace, Kan. (Showing five feet of excavation.)

ECHINACEA ROOTS.

By L. E. SAYRE, University of Kansas, Lawrence.

Read before the Academy, at Manhattan, November 27, 1903.

SOME few years ago a report was made to this Academy under the head of "Kansas Medicinal Plants," which referred to echinacea root. It was then stated that large quantities of it were gathered in different parts of the state of Kansas and in some other sections of the Western country. Reference was also made to the growing importance of this root as a medicinal drug. This report, as far as we know, was never published in the proceedings. At this time we will review in brief what was said at that time, and will give a report which relates to the further developments in connection with the commercial aspect of the *Echinacea* and will incorporate some results of chemical examination.

We have in the state of Kansas two species of echinacea root. One is known as *Echinacea purpurea* and the other *Echinacea angustifolia*.

1. *Echinacea purpurea.* Leaves rough, ofter serrate; the lowest ovate, five-nerved, veiny, long-petioled; the others ovate-lanceolate; the involucre imbricated in three to five rows; stem smooth or in one form rough-bristly, as well as the leaves. Rays fifteen to twenty, dull purple (rarely whitish), one to two inches long or more. Root thick, black, very pungent to the taste.

2. *Echinacea angustifolia.* Leaves, as well as the simple slender stem, bristly-hairy, lanceolate and linear-lanceolate, alternate at the base, three-nerved, entire; involucre less imbricated and heads often smaller; rays twelve to fiteen, two inches long, rose color or red.

The root of the *angustifolia* species is the one which is in demand as a medicinal drug, although it is a question whether the *purpurea* does not have similar properties. Judging from its gross characteristics, one would suppose that the latter had similar medicinal action to the former.

The common names of the plant in the state are: Nigger-head, hedgehog, cone-flower, and black susans. One of these appellations, the "hedgehog," as also the botanical name, "*Echinacea*" (*echinos*, spiny), are derived from the physical features of the plant, the fruiting head being spiny.

Echinacea root, when dry, has a brownish-black color, longitudinally wrinkled and twisted, the epidermis frequently shrunken. In cross-section, the wood wedges are seen to be of a gray color, and the intervening parenchymatous tissue (medullary rays) is colored dark gray, or grayish-black, due to the infiltrated coloring matter. The fracture is short and rough; the taste is peculiar, biting, somewhat acrid, producing a sensation slightly reminding one of pyrethrum; the odor—more prominent in concentrated preparations—cannot be compared to that of any other substance; it has a somewhat musty or mousey odor, accompanied with a peculiar pungency.

We have chemically examined each in the laboratory, and find the following constituents:

Chloroform extract	1.353
Petroleum ether extract	1.32
Benzole extract	2.025
(*a*) Soluble in alcohol	87.66
(*b*) Insoluble residue	12.34
Ether extract	2.12
(*a*) Soluble in water	18.95
(*b*) Soluble in alcohol	57.87
(1) Soluble in carbon disulphide	50.12
(2) Soluble in benzene	18.98
(3) Residue (insoluble in dilute acids)	30.90
(*c*) Insoluble residue	23.19
Alcoholic extract	12.078
(*a*) Resin	9.78
(*b*) Vegetable acids	38.62
(*c*) Coloring matter	51.58
Aqueous extract	9.744
(*a*) Gum	32.33
(*b*) Carbohydrates	18.95
(*c*) Undetermined residue	51.28
Soda extract	20.026
(*a*) Albuminoids	13.36
(*b*) Undetermined residue	86.64

Carbon Disulphide Extract.—It was found by the preliminary analysis that, among the various solvents used, carbon disulphide would be the most promising as the one which might yield the activities of the drug and leave behind in the extraction apparatus the largest percentage of inert and coloring matter. Acting upon this, it was found that our predictions were correct, as will be seen from the following: Fifty grams of the powdered root were introduced into a Soxhlot apparatus, and by continuous percolation for eight hours was thoroughly extracted by this solvent. After slowly evaporating the tincture spontaneously, and when the concentrate reached a small bulk, acicular crystals appeared. These were large and well defined. When the liquid was concentrated to a semi-solid, under the microscope it could be well intermixed with the large acicular crystals and small sheafs and rosettes. These were suspended in a brownish, somewhat sirupy liquid. The crop of crystals was quite abundant, almost entirely solidifying the entire mass. The crystalline mass as contained in the sirupy evaporate had an odor and taste characteristic of the drug, but very much intensified. It was believed that the active principle or principles were contained within this concentrate, but when the crystals were purified they proved to be of a fatty character. The pungency and acridity seem to reside in an oleo-resinous compound, which we have not had the opportunity to study in detail as yet. The acridity of the crystals was due probably to adhering resin. Alcohol dissolved the crystals very sparingly indeed; chloroform affected them somewhat; ether had some effect; but carbon disulphide dissolved them immediately, from which solution on evaporation the acicular and sheath-like crystals reformed. A few of them were placed on a platinum foil and heated over a Bunsen flame. At first they fused into a globular form. A continued heat carbonized the mass, which evolved grayish-brown fumes. On continuous heating the whole disappeared from the platinum foil. We regret that time has not allowed a chemical examination of these crystals and that a further report on them must be deferred. Our impression is that these crystals are composed of fatty matter in which is dissolved a considerable amount of the acrid principle.

Quite recently much interest has been manifested in echinacea from an economic point of view. On October 12 last a representative of a large manufacturing house in Cleveland, Ohio, was sent to me to assist him in the study of the source of echinacea, and to assist him in collecting it. To my surprise, I found the house he represented desired 40,000 pounds of the drug. About three weeks later another Eastern house sent to me, asking that I might assist them in obtaining collectors who might supply 20,000 pounds. Numerous other smaller demands have been made from the various drug houses and manufacturers for large quantities, such as 100-pound or 200-pound lots. We mention this merely to show to what extent the demand for echinacea has grown in the past few years, and also to show what economic value the plant has become to the state. It is safe to say that in one year it has brought to the state over $100,000, as over 200,000 pounds have been collected, and it has brought at times as much as fifty cents per pound. In view of this fact, that the demand was so great as to injure the source of supply, we wrote to the Department of Agriculture, at Washington, D. C., to Rodney H. True, who is in charge of the drug and medical-plant investigation, asking that something be done by the government for the protection of this weed against extermination. Mr. True replied that the matter of cultivating the weed had suggested itself to him, but he was not aware of the shortage of the plant, as I had represented it. Under the circumstances, he said he would be very glad to study the habits of the plant, and for that purpose would like to obtain seeds or living roots for such purpose, and for these and for information and help in this matter he was recommended to address Professor Roberts, of the Agricultural College.

On November 9 I received a letter from the house in Cleveland, in reply to a letter from me asking for information regarding the results of their investigation on the habits of the plant, etc. Their reply stated that their agent found it growing pretty well all over the state of Kansas, but that it is only gathered in commercial quantities in the northwestern part of the state. The reason for this seems to be, that the root thrives better in the rocky soil of that district. They further stated: "We think that your suggestion on the cultivation of the root would prove of benefit to the drug trade as well as to the farmers of Kansas." This writer found two objections to this cultivation, one being that it takes five years for the plant to come to maturity. This makes a very slow crop. And, secondly, that when grown on rich soil, suitable for cultivation, the root never becomes large enough in size to pay for digging it—never becomes larger than a lead-pencil, and strikes right down in the earth. In the rocky soil where it is gathered, most of the root becomes large in diameter, and is easily gathered in quantities by aid of a pick.

As an appendix to the above, we wish to say that a contrary opinion is held by W. H. Baker, of Manhattan, formerly of Topeka, as to the kind of soil suitable for growing *Echinacea augustifolia.* He states that, from his observation of the habits and growth of it, he is led to believe that the plant can be grown in ordinary garden soil. In Jefferson county, three miles east of Grantville, he saw the plant growing in abundance on a rich upland meadow that was slightly sandy. Jefferson county is among the eastern tier of counties. In one-half day, in this meadow, Mr. Baker says he dug seventy-five pounds of root. Many of the roots would measure an inch in diameter, and a few were two inches in diameter. He transplanted some small roots in a garden in Topeka. These roots grew very rapidly.

In the summer of 1892, the students of the pharmacy school of the Kansas University collected and dried 150 pounds of the root from the fields around and about Lawrence, but these roots were none of them very large. From our own observations, we are inclined to think that Mr. Baker's views are correct—the plant will thrive under cultivation.

The medicinal quality of echinacea seems to be unique. The last edition of King's American Dispensatory devoted about seven pages to the description of the drug, its medicinal properties, etc. This authority states: "Under the older classification of remedies, echinacea would probably be classed as an antiseptic and alterative. Strictly speaking, it is practically impossible to classify an agent like echinacea by applying to it one or two words to indicate its virtues. If any single statement was to be made concerning the virtues of echinacea, it would read something like this: 'A corrector of the depravation of the body fluids,' and even this does not sufficiently cover the ground. Its extraordinary powers—combining essentially what was formerly included under the terms antiseptic, antifermentative, and antizymotic—are well shown in its power over changes produced in the fluids of the body, whether from internal causes or from external introductions. The changes may be manifested in a disturbed balance of the fluids, resulting in such tissue alterations as are exhibited in boils, carbuncles, abscesses, or cellular or glandular inflammations. Such changes, whether they be septic or of divitalized, morbid accumulations, or alterations in the fluids themselves, appear to have met their antagonist in echinacea."

One authority, in speaking of the value of the drug in eczema, states: "Many physicians have treated these conditions as a local skin disease. This is a great mistake. Preparations of echinacea, taken internally, have clearly demonstrated its value as an internal remedy in all eczematous conditions."

It is hoped that the experiments of the agricultural department will result in a better knowledge of the habits of the plant and in practical suggestions for its cultivation.

NOTES ON THE CULTURE OF WILD FLOWERS.

By HARVEY W. BAKER, Kansas Agricultural College, Manhattan.

Read before the Academy, at Manhattan, November 27, 1903.

THE culture of wild flowers has long been a subject of interest to a few people; but the great majority have paid little or no attention to it. There are a few places in the East where the culture of wild flowers has received considerable attention. Among these may be mentioned the New York botanical gardens, Thomas Mehan's nursery, at Philadelphia, the Shaw botanical gardens, at St. Louis, and perhaps a few other smaller places. There are many species growing in the Western states that have never been transplanted.

A few papers have been written on this subject by Kansas people, and a few plants have been cultivated, but nothing has been done in the state to bring the subject prominently before the people. There are a great many people in Kansas, as well as elsewhere, who like flowers. One reason why they do not have more plants is, that the retail price of nursery-grown plants is so high, and those that are bought are often not cared for properly, and consequently do not give satisfaction.

The cultivation of wild flowers secures for us plants that are adapted to our climate and that require but little care, yet have the peculiar decorative quality, in flowers or foliage, that distinguish them from the great mass of plants as special objects of beauty. Many of our native plants possess these qualities, but are generally looked upon as mere weeds, not worthy of notice.

I have long had the desire to cultivate the wild flowers; and having an opportunity offered in the fall of 1902, I began collecting for a garden at Grace cathedral, in Topeka. For the success of this garden I am indebted to Dean Kaye, Mr. John R. Mulvane, Dr. C. F. Menninger, Mr. A. T. Daniels, and Mr. Edward Wilder, all of Topeka, and Mr. Elam Bartholomew, of Rooks county.

November was spent in collecting in Shawnee and Jefferson counties. During December collections were made in Chase, Rice, Edwards and Clark counties. When the last shipment of plants reached Topeka, the ground was frozen so deep that the plants could not be set out, and they were "heeled in" until spring. Heeling in should be avoided, if possible, since some of the plants will rot, while others will be lost or their labels be destroyed. In April I did some collecting in Kearny county, and Mr. Bartholomew sent me some plants from Rooks county, and a few plants were collected during the summer in the vicinity of Topeka. In all, 154 species were planted, of which five were lost. Some of the others barely survived. Those that lived manifested all degrees of vigor, some scarcely growing at all; others growing so luxuriantly that they had to receive artificial support. One hundred and seventeen species bloomed, of which about eighty per cent. made a better showing than in their native condition.

It is surprising to note the expressions of interest on the part of many farmers in the plants about them, when the subject of wild flowers and their culture is approached from an economic standpoint. I have shown people plants that they had looked at all their lives, and yet had never seen. After they had really seen them, they were surprised and delighted, and wondered why they had never known before that these plants possessed such beauty.

A strong reason why more wild flowers are not cultivated is because of the erroneous idea that the deep-rooted perennials are difficult to transplant. I think that I have shown that they are not difficult, and that many of them are easy to transplant. For example, I dug two roots of bush morning-glory (*Ipomœa leptophylla*)—one five inches in diameter where cut off, and weighing sixty pounds; the other weighing five pounds. No fibrous roots were secured in either case. The larger root sent up several shoots, but soon stopped growing and even withered considerably. After a little, however, it began to grow again, gradually increasing until fall, by which time it had become well established. The other one grew into a vigorous plant and bloomed profusely. Another flower that is thought to be difficult to transplant is the sensitive brier (*Morongia uncinata*). Of this, five roots were collected on the 10th of June; four of them grew fairly well and bloomed. *Yucca glauca* is another deep-rooted plant, of which five specimens were secured, having roots about two feet long, but no fibrous roots. All of these grew.

Evening primrose (*Megapterium missouriense*) has a deep, fleshy root, with no fibrous roots near the surface. I secured six specimens of this plant about the 10th of August. They had crooked, knotty roots about a half-inch in diameter and eight inches long. Within a week from the time of planting they showed a marked new growth, and by the middle of September there was a goodly supply of new leaves, and the plants seemed well established.

I have found a few species a little more difficult to transplant; but their value compensates for the labor expended—Mexican poppy (*Argemone alba*) and evening aster (*Mentzelea ornata*). The latter is a biennial. Of the former, forty plants were planted, of which two survived. These grew very thriftily and bloomed for three months. One of these plants bore 325 flowers, while the other bore

380. These beautiful plants were objects of admiration to every one who visited the garden. To secure a plant three feet high, and branched out like a small tree, with large glaucous leaves fringed with yellow spines, and bearing thirty or forty large white flowers, each four inches in diameter, is worth not a little extra effort. Evening aster might well be considered the queen of the Kansas prairie flowers. I secured fifty roots of this plant from Clark, Kearny and Rooks counties. Only one specimen lived. This made as large and healthy a plant as I ever saw on the plains. It commenced blooming on the 10th of August and continued until the 15th of September, producing 178 flowers in all, and having as many as thirty-five at one time. The flowers are four to five inches in diameter, of a creamy-white color, and very fragrant. The plant is very punctual in its actions. The flowers begin opening about twenty minutes past six o'clock in the evening and in ten minutes are open wide. The second evening these blossoms open ten minutes earlier than the new ones. Occasionally they will open a third time. They always close between twelve and one o'clock at night. The plant is a luxury, and worth any reasonable effort to secure.

No attention need be paid to the soil from which plants are taken. The fact that a flower is found growing in a certain place does not necessarily prove that it is growing in the best place. It may be growing there because it has been crowded out of a better place.

It is marvelous how some plants respond to a little care. It is always advisable to use plenty of sand, and a little fertilizer may be employed to advantage; but, generally, fertilizers should be used sparingly. There were in my garden plants from the swamps along the Kaw river, from deep woodlands, from fertile meadows, from the rocky bluffs of Chase county, from the saline marshes on the Arkansas, from the sandy plains of the southwest, and from the chalk hills of the northwest—all growing side by side in the same soil. And each one seemed to be perfectly at home; in fact, many of them grew better than in their wild condition.

An ideal garden would be one in which a pond and a rockery had a place. A rockery is more essential and is more available in most localities. On it many low plants can be grown to advantage that are otherwise undesirable; and many of those that can be grown on level culture show better on a rockery.

The best time, of course, to move plants is while they are dormant; but with proper care they may be moved at any time. When plants are moved in the summer, it is necessary to prune the tops severely; and special care should be taken to firm the soil about the roots. When convenient, it is advisable to take the plants up in a lump of

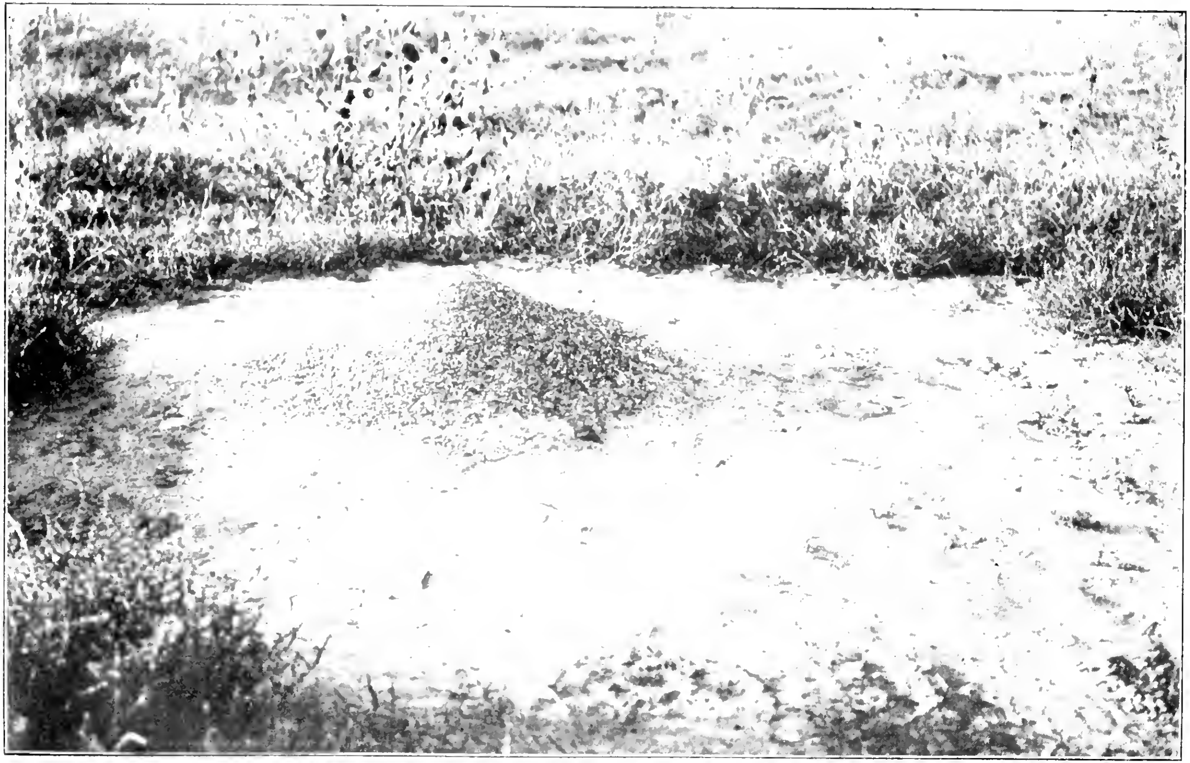

Plate XXVII.—Ant Mound (No. 1 of table), Wallace, Kan.

earth. Judgment should be used in watering wild plants. The water that is necessary to secure the best results with those from the lowlands will drown some of those from the arid plains.

Only a comparatively small amount of work has been done as yet. And one year is not sufficient to fully develop a plant and show what it will be under cultivation.

This subject should interest every Kansas home-maker; and it cannot fail to interest many when they give to it the attention its importance deserves. The subject is worthy of a place in the work of the Experiment Station in the Agricultural College.

ADDITIONS TO THE LIST OF KANSAS COLEOPTERA, 1903-'04.

By WARREN KNAUS, McPherson, Kan.

Read before the Academy, at Topeka, December 30, 1904.

THE 115 species of Coleoptera contained in the following list, not previously recorded from Kansas, come from all parts of the state, but more than one-half of them are from Kiowa and Meade counties. The additions were mostly made by Prof. F. H. Snow and party, who collected in June and July, 1903, in Clark county, near Englewood, and the previous season in Hamilton and Morton counties. Sixty-one of the species of this list should be credited to Professor Snow from these counties, and three species from Douglas county. F. F. Crevecœur added twenty-three species from near Onaga, and Prof. E. A. Popenoe contributed two species from Meade and Hamilton counties. The others were added by myself from Kiowa, McPherson and Reno counties, and southeast Kansas.

These additions bring the list of Kansas Coleoptera up to near 3000 species, and, when the various families are worked over, the list will be found to considerably exceed 3000 species.

Thanks are due to Mr. H. C. Fall, of Pasadena, Cal., H. F. Wickham, of Iowa City, Iowa, Charles Liebeck, of Philadelphia, Pa., and the late P. Jerome Schmidt, of Beatty, Pa., for determinations.

126 Calosoma protractum Lec. Clark county.
215 Pasimachus duplicatus Lec. Clark county.
397 Bembidium dejectum Cas. Hamilton county.
408 Bembidium dubitans Lec. Hamilton county.
440 Tachys corruscus Lec. Hamilton county.
666 Amara confusa Lec. Clark county.
739 Badister flavipes Lec. Hamilton county.
858 Diaphorus tenuicollis Lec. McPherson, Kan., October. One specimen.
977*a* Brachynus similis Lec. Hamilton county.
1176 Harpalus dichrous Dej. Onaga, Kan. Common.
1110 Harpalus funestus Lec. Hamilton and Clark counties.
1177 Anisodactylus harpaloides Laf. Clark county.
1179 Anisodactylus opaculus Lec. Clark county.
1607 Berosus subsignatus Lec. Clark county.
1664 Cercyom pubescens Lec. Onaga, July and August. Four specimens.
9332 Cercyom hæmorrhoidalis Fall. Onaga, July and August. Three specimens.
1690 Cryptopleurum minutum Fab. Onaga, August. Common.
Scydmænis, n. sp. Onaga, July 14. One specimen.
Batrisus harringtonii Cas. Onaga, May 17. Two specimens.
Reichenbachia kansanus Cas. Onaga, May 7. Several specimens.
Reichenbachia arctifer Cas. Described from Kansas.
Falagria sp. McPherson, May. Several specimens.

Atheta sp. McPherson, May. Two specimens.
Tachyusa sp. Belvidere, June. Two specimens.
Gyrophœna sp. Onaga, July. On fungus.
2164 Philonthus semiruber Horn. Clark county.
2179 Philonthus longicornis Steph. Onaga, June. Three specimens.
2182 Philonthus alumnus Er. Onaga.
2294 Leptacinus cephalicus Lec. Onaga. Two specimens.
2640 Cilea silphoides Linn. Onaga, July and August. Common.
2676 Mycetoporus splendidus Grav. March. Two specimens.
2712 Bledius armatus Er. Hamilton county.
2738(?) Bledius suturalis Lec. Hamilton county.
9713 Oxytelus densus Cas. Onaga, April. Six specimens, under stones.
Trogophlœus sp. Belvidere, June.
Trogophleus sp. Onaga, July.
Bæocera sp. Onaga, July. On fungus.
9879 Acylomus calcaratus Cas. Onaga, July, August. Common on fungus.
Atomaria sp. McPherson, April and May. Common on grass.
Elmis sp. Belvidere, July.
4109 Cardiophorus gagates Er. Clark county.
10052 Cryptohypnus cucullatus Horn. Hamilton county.
4343? Melanotus sagittarus Lec. Clark county.
4639*a* Chrysobothris alabamæ Gory. Belvidere, and Kiowa and Clark counties, June.
4642 Chrysobothris contigua Lec. McPherson, May. One specimen.
4751 Agrilus pulchellus Bland. Clark county, June. One specimen.
Agrilus sp. Belvidere, July. On elm and willow.
4891 Podabrus brunnicollis Lec. Onaga, July. Three specimens.
Hydnocera sp. Onaga, June and July.
Hydnocera sp. Belvidere, July; McPherson, October.
5451 Phaneus difformis Lec. Belvidere and west, July.
5480 Rhyssemus scaber Hald. Medora, June. One specimen.
5482 Rhyssemus sonatus Lec. Clark county.
5490 Ætenius figurator Horn. Hamilton county.
Ætenius sp. Hamilton county.
5590*a* Bolbocerus tumefactus Beauv. Lawrence.
5615 Trox asper Lec. Lawrence.
Diplotaxis sp. Belvidere, June. One specimen.
5737 Lachnosterna cribrosa Lec. Clark county. One specimen.
5818 Listrochoelus fimbripes Lec. Clark county. One specimen.
5881 Strategus anteus Fab. Sedan, Kan., July 30. Doubtfully reported (Cooper) from Topeka, Kan., in Popenoe's first list of Kansas Coleoptera.
5929 Cremastochilus canaliculatus Kirby. Lawrence.
5931 Cremastochilus castanea Knoch., var. lecontei. East Kansas. One specimen.
6141 Batyle suturalis Say, var. pearsalli Bland. Hamilton county.
6208 Clytanthus albofasciatus Laf. Clark and Kiowa counties, June.
6381 Monilema crassum Lec. Clark county.
6513*c* Tetraopes oregonensis Lec. Hamilton county.
6564 Lema texana Cr. Clark county.
6574 Lema texana negrovittata Guer. Clark county.
6584 Coscinoptera æneipennis Lec. Hamilton county, June (Popenoe); Clark county (Snow).

6707 Diachus auratus Fab. Rago and Belvidere, June.

6713 Diachus pallidicornis Suffr. Rooks county and northwest, July.

10354 Metachroma æneicolle Horn. Clark county.

10369 Colaspoides opasicollis Horn. Clark county.

6796 Chrysomela conjuncta Rog., var. pallida Say. Hamilton and Morton counties.

6909 Galerucella notulata Fab. Clark county.

10434 Longitarsus turbatus Horn. Onaga, July. Three specimens.

6963 Haltica ingnita Ill. Medora, June. On willow.

7092 Stenopodius flavidus Horn. Clark county.

10475 Zabrotes subnitens. Clark county.

7314 Eusattus difficilis Lec. Clark county.

Blapstinus, sp. near dilatatus Lec. Clark county.

7434 Blapstinus fortis Lec. Clark county.

7436 Blapstinus brevicollis Lec. Wallace county.

7437 Lecontei Muls. Wallace county. Rare.

7481 Uloma impressa Melsh. Southeast Kansas. Rare.

7492 Præteus fusculus Lec. Benedict. One specimen.

7516–17 Platydema subquadratum Mots. Benedict. One specimen.

7542 Boletophagus depressus Rand. East Kansas. Rare.

7580 Strongylium terminatum Say. Onaga, July and August.

7784 Mordella lunulata Helm. Hamilton county.

Mordella sp. Hamilton county.

7819 Mordellissema tosta Lec. Onaga. Two specimens at light.

7858 Mordellissema æthiops Smith. Clark county.

Amthycus mimus Cas. Hamilton county.

Amthycus near spretus Lec. Clark county.

8048 Zonitis flavida Lec. Meade county. One specimen.

8108 Pyrota terminata Lec. Meade county, May. (Popenoe.)

8119 Pyrota sinuata Oliv. Clark county.

8241 Calyptinus cryptops Horn. Clark county.

8267 Peritaxia hispida Horn. Clark county.

8324 Phacepholis obscura Horn. Clark county.

10822 Macrops interpunctatus Dietz. Clark county.

Macrops, sp. near montanus Dietz. Clark county.

8491 Lixus silvius Boh. Clark county.

8513 Stephanocleonis plumbeus Lec. Clark county.

8555 Smicronyx tichoides Lec. Hamilton county.

8575? Endalus ovalis Lec. Clark county.

8758 Acalles nobilus Lec. Clark county. Common.

11127 Onychobaris millepore Cas. Clark county.

8916? Calandrinus grandicollis Lec. Clark county.

11169 Cendrinus pulverulendus Cas. Hamilton, Morton and Clark counties.

Rhyncolus eximius Lec. Hamilton county.

9227 Brachytarsus vestitus Lec. Clark county.

9054 Corchylus punctatissimus Zimm. Onaga, June. One specimen.

4097 Cardiophorus convexus Say. Belvidere, July 2. One specimen.

7139 Bruchus protractus Horn. Belvidere, July 2. One specimen.

NOTES AND DESCRIPTIONS OF ORTHOPTERA FROM THE WESTERN UNITED STATES,

In the Entomological Collection of the University of Kansas.

By JAMES A. G. REHN, of the Academy of Natural Sciences of Philadelphia.

Read (by title) before the Academy, at Topeka, December 31, 1904.

THE material treated in the following pages was kindly submitted to me for study by Prof. F. H. Snow, of the University of Kansas. The greater part of the material was collected by the University expedition of 1903 to Arizona, the details of which trip have already been published by Professor Snow.* As the localities are there discussed by one thoroughly acquainted with them, no remarks need be made here. The types of all new forms are in the University museum. Finally, I wish to thank Professor Snow for the opportunity afforded to study the material:

Family FORFICULIDÆ.

Labia minor Linnæus.

Douglas county, Kan.; July, E. S. Tucker. One female.

Clark county, Kan., 1962 ft.; June, F. H. Snow. One female.

Family BLATTIDÆ.

Ischnoptera borealis Bruner.

Clark county, Kan., 1962 ft.; June, F. H. Snow. One male. This individual fully agrees with a specimen from Nebraska City, Otoe county, Neb.

Nyctobora mexicana Saussure.

Texas. One female.

Homœogamia erratica Rehn.

Clark county, Kan., 1962 ft.; June, F. H. Snow. One male. This record extends the range of the species considerably to the north.

Family MANTIDÆ.

Litaneutria minor Scudder.

Bill Williams Fork, Mohave-Yuma counties, Ariz.; August, F. H. Snow. One female.

Cactus Plain, Yuma-Yavapai counties, Ariz.; F. H. Snow. One female.

Stagmomantis carolina Linnæus.

Lawrence, Douglas county, Kan.; September, E. S. Tucker; and October 4, 1895, B. Brown. Two females.

Douglas county Kan.; October, at electric light, E. S. Tucker. One male.

Stagmomantis limbata Hahn.

Bill Williams Fork, Mohave-Yuma counties, Ariz.; August, F. H. Snow. One female.

* Kansas University Science Bulletin, vol. II, No. 12, pp. 323, 324.

Family ACRIDIIDÆ.

Paratettix toltecus Saussure.
Bill Williams Fork, Mohave-Yuma counties, Ariz.; August, F. H. Snow. Five females.

Telmatettix aztecus Saussure.
Bill Williams Fork, Mohave-Yuma counties, Ariz.; August, F. H. Snow. One male.

Bootettix argentatus Bruner.
Bill Williams Fork, Mohave-Yuma counties, Ariz.; August, F. H. Snow. One female.

Eritettix navicula Scudder.
Hamilton county, Kan., 3350 ft.; F. H. Snow. One female.
Morton county, Kan., 3200 ft.; June, 1902, F. H. Snow. Three males.
Clark county, Kan., 1962 ft.; May, F. H. Snow. Two females.
Considerable variation in the flexure of the lateral carinæ of the pronotum is exhibited by the above-listed specimens. In one female, these carinæ are practically straight and without any appreciable constriction, while the others have the reverse true to a greater or less extent.

Amphitornis bicolor Thomas.
Morton county, Kan., 3200 ft.; F. H. Snow. One male.
Clark county, Kan., 1962 ft.; F. H. Snow. One female.
The black lateral bars on the pronotum are not as broad and distinct as in some Nebraska specimens examined.

Orphulella compta Scudder.
Bill Williams Fork, Mohave-Yuma counties, Ariz.; August, F. H. Snow. One male.

Boopedon nubilum Say.
Kansas; July. One female.

Psolœssa maculipennis Scudder.
Clark county, Kan., 1962 ft.; May or June, F. H. Snow. Two females.

Stirapleura delicatula Scudder.
Morton county, Kan., 3200 ft.; F. H. Snow. One male.
Hamilton county, Kan., 3350 ft.; June, F. H. Snow. One female.
Willow Park, Colo. Two females.
Estes Park, Larimer county, Colo.; July, 1892, F. H. Snow. One female.

Ligurotettix kunzei Caudell.
Bill Williams Fork, Mohave-Yuma counties, Ariz.; August, F. H. Snow. One male, one female.

Arphia conspersa Scudder.
Clark county, Kan., 1962 ft.; May or June, F. H. Snow. One male, one female.

Chortophaga varidifasciata De Geer.
Clark county, Kan., 1962 ft.; F. H. Snow. One male, two females.

Hippiscus tuberculatus Palisot.
Clark county, Kan., 1962 ft.; May, F. H. Snow. One male.

Hippiscus corallipes Haldeman.
Clark county, Kan., 1962 ft.; June, F. H. Snow. Two males, two females.

Hippiscus conspicuus Scudder.
Hamilton county, Kan., 3350 ft.; F. H. Snow. One male.

Derotmema delicatum Scudder.

Bill Williams Fork, Mohave-Yuma counties, Ariz.; August, F. H. Snow. One male.

Mestobregma boreale Saussure.

Caddoa, Bent county, Colo.; F. H. Snow. One male. As far as can be made out from the meager original description, this specimen represents Saussure's boreale. It is separated from plattei by the superiorly constricted frontal costa.

Trepidulus rosaceus McNeill.

Bill Williams Fork, Mohave-Yuma counties, Ariz.; August, F. H. Snow. One female.

Conozoa sulcifrons Scudder?

Bill Williams Fork, Mohave-Yuma counties, Ariz.; August, F. H. Snow. Two females.

Trimerotropis salina McNeill?

Clark county, Kan., 1962 ft.; June, F. H. Snow. One male.

Trimerotropis saxatilis McNeill.

Caddoa, Bent county, Colo.; F. H. Snow. One male.

Trimerotropis snowi, n. sp.

Type: female. Congress Junction, Yavapai county, Ariz.; July, F. H. Snow. Collection University of Kansas. Allied to T. melanoptera McNeill, but with the vertex slightly narrower, the eye slightly shorter, the basal and median dark bands of the tegmina more distinctly composed of spots, the yellow of the wings more extensive and the fuscous band narrower. Some characters would throw this species under F1 of McNeill's table, but it agrees with nothing in that section, and is no doubt close to melanoptera, paratypes of which have been compared with snowi.

Size large; form somewhat robust. Interspace between the eyes equal to the transverse diameter of the eye; scutellum of the vertex slightly broader than long, shallow, median and lateral carina distinct but low, the former not distinguishable on the occiput; lateral foveolæ rather small, sublanceolate, shallow; frontal costa subequal for the greater part with a slight constriction above the ocellus, moderately sulcate, failing to reach the clypeus by a considerable distance; eye not prominent, very distinctly shorter than the infraocular portion of the genæ; antennæ slender, elongate, exceeding the head and pronotum by half the length of the latter. Pronotum considerably expanded posteriorly, metazona about one and three-fourths the length of the prozona; anterior margin subtruncate, posterior margin rectangulate with the angle rounded; median carina low and weak; prozona with several transverse rugæ, metazona subgranulose; lateral lobes subequal in width, the anterior margin slightly arcuate, postero-inferior angle rounded. Tegmina long and rather broad, apex obliquely truncate; the costal field wide; intercalary vein for its whole length closer to the median than to the ulnar vein, though somewhat approaching the latter proximately. Wings moderately long, rather broad, slightly more than half again as long as broad. Posterior femora comparatively slender, not exceeding the apex of the abdomen.

General color vinaceous buff, becoming vinaceous on the head and pleura. Lower part of head and face hoary; eyes burnt sienna; antennæ blackish brown. Pronotum with several whitish, longitudinal bars on the lateral lobes and a number of small blackish points on the disk of the metazona. Tegmina with the transverse bands broken and dissected into blotches of greater or less size, yet retaining their position in their respective groups; the apical bar is not defined, as the blotches are more properly annuli and more isolated; apical portion hyaline except at the costal margin, and with a number of scattered annuli. Wings with the disk longer than broad, primrose yellow; fuscous band broad and solid blackish brown, equaling one-third the length of the wing and extending to the internal margin of the wing; apical fourth hyaline with the longitudinal veins blackish brown; ulnar tænia very short and blunt, not reaching one-third the distance to the base of the wing. Abdomen above scarlet vermillion, below wood brown. Posterior femora externally dull vinaceous, faintly hoary, and with three obscure blackish bars, the preapical one of which is the most distinct; internal face scarlet vermilion with two black bars; inferior sulcus scarlet vermilion with one (preapical) black bar; genicular region blackish internally, dull fuscous externally. Posterior tibiæ with the external face basally flesh color, median and apical sections and the basal internal face scarlet vermilion; spines tipped with black.

Measurements: Length of body, 38 mm.; length of pronotum, 8.2 mm.; greatest width of pronotum, 7 mm.; length of tegmina, 38 mm.; greatest width of tegmina, 8 mm.; length of wings, 35 mm.; width of wings, 21 mm.; length of posterior femora, 17.5 mm.

The type is the only specimen of this species examined. I take pleasure in dedicating this species to Prof. F. H. Snow, who collected the type.

Anconia integra Scudder.

Bill Williams Fork, Mohave-Yuma counties, Ariz.; July and August, F. H. Snow. Three females. As is usual with this species, the above series exhibits a great amount of color variation.

Heliastus aridus Bruner.

Bill Williams Fork, Mohave-Yuma counties, Ariz.; August, F. H. Snow. Two females.

Heliastus minimus Scudder.

Bill Williams Fork, Mohave-Yuma counties, Ariz.; August, F. H. Snow. One female. This specimen is undoubtedly this species, but it is considerably larger than the measurements given by Scudder. The form of the lower portion of the lateral lobes of the pronotum does not appear very materially different from H. aridus, but the form of the pronotum, the slender posterior femora and peculiar coloration as well as size will readily distinguish this well-marked species.

Titthotyle maculata Bruner.

Bill Williams Fork, Mohave-Yuma counties, Ariz.; August, F. H. Snow. One female. This species has been definitely recorded but once before, then from Needles, Cal., a locality not very distant from Bill Williams Fork.

Leptysma marginicollis Serville.

Bill Williams Fork, Mohave-Yuma counties, Ariz.; August, F. H. Snow. One female. This individual is inseparable from Florida specimens.

Schistocerca shoshone Thomas.

Bill Williams Fork, Mohave-Yuma counties, Ariz.; August, F. H. Snow. One male.

PLATE XXVIII.—Vertical Section of Ant Mound at Hays City, Kan.
(Showing five feet of excavation.)

Schistocerca venusta Scudder.
Bill Williams Fork, Mohave-Yuma counties, Ariz.; August, F. H. Snow. One female. This individual is considerably larger than representatives of the same sex from Salt Lake City, Utah, and San Diego county, Cal.

Schistocerca vaga Scudder.
Bill Williams Fork, Mohave-Yuma counties, Ariz.; August, F. H. Snow. One male.

Melanoplus flavescens Scudder.
Bill Williams Fork, Mohave-Yuma counties, Ariz.; August, F. H. Snow. One female. I owe the identification of this specimen to Mr. A. N. Caudell, who kindly compared it with United States National Museum material.

Melanoplus flavidus Scudder.
Bill Williams Fork, Mohave-Yuma counties, Ariz.; August, F. H. Snow. One male. Mr. A. N. Caudell kindly compared this specimen and supplied the above identification.
Clark county, Kan., 1962 ft.; June, F. H. Snow. One female.

Melanoplus canonicus Scudder.
Bill Williams Fork, Mohave-Yuma counties, Ariz.; August, F. H. Snow. One male, one female. The furcula of the male individual are more robust apically than in Scudder's figure.

Melanoplus compactus Scudder.
Clark county, Kan., 1962 ft.; June, F. H. Snow. Two females. Previously recorded from Dakota and Sheridan county, Neb.

Melanoplus minor Scudder.
Clark county, Kan., 1962 ft.; June, F. H. Snow. One male, one female.

Melanoplus yarrowi Thomas.
Bill Williams Fork, Mohave-Yuma counties, Ariz.; August, F. H. Snow. One male, one female.
South Arizona; August, 1902, F. H. Snow. One male.
These individuals agree well with a pair from Phœnix, Ariz. A female specimen from Logan county, Kan., F. H. Snow, August, is doubtfully referred to this species. The specimen is almost identical in structure, and, if true yarrowi, considerably extends the range of the species.

Pœcilotettix sanguineus Scudder.
Bill Williams Fork, Mohave-Yuma counties, Ariz.; August, F. H. Snow. One male, one female.

Family Locustidæ.

Scudderia furcata Bruner.
Douglas county, Kan., 900 ft.; September, V. L. Kellogg and E. S. Tucker. Two males, five females.

Scudderia furcifera Scudder.
Southern Arizona; August, 1901, F. H. Snow. One male, one female. Previously recorded in the United States from Prescott, Ariz.

Amblycorypha scudderi Bruner.
Douglas county, Kan., 900 ft.; V. L. Kellogg. One female. This species was described from eastern Nebraska.

Amblycorypha parvipennis Stal.
Douglas county, Kan., 900 ft.; F. H. Snow. One male. This species was previously known only from Texas.

Amblycorypha hausteca Saussure.

Southern Arizona; August, 1902, F. H. Snow. One female. This record extends the range of the species considerably to the west.

Microcentrum laurifolium Linnæus.

Douglas county, Kan.; September. One male.

Southern Arizona; August, 1902, F. H. Snow. One male.

The Arizona record is considerably west of any previous captures, and may represent accidentally introduced stock.

Conocephalus crepitans Scudder.

Douglas county, Kan.; September. One male.

Sedgwick county, Kan., 1300 ft.; E. S. Tucker. One male.

These individuals fully agree with Lincoln, Neb., specimens.

Conocephalus triops Linnæus.

Douglas county, Kan.; taken at electric light, September, E. S. Tucker. One male.

Concephalus mexicanus Saussure.

Bill Williams Fork, Mohave-Yuma counties, Ariz.; August, F. H. Snow. One male.

Orchelimum glaberrimum Burmeister.

Douglas county, Kan.; taken at electric light, September, E. S. Tucker. One male.

Orchelimum volantum McNeill.

Douglas county, Kan.; taken at electric light, July, E. S. Tucker. One female.

This species was previously known only from Illinois and Indiana.

Orchelimum gladiator Bruner.

Douglas county, Kan., 900 ft.; F. H. Snow. One male. This species was previously recorded only from Nebraska and Indiana.

Orchelimum cuticulare Serville—Redt (?)

Douglas county, Kan., 900 ft.; September, Mary H. Wellman. One female. This form was previously recorded from Texas.

Orchelimum longipenne Scudder.

Douglas county, Kan ; taken at electric light, July, E. S. Tucker. One female.

Xiphidium fasciatum De Geer.

Colorado Springs, El Paso county, Colo., 5915 ft.; August, E. S. Tucker. One male.

Xiphidium strictum Scudder.

Douglas county, Kan.; September. Two females.

Xiphidium attenuatum Scudder.

Douglas county, Kan.; taken at electaic light, August, E. S. Tucker. One male. On comparing authentic specimens of lanceolatum Bruner, they are seen to be identical with this species.

Capnobotes fuliginosus Thomas.

Congress Junction, Yavapai county, Ariz.; July, F. H. Snow. One female.

Stipator (Orchesticus) cragini Bruner.

Wallace county, Kan., 3000 ft.; F. H. Snow. One male.

Eremopedes balli Caudell.

Magdalena mountains, Socorro county, N. M.; August, 1894, F. H. Snow. One female. This specimen was determimed by Mr. A. N. Caudell.

Plagiostira gracila, n. sp.

Type: Female. Bill Williams Fork, Mohave-Yuma counties, Ariz.; August, F. H. Snow. Apparently allied to P. albofasciata Scudder and Cockerell, but differing in the smaller size, the slenderer posterior femora and broader and weaker longitudinal bars on the pronotum and abdomen.

Size medium; form slender and elongate. Head with the occiput rather flat, slightly arched transversely; fastigium broader than the first antennal joint, apically decurved and touching the frontal process, slightly sulcate in the basal portion; eyes rather large and moderately prominent, subglobose, truncate anteriorly; antennæ equal to the body and ovipositor in length. Pronotum longitudinal, transversely arched; anterior margin subtruncate, posterior margin very broadly and shallowly emarginate; lateral lobes almost twice as long as high, posterior half of the margin diagonally emarginate. Abdomen somewhat compressed; ovipositor almost equal to the body in length, rather broad, slightly arcuate, apex acute; subgenital plate slightly longer than broad, the apical margin with a median V-shaped emargination. Prosternum unarmed. Limbs all slender. Anterior femora slightly shorter than the head and pronotum, unarmed except for a pair of genicular spines; tibiæ slightly longer than the femora, armed on the superior anterior margin with two or three spines, inferior margins regularly armed. Median femora slightly longer than the anterior pair and similarly armed; tibiæ with four spines on the superior anterior and two on the superior posterior margins, inferior margins regularly armed. Posterior femora very slender and elongate, almost equal to the body in length, moderately bullate basally, tapering gradually to the slender distal half which is subequal, inferior internal margin with three to five small median spines; tibiæ compressed quadrate in section, slightly longer than the femora, regularly armed above except at the base, beneath irregularly armed with six or seven pairs and a few scattered spines; metatarsi about equal to the third and fourth tarsal joints united.

General color, cinnamon, with a pair of rather broad, subparallel streaks of ecru drab extending from the upper margin of the eyes to the apex of the abdomen, lateral margins of the pronotum broadly margined with the same tint, face washed with greenish, eyes walnut brown, flanked posteriorly on the head by a brownish postocular bar; anterior and median femora liver brown, tibiæ clear green; posterior femora hoary, suffused apically with clear green, which latter is the color of the tibiæ and tarsi.

Measurements: Length of body, 26 mm.; length of pronotum, 6.1 mm.; greatest dorsal width of pronotum, 4 mm.; length of posterior femora, 25 mm.: length of ovipositor, 23.2 mm.

The type is the only specimen examined.

Anteloplus notatus Scudder.

Bill Williams Fork, Mohave-Yuma counties, Ariz.; August, F. H. Snow. One male. This specimen has been examined and compared with U. S. National Museum material by Mr. A. N. Caudell.

Stenopelmatus oculatus Scudder.

Clark county, Kan., 1962 ft.; June, F. H. Snow. One male.

Magdalena mountains, Socorro county, N. M.; August, 1894, F. H. Snow. Three males, one female.

Ceutophilus paucispinosa, n. sp.

Type: Female. Southern Arizona; August, 1902, F. H. Snow. Allied to C. varicator Scudder, but differing in the regularly serrate inferior margins of the posterior femora, the fewer spines on the anterior and median femora, and the longer ovipositor.

Size rather large; form rather robust. Head short and broad; vertex strongly declivent; fastigium not half as wide as the first antennal joint, narrowly sulcate; interspace between the eyes equal to about twice the length of the eye; antennæ rather stout, exceeding the body in length; eyes pyriform in outline; palpi with the terminal joint curved. Pronotum strongly arched transversely; anterior and posterior margins truncate, lateral lobes inferiorly subtruncate. Mesonotum and metanotum laterally extending below the pronotum. Abdomen briefly but uniformly hirsute; cerci not half the length of the ovipositor, basally stout, apically attenuate; ovipositor about four-fifths the length of the posterior femora, stout basally, tapering to the apex, which is slightly upturned and rounded below. Anterior femora one and a third times the length of the pronotum, armed on the anterior margin with a single preapical spine; tibiæ unarmed above. Median femora very slightly exceeding the anterior femora in length, unarmed below and with a single genicular spine; tibiæ armed above with two pair of spines. Posterior femora rather stout, considerably shorter than the body, three and a half times as long as broad, apical portion rather stout, inferior margins minutely serrulate; tibiæ about one and one-sixth the length of femora, spurs four pairs in number, margins distinctly serratodentate, median inner calcaria distinctly longer than the external, inferior surface with a single median spine in addition to the apical pair; metatarsi about as long as the other tarsal joints united; third joint about half the length of the second.

General color, tawny-olive, suffused on the pronotum with bistre, each abdominal segment posteriorly edged with the same. Ovipositor ferruginous. Tarsi pale cinnamon.

Measurements: Length of body, 18.5 mm.; length of pronotum, 5.5 mm.; greatest width of pronotum, 5.7 mm.; length of posterior femora, 14 mm.; length of ovipositor, 12 mm.

Ceutophilus arizonensis Scudder.

Magdalena mountains, Socorro county, N. M.; July, 1894, F. H. Snow. One male.

Ceutophilus neomexicanus Scudder.

Clark county, Kan., 1962 ft.; June, F. H. Snow. One male. This specimen fully agrees with the structural characters of neomexicanus, as given by Scudder, but differs slightly in the color, which, however, appears in this case to be of very trifling importance.

Ceutophilus ater Scudder.

Douglas county, Kan.; April, F. H. Snow. One male. This individual agrees very well with the specimens from San Miguel county, New Mexico, referred by me to this species, except for its paler coloration.

Phrixocnemis franciscanus, n. sp.

Types: Male and female. Humphrey's Peak, at base, 9500 ft., Coconino county, Arizona: August, F. H. Snow. This species and the following can readily be distinguished from the other species of Phrixocnemis by the larger posterior tibiæ, which are about equal to the femora in length. The tibiæ are not expanded above as they are in validus and bellicosus, while the comparatively straight tibiæ removes them from truculentus.

Male.—Size large; form very stout, subfusiform. Head broad, anteriorly flattened; occiput rounded and descending vertically to the interocular region; eyes irregularly quadrate in outline, separated by one and one-half times their greatest length; antennæ somewhat exceeding the body in length; palpi with the third joint slightly shorter than the fifth. Pronotum arched transversely, somewhat flattened above: anterior margin with the median portion slightly emarginate, posterior margin truncate, inferior margin broadly rotundate. Mesonotum and mesonotum (metanotum?) posteriorly truncate, laterally extending a short distance below the pronotum. Abdomen regularly armed with minute spiniform tubercles; cerci about half the length of the posterior femur, regularly tapering from the base to the apex; subgenital plate divided to the base by a narrow slit, tips divergent. Anterior femora about a fifth as long again as the pronotum, armed beneath on the anterior margin with a single large preapical spine and several smaller ones, no genicular spine present; tibiæ unarmed above. Median femora about equal to the anterior pair in length, armed beneath on the anterior margin with three or four spines, on the posterior margin with several spines, genicular spine present on one limb and absent on the other; tibiæ armed above with two pairs of spines. Posterior femora short, stout, not quite three times as long as broad, inferior margins with their distal two-thirds closely and strongly armed with short, stout teeth, no genicular spine present: tibiæ slightly shorter than the femora, hardly curved, armed above with four pairs of spines, below with two apical pairs and four longitudinally disposed spines, calcaria comparatively short, the median pair considerably exceeding the others in length: metatarsi slightly longer than the fourth tarsal joint, second joint very slightly longer than the third joint.

FEMALE.—Size medium; form moderately elongate, subequal: structure as in the male, with the following exceptions: Head with the interspace between the eyes somewhat greater; antennæ not exceeding the body in length. Cerci short, not more than one-third the length of the posterior femur; ovipositor two-thirds the length of the posterior femur, thick at the base, narrow and subequal in the apical half, not curved, apex obliquely truncate, the superior point acute and spiniform, internal valves with five teeth; subgenital plate transverse, apically rounded, with a slight median emargination. Anterior femora with the distinct pregenicular spine but no smaller ones.

General color ochraceous, suffused above with Vandyke brown.

Measurements: Length of body, male 22 mm., female 19 mm.; length of pronotum, male 6.5 mm., female 4.8 mm.; greatest width of pronotum, male 9 mm., female 6 mm.; length of posterior femora, male 16 mm., female 9.5 mm.; length of ovipositor, 6.2 mm.

An additional smaller male from the type locality has been examined.

Phrixocnemis socorrensis, n. sp.

Types: Male and female. Magdalena mountains, Socorro county, N. M.; August, 1894, F. H. Snow. Allied to P. franciscanus, but differing in the longer and slenderer ovipositor.

MALE.—Size large; form rather elongate, compressed. Head broad, flattened anteriorly; interspace between the eyes not quite twice the greatest diameter of the eye; eye subpyriform; antennæ slightly longer than the body; third palpal joint slightly shorter than the fifth. Pronotum arched transversely, somewhat compressed; anterior margin slightly emarginate, posterior truncate. Mesonotum and metanotum extending slightly below the pronotum. Abdomen somewhat compressed; cerci about half the length of the posterior femora, stout basally but tapering to a fine point; subgenital plate divided for half its length. Anterior femora exceeding the pronotum by about one-sixth the length of the latter, armed with a single preapical spine on anterior inferior margin; tibiæ somewhat flattened but unarmed above. Median femora about equal to the anterior pair in length, armed inferiorly on the anterior margin with two and on the posterior margin with five spines; tibiæ armed above with two pairs of spines. Posterior femora moderately stout, three times as long as broad, armed below on the distal half of the external and on almost the entire length of the internal with closely set, short teeth, intervening sulcus deep; tibiæ equal to the femora in length, straight, bearing four pairs of spurs, and between them supplied a number of blunt spines of the second grade, below armed with two apical pairs of spines and a longitudinally disposed series of four spines; middle calcaria but slightly longer than the upper pair; metatarsi slightly longer than the fourth tarsal joint, second joint slightly longer than the third.

FEMALE.—Similar to the male except for the following points: Ovipositor almost two-thirds the length of the posterior femora, stout basally, slender apically, the apex obliquely truncate and produced above into a spiniform process, internal valves with five recurved hooks; cerci short, thick basally, tapering; subgenital plate transverse, rounded, with no appreciable median emargination. Median femora armed on each inferior margin with three spines. Posterior femora slenderer than in the male, almost three and a half times as long as broad; tibiæ armed with but three spines in the inferior longitudinal series instead of four.

General color ochraceous, suffused above and particularly on the margins of segments with Vandyke brown.

Measurements: Length of body, male 26.5 mm., female 24 mm.; length of pronotum, male 6.8 mm., female 6.5 mm.; greatest width of pronotum, male 8.6 mm., female 7.5 mm.; length of posterior femora, male 16.5 mm., female 14 5 mm.; length of ovipositor, 9 mm.

Two additional specimens, a male and a female, from the type locality have also been examined, both smaller than the type individuals.

Daihinia brevipes Haldeman.

Colorado; July, F. H. Snow. One male, one female.

Clark county, Kan., 1962 ft.; F. H. Snow. One female.

The male individual has, with the preapical spine, but one exceptionally large spine on the external margin of the posterior femora.

Udeopsylla nigra Scudder.

Douglas county, Kan.; June. One male.

Udeopsylla robusta Haldeman.

Clark county, Kan., 1962 ft.; June, F. H. Snow. One male.

Colorado; July, F. H. Snow. One male.

The University collection also contains a large male individual of this species from Sedgwick county, Kan., collected by E. S. Tucker.

Udeopsylla serrata, n. sp.

Type: Male. Southern Arizona; August, 1902, F. H. Snow. Differing from U. robusta and nigra by the smaller spines of the inferior margin of the posterior femora, and the considerably smaller size. From U. vierecki, with which it agrees in the spine armature of the posterior femora, it differs in the smaller size, slenderer posterior tibiæ, and the slightly more recurved lateral lobes of the mesonotum and metanotum.

Size medium; form short, broad fusiform. Head broad; interspace between the eyes almost equal to twice the width of the eye; eyes broad ovoid; antennæ almost twice the length of the body; palpi with the fifth joint half again as long as the third. Pronotum arched transversely, slighly compressed; anterior border broadly emarginate, posterior truncate, lateral lobes subtruncate. Mesonotum and metanotum very slightly deeper than the pronotum. Abdomen distinctly but moderately compressed, lateral aspects sprinkled with fine granules, cerci short, about one-fourth the length of the posterior femora, subgenital plate deeply and broadly emarginate, the lateral portions projecting as obtuse-angulate lobes. Anterior femora about one-sixth longer than the pronotum, anterior inferior margin unarmed or with a single preapical spine; tibiæ unarmed above. Median femora about equal in length to the anterior pair, armed beneath on the anterior margin with one to four spines, on the posterior margin with five spines. Posterior femora slightly more than three times as long as broad, the superior face bearing a number of short spiniform tubercles, distal two-thirds of the inferior margins with close-set series of short teeth, intervening sulcus moderately deep; tibiæ equal to the femora in length, very slightly bent, armed above with four pairs of spurs and a number of spines of the second grade, below armed apically with two pairs and two single spines, inferior calcaria exceeding the others in length.

General color of the dorsal surface of the body burnt sienna inclining toward Vandyke brown on the abdomen. Ventral surface and limbs ochraceous.

Measurements: Length of body, 15 mm.; length of pronotum, 5.2 mm.; greatest width of pronotum, 6.5 mm.; length of posterior femora, 14 mm.

Family GRYLLIDÆ.

Tridactylus apicalis Say.

Bill Williams Fork, Mohave-Yuma counties, Ariz.; August, F. H. Snow. One individual.

Gryllus pennsylvanicus Burmeister.

Bill Williams Fork, Mohave-Yuma counties, Ariz.; August, F. H. Snow. One male.

Œcanthus fasciatus Fitch ?

Bill Williams Fork, Mohave-Yuma counties, Ariz.; August, F. H. Snow. One female. Some doubt is attached to this identification.

ADDITIONS TO THE LIST OF THE HEMIPTEROUS FAUNA OF KANSAS.

By F. F. CREVECŒUR, Onaga.

Read before the Academy, at Topeka, December 29, 1904.

IT appears that there has not been any list of the Hemiptera of Kansas published since that of Prof. E. A. Popenoe, in volume IX of the Transactions of the Kansas Academy of Science, on pages 62 *et seq.;* so the writer has thought it incumbent upon him to make out a list of additions to that list, comprising the unlisted species collected by him, and of others mentioned in publications to which he has had access.

With the exception of the nine species of coccids at the end of this list, which are found mentioned in Bulletin No. 98 of the Kansas State Agricultural College, the species in this list were, with the exception noted in its proper place, collected by the writer within a few miles of his home, five miles northeast of Onaga. There are 147 species in Professor Popenoe's list and 244 in this, and, making allowance for about ten species that may perhaps with safety be referred to both lists, we have a total of 381 species so far reported from the state.

Acknowledgments are due the United States Department of Agriculture, Prof. C. P. Gillette, of the Colorado Agricultural College, Prof. E. D. Ball, of the Utah Agricultural College, Prof. E. P. Van Duzee, of Buffalo, N. Y., and Prof. E A. Popenoe, for determinations and other favors shown the writer.

HETEROPTERA.

Homœmus grammicus Wolff. On weeds on high prairie. June.
ænifrons Say. On weeds in slough. September. Rare.
Corimelæna atra A. & S. On weeds in slough. May.
Amnestus spinifrons Say. On weeds in slough. May.
Perillus confluens H. Sch. In houses in winter.
Podisus cynicus Say. On weeds in timber. June.
Podops cinctipes Say. Under stones on prairie. April.
Neotiglossa sulcifrons Stal. On prairie. June.
Euschistus tricinctus. On weeds in timber. September.
Coenus delius Say. On weeds in low meadow. June.
Hymenarcys nervosa Say. On weeds in timber. June.
Nezara hilaris Say. On weeds in timber. May.
Catorintha mendica Stal. On weeds in timber. June.
Anasa armigera Say. On weeds in timber. June.
Alydus 5-spinosus Say. On weeds in timber. August, September.
Jalysus spinosus Say. On Gaura biennis. August.
Orcillacus productus Uhl. On forest-trees. April.
Ischnorhynchus didymus Zett. On Symphoricarpus vulgaris. April.

Cymus angustatus Stal. On weeds in slough. July.
Geocoris fuliginosus Say. Under wood in dooryard. November.
Cryphula parallelogramma Stal. Under wood in timber. March.
Œdancala dorsalis Say. Under sticks in dooryard. April?
Lygyrocoris sp.
Ptochiomera clavigera Uhl. Under wood in dooryard. October, November.
nodosa Uhl. Under stones in dooryard. November.
Cnemodus mavortius Say. Under stones on bank in timber. October.
Taleonemia elongata Uhl. On weeds in slough. May, June.
Emblethus arenarius Linn. Under sticks in orchard. October.
Peritrechus fraternus Uhl.
Peliopelta abbreviata Uhl. Under stones at edge of field. April.
Pamera basalis Dall. Under sticks in orchard. October.
Psilophorus confusus Kirsch. In orchard. July.
Melanocoryphus facetus Say.
Trigonotylus ruficornis Fall. On weeds on prairie. August.
Miris rubillus Uhl. At light. August.
Collaris oculata Reut. On weeds in timber. June.
Garganus fusiformis Say. On weeds in timber. June.
Calirmiris uhleri Reut. In low meadow. June.
Lopidea media Say. On weeds in timber. June.
Oncognathus binotatus Fabr. On weeds in timber. June.
Hadronema militaris Uhl. On weeds on prairie. June.
pulverulenta Uhl. On weeds in timber. June.
Phytocoris eximius Reut. On weeds in timber. June.
Neurocolpus nubilus Say. On weeds in timber. June.
Calocoris superbus Uhl. On weeds in timber. June.
bipunctatus Fabr. On weeds in timber. June.
Lygus sp. In timber. May.
Neoborus petitii Uhl. On weeds near water in timber. June.
Pœcilocapsus gonipherus Say. On weeds in timber. May.
Calicapsus histrio Reut. On Symphoricarpus vulgaris. April.
Systratiotus americanus Reut. On weeds in timber. June.
venaticus Uhl. On weeds in slough. June.
Camptobrochis grandis Uhl. On weeds in timber. June.
Orthops scutellaris Uhl. In grove on prairie. June.
Pamerocoris anthocoroides Uhl. On weeds in timber. June.
Myacœlum catulum Uhl. On cottonwood in grove. June.
Diommatus congrex Uhl. Under piece of cloth in tree in grove. July.
Halticus uhleri Girard. On weeds in slough. July.
Cyrtopeltocoris sp. On weeds in pasture. October.
Dicyphus californicus Stal. On hazel bushes. June.
Eucerocoris guttulatus Uhl. On weeds in timber. July.
Episcopus ornatus Reut. On Ambrosia artemisiæfolia. August.
Hyalioides vitripennis Say. On hazel bushes. July.
Plagiognathus pallipes Uhl. On hazel. June.
obscurus Uhl. On weeds on prairie. June.
sp. On prairie. June.
Malorocoris irroratus Say. On bur-oak in orchard. July.
Agalliastes decolor Uhl. At light. August.
simplex Uhl. On weeds in timber. June.
signata Uhl. In orchard. June.
associatus Uhl. On weeds along road. June.

Melinna modesta Uhl. Under cloth in tree in orchard. July.
pumila Uhl. In orchard. July.
minuta Uhl. On weeds on prairie. July.
Psallus sp. On weeds in pasture. September.
Lyctocoris campestris Fabr. In low meadow. June.
Triphleps insidiosus Say. On flowers of Helianthus sp. September.
Anthocoris musculus Say. Under cloth in cottonwood tree.
Piesma cenerea Say. On Amarantus chlorostachya. August.
Corythuca ciliata Say. On weeds in timber. June.
sp. On weeds in timber. May.
sp. In timber. May.
Gargaphia amorphæ Walsh. On bushes in timber. May.
Leptostyla oblonga Say. On weeds in slough. May.
Tingis clavata Say. On weeds on prairie. June.
Physatochila plexa Say. On weeds in slough. May.
Aradus robustus Uhl. Under sticks in orchard. November.
Phymata angulata. On flowers of Compositæ on prairie. June.
Coriscus ferus Linn. Under stones on prairie. April.
Diplodus luridus Stal. On weeds in timber. May.
Emesa longipes DeGeer. On weeds in timber. August.
sp. Under stones on prairie. October, April.
Hygrotrechus remiges Say. On water in streams. May.
Limnotrechus marginatus Say. On water in streams. April. October.
Hebrus pusillus Burm. About a spring on creek bank. April.
Salda interstialis Say. On sandy beach. June.
humilis Say. In swamp. May.
Mesoretia bisignata Uhl. On water of stock pond. August.
Ranatra fusca P. B. In ponds and streams. April.
Corisa scutellata. In stock pond. March, October.
harrisii Uhl. In stock pond. March, October.

HOMOPTERA.

Cicada dorsata Say. On prairie. August, September.
pruinoso Say. In timber. July, September.
Publilia concava Say. On weeds in timber. June.
Entilia sinuata Fabr. On weeds in timber. May.
Ceresa albidospersa Stal. On hazel bushes. July.
Cyrtolobus vau Say. On bushes in timber. June.
sp. In timber. June.
Ophioderma salamandræ Fairm. On Psoralea floribunda. June, July.
Vanduzea vestita Godg. On Psoralea floribunda. June, July.
Phylloscelis atrata Germ. On the prairie. July.
Dictyophora macrorhina Walk. On weeds in timber. August.
Cixius stigmaticus Say. On weeds in timber. June.
Oliarus humilis Say. On weeds in timber. August.
sp. On the prairie. July.
sp. On the prairie. July.
Ketsea crocea Van D. On weeds in timber. May, June.
Stenocranus lautus Van D. On weeds in a swamp. June 15. Rare.
Delphacinus sp.
Œcalus decens Stal. On weeds in slough. June.
Stiprosoma stygica Say. On weeds in timber. May.

Liburnia osborni Van D.
puella Van D.
Lamenia vulgaris Fitch. On weeds in timber. August.
Otiocera wolfii Kirby. On weeds (Urtica gracilis?) in timber. July.
degeeri Kirby. On weeds (Urtica gracilis?) in timber. August.
Bruchomorpha dorsata Fitch. On weeds on prairie. August.
Naso robertsonii Fitch. On weeds on prairie. June.
Dryotura robusta O. & B. On weeds on prairie. June.
Peltonotellus bivittatus Ball. On weeds on prairie. July 3. Rare.
Clastoptera xanthocephala Germ. On weeds in timber. August.
obtusa Say. On weeds in timber. June.
proteus Fitch. On weeds in timber. June.
Moncephora bicincta Say. On weeds in slough. June.
Bythoscopus distinctus Van D. On walnut. June.
Pediopsis tristis Van D. At light. July.
suturalis O. & B. On Salix amygdaloides. June.
punctifrons Van D. In orchard. June.
trimaculata Fitch. In orchard. June.
Idiocerus dugeei Prov. At Westmoreland, Kan. July.
pallidus Fitch. On weeds in pasture. July.
Agallia novella Say. On weeds in timber. August.
quadripunctata Prov. On weeds in timber. May.
sanguineolenta Prov. On prairie. August.
Xestocephalus pulicarius Van D. On weeds in pasture. July.
Tettigonia bifida Say. On weeds in timber. August.
Xerophlœa peltata Uhl. On prairie. October.
viridis Fabr. On prairie. August.
Gypona melanota Speng. On weeds in timber. July.
albomarginata Woodw. On weeds in timber. June.
pectoralis Spang. On prairie. June.
sp. On weeds in timber. June.
Hecalus lineatus Uhl. In low meadow. August.
Penthimia atra Fabr. On weeds in timber. June.
Paramesius stramineus O. & B. On weeds on prairie. June.
Parabolocratus flavideus Sign. On weeds in pasture. June.
Platymetopius frontalis Van D. On hazel. June.
fuscifrons Van D. On weeds in timber. May.
Deltocephalus compactus O. & B. On prairie. June.
sayi Fitch. On weeds on prairie. September.
flavocosta Stal. On weeds on prairie. August.
melsheimeri Fitch. On weeds in slough. May.
oculatus O. & B. On weeds in slough. July.
inimicus Say. On weeds in slough. October.
Athysanus magnus O. & B. In pasture. October.
exitiosa Uhl. On weeds in pasture. October.
obtusus Van D. On weeds in pasture. October.
bicolor Van D. On weeds in pasture. June.
anthracinus Van D. On weeds in timber. June.
comma Van D. On Cassia chamæchrista. August.
Phlepsius majestus O. & B. In timber.
altus O. & B. On weeds in pasture. July.
infumatus. On Ambrosia artemisiæfolia. August.
irroratus Say. On weeds on prairie. August.

Thamnotettix clitellarius Say. On hazel. June.
kennicotti Uhl. On hazel. July.
Eutettix strobi Fitch. On weeds in timber. June.
cincta O. & B. At light. August 3. Rare.
Chlorotettix tergata Fitch. On grasses. June.
spatulata O. & B. In pasture. July.
lusoria O. & B. On weeds in timber. June.
galbanata Van D.
Gnathodus abdominalis Van D. On blue-grass. July.
Cicadula exnotata Fabr. On weeds in pasture.
quadrilineata Forbes. On weeds in pasture. May.
variata Fall. On weeds in pasture. October.
Alebra albostriella Fieb. On bur-oak in orchard. July.
Diacraneura abnormis Walsh. On weeds in pasture. July.
Empoasca pura Stal. On hazel. June.
mali LeBaron. On apple. July.
unicolor Gill. On Amorpha fruticosa. July.
flavescens Fabr. Under dead leaves in timber. March.
obtusa Fitch. In orchard.
Typhlocyba tricincta Fitch. Under dead leaves in timber. March, April.
rubroscuta Gill. Under dead leaves in timber. March, April.
trifasciata Say. Under dead leaves in timber. March, April.
obliqua Say. Under dead leaves in timber. March, April.
dorsalis Gill. On apple. October.
nævus Gill. Under dead leaves in timber. March, April.
fumida Gill. Under dead leaves in timber. March, April.
comes Say. On apple. October.
maculata Gill. Under dead leaves in timber. March, April.
basilaris Say. Under dead leaves in timber. March, April.
vitis Harris. Under dead leaves in timber. March, April.
ziczac Walsh. On the prairie. July.
coloradensis Gill. Under dead leaves in timber. March, April.
scutellaris Gill. Under dead leaves in timber. March, April.
infuscata Gill. Under dead leaves in timber. March, April.
comes comes Say. Under dead leaves in timber. March, April.
vulnerata Fitch. Under dead leaves in timber. March, April.
querci Fitch. On bur-oak in orchard. July.
querci bifasciata G. & B. In timber. May.
crevecœuri Gill. Under dead leaves in timber. March, April.
niger Gill. In grove. April.
bakeri. In timber. May.
Psocus bifasciatus Walsh. On weeds in timber. August.
sp. On cottonwood. July.
sp. In pasture. October.
sp. In orchard. October.
Pemphigus populi-transversus Riley & Monell. On Salix longifolia. May.
Siphonophora rudbeckiæ Fitch.
Trioza diospyri Ashm. In orchard. April.
Chaitophorus negundinis Thos. On box-elder. May.
Coecilius sp. On apple. June.

Aphis sp. On apple. June.
sp. On cherry. June.
sp. On apple. June.
sp. On weeds in orchard. June.
sp. On Prunus americana. June.
Phlœothrips caryæ Fitch. In timber. June.
Aleyrodes sp. On weeds in slough. May.
sp. On bur-oak in orchard. July.
Hæmatopinus urius Nitzsch. On domestic hog.
piliferus Burm. On young dog. February.
Antonina boutelouæ Popenoe. On Bouteloua hirsuta; Manhattan, May.
purpurea Sign. On Milium and Agropyrum; Manhattan, April 25.
nortoni Parrott & Ckll. On Milium racemosa; Manhattan, April 2.
graminis Pope. On Eragrostis trichoides; St. George, May 30. On Bulbilis dactyloides; Manhattan. On Eragrostis trichoides, E. pectinacea, Paspalum ciliatifolium; Hutchinson. On E. trichoides; Nickerson, August.
Gymnococcus nativus Pope. On Sporobolus cryptandrus; Nickerson, August.
Aspidiotus marlatti Parrott. On Andropogon furcatus, A. scoparius, Panicum virgatum, and Chrysopogon arenaceus.
Eriococcus kemptoni Pope. On Andropogon scoparius; Riley county, June 1. On Andropogon scoparius; Dundee, August.
Pseudolecanium obscurum Pope. On Andropogon scoparius; Lost Springs, Parsons, and Fredonia. On Andropogon scoparius and Sporobolus longifolius; Green Mound, October 28.
californicum Ehrhorn. On Andropogon furcatus; Manhattan and St. George.

NOTES ON KANSAS ORTHOPTERA.

By F. B. Isely, Wichita, Kan.

Read before the Academy, at Topeka, December 30, 1904.

THE Orthoptera fauna of the vicinity of Wichita was the subject for special study in connection with a correspondence course in faunistic zoology, taken by the writer during the past year, 1903–'04, under the direction of Dr. C. B. Davenport and Mr. F. E. Lutz, of the University of Chicago.

A small collection, of about 800 specimens, including ninety-seven species, was made. Notes were taken, giving attention to habitat, physiography, habits, seasonal range, and geographical distribution. This paper is based on the collection made and notes taken in connection with this work, the field of study being somewhat extended.

Habitat and seasonal range are given principal consideration. Most of the observations with reference to habits, especially movements and stridulation, are withheld for later report and further study. While most of the species secured are common, several interesting and rare specimens have been taken. To the student of Orthoptera the mere record of locality will be of some value. As far as can be ascertained from Scudder's Index, thirty-four species are reported from Kansas for the first time.

Mr. A. N. Caudell, of the United States National Museum, has kindly passed the specimens in review, so that the identification is assured. The writer is especially indebted to Mr. Caudell for his aid and courtesy, and to Mr. F. E. Lutz for many helpful suggestions.

The various places where collecting was done are here briefly described, to save repetition in the notes.

WICHITA (37° 40′ N. Lat., 97° 20′ E. Long.) Four different localities at Wichita need special mention.

1. *Fairmount.* Fairmount is a small suburb, three and one-half miles northeast of the business center of Wichita, and is the seat of Fairmount College. Fairmount has an altitude of 1380 feet and is 100 feet above the city. Several large prairie pastures, wheat, and alfalfa-fields are in the near vicinity. The writer's residence has been 1337 Fairmount avenue. Fairmount and vicinity were thoroughly searched for specimens, several field trips being made each month from January to December. Seventy-six species were taken on Fairmount during the year. In two hours' time, on September 24, 1904, thirty-three different species were taken in a pasture east of Fairmount.

2. *Cemetery.* Maple Grove cemetery, south of Fairmount, has an altitude of 1350 feet. This place is often mentioned in the notes.

3. *Riverside Park.* The park is located a mile northwest of the business center of the city, and is traversed by the Little Arkansas river. The altitude is about 1260. Several trips were made to the park. Specimens were taken along the river and near Dale's pond not found elsewhere.

4. *Chisholm Creek.* Chisholm creek flows south through the east part of Wichita and about a mile west of Fairmount. Several trips were made in search of specimens along the creek.

CLEARWATER. Clearwater is sixteen miles southwest of Wichita, *via* the Missouri Pacific railroad. Here several days were spent in collecting – December 28 and 29, 1903; and during the present year, 1904, May 7, June 30, July 1–4, August 29–31, and November 19. The collecting-ground was on the Nickerson farm, three miles west of Clearwater, in the Ninnescah river valley. The river bounds the farm on the north. The soil for three-fourths of a mile south is sandy, and shades off into a sandy loam as you reach the higher land. The altitude is from 1240 to 1300 feet. Several interesting specimens were taken in this vicinity.

SEDGWICK. One day, September 17, 1904, was spent on the Finn farm, one mile southeast of Sedgwick, Kan. Some time was spent in Harvey county, as the Finn farm is just on the county line. The altitude of Sedgwick is 1400 feet.

HIAWATHA. Located in the central part of Brown county, in the northeast part of the state; altitude, 1075 feet. As the writer taught in the Brown county institute during August, some collecting was done in this vicinity.

FAIRVIEW. On the Isely farm, two miles north and one-half mile west of Fairview, in the west part of Brown county. Collecting was done August 6–8, 13–15, 20–22, 1904. All Fairview specimens come from the Isely farm; altitude, 1200 feet. The farm is traversed by Spring creek, and on the banks south of the creek some specimens were taken that were not found elsewhere.

ATCHISON. August 1, 1904, several hours were spent among the hills in the east part of the city; also some time along the Missouri river.

1. Labia minor Linn.

Two males were taken at light October 1, 1904.

2. Ischnoptera pennsylvanica DeGeer.

This roach is common, being found beneath trash, bark, boards, in beehives, and moist, protected places. Half-grown specimens were taken on December 28, 1903, under the bark of cottonwood stumps along the Ninnescah river, on the Nickerson farm, Clearwater, Kan. Nymphs were taken under cottonwood bark, May 18, 1904, along the Little Arkansas, in the city park. The first adult, a male, was taken June 22, 1904, under old tin in the park. July 1, 1904, a large number of both sexes were taken beneath trash along the Ninnescah river, on the Nickerson farm. August 15, 1904, nymphs and adults were secured in the tops of beehives on the C. H. Isely farm, Fairview, Kan.

3. Blattella germanica Linn.

Found in dwelling-houses, meat shops, hotels, water-pipes, and similar situations. In a large tenement block in Wichita this "croton bug" was so serious a pest as to make rental impossible. I have found it in adult and nymph stages through the year. In a vinegar factory visited the 13th of April, 1904, this roach was a serious nuisance.

4. Blatta orientalis Linn.

Found in company with B. germanica, having very similar range as to habitat and seasonal distribution.

5. Unnamed Blattidæ.

Nymphs taken from beneath stones in an open field on Fairmount, during all the winter and spring months. Two adults taken at the same place as these nymphs, June 21, 1904. Two at light June 17, 1904.

6. Stagmomantis carolina Linn.

Found in tall grass, weeds, and around light. Eggs kept in the high-school laboratory hatched early in April. Adults are common from August to October.

7. Diapheromera femorata Say.

As many as a dozen specimens were taken July 3, 1904, north of 1636 Holyoke avenue, Fairmount, feeding on grass and weeds.

8. Diapheromera veliei Walsh.

Two specimens, on the open prairie in a large pasture on the Nickerson farm, September 3, 1904. New to Kansas.

9. Nomotettix accuminatus Hanck.

Three specimens, one male and two females, found on south bank of Spring creek, Isely farm, August 21, 1904. This species was first reported from Kansas and by Scudder's Index; is not reported elsewhere.

10. Tettix hancocki Morse.

One specimen, sent to me by Dwight B. Isely, from Fairview, Kan. Taken in a meadow September 24, 1904.

11. Tettix obscurus Hanck.

Found on a moist, sandy bank, along the Little river, in the park. Two male specimens, April 12, 1904. A pair mating June 22.

12. Paratettix cuculatus Brun.

This is the most common of the grouse locusts found in the state. It frequents moist banks of streams and ponds, and will occasionally be found quite remote from water. Specimens have been taken on the Ninnescah and Little Arkansas rivers, also at numerous small ponds in Sedgwick county, on Sand creek, in Harvey county, along the Missouri river, in Atchison county, and along Spring creek, in Brown county. From June to October specimens of this species have been found in situations suitable to their liking.

13. Tettigidea parvipennis Harr.

Found in company with T. obscurus. Only one pair secured, June 22, 1904. The last three species are not listed in Scudder's Index as being reported from Kansas. Mr. F. E. Lutz, however, informs me that they are reported from Kansas in Doctor Hancock's monograph.

14. Mermiria bivittata Serv.

This interesting angle-head frequents prairie pastures and meadows. It reaches maturity in Sedgwick county about the middle of July and is found until October. The first specimens, males, were taken in tall grass along the Frisco railroad east of Fairmount. In Brown county only one immature female was taken, August 20, 1904. Stridulation while at rest is one of the characteristics of the males.

15. Opeia obscura Thos.

This species was found only in short grass on the hilltops, especially buffalo-grass. Only a few specimens were taken and all were females; these on different dates in September.

16. Eritetitix carinatus McNeill.

This species is also found in pastures. Several specimens were taken on the Nickerson farm May 7, 1904; others in the Maple Grove cemetery June 14. Later in the season no specimens could be found. October 30 and November 6 I found two larvæ in the third molt. When we couple this record with its early appearance in the spring, it shows that this species hibernates in the nymph stage. Prof. W. S. Blatchley says of the subfamily Tryxalinæ; "The winter of all is passed in the egg stage." Here certainly is an exception. The male of this species, like M. bivittata, has the interesting method of stridulating when at rest. On Decoration day, in the Maple Grove cemetery, I observed several males intent on sound-making. New to Kansas.

17. Eritetitix tricarinatus Thos.

Only one specimen, a female, in a pasture east of Fairmount, in short grass, July 21, 1904. New to Kansas.

18. Syrbula admirabilis Uhl.

This handsome locust is found only on the upland prairies in tall and short grass. It is rather common and reaches maturity late in August.

19. Dichromorpha viridis Scudd.

Unlike the other Trixalinæ noted, this species is not especially fond of the prairies. It is often found in brushes, and in shrubbery around houses; also in timber margins and shaded places. It reaches maturity early in July and is found until October. The first adult in my collection was taken July 8, 1904. In Atchison county, on August 1, I found this species as one of the most common Acrididæ among the hills east of the city. I have taken specimens in Sedgwick, Brown, Atchison and Harvey counties. The green form is more common than the brown. One specimen, a female, of the long-winged variety, punctulata, was taken at Sedgwick, on the Finn farm, September 17, 1904. Mr. Caudell, writing from the National Museum, says: "We have no specimens of this variety in the collection." New to Kansas.

20. Orphulella speciosa Scudd.

Exceedingly common in short grass, especially buffalo-grass. Found equally abundant on high and low ground. Reaches maturity by the middle of July in Sedgwick county. First adult taken July 14, 1904. This species was found in all the counties where collecting was done, but is far more common in Sedgwick than in the northeast part of the state.

21. Boopedon nubilum Say.

Only one male specimen, taken July 13, among weeds in a pasture, on Fairmount.

22. Ageneotettix scudderi Brun.

This species was also found in all places where I have collected. It is especially abundant in short grass, on hilltops and bare places. It is very common in favorable situations. It reaches maturity early in July in Sedgwick county. First specimen July 14, 1904. Heretofore reported from Kansas by its synonyms, Aulocara scudderi Brun. (Proc. U. S. Nat'l Mus., XII, pp. 63, 64, 1890); also its other synonym, Philbostroma parvum Scudd. (Bull. Wasb. Coll., I, p. 199, 1886).

23. Arphia luteola Scudd.

In Sedgwick county this is one of the most common Acrididæ during the latter half of June and 1st part of July. Later it seems to give way to others. It frequents open fields, short bunch-grass, and cattle paths in the prairies. The wings are a pretty bright-yellow and the male flies with a loud crackling sound. These Arphia are much easier to catch than either of the above. They seem to be a Southern and Western species, being reported from Texas, Utah, and Colorado, but not from Kansas up to this time. The first adult was taken May 30, 1904; several specimens June 14 and July 3.

24. Arphia sulphurea Fab.

Four specimens of this species were taken on May 7, 1904, on the Nickerson farm, in waste ground along the Ninnescah river. A few more were taken a little later in the season, and one on August 24, at Fairview. This species winters in the nymph stage. Heretofore not reported from Kansas.

25. Arphia xanthoptera Germar.

This species frequents open prairies, is abundant along roadsides and in alfalfa-fields. It reaches maturity late in August. Several specimens were taken August 20 on the Isely farm. During September it is very common in Sedgwick county. The males have a quick, jerking flight, and make a cackling sound while on the wing. New to Kansas.

26. Chortophaga viridifasciata DeGeer.

This species is especially interesting on account of the long period of adult activity. It is found pretty generally distributed in open fields and on the prairies, but seems especially to be found in the lowlands near streams. The brown form, infuscate, is the most numerous early in the spring, viridifasciata not being prevalent until May. I have taken nymphs in every month from November to July, and adults from March to November. I have nymphs in my collection November 21 and December 28, 1903; February 27, March 19, and May 30, 1904. The first adult was taken March 29, 1904, among dry weeds along the Little river, in Riverside park. On this date I secured seven specimens. New to Kansas.

27. Encaptolophus sordidus Burm.

This is a fall species. It reaches maturity about the middle of August, and is fairly common until November. It is found in fields and pastures. The male makes a sharp, crackling sound during flight. The first adult was taken August 20, in Brown county. Specimens were seen in Sedgwick county November 24, 1904.

28. Hippiscus haldemanii Scudd.

I secured in all ten specimens of this species; July 3, two males and five females. They are found in pastures and fields. Later in the season they seem to pass by to give room for others.

29. Hippiscus rugosus Scudd.

This is a fall species, reaching maturity about the middle of August.

It is very common among bunch-grass and on hillsides. On September 24, 1904, along a grassy upland road in Harvey county, hundreds of this species flew before the team as we drove along the road.

30. Hippiscus tuberculatus Palde Beauv.

One specimen of this fine-looking locust was taken April 24, 1904, on Fairmount hill. Mr. Caudell has not seen this specimen, but I feel sure that the identification is correct.

31. Dissosteria carolina Linn.

This roadside grasshopper reaches maturity in Sedgwick county about July 1. After this date it is common along roads, paths, railroad tracks and bare places. Of all Acrididæ, it is one of the most difficult to secure. Taken in Sedgwick, Brown and Atchison counties.

32. Spharagemon cristatum Scudd.

This species was not found around Wichita. In sandy fields and pastures on the Nickerson farm it was numerous in June and July. It is certainly well adapted in color to the sandy soil it frequents. June 30, 1904, was the date that the first adult was taken. This species is new to Kansas.

33. Mestobregma plattei Thos.

The gray, ashy, gypsous soil of the bare hillsides east of Fairmount is especially suited to protect this species. In suitable situations, they are to be found in small numbers from the middle of July until cold weather.

34. Mestobregma kiowa Thos.

This species is found in company with plattei, which it resembles. It is however much more numerous. I have taken specimens in Harvey, Brown and Sedgwick counties.

35. Trimerotropis citrina Scudd,

Only on the white drift sand along the Arkansas and the Ninnescah rivers have I been able to find this species. Adult specimens were not secured until September. Others were taken as late as November 20, 1904. This species is exceedingly wary and hard to catch. I have started them as many as twenty times befere being able to get near enough to net them. New to Kansas.

36. Hadrotettix trifasciatus Say.

This species, as taken in Sedgwick county, is perhaps the best adapted to its surroundings of any Acrididæ observed. In my field-notes of July 16, I observe: "This handsome large locust was found only on the bare ground on the west side of a ridge where the light colored, ashy gypsous soil is exposed. They seem to feel that they are entirely secure and could be caught with the greatest ease when once seen. The adaptation to soil color is striking."

37. Schistocerca americana Drury.

This well-known species is found in fields and pastures. Very often a single specimen will be flushed, rise ten to fifteen feet high and fly rapidly ten to twenty rods, lighting, if possible, on some tall weeds, bushes, or trees. I have seen adult specimens from April to November. Blatchley suggests that the early spring species are migratory, flying in from the south.

38. Schistocerca alutacea Harr.

This species is found in tall prairie-grass, especially in low places. It reaches maturity about the middle of August. Found in Brown and Sedgwick counties.

39. Hesperotettix pratensis Scud.

This is not a numerous species in Sedgwick county. I took several specimens in the rank-growing prairie-grass on Fairmount. My field-notes for

July 9 read as follows: "This pretty little locust is just reaching maturity. I secured seven specimens, five males and two females, on the prairie north of 1626 Holyoke."

40. Hesperotettix speciosus Scud.

Found in situations similar to the above, but especially along sloughs. It is not a numerous species in Sedgwick county, and reaches maturity late in July. Prof. Lawrence Bruner says that they feed on several species of Helianthus.

41. Hypochlora alba Dodge.

Found in pastures and waste fields, especially on a silver-colored sage-weed, to which it is well adapted by protective coloration. It reaches maturity about the middle of July, and is found until October. Several specimens were taken at Wichita July 20, 1904.

42. Campylacantha olivacea Scud.

Found in pastures and waste fields in company with M. gracilis. Reaches maturity late in July.

43. Melanoplus atlantis Riley.

One of the most widely distributed species found in Sedgwick county. Upland prairies, waste fields, stubble, along streams, and in meadows. In no one place, however, was the Lesser locust found in large numbers. First adult specimen taken May 30, 1904. Common from June to November.

44. Melanoplus bivittatus Say.

The Two-lined locust is common early in July in pastures and along roadsides. Several specimens taken on Fairmount July 8, 1904.

45. Melanoplus coccineipes Scud.

Only two specimens secured, male and female; found in waste field, sandy soil, Nickerson farm, June 30, 1904.

46. Melanoplus differentialis Uhler.

Very common; found in fields, gardens, and roadsides. Reaches maturity by the middle of July. Taken in Brown, Sedgwick and Harvey counties.

47. Melanoplus femur-rubrum DeGeer.

The common red-legged locust is found everywhere that vegetation grows, from the middle of August to November. Alfalfa-fields, however, are favorite places. A small alfalfa field on Fairmount was mown the afternoon of September 14, 1904. By sweeping in the tall grass growing along the north side of the field I secured 161 adult Acrididæ. Of these, 121 were femur-rubrum; fifty-one males, seventy females. My notion would be that this species would average one-half bushel or more to the acre in the alfalfa-fields of Sedgwick county any time during September.

48. Melanoplus gracilis Brun.

Found along sloughs, in waste fields, and in gardens. Reaches maturity late in July. Not reported from Kansas.

49. Melanoplus impiger Scudd.

Only three specimens of this species in my collection. Taken in a prairie pasture on the Nickerson farm, August 31, 1904.

50. Melanoplus luridus Dodge.

This species is rather common on the open prairies in September. It did not come under my observation until September 7, 1904, when several specimens were taken on Fairmount. Afterward it was found to be fairly numerous.

51. Melanoplus minor Scudd.

Found in pastures and meadows; common during June, but not numerous. First adult taken June 4, 1904. Not reported from Kansas.

52. Melanoplus packardii Scudd.

Found on the prairies and in the waste fields. Very variable in color. Reaches maturity by the middle of July. Earliest specimen in my collection, July 19, 1904.

53. Melanoplus plumbeus Dodge.

Rare in Sedgwick county. Only three specimens were taken; these on different dates in September. One found in the high school yard, Wichita, others in a pasture. One female specimen taken at Hiawatha, August 20, 1904.

54. Melanoplus scudderi Uhler.

This species reaches maturity late in August, and is abundant on prairies and waste fields. One specimen taken in Brown county, on the Isely farm, August 22, 1904.

55. Phœtaliotes nebrascensis Thom.

Fairly common on the prairies in September. First taken in the pastures on the Nickerson farm, August 29, 1904. Reported in the Washburn College Bulletin, I, 136, 137 (1885), by its synonym, Pezotettix nebrascensis Thom.

56. Scudderia texensis Sauss Pictet.

Two specimens were taken in tall weeds along Spring creek, August 15, 1904; two other specimens, in a similar situation, August 30, along the Ninnescah river; all females. New to Kansas.

57. Scudderia furcata Brun.

Found in company with S. texensis, but more common. First taken August 21, 1904, on the Isely farm; later, in September and October, at Clearwater, Wichita, and Sedgwick.

58. Arethæa gracilipes Thom.

This species was found on the open prairies east of Fairmount during July. Only a few specimens were taken.

59. Amblycorypha iselyi Caud., n. sp.

Seven specimens, three males and four females. Two pairs were sent to Mr. A. N. Caudell, who pronounces this a new species. I take the following from my field-notes, July 12, 1904: "A species of katydid caught on the vines at the Lewis residence. The males begin their music a little after sundown, but are not in full chorus before nine P. M. Caught five specimens, one male and four females—the females by sweeping across the woodbine vines about nine P. M. Many males were heard on the vines and weeds near this place, but they were cautious and hard to approach; only one was secured. No good reason can be assigned why they should be found only near the Lewis house, but nowhere else on the hill were they found. Females measure as follows: Body, 29 mm.; tegmen, 25 mm.; width of tegmen, 9 mm.; femur, 27 mm.; antennæ, 35 mm.; pronotum, 8 mm.; ovipositor, 12½ mm."

Mr. Caudell's description, taken from the Journal of the New York Entomological Society, volume XIII, page 50, follows: "In size comparable with A. rotundifolia, but differing from that species in having the elytra more rotundate and the wings aborted, not reaching the tips of the elytra, in this respect allied to the larger parvipennis of Stal. Ovipositor of about the same length and shape as that of rotundifolia, but a little stouter. Pronotum flat above, the lateral carinæ sharp and persistent. Hind femora extending considerably beyond the tips of the elytra in both sexes. Length of pronotum, male, 7.5 mm.; female, 8 mm.; elytra, male, 22.5 mm.; female, 25 mm.; hind femora, male, 25 mm.; female, 26 mm.; of hind femora beyond the tips of the elytra, male, 6.5 mm.; female, 7 mm.; ovipositor, female, 10 mm.; width of elytra, male, 9 mm.; female, 9 mm.;

of pronotum in front, male, 3.25 mm.; female, 3.5 mm.; behind, male, 4.75 mm.; female, 5 mm.

"Type.—No. 8197, U. S. National Museum."

60. Amblycorypha haustica Sauss.

Two specimens, females, taken on the prairie on Fairmount, July 20, 1904.

61. Amblycorypha oblongifolia DeGeer.

Only two specimens, at Wichita; both females. Taken on the prairie east of Fairmount, September 24. At Fairview, Kan., August 15, 1904, several male specimens were secured after nine P. M. on the Isely farm. While several species of Conocephalus, Œcanthus and Microcentrum laurifolium were heard at dusk and a little later, this Amblycorypha did not appear until an hour and one-half after sunset. This I noted to be the case on several evenings. New to Kansas.

62. Microcentrum laurifolium Linn.

Frequents shrubs, trees, and vines, and is also attracted by light. Common during August and September.

63. Conocephalus crepitans Scudd.

Found in tall grass, and especially in cane-fields. Common in Wichita during September.

64. Conocephalus ensigner Harr.

Found in tall grass and weeds. I have taken it only after dark, when the males may be easily located by their loud stridulation. First taken at Wichita July 20, 1904; later, in August, at Fairview, and at Wichita again in September. Only one female secured. This is a common species. New to Kansas.

65. Conocephalus robustus Scudd.

First specimen taken July 30, 1904. Very common during latter part of August and September. Found in tall grass, weeds, and cane-fields. The males begin their music a little before sundown. During the latter part of September, 1903, they were especially numerous at Wichita. They swarmed in great numbers around the electric lights and covered the walks in the morning. The local papers commented on the "unusual insect hordes." New to Kansas.

66. Conocephalus nebrascensis Brun.

This species was taken only at Fairview. Three specimens, all males, were taken on shrubs after dark September 15, 1904. Unlike the other members of this genus so far observed, this species is found among trees and bushes, rather than out in the fields and on the prairie. Not reported from Kansas.

67. Orchelimum agile Desur.

Reaches maturity late in July, and is found upon bushes, small trees, weeds, and tall grass. Numerous in Sedgwick county.

68. Orchelimum glaberrimum Brun.

Very common in grass and weeds along streets and roadsides. Reaches maturity early in August. Found at Fairview, Clearwater, Hiawatha, Sedgwick, and Wichita.

69. Orchelimum gossypii Ashm.

One specimen sent to me by Dwight B. Isely, caught in corn-field September 22, 1904, Fairview, Kan. New to Kansas.

70. Orchelimum longipenni Scudd.

Only three specimens. Two taken at Hiawatha, Kan., August 19, 1904, and one at Clearwater August 30, 1904. Those at Hiawatha found in tall weeds along the streets of the city.

71. Orchelimum nitidum McNeill.

One specimen, a female, on a small tree in my front yard, secured September 7, 1904, Wichita, Kan. New to Kansas.

72. Orchelimum nigripes Scudd.

Very common along streams and ponds. Ten specimens, seven males and three females, were taken in tall slough-grass along the Little river in the city park, October 3, 1904.

73. Orchelimum vulgare Harr.

Common at Hiawatha and Wichita in grass and weeds during August and September.

74. Xiphidium attenuatum Scudd.

Only one specimen, a female; taken October 3, 1904, in the city park, in tall grass near the river. New to Kansas.

75. Xiphidium ensiferum Scudd.

One female specimen, secured by Mrs. Mary N. Isely on a bush in the yard, September 15, 1904. Not reported from Kansas.

76. Xiphidium fasciatum DeGeer.

Reaches maturity the latter part of July. Found in tall and short grass along sloughs, streams, and low ground. Taken at Atchison, Hiawatha, Fairview, Wichita, Sedgwick, and Clearwater. Very variable as to wing length.

77. Xiphidium nemorale Scudd.

Found on the open prairies. First specimen reported from Wichita July 27, 1904. Several specimens, both male and female, taken during August and September. Rather rare. Not reported from Kansas.

78. Xiphidium saltans Scudd.

Tall grass, damp situations. Several specimens taken at Fairview August 9, 1904.

79. Xiphidium strictum Scudd.

This is the most common member of the genus. Reaches maturity early in August. Found on the open prairies and in alfalfa-fields. "On September 14, 1904, a little after sundown, in sweeping the tall grass along the north side of a small alfalfa-field that had been mown that afternoon, I secured seventy-six specimens of this genus, thirty-two males and fourty-four females. Of the females, the ovipositor of thirty-eight measured about 22 mm.; of the remaining six the ovipositor measured 17 mm. These measurements class the first lot as X. strictum and the six as X. saltans. The males would doubtless show a like proportion." (From my field-notes, September 14.)

80. Udeopsylla nigra Scudd.

Found under stones, clods, and boards. Nymphs taken in November, March, and June. Adults were numerous in wheat-fields early in July.

81. Ceutophilus sp.

Found in wheat stubble in large numbers, Nickerson farm, August 30, 1904. Mr. Caudell writes that Professor Blatchley, to whom he referred this species, regards it as close to spinosus, and also allied to blatchleyi and uhleri.

82. Ceutophilus sp.

One female specimen secured October 14, 1904, near a sidewalk, about six P. M. Probably C. latens Scudd.

83. Stipator nigromarginata Caud.

One female specimen, Nickerson farm, September 30, 1904. Found in a prairie pasture. New to Kansas. Mr. Caudell writes: "We have no male specimens. I hope you may find some."

84. Gryllotalpa borealis Brun.

One specimen, a male, was taken October 15, 1904. This was located by its stridulation. Found in a burrow, in a slough on Fairmount. Several were heard along the margin of a small pond in the cemetery. (Mr. Caudell has not seen this specimen.)

85. Myrmecophila sp.

Several specimens found in company with ant colonies under stones. Fairmont, April 30, 1904.

86. Nemobius carolinus Scudd.

I take the following from my field-note book: "June 22, 1904, visited Riverside park. In the rushes southwest of Dale's pond I found a pretty little nemobid, very active and difficult to catch. After a careful search for an hour, I secured six specimens, three males and three females." New to Kansas.

87. Nemobius exiguus Scudd.

Specimens of this species have been taken at Fairview, Clearwater, and Wichita. The first were taken along Spring creek on the Isely farm. They were found under stones in wet places. Several specimens, male and female, adults and nymphs, were taken August 14 and 20, 1904. On the Nickerson farm I secured two females August 31, 1904; these were taken in a stubble-field. One female was taken under a log in Matheson's grove October 13, 1904. The specimens taken along Spring creek were mottled with gray while the others were brownish-yellow in color. Prof. W. S. Blatchley, to whom Mr. Caudell referred the Spring creek specimens, says the two are the same. The habitat, as the notes indicate, is very different. Not reported from Kansas.

88. Nemobius fasciatus DeGeer.

During August and September this species was very numerous; found everywhere in the open fields, along walks in town, and on lawns. This is especially true of the form vittatus, which was first taken in a slough west of the park, July 23, 1904. Later taken at Hiawatha, Atchison, Fairview, Clearwater, and Sedgwick. The macropterous form of this species was taken at light in Hiawatha and Wichita.

89. Gryllus abbreviatus Serv.

Very numerous from August to October. Found everywhere in fields, under walks, and on the prairies. Hundreds of specimens were seen in a stubble-field that was being plowed on the Nickerson farm August 30, 1904. Long- and short-winged forms were equally abundant.

90. Gryllus pennsylvanicus Brun.

This species passes the winter in the nymph stage. On Fairmount nymphs were taken under stones in March, April, May, and June. The first adult was taken June 18, 1904. By the last of June they were very numerous, the merry chirp of the male resounding from every crevice, mouse hole or crack in the ground in fields and pastures. Two females of the macropterous form were taken beneath sand-bags in the city July 17, 1904.

91. Miogryllus oklahomæ Caud.

This is the first cricket to reach maturity at Wichita. The first adult was taken on the cemetery hill south of Fairmount, May 22, 1904. In a few days they became very numerous and the males' stridulation could be heard on all sides in the afternoon and evening. They were especially abundant in the thick, short, dead grass on cemetery hill. This species is of special interest, as will be shown by the following reference to a letter from Mr. Caudell. Under date of August 30, 1904, he writes: "The small gryllid in the vial from Wichita, G 4, is my Miogryllus oklahomæ. These two specimens, male and female, are the only specimens known except the *single male* type. This is the *first* female specimen seen, and is apparently remarkable for the very short ovipositor. I hope you will find more of this species." Eleven specimens were secured, six males and five females. Four are now in the United States National Museum collection and two in Dr. F. H. Snow's collection at the University of Kansas. I still have five specimens in my collection. As no one else has studied this species in the field, I add the following habit notes from my field-note book: "May 31, 1904.—Located three little brown crickets in small burrows from one to one and one-half inches deep. Dug out three males, all in similar situations, and caught one female wandering about in the open. They certainly are very, very difficult to catch. When you are from five to ten yards away they stop their stridulation and often refuse to start again—stand as quiet as you please. The sound is also very hard to locate. Sometimes you think you are near and you are still five or more yards away. The burrows are small and often perpendicular. They look very much as though they were made for the crickets' special use. Three specimens were taken beneath stones. No specimens were secured after June 23, 1904. New to Kansas.

92. Miogryllus saussurei Scudd.

Only five specimens of this species were taken, four females and one male; found under stones on the north slope of a clay hill on the Isely farm, August 8, 1904. New to Kansss.

93. Œcanthus argentinus Sauss.

Only one specimen taken, by Dwight B. Isely, Fairview, Kan., September 24, 1904. New to Kansas.

94. Œcanthus augustipennis Fitch.

This species is numerous and reaches maturity late in August. It is arboreal and most successfully taken by clubbing. By this method I secured a large number of specimens after dark September 7, 1904. New to Kansas.

95. Œcanthus fasciatus Fitch.

This is a very common species and is found everywhere in tall grass, weeds, and wheat-fields. It reaches maturity early in July. New to Kansas.

96. Œcanthus niveus DeGeer.

This is strictly an arboreal species; often only heard in the tree tops. It reaches maturity late in July and is common until October. After dark, on September 7, 1904, I secured a number of specimens by clubbing.

97. Œcanthus quadripunctatus Beut.

This species is also common and is found in fields and pastures. The first specimens of the season were taken in a pasture on the Isely farm August 21, 1904. New to Kansas. This and the three preceding species were found at Wichita, Clearwater, and Fairview.

THE DIPTERA OF KANSAS AND NEW MEXICO.

By T. D. A. COCKERELL, Colorado Springs, Colo.

Read (by title) before the Academy, at Topeka, December 31, 1904.

THE interesting list of the Diptera of Kansas published by Professor Snow does not pretend to be complete, but it is of much value in view of the rarity of such contributions in dipterology. I have been interested in comparing it with the unpublished catalogue of New Mexico Diptera, which I have compiled during the past ten years, and am surprised at the amount of difference between the two faunæ. While this difference is certainly due in part to the incompleteness of the lists, it cannot be wholly without real significance, and it seems worth while to put some of the facts on record for future reference. About 133 species are common to the two lists. The following tabular statement shows some of the details; when numbers are given they relate to species:

Family or genus.	Kansas; not New Mexico.	Kansas and New Mexico.	New Mexico; not Kansas.
Bibionidæ	3	3	4
Culicidæ	6	5	5
Stratiomyidæ	13	5	8
Stratiomyia	apicula Lw. meigenii Wd.	constans Lw.	barbata Lw.
Odontomyia	cincta Oliv. aldrichii Johns. americana Day. intermedia Wd. nigra Day. arcuata Lw.	binotata Lw.	nigrirostris Lw. inæqualis Lw. megacephala Lw.
Tabanidæ:			
Tabanus	exul O. S. fulvulus Wd. melanocerus Wd. venustus O. S.	atratus Fb.	lineola Fb. punctifer O. S. (abundant). guttatulus Twns. gilanus Twns. intensivus Twns. rhombicus O. S.
Asilidæ	29	4	34
Bombyliidæ	20	15	32
Exoprosopa	5	0	3
Anthrax	9	7	14
Empidæ	5	1	32
Dolichopodidæ	19	0	7 (Others undet.)
Psilopus	5	0	melampus Lw. (abundant).
Syrphidæ	21	16	88
Volucella	1	0	13
Conopidæ	9	8	10
Platypezidæ:			
Platypeza	0	1	5
Muscidæ	5	11	2
Sarcophagidæ:			
Sarcophaga	2	0	3

Family or genus.	Kansas; not New Mexico.	Kansas and New Mexico.	New Mexico; not Kansas.
Ortalidæ........	13	2	6
Sapromyzidæ:			
Sapromyza....	tenuispina Lw.	0	vulgaris Th. (abundant). fraterna Lw. longipennis Feb.
Drosophilidæ:			
Drosophila....	0	1	4
Oscinidæ:			
Chlorops......	8	2	1
Sciomyzidæ.....	4	0	4

Of course any comparison between Kansas and New Mexico, even were the lists complete, would fail to bring out the exact nature of the facts, since Kansas contains at least two different faunæ, and New Mexico several. The thing to do now is to accumulate data as rapidly as possible, so that a detailed comparison of all the faunæ and faunulæ may be made.

NOTES ON COLLECTING CICINDELIDÆ.

By D. E. LANTZ, Biological Survey, Washington, D. C.

Read before the Academy, at Manhattan, November 28, 1903.

DURING the past two or three years, in going about the state, I have spent some leisure hours in collecting insects for the department of zoology in the State Agricultural College. The great beauty of most of the representatives of the family of Cicindelidæ attracted my special attention to them, and I began to form a private collection of them. In addition to the varieties and species found in Kansas, I have collected several in Colorado, and have done some exchanging. My experience in the field has given me a fair knowledge of the habits and special characteristics of the species that have come under my notice, and I have found some new localities for some of them. With the expectation that some of the members of the Academy may be interested, I have ventured to present a few notes of my observations of this interesting family.

Amblychila cylindriformis Say. Taken near Wallace, July 8, 9, 10, and 24, and August 4 and 5, 1902. A few specimens were found on the open prairie at a considerable distance from the clay banks on which they are usually found. A single specimen was found August 24, 1902, on the embankment of an irrigation ditch near Bent's Fort, Bent county, Colorado. I found this insect feeding most commonly on the mounds of the Occident ant (Pogonomyrmex occidentalis). It may be of interest to mention that Dr. Walther Horn, of Berlin, has recently described a new North American Amblychila, calling it Am. swartzi, thus recognizing four forms—cylindriformis, baroni, piccolominii, and swartzi.

Tetracha virginica Linn. Occurs at Manhattan in June, July, and August. Taken by me only in July, 1902. The notable scarcity of this species during the past season in the Kansas valley may be attributed to the June floods.

Dromochorus belfragei Salle. Previous to 1902 this insect was regarded as rare in the vicinity of Manhattan, the annual catch by college collectors being confined to a few individuals each season. In 1902 it was abundant over a limited area southeast of town on the hills. It was first observed June 15, by Mr. Charles Popenoe, who captured a single specimen. On the following day I went with him to the same locality and we succeeded in finding nearly fifty specimens. They were afterward taken plentifully on various days up to about August 15. In all, six collectors took about a thousand of them. During the season just ended, a careful outlook was kept for this species but no representatives were discovered earlier than July 2, and the total catch at Manhattan did not exceed six. I took a single specimen at Alma. My observations do not confirm the statement that this insect is crepuscular in its habits. It seemed to be abundant at all hours in which I looked for it, which were from nine A. M. to five P. M. The great majority of the specimens captured were taken between two and five o'clock. The presence or absence of sunlight did not seem to affect their numbers, and they did not hide or disappear during a sudden shower of rain. Early in the season, they were found near the tops of the hills: later, farther down the slopes; and when the dry August weather prevailed, they came down to the moist watercourses in the valleys.

Cicindela celeripes Lec. About a dozen years ago Professor Popenoe found this species common at Manhattan and in Clay county. Since then none had been collected until the season of 1902. I found the species near Junction City, on the Fort Riley military reservation, on May 23, 1902, and captured twenty-five specimens. They seemed to have just emerged, and were confined to a space of four or five square rods. On June 6, I found them more abundant at the same place and also more widely distributed. A few days afterward I found them about four miles south of Manhattan, in the sand hills. They were abundant at this place and college collectors afterward captured large series. Later other localities were found and they continued common during the month of July. In 1903 a few specimens were seen east of town on May 25, but the inundation which followed covered all of the localities in which this species was taken in 1902 except one. I was subsequently very much surprised to find the insect abundant on top of the hills southwest of Manhattan. I also found a few at the side of the railroad tracks in the south part of town, at a place not reached by the earlier flood. Although this species cannot fly, it is very difficult to capture until one learns how by actual experience. It is a very swift runner and an artful dodger. I take it by placing the left hand quickly directly in its way, and as it runs up over the palm, I grasp it with the thumb and first finger of the right. Dr. Walther Horn has announced* the discovery of a specific difference between this species and the variety cursitans. He finds it in the sparse white bristles on the elytra in celeripes which are lacking in cursitans. I find, however, that in looking over a large series of those taken here, there are all degrees of pilosity, and in about half the specimens no evidence at all of such bristles on the elytra. I conclude that this character would be of no use in the determination of any but fresh specimens.

*Deutsche Entomol Zeitung.

C. longilabris var. laurentii Schaupp. Taken by me at Leadville, Colo., on flats west of town, July 24, 1903. I found it associated with C. cimarrona, and found both species equally hard to capture. This may have been partly because of the strong wind that was blowing, but my experience is that they were exceedingly wary and hard to approach. I saw a single specimen of laurentii at Victor, Colo, on July 31. Altitude of both localities is about 10,000 feet.

C. obsoleta Say. Two specimens taken near Bent's Fort, Colo., August 23, 1902; one at Las Animas two days later; one at Las Animas, July 13, 1903; two at La Junta, August 3; ten at Syracuse, Kan., August 4; ten at the same place, August 27. Of these only three showed any sign of maculation.

C. obsoleta var. prasina Lec. Three taken at Syracuse, Kan., August 4, and twenty at the same place, August 27, 1903. All immaculate except one. Associated with obsoleta, from which it does not differ except in color. The flight of these two insects is quite slow, but often very much prolonged. They are easy of capture, especially at the moment of rising.

C. scutellaris Say. Common on sandy soil throughout the state. In the eastern half of the state the specimens have a distinct green suffusion near the base of the elytra, but this becomes less prominent as we go westward, and is entirely lacking in specimens from beyond the middle of the state. The western specimens are of the typical form. Those from eastern Kansas are also very often spotted and sometimes approach variety lecontei in color. A single Manhattan specimen closely resembles var. rugifrons. Found in the spring and fall; rare in midsummer. I have taken this species at Manhattan, Topeka, Medora, Meade, Morland, Ellis, Junction City, Ellsworth, and Grainfield, Kan.; at Superior, Benkelman, and Haigler, Neb.; also at Wray, Colo.

C. nigrocœrulea Lec. In August, 1902, I accompanied Mr. Warren Knaus to Bent's Fort, Colo., in search of this species. We found it common in suitable localities at this place and also at Las Animas, in the same county. We captured over a hundred specimens on the trip. We found blue-black and green forms associated together and pairing indiscriminately, thus proving the practical identity of nigrocœrulea and robusta Leng. The captures were August 23–25. A few days later Eugene Smyth found two specimens of this insect just east of the Colorado line, near Coolidge, Kan., thus being the first to add it to the state list. In 1903 I took nine specimens at Las Animas, July 13, and nearly a hundred at La Junta, August 3. At Syracuse, Kan., I took five on August 4, and ten on August 27. This species is found on damp soil on bare spots in pastures and in alfalfa-fields. I also found it in irrigated sugar-beet fields, along the borders of alkali spots where plants were missing. It flies much more slowly than C. punctulata and its variety micans, both of which inhabit similar places, and the latter of which the green form closely resembles. Its flight is also much longer than that of micans. It rises almost perpendicularly to the height of three or four feet and then goes out horizontally, much after the manner of C. obsoleta, but of course not so far.

C. pulchra Say. I first took this species at Meade, Kan., May 15, 1902, taking sixteen specimens. Common at Lakin, June 13; at Wallace, July 8–10; August 4, at Wallace, several dead ones were seen and one battered live specimen. I concluded that this was the end of the season; but later, August 25, I found several apparently fresh specimens at Las Animas, Colo. At Oakley, Kan., I took a fresh specimen September 15, and, the present season, one at Grainfield on September 25. I conclude that there is a second brood of this species, not so numerous as the first. The species is found in Colorado in the Arkansas valley as far west as Salida.

C. sexguttata var. violacea Fab. The true relation of violacea to the type is not well defined. The original description as well as Schaupp's definition would fix all immaculate specimens as variety violacea. Leng, on the other hand, confines that variety to the rare form which is entirely violet in color. Both these seem to me to be extreme views. An examination and comparison of specimens from various parts of the country shows that the Western forms have legs uniformly violet, while the Eastern and Southern ones have green legs. Immaculate individuals are common both in the East and the West. So also are individuals with one, two, three or even four spots on each elytron. Of course a larger proportion of the specimens in the West are immaculate, but the violet form mentioned by Leng has a large proportion of the individuals spotted. The original description would not apply to them. I am inclined to place all Kansas specimens under the variety violacea, on the ground of the color of the legs and without regard to maculation. This insect appears at Manhattan about May 15, and remains until about August 20. It is abundant. The bright violet form is found at Manhattan, Topeka, Alma, and Onaga. No doubt there are other good localities for it in the state.

C. purpurea Oliv. Occasional at Manhattan. More common both to the east and west where the country is less broken. Westward it gradually grades into the variety graminea. While it occurs here in company with both vulgaris and splendida, the association seems to me to be an accidental one. No evidence of hybridism with splendida has been observed. Taken in April, May, September, and October.

C. purpurea var. audubonii Lec. Found abundantly over the western half of the state in spring and fall, and occasionally on warm days in winter. It evidently hibernates. Taken by me at Ellsworth, Hays, Ellis, Wa Keeney, Grainfield, Oakley, Dodge City, Meade, Goodland, and Colby, Kan.; at Benkelman, Neb.; at Colorado Springs and Limon, Colo.

C. purpurea var. graminea Schaupp. Found associated with purpurea and audubonii, and taken on the same dates and in the same localities as the latter. The specimens taken in Colorado and westward differ much in shape from those taken further east.

C. purpurea var. cimarrona Lec. Taken at Leadville, Colo., July 24, and at Victor, Colo., July 31, 1903. Only a few seen, associated with C. laurentii. I have already spoken of my difficulty in taking this species.

C. splendida Hentz. Occurs in spring and fall and on warm days in winter. I have found them in midwinter by excavating their burrows, and have taken considerable numbers in this way. A few may be found in favorable places in midsummer, so that, in a few successive years, one could have records of their capture in every month of the year. I have collected the species at Manhattan, Topeka, Meade, Hays, Wa Keeney, Colby, and at Benkelman, Neb. There are records of its occurrence as far west as Denver.

Var. amœna Lec. This variety is not really separable from splendida in any particular but in having the full elytral markings of limbalis. About one-third of the specimens taken at Manhattan have these markings and may be placed under this name, but many intermediate varieties of marking occur. The most common form is that of Leng's new variety transversa. The latter insect is, however, described as a variety of purpurea, and as having the same color. The fact that the markings of transversa reappear both in splendida and in the closely related denverensis shows the intimate relations of the whole so-called purpurea group.

C. denverensis Casey. First taken by me at Oakley, Kan., October 28, 1901, which is also the first recorded capture in the state; however, there are specimens in the Agricultural College collection which were taken in Meade county several years earlier. I took several specimens at Meade, Kan., May 15, 1902, and in May, 1903, I found it common at Benkelman and Haigler, Neb. I found it associated with a few specimens of splendida, with which it corresponds in habits. In four cases I found denverensis and splendida in copulation, and my friend, Mr. Johnson, of the Fort Collins, Colo., Experiment Station, has observed similar cases near Denver. I have observed a few specimens that I regard as intermediate forms between the two. For example, I have a denverensis with a blue thorax. A study of the habits of the purpurea group leads me to recognize two series. The first is represented by purpurea and the varieties graminea, audubonii, cimarrona, etc. This series has usually a detached, oblique middle band. They stay mostly on nearly level, open country, along paths and on bare spots in pastures. The other series has the middle band less oblique when complete, but often short and at right angles to the border of the elytron, or even lacking. It is usually found on steeply sloping clay banks or along deeply washed gullies. To it belong limbalis, splendida, denverensis, etc.

C. formosa Say. I have taken this beautiful species at Topeka, Manhattan, Junction City, Abilene, Ellsworth, Ellis, Grainfield, Morland, Dodge City, Lakin, Medora, Meade, Belvidere, Englewood, and other Kansas places; at Limon, Wray, and Salida, Colo.; at Superior, Benkelman, and Haigler, Neb. Abundant in spring and fall. Specimens from eastern and middle Kansas are usually smaller and darker than they are farther west. I have seen no typical examples of var. generosa from Kansas, although an occasional specimen approaches it.

C. venusta Lec. This is regarded by both Mr. Leng and Doctor Horn as a distinct species and not as a variety of the preceding. While it inhabits sandy places where the other species is also usually present, the association is never a close one, and its distribution is much more limited. I have taken specimens at Medora and Grainfield, Kan., at Limon, Colo., and at Benkelman, Neb. I found it common at Grainfield, over a limited area of grassy sand, on September 25 of the present year.

C. fulgida Say. Occurs on the salt marshes of Kansas, and wherever the alkali in the soil comes to the surface so as to make small, bare spots. On the salt marshes it prefers the border, close to the grass, in which it often seeks safety when disturbed. I have captured it at Talmo, Jamestown, Belvidere, Lakin, Englewood, and Wallace, Kan.; at Benkelman and Haigler, Neb.; at Wray, Robinson, and La Junta, Colo. It begins to be common by the middle of May and remains through June and July, while a few persist even longer. At Robinson, Colo., near Bent's Fort, I found fresh specimens, August 23, in considerable numbers. This would indicate that, as with C. pulchra, there is sometimes a fall brood.

C. vulgaris Say. Common throughout the state. A species subject to many variations in size and color. Small, bright green specimens with faint markings are found, and in western Kansas and the eastern part of Colorado a well-marked variety approaching the description of var. obliquata is taken. This has been distributed and appears in many collections as obliquata, but Doctor Horn says that it is not the true obliquata, but an undescribed variety.

C. repanda Dej. Common everywhere in Kansas that I have collected. It is very numerous in spring and fall and almost disappears in midsummer. Casey's variety unijuncta also occurs, but is so feebly differentiated from repanda that it may be disregarded, especially as specimens occur with the humeral and middle bands united on only one side.

C. duodecimguttata Dej. Taken by me at Hays and Wa Keeney, but I have seen specimens taken at Manhattan and other points in the state. Occurs in spring and fall.

C. oregona Lec. I have collected this species at Colorado Springs and Salida, Colo.; common late in the fall and early in the spring, but specimens may be found throughout the summer. This species figures in several Eastern collections as from Kansas; in one case the locality Salina is given. If it were not for this case, I would advance the theory that the specimens date back to the time when Kansas extended to the top of the Rocky Mountains, and are really from Colorado.

C. hirticollis Say. Occurs in eastern Kansas and in some parts of western Kansas, but is replaced over the greater part of the state by the variety ponderosa Thom. The two forms, however, grade into each other, so that it is often difficult to decide to which some individuals belong. The extremes differ widely in size, outline, and color. At Syracuse, Kan., I took specimens very dark in color, large in size, heavily marked, and with scarcely any pilosity. They had the outlines of typical hirticollis instead of the broadened ponderosa form. Both the species and the variety are common on wet sand-bars from May 1 to July 1, and from August 25 to November 1, or even later.

C. limbata Say. I first found this fine species at Benkelman, Neb., about three miles north of the Kansas line, on sand-hills. This was on May 18, 1903. On May 20, I found them more numerous at Wray, Colo., a few miles further west, and collected about eighty specimens. They were around the top of a sand mound which rose some 200 or 300 feet above the valley of the Republican river. On the top of the mound was a blow-out in the form of an elongated crater, composed of white sand. All around the top of the mound and extending about a hundred feet down the slopes the white sand was found, and sparse grass grew up through it. Wherever this white sand extended I found the insects, both in the blow-out and on the slopes. No other tiger-beetles were found here, but C. formosa was found to the edge of the white sand. This was the only sand-hill in the neighborhood on which limbata was found, and I found it only on one small spot at Benkelman. It is a quick flyer, but its flight is short, and it is not hard to capture.

C. cinctipennis Lec. On August 23, 1902, I captured a single specimen of this species in a sugar-beet field near Bent's Fort, Colo.; and Mr. Knaus captured one at the same place the next day. The insects were in the shade of the beet plants, on moist ground. On July 18, 1903, at Glenwood Springs, Colo., I found the species rather common, but the day was too cloudy for collecting, and the insects disappeared as soon as the sun was hidden by clouds, so that I captured only a small number.

C. punctulata Fab. Found everywhere from June 10 until November. When captured in the net, emits a strong but not disagreeable odor. Some of the other tiger-beetles emit similar odors, but none of them such a strong one as this.

C. punctulata var. micans Fab. Occurs throughout western Kansas and eastern Colorado. It does not differ from punctulata, except in color, and is usually found associated with that form. At Glenwood Springs I found specimens in which the green or blue color extended over the thorax and head. They had none of the bronzed shade seen in specimens from the plains east of the mountains. They had also much more prominent markings, in some cases a complete middle band. They seemed to be abundant, and punctulata were present with them, but much more rare. The latter had also prominent elytral markings.

C. cuprascens Lec. Common along the borders of the Kansas and Arkansas rivers. Specimens taken from Dodge City westward are more uniformly coppery bronze in color, and are more heavily marked than Topeka and Manhattan specimens. Taken during June, July, and August.

C. macra Lec. This is properly a variety of cuprascens. Mr. Leng dropped it entirely from the list, on the ground that he was unable to separate it from that species, but his action was based on material from east of the Mississippi river. An examination of material sent him from Topeka and other Kansas points convinced him that he was in error, and he will hereafter include it as a variety. This is also in accord with the views of Doctor Horn. The insect is more plentiful in eastern Kansas than cuprascens, but does not extend so far westward. It is usually without the coppery shade and more greenish in color. There is in nearly all specimens a more evident parallelism of the outer edges of the elytra, and a narrowness in proportion to the length, but the differences in the elytral apex are in some cases the only means of their determination. It has the same season as cuprascens. In addition to the river localities given, I have taken both insects on salt marshes.

C. knaussi Leng. Found on salt marshes and along the borders of alkali ponds and irrigation ditches, always on moist places. It varies much in color, after the manner of C. sperata, with which it is closely related. Doctor Horn thinks it a variety of C. nevadica Lec., a species not recently collected. I have taken bright green specimens at Englewood, Kan., and at Las Animas and Pueblo, Colo.

C. lepida Dej. Found on bare, white sand along rivers and in sand-hills. It is not common at any place in which I have collected it. Most of my specimens were taken at electric lights in Manhattan and Dodge City.

C. togata var. apicalis W. Horn. This insect is common on the salt marshes of Kansas from about May 20 to the last of August. It is a swift runner and does not rise unless closely followed. It keeps on the open, unobstructed parts of the marsh, where the surface is white and hard. I have taken it at Belvidere, Englewood, Jamestown, and Talmo. I have seen specimens that closely resemble the typical togata.

C. circumpicta Laf. Common on salt marshes and on alkali soil in western Kansas and eastern Colorado from about June 10 to the last of August, Green, blue and bronze forms occur, but the last is more common and the blue quite rare.

Of the above mentioned thirty-seven species and varieties of tiger-beetles collected by me, all but five—laurentii, cimarrona, limbata, oregona, and cinctipennis—were collected in Kansas. It is probable that cinctipennis and oregona occur in the state, and there is a possibility that limbata may also be found. Some other species and varieties are to be looked for in the state. Limbalis Klug. and lecontei Hald. have been reported as occurring, and may be not uncommon in northeastern Kansas. Other possible finds might be tetracha, carolina, C. cursitans, C. ludoviciana, and C. sperata.

C. pusilla and C. cyanella are quoted by Schaupp, Leng and others as Kansas species. It is probable that this statement had its origin in their capture at the time in which Kansas territory extended to the summit of the Rocky Mountains, and that the specimens with locality labels "Kansas" actually exist.

My experience in handling Cicindelidæ, whether of my own collecting or those collected by others, has taught me that they make the best specimens when taken from the cyanide bottle as soon as convenient after they are dead and pinned promptly. They should not be put in alcohol or formaline, as the legs and antennæ become fixed, and never again relax so as to be easily placed in proper position. In the absence of facilities for pinning, paper rolls may be used, or gelatine capsules. If the latter are used not more than one specimen should be placed in a capsule, because the confined air is not sufficient to let the insect dry, and decay sets in.

NOTES FOR 1903 ON THE BIRDS OF KANSAS.

By F. H. SNOW, University of Kansas, Lawrence.

Read before the Academy, at Manhattan, November 27, 1903.

AT the last meeting of the Academy I presented the fifth edition of my catalogue of the birds of Kansas. This edition enumerated 342 species and varieties of birds known to me personally as having occurred in Kansas since the opening of the University of Kansas, in September, 1866. I now have the pleasure of reporting three additional species, as follows:

I. THE BLACK-BELLIED PLOVER (*Charadrius squatarola* Linn.) This species was included in the preceding editions of my catalogue upon the authority of Prof. Spencer F. Baird, director of the Smithsonian Institution, but, with thirteen other species authorized by Dr. T. M. Brewer and Professor Baird, was excluded from my fifth edition, which contained only those species whose occurrence in Kansas could be verified by actual captures. On the 22d of May, 1903, I received from Dr. R. Matthews a mounted specimen of this bird from his own collection. It was captured near Wichita, in 1896, by Mr. Ed. Goldberg.

II. THE ROAD-RUNNER, OR CHAPARRAL COCK (*Geococcyx californianus* Less.) A special trip to the southwestern corner of Kiowa county, in November, 1903, enabled me to secure the following information: A specimen of this bird was found in the chicken-yard of Mr. W. H. Wilbur one morning in the last week of June, 1903. This yard is surrounded by a coarse wire netting, and the bird, when discovered, was making strenuous efforts to escape by running along the fence in search of an opening. Mrs. Wilbur caught the bird with her hands and placed it in a cracker-box covered by an old stove grate. She fed it for two weeks upon grasshoppers and other insects, until becoming weary of the labor of providing its daily food she turned it loose upon the prairie. Mrs. Wilbur had identified this bird from having been with her brother, Mr. Oris Ham, when the latter shot a specimen of it on January 24, 1901, in Oklahoma, about thirty-five miles south of the Kansas line. The wings and tail of this specimen were preserved so that the identification was entirely satisfactory. The date of capture of the Kansas specimen indicates that the species breeds in Kansas.

In May, 1903, Prof. Chas. N. Gould, of the University of Oklahoma, whom I met at Englewood, in Clark county, Kansas, gave me he following memorandum: "In the summer of 1894 I saw a chaparral cock in the canyons west of Ashland, in Clark county, Kansas. In 1897 Dr. Lester F. Ward and I saw this bird at Belvidere, Kiowa county, Kansas. But a single specimen was seen in each instance. The one at Belvidere was seen repeatedly in the evening, remaining around camp for several days."

III. THE BLACK-THROATED GREEN WARBLER (*Dendroica virens* Gmel.) I have received a fragmentary skin of this species, which has been identified by Mr. J. A. Allen, of the American Museum of Natural History, from Mr. F. F. Crevecœur, of Onaga, Pottawatomie county, Kansas, who states that "it was shot, as near as I can remember, in 1890, on French creek, three miles north of Onaga." This species was included in the early editions of my catalogue of the birds of Kansas upon the authority of Prof. S. F. Baird.

The addition of the three species above indicated increases my list of birds personally known to me to have been captured in Kansas to 345 species and varieties.

NOTES OF 1904 ON THE BIRDS OF KANSAS.

By F. H. Snow, University of Kansas, Lawrence.

Read before the Academy, at Topeka, December 30, 1904.

I WISH to record the addition of three species to the bird fauna of Kansas.

I. The Parasitic Jæger (*Stercorarius parasiticus* Linn.) A young male of this species was captured along the Kansas river near Lawrence on October 10, 1898, by Banks Brown. The specimen was mounted by Leverett A. Adams and is now in the museum of the University of Kansas. This species, not having been previously reported as "seen" or "likely to occur in Kansas," is an absolute addition to our avifauna.

II. The White-winged Crossbill (*Loxia leucoptera* Gmel.) This species was included in the early editions of my "Catalogue of the Birds of Kansas" on the authority of Dr. T. M. Brewer, and was omitted from my fifth edition (May, 1903,) because its occurrence in Kansas had not been verified by actual specimens. I am glad to report two recent captures. The first was that of an adult male in fall plumage, shot by Leverett A. Adams, near Lawrence, in Douglas county, November 4, 1899. This specimen, mounted by E. D. Bunker, is now in the museum of the University of Kansas. The second capture was that of a young male, taken at Hays City, in Ellis county, in western Kansas, September 15, 1902, by C. W. Miller, who has the specimen in his own collection.

III. The Groove-billed Ani (*Crotophaga sulcirostris* Swains.) A specimen of this bird was captured by a farmer near Emporia about November 1, 1904. It is in the collection of the Kansas State Normal School, and was reported to me by Prof. L. C. Wooster, of that institution. This is the first instance known of the occurrence of this species north of the Lower Rio Grande, in Texas.

These three additions increase the number of species and varieties of birds whose actual occurrence in Kansas has been verified by me to 348.

NOTES AND DESCRIPTIONS OF HYMENOPTERA FROM THE WESTERN UNITED STATES,

IN THE COLLECTION OF THE UNIVERSITY OF KANSAS.

By H. L VIERECK, Academy of Natural Sciences, Philadelphia, Pa.

THE material furnished me for study by Dr. F. H. Snow, of the University of Kansas, from his collection of undetermined Hymenoptera, is rich in new species. Parasitic Hymenoptera, particularly, are apt to lie idle in collections; to determine old species and then quite often to describe new species has taken considerable time; but the results of my work in describing so many new species are not at all surprising, since the field is only partly worked.

The species are arranged by states, and systematically, according to Ashmead's classification, but starting with the least specialized and not with the most specialized, as in that classification.

Of the super family Ichneumonoidea, four families are represented, in order of treatment—Evaniidæ, Ichneumonidæ, Braconidæ, and Stephanidæ—and the results obtained in each are as follows:

Family EVANIIDÆ.

GENUS.	OLD SPECIES.	NEW SPECIES.
Gasteruption	1 (Ariz.)	

Family BRACONIDÆ.

GENUS.	OLD SPECIES.	NEW SPECIES.
Rhogas	2 (Ks.)	2 (Ks.)
Heterogamus	1 "	
Lytopylus		1 (Ks.)
Bracon	1 (Ks.)	2 "
Melanobracon	2 (Ks. 1; Colo. 1.)	
Vipio	1 (Ks.)	2 (Ks. 1; Ariz. 1.)
Iphiaulax	4 (Ks. 2; Ariz. 2.)	5 (Ks. 2; Ariz. 3.)
Opius		4 (Ks.)
Diachasma		2 "
Bioteres		1 "
Ischneutidea?		1 "
Microplitis	1 (Ks.)	
Microgaster		1 (Ks.)
Apanteles	1 (Ks.)	
var	1 "	
Cardiochiles	2 (Ks. 1; Colo. 1.)	1 (Ks.)
Microdus		5 "
Crassomicrodus	3 (Ks. 1; Colo. 2.)	1 (Colo.)
Agathis	2 (Ks.)	1 (Wyo.)
Ascogaster		1 (Ks.)
Chelonus	1 (Ks.)	5 (Ks. 2; Ariz. 3.)
Brachistes		1 (Ks.)

Family BRACONIDÆ—*Continued.*

GENUS.		OLD SPECIES.	NEW SPECIES.
Cœnocelius			1 (Ks.)
Zele			1 "
Macrocentrus		2 (Ks.)	
Meteorus			3 (Ks.)
Lysiphlebus			1 "
Aspilota			1 "
Sphæreta			2 "
28 genera.		24 old sp.	45 new sp.

Total species, 69.

Family ICHNEUMONIDÆ.

GENUS.	SUBGENUS.	OLD SPECIES.	NEW SPECIES.
Pristomerus			1 (Ks.)
var			1 "
Thersilochus			5 "
Mesochorus			1 "
Agathobanchus			1 (Ks.) = n. n.
Paniscus		1 (Ks. and Colo.).	
Limnerium			1 (Ks.) undt. 1. (Ks.)
Ischnoscopus			1 (Ks.)
Olesicampa			1 "
Amorphota			4 "
Campoplex		1 (Ks.)	1 "
Exochilum		1 "	
Anomolon			1 (Ks.)
var			1 "
Atrometus			1 "
Eiphosoma		1 (Ks.)	
Nototrachys		2 (Ariz)	
Erymotylus			1 (Ks.)
Ophion		1 (Ks.)	1 "
Thyreodon		1 "	1 "
Metopius			1 "
Bassus		1 (Ariz)	
Bœthus			1 (Ks.)
Sychnoporthus			1 "
Glypta			4 (Ks. 3; Ariz. 1.)
Pimpla		3 (Ks. 1; Ariz. 2.)	
Ephialtes		1 (Ks.)	
Thalessa		1 "	
Rhyssa		1 (Colo.)	
Harrimaniella			1 (Ks.)
Arenetra			1 "
Nematopodius		1 (Ks)	1 "
Mesostenus		1 "	1 "
Cryptus	Callicryptus	1 "	
	Itamoplex	1 "	
	Mansa		1 (Ariz.)
	Habrocryptus ?	1 (Colo.)	
Pezomachus			3 (Ks. 2; Ariz. 1.)

Family ICHNEUMONIDÆ—*Continued.*

	SUBGENUS.	OLD SPECIES.	NEW SPECIES.
Hemiteles	Diaglypta ?		2 (Colo. 1; Ariz. 1.)
Platylabus	Colocnema ?		1 (Ks.)
Phygadeuon	Bathymetis		1 (N. M.)
	Pezoporus ?	1 (Ks.)	
Ichneumon	Stiboscopus ?		1 (Ks.)
	Eurylabus	1 (Ks.)	1 (Ariz.)
	Probolus		1 (Colo.)
Amblyteles		1 (Ariz.)	
Ichneumon	Barichneumon	2 (Ks. 1; Colo. 1.)	4 (Colo. 1; Ariz. 3.)
	Cratichneumon ?	1 (Colo.)	
	Stenichneumon	1 (Ks.)	
Trogus		2 "	
39 genera.	14 subgenera.	29 old sp.	50 new sp.

Total: 79 determined; 1 undetermined species; total 80, including two named varieties.

Family STEPHANIDÆ.

GENUS.	OLD SPECIES.	NEW SPECIES.
Stephanus	? (Mo.)	?

Grand total for the superfamily Ichneumonoidea: Families, 4; genera, 69; subgenera, 14; old species, including one variety, 55; new species, including two varieties, 97; total species, less three varieties, 149.

Determinations, notes and descriptions follow:

Family EVANIIDÆ.

Gasteruption perplexus Cresson.

Female. Oak Creek Canyon, Arizona; August, 1902, F. H. Snow.

Family BRACONIDÆ.

Rhogas intermedius Cresson.

Douglas county, Kansas, May; Lawrence, at night, May, E. S. Tucker. Douglas county; August, E. S. Tucker.

Variety with median lobe of dorsulum shining; dorsulum, metanotum and first abdominal segment maculated with black. Douglas county, Kansas; August, E. S. Tucker.

Rhogas terminalis Cresson.

Douglas county, Kansas, at electric light; June, E. S. Tucker.

Rhogas cockerelli, n. sp.

Related to R. rileyi and atricornis, from which it is at once separated by the black markings.

MALE.—Length, 7 mm. Head dull, almost uniformly rugulose, appearing somewhat reticulate, clypeus differentiated, the occipital raised line sharp and distinct; scape nearly twice as broad as the first joint of the flagellum and as long as the pedicellum and first joint of the flagellum combined. Antennæ sixty-two jointed. Thorax dullish; pleura rather shining, dorsulum closely punctured, the punctures shallow and indistinct, parapsidal grooves distinct, pleura in part punctured nearly like the dorsulum, partly rugulose; metanotum rugulose, almost reticulate with an incomplete median raised line on the basal half and a V-shaped raised line at apex; wings slightly brownish; nervures pale brown, stigma dark brown; second submarginal cell quadrangular, nearly as long on the radius as the first abscissa of the radius and the first transverse cubitus combined, the transverse median nervure is a little further removed from the basal nervures than the first transverse cubitus from the stigma. Abdomen shining, the first three segments longitudinally regulose, the first and second segments have a distinct median raised line, on the third segment this line is indistinct and not prolonged beyond the middle, the apical half of the third segment is sparsely punctured and without striæ, beyond the third segment the segments are smooth and polished. Dull yellowish red: the face, prothorax and dorsum of thorax in greater part ferruginous; space between ocelli, terminal tarsal joints, apex of posterior femora and tibiæ, mesopleura, mesosternum and part of basal half of metapleura and apex of abdomen black. Pubescence short and faintly yellowish.

Type: University of Kansas. Type locality: Douglas county, Kansas, 900 feet. F. H. Snow. One specimen.

Rhogas melanothorax, n. sp.

FEMALES—Length, 2 mm. Head polished, face dull, minutely punctured cheeks with a distinct margin, scape broader than the pedicellum, twice as long. Flagellum destroyed. Thorax polished, parapsidal grooves on the anterior half of the dorsulum but not deeply impressed; metanotum unevenly sculptured, rather rugulose, anteriorly in the middle with a longitudinal raised line that terminates posteriorly in a smooth narrow space; wings pale hyaline, nervures and stigma brown, first transverse nervure longer than the second abcissa of the radius, the second submarginal cell rhomboidal. Abdomen shining and polished, the first two segments finely striate without a distinct median longitudinal raised line, the remaining abdominal segments smooth and polished. Black; flagellum, pedicellum and legs testaceous to brownish testaceous, posterior tibiæ and tarsi brown, ovipositor testaceous. Covered with a fine silvery pubescence which is nowhere very abundant.

Type: University of Kansas. Type locality: Douglas county, Kansas. One specimen; August, E. S. Tucker.

Heterogamus graphicus Cresson.

Clark county, Kansas, 1962 feet; June, F. H. Snow.

Lytopylus azygos, n. sp.

FEMALE—Length, 5 mm. Head polished and smooth, the occiput sparsely punctured, face with rather indistinct minute punctures, elevated along the middle line, almost forming a keel; scape rather clavate, polished, the flagellum dull. Antennæ broken. Thorax polished, the parapsidal grooves represented by a dent in the middle of the posterior half of the dorsulum; metanotum regulose in the middle, the metapleura minutely punctured; wings with the first abcissa of the cubitus represented by a short stump, submedian cell distinctly longer than the median cell in the anterior wings, first submarginal cell triangular; nervures very dark brown, the membrane brownish. Abdomen polished, smooth, basal half of the basal segment impressed; ovipositor about as long as the metathorax and abdomen combined. Red; head, antennæ, pectus, coxæ, trochanters, four anterior femora except at tip and the sheaths of the ovipositor black; tibiæ more or less dark brown; ovipositor brown. Covered with a short silvery pubescence which in no place is so close as to obscure the tegument.

Type: University of Kansas. Type locality: Morton county, Kansas. 3200 feet; June, 1902, F. H. Snow. One specimen.

Bracon piceiceps, n. sp.

MALE.— Length, 2 mm. One of the smallest species in the genus. Head shining; scape a little longer than the first joint of the flagellum, joints of the flagellum subequal. Tips of the antennæ broken, more than eighteen jointed. Thorax polished, smooth; wings clear, stigma and nervures blackish, first discoidal cell petiolate, the petiole nearly as long as the second abcissa of the cubitus, first abcissa of the radius a little shorter than the second transverse cubitus; parapsidal grooves not strongly impressed. Abdomen dullish, granular, first segment convex, bulged in the middle, depressed laterally. Ferruginous; abdomen and legs rather testaceous; head strongly brownish, almost piceous, especially the vertex; antennæ dark brown, almost black; anterior half of dorsulum and posterior half of abdomen dark brownish; claws and apical tarsal joints brownish. Thinly pubescent, the pubscence fine and whitish.

Type: University of Kansas. Type locality: Douglas county, Kansas. E. S. Tucker. One specimen.

Bracon kansensis, n. sp.

FEMALE.—Length, 3 mm. Head shining except the face which is dull and minutely sculptured; scape somewhat broader than the pedicellum, a little longer than the first joint of the flagellum. Antennæ broken. Thorax shining, dorsulum and pleura polished, metanotum polished, metapleura minutely sculptured, dullish; wings brownish, especially the basal half, nervures and stigma dark brown, second submarginal cell a little more than twice as long as broad, longer on the cubitus than on the radius. Abdomen shining, the first segment minutely sculptured on the sides and with a median impressed Y, apical half with some poorly defined striæ in the middle; second segment minutely rugulose with a longitudinal median elevation; terminal segments smooth, sparsely minutely pitted or punctured; ovipositor nearly one-half as long as the abdomen. Black; legs excepting coxæ, trochanters and femora at base brown, the edge of the abdomen and abdominal segments beyond the second brown, triangular lateral space, mandibles except castaneous apex and supraorbital line yellow. Pubescence silvery, not very abundant except on the parapsidal grooves of the dorsulum and on the metapleura of the thorax where it nearly obscures the tegument.

Type: University of Kansas. Type locality: Sedgwick county, Kansas. Taken in vineyard, September, 1895. E. S. Tucker. One specimen.

Bracon xanthostigma Cresson.

A variable species, usually honey yellow tinted with brown. One specimen has the dorsum of thorax, pectus, dorsum of first abdominal segment and a spot on the base of the second abdominal segment black; another specimen with the metanotum, dorsum of first abdominal segment and a spot at base of second abdominal segment black; a third specimen has a large spot on the metathorax black; a fourth specimen has the vertex, thorax excepting pleura and scutellum, dorsum of first abdominal segment, a large proportion of the dorsum segments two, three, four and five black. These specimens seem to represent only color varieties of the typical insect.

Douglas county, Kansas, May, 1892, W. J. Coleman; August, 1893, V. L. Kellogg and E. S. Tucker; April and August, E. S. Tucker; and one specimen, F. H. Snow. Morton county, Kansas; June, 1902, F. H. Snow.

Melanobracon rugosiventris Ashmead.

Clark county, Kansas, 1962 feet; June, 1903, F. H. Snow.

Vipio croceus Cresson.

Clark county, Kansas, 1962 feet; May, 1903, F. H. Snow. Morton county, Kansas, 3200 feet; June, 1902, F. H. Snow. Hamilton county, Kansas, 3350 feet; June, 1902, F. H. Snow.

Vipio piceipectus, n. sp.

Related to croceus, from which it is at once separated by the shorter ovipositor.

FEMALE.—Length, 7 mm. Head shining and polished, face dullish, minutely sculptured, vertex sparsely punctured, the space between the antennæ and ocelli not deeply impressed, but with a narrow median groove: pedicellum a little more than half as long as the first joint of the flagellum; first joint of the flagellum nearly as long as the next two joints combined. Antennæ more than thirty-eight jointed; broken. Thorax polished, the parapsidal grooves rather deeply impressed: metathorax rather indistinctly punctured, the sinuate impressed line on the metapleura quite deep, the adjoining surface rather closely punctured; wings strongly brownish, nervures and stigma nearly black. Abdomen shining and polished: first segment with a median elevated convex disc that is longitudinally striate, smooth on the anterior and posterior edge, an uneven space on each side of the central disc, the space bounded by a narrow fold that constitutes the upper lateral edge of the segment, the lower lateral edge not extending beyond the upper lateral edge, a very narrow groove lies between these edges; second segment with three smooth triangular spaces at the base of the middle space largest and terminating posteriorly in a narrow polished raised line, the remaining portion of the segment with closely arranged longitudinal striæ that do not attain the posterior border of the segment which is smooth; third segment with lateral basal, triangular, smooth spaces and small median triangular space which is rather striated and has the apex prolonged as a low ridge, in the middle of the segment the basal half is striated longitudinally, on the sides the striæ extend further back, but leave a broad smooth margin at the apex of the segment, the bifurcation of the crenulate furrow is not sharply defined; the fourth segment is smooth in the middle and has short striæ prolonged from the base at the sides of the segment; fifth and sixth segments smooth; ovipositor a little longer than the abdomen. Honey yellow; antennæ black at base, the flagellum largely dark brown; anterior legs black, excepting the apex of the femora, tibiæ, and tarsi; tips of the mandibles, pectus, middle legs excepting joints black; trochanters, tibiæ and tarsi of posterior legs black: ovipositor black, sheaths brown. Thinly pubescent with fine white or silvery pubescence.

Type: University of Kansas. Type locality: Hamilton county, Kansas. July, S. J. Hunter. One specimen.

Iphiaulax faustus Cresson.

Clark county, Kansas, 1962 feet; May, 1903, F. H. Snow.

Iphiaulax rugator Say.

Douglas county, Kansas, 900 feet; August, 1893, E. S. Tucker.

Iphiaulax militaris, n. sp.

Distinct in having the third, fourth and fifth abdominal segments smooth.

FEMALE.—Length, 6 mm. Head nearly cubical, dullish, finely punctured, and with a median groove between the antennæ and ocelli, vertex, occiput and cheeks polished, nearly impunctate; face shining, closely punctured, the punctures indistinct and shallow; anterior margin of the clypeus as usual, curved in by the characteristic polished basin-like depression below it; temples not as broad as the eyes; scape dull, not stout, the margins not produced; pedicellum about one-half as long as the first joint of the flagellum, the first joint of the flagellum nearly as long as the second plus one-half of the third. Antennæ broken. Thorax polished; parapsidal grooves of mesonotum not sharply impressed, metathorax rather granular, the pleura with a sinuate groove extending from a pit near the anterior margin to the posterior margin; wings fuscous, but not deeply; neuration typical as in the preceding species. Abdomen polished; first segment elevated in the middle with two longitudinal grooves to each side, all rugose except the exterior groove which is smooth; second abdominal segment with a small equilateral triangular smooth space at the base extending posteriorly as a raised line nearly to the posterior border, an oblique groove diverging to each side from the lateral angles of the triangular space to a point near an oblique line that represents the suture between the second and third abdominal segments; third segment with the usual basal crenulated grooves which bifurcates laterally as in perepicus; the third, fourth and fifth abdominal segments are smooth and polished excepting the lateral portion which is rugulose; ovipositor about as long as the last three segments of the abdomen. Black; abdomen red; ovipositor brown, the sheaths black. Sericeous as in perepicus.

Type: University of Kansas. Type locality: Douglas county, Kansas, 900 feet. One specimen. F. H. Snow.

Iphiaulax melanogaster, n. sp.

FEMALE.—Length, 7 mm. As in militis, differs as follows: Clypeus and clypeal region with rugæ, this may be an aberration; antennæ fifty-two jointed or nearly; first abdominal segment with longitudinal groove in the middle of the median raised portion; the second segment with a basal flat lunule from the middle of which extends a raised line nearly to the posterior border of the segment, the segment is more coarsely sculptured, rather reticulate; the third and fourth segments are smooth, rugulose laterally; the fifth segment entirely rugulose; the ovipositor as long as the last four segments of the abdomen. Black; abdomen brownish, ovipositor brown, the sheaths black.

Type: University of Kansas. Type locality: Douglas county, Kansas, 900 feet. One specimen. July, F. H. Snow.

Opius basiniger, n. sp.

Second subdiscoidal cell open; should, perhaps, form a new genus allied to Nosopoea, from which it differs in having the stigma triangular. Related to O. brunneiventris, of which it may prove to be the female.

FEMALE.—Length, 3.5 mm. Head shining; cheeks apparently impunctate, polished; vertex and occiput smooth polished; face not distinctly polished, rather closely punctured, broad supraclypeal cuneiform polished convex space in the middle of the face, extending up to near the antennal line (an imaginary line across the face and joining the lower edges of the antennal sockets); clypeus shining, sparsely punctured; mandibles shining, crossing at tips; antennæ thirty-two jointed, the scape nearly as long as the first joint of the flagellum. Thorax polished; parapsidal grooves very abbreviated, represented only at the anterior margin of the mesonotum by linear pits, a median dimple on the posterior fourth of the mesonotum; scutellum elevated, polished, smooth; mesopleura with a shallow, rather broad impression; metathorax rather coarsely rugose, the metapleura shining and somewhat roughened; wings clear, tinted with brown, stigma and costal nervure brown, the other nervures blackish testaceous, petiole of the first discoidal cell as long as the first abcissa of the subdiscoidal nervure, petiole of second submarginal cell nearly as long as the second transverse cubitus, second abcissa of the cubitus about as long as the petiole of the first discoidal cell. Abdomen with the first segment shining, rugulose, the rugæ not very elevated, a linear ridge on each side of the basal segment, the remaining segments polished; the second segment with an apparently semilunar impression on each side of a medial raised portion at the extreme base of the segment; the ovipositor would apparently not extend beyond the tip of the abdomen. Black; clypeus and mandibles except at tips castaneous; scape and pedicellum brownish, inclining to testaceous; legs testaceous, apical tarsal joint and claws dark brown; tegulæ and tubercles testaceous to brownish, first segment of the abdomen black, excepting the lateral margins which, like the remainder of the abdomen, are brown, the dorsum of abdomen is stained with black in the middle: sheath of ovipositor brownish testaceous. Very thinly pubescent with whitish, fine hairs, most abundant on the face and metanotum.

Type: University of Kansas. Type locality: Douglas county, Kansas. One specimen. July, E. S. Tucker.

Opius aberrans, n. sp.

Opius with the venation not quite typical.

Female.—Length, 3 mm. Head polished; cheeks, vertex and occiput apparently without sculpture of any kind; face minutely, sparsely punctured; clypeus more distinctly closely punctured; mandibles not fitting closely to the anterior edge of the clypeus; antennæ twenty-eight jointed; scape a little longer than the first joint of the flagellum. Thorax polished, dorsulum with the parapsidal grooves abbreviated, represented anteriorly only by dimples or very short foveæ; scutellum elevated, smooth, and polished, mesopleura with a rather distinct oval rugulose impression; metanotum dullish, rather uniformly finely rugulose; the metapleura somewhat roughened, nearly smooth; wings pale, tinted with blackish, first abcissa of the radius about as long as the second abcissa of the cubitus, the second abcissa of the radius nearly as long as the first and second transverse cubiti combined, petiole of the first discoidal cell a little longer than the transverse median nervure, the first abcissa of the subdiscoidal nervure distinctly shorter than the petiole of the second cubital cell. First abdominal segment finely longitudinally rugulose, almost striate, remaining segments highly polished and smooth. The second segment has two dimples or impressions on each side of the middle of the base. Black; head except the occipital region and a large spot on vertex and front encircling the ocelli yellowish brown, cheeks brownish, scape and pedicellum brownish; tegulæ testaceous; legs testaceous, apical tarsal joints and claws brown; abdomen brownish testaceous, basal two-thirds of basal segment and apical third of the abdomen black, the black of the apical third of the abdomen extending along the sides to the middle. The pubescence is very thin and whitish, most abundant on the face and metathorax, but sparse even in those places.

Type: University of Kansas. Type locality: Douglas county, Kansas. August, E. S. Tucker.

Paratype, same place and date, has the abdomen blacker.

Opius luteiceps, n. sp.

Congeneric with O. aberrans.

Male. Length, 2.5 mm. Face shining, distictly punctured on the lower portion of the inner orbital margin; clypeus distinctly punctured; vertex, occiput and cheeks highly polished, apparently impunctate; antennæ twenty-eight jointed, the scape a little longer than the first joint of the flagellum. Thorax polished, sculptured nearly as in the preceding species, the pleural impression, however, is represented by an almost unwrinkled impressed line, the metanotum more shining and not so extensively rugulose, being appreciably smoother but not entirely so; wings as in the preceding species. First abdominal segment finely striate, the remaining segments smooth, highly polished; very thinly pubescent, the pubescence fine and whitish, most abundant on the face and metanotum. Black; head yellow, except a large brown spot on the vertex enveloping the ocelli; scape, pedicellum, tegulæ and legs testaceous, terminal tarsal joint and claws brown; two basal segments brownish testaceous, the third and fourth segments with some dark testaceous in the middle.

Type: University of Kansas. Type locality: Douglas county, Kansas. August, E. S. Tucker. One specimen.

Opius nigrocastaneus, n. sp.

Congeneric with O. aberrans and O. luteiceps.

MALE.—Length, 2.5 mm. Face shining, almost polished, sculptured, but not distinctly, punctures apparent along the inner orbital margin; clypeus distinctly, closely punctured; cheeks, vertex and occiput highly polished, apparently impunctate; antennæ twenty-nine jointed, scape broad, apparently a little shorter than the first joint of the flagellum. Thorax highly polished; the dorsulum with a round impression or dimple in the middle of the posterior half around which the tegument is rugulose, the parapsidal grooves are distinctly impressed near the anterior margin and are continued posteriorly to this dimple-like impression as faint impressions; metanotum finely rugulose; mesopleura with an oblique, shallow, linear impression; metapleura polished; wings as in the preceding congeneric species. Pubescence likewise as in the preceding species. Castaneous; front, vertex, occiput and cheeks, all but the lower or malar portion, black; scape, pedicellum and legs testaceous, terminal joints of tarsi and claws brown; dorsum of thorax black, brown streaks following the parapsidal grooves; scutellum brown; two basal abdominal segments and base of third abdominal segment brown, remaining portion of the abdomen black.

Type: University of Kansas. Type locality: Douglas county, Kansas. One specimen. E. S. Tucker.

Diachasma appalachicola, n. sp.

FEMALE.—Length, 2 mm. Head polished, apparently without sculpture of any kind; antennæ twenty-three jointed. Dorsulum granular, with distinct parapsidal grooves that terminate posteriorly in a striate space in the middle of the posterior half of the dorsulum; mesopleura highly polished, with a linear groove nearly parallel to the dorsum; metathorax entirely rugose, approaching the reticulate; wings transparent with a yellowish-brown tint, stigma and nervures blackish testaceous; petiole of the first discoidal cell nearly as long as the first abcissa of the radius; first abcissa of the radius a little shorter than the second, the second abcissa as long as the second transverse cubitus; first transverse cubitus almost obsolete; if complete it would apparently mark off on the cubitus a second abcissa equal in length to the transverse median nervure; transverse median nervure almost interstitial only, a trifle distad of the basal nervure. Abdomen with the first two segments finely striated, the striæ longitudinal and close together, and extending on to the third segment to form a narrow basal border, which does not extend to the sides, terminating so as to leave the lateral fourths of the base free, the remaining portion of the third segment and the succeeding segments highly polished and smooth; ovipositor extending beyond the abdomen for nearly two-thirds the length of the abdomen; very thinly pubescent, the hairs fine and whitish, most abundant on the metathorax, but even there sparse. Black; clypeus, mandibles and anterior portion of prothorax brownish to brownish testaceous; scape, pedicellum and legs testaceous; metathorax except dorsum, which is blackish, and first two abdominal segments, dark chestnut brown; apical third of abdomen brownish testaceous; ovipositor brown, sheaths black.

Type: University of Kansas. Type locality: Douglas county, Kansas. One specimen. July, E. S. Tucker.

Diachasma secunda, n. sp.

Female.—Length, 2.5 mm. Head polished, smooth, apparently impunctate; antennæ twenty jointed, the scape and pedicellum together about as long as the first joint of the flagellum. Thorax polished, parapsidal grooves distinctly impressed; the dorsulum and scutellum smooth without sculpture of any kind; mesopleura with an oblique impression, above which the tegument is striate, the striæ distinct and curving from the superior margin to the posterior margin, thereby making short arcs; metathorax almost uniformly rugose and shining; wings transparent, tinted with yellowish, stigma pale testaceous, nervures blackish testaceous, first discoidal cell with a very short petiole, transverse medius interstitial, recurrent nervure almost interstitial, received by the second cubital cell a trifle beyond the first transverse cubitus, second transverse cubitus absolescent, as long as the first abcissa of the radius, a trifle shorter than the second abcissa. Abdomen shining, the segments wrinkled; the basal segment with a large smooth space on basal two-thirds in the middle, the remaining portion of the segment more distinctly wrinkled than the succeeding segments; ovipositor extending beyond the tip of the abdomen about half the length of the abdomen. · The head is of a dark chestnut brown; the mouth and mandibles more testaceous, pedicellum brownish, flagellum very dark brown, almost black; prothorax at least partly testaceous, mesonotum with the anterior half largely black or blackish, the posterior half dark brown, the parapsidal grooves brown, of the same hue as posterior portion of mesonotum, mesosternum apparently black, the mesopleura dark brownish and blackish, scutellum and metathorax very dark brown; abdomen brown like the metathorax and blackish on the dorsum; legs pale testaceous, apical tarsal joints and claws brownish.

Type: University of Kansas. Type locality: Douglas county, Kansas. One specimen. July, E. S. Tucker.

Biosteres indotatus, n. sp.

Male.—Length, 3 mm. Front, vertex, occiput and cheeks polished, apparently impunctate; face shining, closely tessellate punctate, with a median longitudinal elevation, almost a keel; clypeus smooth with an impunctate or nearly impunctate anterior margin, closely punctured posteriorly, at least, more coarsely punctured than the face; antennæ thirty-six jointed, the scape about as long as the first joint of the flagellum, pedicellum globular. Thorax, except the metanotum, polished; anterior third of mesonotum punctured and traversed nearly longitudinally for a short distance by the parapsidal grooves which are finally curved and diverge, terminating in a groove bounding the anterior lateral edge of the mesonotum; posterior third of the mesonotum with a median, longitudinal, fusiform impression that is apparently smooth; metanotum rather flat, irregularly regulose; wings with the membrane colorless, nervures and stigma blackish; first abcissa of the radius a little less than one-half as long as the cubitus, equal in length to the first abcissa of the discoidal nervure, or nearly as long as the pedicellum; first discoidal cell petiolate, the petiole as long as the first abcissa of the radius. First abdominal segment finely, closely striated and shining, the remaining segments smooth and polished. Face with a rather abundant thin white pubescence, polished surfaces apparently without pubescence. Black; clypeus, scape and pedicellum brown; mandibles except tips, which are brown, and legs excepting the tarsi, which are more or less brownish, testaceous.

Type: University of Kansas. Type locality: Douglas county, Kansas. One specimen. August, E. S. Tucker.

Ischneutidea ? proteroptoides, n. sp.

Ocelli and neuration of anterior wings as in Ischneutidea, posterior wings as in Proterops. Perhaps this is entitled to generic rank.

FEMALE.—Length, 4.5 mm. Head shining, rather closely, minutely punctured or tessellate, a deep impression on each side of the clypeus near the eye; antennæ twenty-six jointed, scape nearly as long as the first joint of the flagellum, pedicellum wider than long; malar space almost obsolete. Thorax smooth and polished; dorsulum and pleura minutely, sparsely tessellate; dorsulum with parapsidal grooves faintly impressed; wings faintly clouded; nervures and stigma blackish; first abcissa of the radius two-thirds the length of the second abcissa, second abcissa of the cubitus a little shorter than the first abcissa of the radius, transverse median nervure almost interstitial; radius in posterior wings distinct and attaining the apex of the wing. Abdomen shining, smooth, minutely, rather closely tessellate. Thinly sericeous with white pubescence, the pubescence nowhere sufficiently abundant to hide the integument. Yellow; a large black spot surrounding and between the ocelli; antennæ, a broad median band on anterior half of dorsulum, lower two-thirds of mesopleura, mesonotum, part of metapleura and metanotum more or less black; disc of scutellum, apex of mandibles, apical dorsal abominal segments in part, apical tarsal joints and posterior legs with apex of tibiæ and all the tarsi more or less dark brown.

Type: University of Kansas. Type locality: Douglas county, Kansas, 900 feet. One specimen. F. H. Snow.

Microplitis croceipes Cresson.

Sedgwick county, near Wichita, Kan., September, 1895; sweepings in peanut vines. E. S. Tucker.

Microgaster tuckeri, n. sp.

FEMALE.—Length, 3 mm. Head dull, finely rugulose; clypeus somewhat shining; scape nearly one and a half times as long as the pedicellum, scape and pedicellum combined a little shorter than the first joint of the flagellum. Antennæ broken, more than thirteen jointed. Dorsulum dull, finely rugulose, parapsidal grooves not deeply impressed; scutellum dull, sculptured like the dorsulum; propleura shining, minutely sculptured; mesopleura smooth, greater part dull, shining in the middle of the posterior half; metathorax somewhat shining, rugulose, almost reticulate, an imperfectly formed longitudinal raised line down the middle of the metanotum. Nervures and stigma varicolored from light to dark brown; second cubital cell oval; first discoidal cell petiolate, the petiole very short; submedian cell distinctly longer than the median cell, but not as much longer as the length of the transverse median nervure. Abdomen shining; first segment dullish, apparently minutely sculptured; remaining segments smooth, apparently impunctate and without sculpture that is not microscopic. Uniformly sericeous with short white pubescence that does not obscure the sculpture in any place. Legs and abdomen brownish yellow, the legs with a somewhat ferruginous tint; extreme base and apical half of abdomen blackish; tarsi blackish.

Type: University of Kansas. Type locality: Douglas county, Kansas. One specimen. June, E. S. Tucker.

Apanteles congregatus Say.

Douglas county, Kansas, 900 feet; June, bred from host on blade of grass; E. S. Tucker.

Apanteles congregatus Say var. hemileucæ Riley.

Douglas county, Kansas, November; bred from cocoon mass on willow leaf; E. S. Tucker.

Cardiochiles seminigrum Cresson.

Hamilton county, Kansas, 3350 feet; June, 1902, F. H. Snow.

FEMALE.—Length, 5 mm.

Cardiochiles nigroclypeus, n. sp.

A variable species in size and sculpture. Related to abdominalis, from which it is readily separated by the smooth polished face and entirely black head.

MALE.—Length, 6.5 mm. Head polished, rather sparsely punctured with small punctures; scape nearly as long as the first and second joints of the flagellum combined, pedicellum inconspicuous, first joint of the flagellum distinctly longer than the second, the second and succeeding joints subequal; antennæ thirty-five jointed. Thorax polished, almost impunctate except on the impressed portions of the pleura; metanotum sparsely rugose, the area not sharply defined, imperfectly quadrangular, more nearly egg-shaped; wings brownish, nervures and stigma dark brown. Abdomen smooth and shining. Black; mandibles tipped with brown; legs, excepting coxæ and trochanters, and abdomen ferruginous; apical tarsal joints of anterior legs, tarsal joints of middle legs, apex of posterior tibiæ, tarsal joints of posterior legs and claspers at tip of abdomen dark brown to black.

Type: University of Kansas. Type locality: Morton county, Kansas, 3200 feet. F. H. Snow.

Paratype, 5 mm. long, from Clark county, Kansas. June, 1903, F. H. Snow.

Paratype about 5 mm. long, with the tip of the abdomen blackish, from Douglas county, Kansas.

Microdus nigrotrochantericus, n. sp.

FEMALE.—Length, 10 mm.; ovipositor, 13 mm. Head polished, face with rather closely arranged small punctures; cheeks more sparsely, minutely punctured; front with two shallow impressions below the antennæ, one below the other; clypeus highly polished, very sparsely punctured; proportions of the joints of the antennæ nearly as in the preceding species, antennæ forty-four jointed. Thorax sculptured almost exactly as in the preceding species, except the metanotum which is polished, somewhat punctured, a medial longitudinal channel rugulose with a narrow longitudinal convexity; metanotum separated from the metapleura by a rugulose line, the posterior face of the metathorax bounded by a raised line that almost describes part of an octagon; wings blackish, very dark; nervures and stigma black; first abcissa of the cubitus obsolete; the second submarginal cell triangular, not petiolate; hind wings with a closed discoidal cell. Abdomen polished, not sculptured. Thinly sericeous, part of the mesopleura bare. Red; head, antennæ, legs excepting posterior femora and coxæ, ovipositor and sheaths black; the posterior coxæ and femora somewhat darker than the integument of the thorax and abdomen.

Type: University of Kansas. Type locality: Douglas county, Kansas, 900 feet. One specimen. F. H. Snow.

Microdus wichitaensis, n. sp.

FEMALE.—Length, 3 mm.; ovipositor, 2 mm. Head polished, apparently impunctate and without sculpture; the face slightly dullish; the clypeus highly polished; antennæ broken, more than fifteen jointed, the scape not as long as the first joint of the flagellum, pedicellum longer than wide, first joints of the flagellum a little longer than the scape and pedicellum combined. Thorax shinning; parapsidal grooves deeply impressed; metathorax dull, moderately regulose, the pleura shining; metanotum with faint carinæ that extend from base to apex and are closer together at the apex than at the base; wings brownish; nervures and stigma brown to brownish testaceous; second submarginal cell triangular and almost petiolate, the transverse median nervure received by the median nervure distinctly beyond the basal nervure. Abdomen, except the basal segment, shining and polished; basal segment dullish, finely longitudinally striate. Pubescence white, and nowhere obscuring the integument. Black; legs and abdomen brown with the following exceptions: Nearly all of the apical half of the abdomen, sheaths of the ovipositor and tarsi more or less blackish, posterior pair of tibiæ whitish, the apical third brownish, and a band near the base brownish.

Type: University of Kansas. Type locality: Sedgwick county, near Wichita, Kan.

One specimen. September, 1895; collected in vineyard; E. S. Tucker.

Microdus castaneicinctus, n. sp.

Related to pygmæus, from which it differs in the absence of foveæ on the second abdominal segment.

FEMALE.—Length, 3 mm.; ovipositor, 2 mm. Head and antennæ almost exactly as in the preceding species; antennæ, twenty-six jointed. Thorax almost as in the preceding species, but the metanotum has two very distinct, not widely separated, nearly parallel carinæ, the pleura dullish and somewhat rugulose; wings with a brownish tint, the nervures brownish testaceous, costal nervure and the costal half of the stigma very dark brown, radial half of the stigma brownish testaceous; second submarginal cell triangular, almost petiolate; transverse median nervure received by the median nervure nearly as far beyond the basal nervure as the transverse median nervure is high. Abdomen shining and polished, except the three basal segments which are dullish and finely rugulose, a deep transverse groove at the suture between the first and second abdominal segments. Black; four anterior legs with the femora, except at base and the tibiæ and base of tarsi brownish testaceous; posterior legs with the femora brownish above, blackish beneath, the tibiæ pale yellowish, apical third and a band in the basal third dark brown; basal half of verter and part of third and fourth dorsal abdominal segments brownish or castaneous. Pubescent as in the preceding species.

Type: University of Kansas. Type locality: Douglas county, Kansas. One specimen. August, E. S. Tucker.

Microdus pimploides, n. sp.

MALE.—Length, 3 mm. Head, polished; face minutely punctured, the punctures well separated; antennæ with the same proportions as in the preceding species, twenty-nine jointed. Thorax polished, the parapsidal grooves distinct and deep; metanotum rather coarsely rugose, somewhat reticulate, metapleura minutely sculptured, dull, appearing closely punctuate: wings almost as in castaneicinctus, the transverse median nervure not so far beyond the basal nervure as in that species. Abdomen polished; the basal segment dullish, more minutely sculptured than the metapleuræ. Pubescent as in castaneicinctus and the other species described here; legs brownish testaceous, except the posterior coxæ which are largely black, and apical half of posterior femora above, a band on the basal third of posterior tibiæ, apical third of posterior tibiæ and tarsi which are more or less deep brown.

Type: University of Kansas. Type locality: Douglas county, Kansas. One specimen. August, E. S. Tucker.

Microdus agathoides, n. sp.

FEMALE.—Length, 4 mm. Head polished: face with small, inconspicuous well-separated punctures; clypeus more highly polished than the other portions of the face; scape nearly as long as the first joint of the flagellum, pedicellum a little wider than long. (Antennæ broken.) Thorax, except the metathorax, polished, almost impunctuate and without sculpture of any kind: metathorax with the pleura somewhat roughened and separated from the metanotum by a rugulose linear area; metanotum with two longitudinal carninæ with a rough surface between, the carinæ a little wider apart near the base than at the apex; wings fuscous, nervures and stigma blackish; second submarginal cell sessile but not broadly thus, almost perfectly triangular; transverse median nervure meeting the median nervure a little beyond the basal nervure. Abdomen polished and with a rather deep lateral impression at the suture between the first and second segments; ovipositor nearly as long as the head, thorax and abdomen together. Thinly pubescent with white short hairs. Red; antennæ, front, coxæ excepting part of anterior pair, trochanters, base of four anterior femora; posterior tibiæ, tarsi, and sheaths of the ovipositor black; tibiæ and tarsi of four anterior legs brownish and blackish.

Type: University of Kansas. Type locality: Morton county, Kansas, 3200 feet. One specimen. June, 1902, F. H. Snow.

Crassomicrodus divisus Cresson.

Douglas county, Kansas, F. H. Snow. Sedgwick county, near Wichita, Kan.; September, 1895; collected in vineyard, E. S. Tucker.

Agathis hæmatodes Brullé.

Morton county, Kansas, 3200 feet; June, 1902, F. H. Snow. Variety: Douglas county, Kansas, 900 feet, F. H. Snow.

Agathus medius Cresson.

Clark county, Kansas, 1962 feet. June, 1903, F. H. Snow.

Ascogaster mimeticus, n. sp.

Superficially almost like Chelonus altitudinis.

FEMALE.—Length, 4 mm. Head dullish, rugulose; cheek nearly twice as broad as the eye, somewhat striate; face and clypeus minutely punctured, the face mostly rugulose, tending to reticulate; scape longer than the first joint of the flagellum, pedicellum nearly as long as wide, antennæ thirty-nine jointed, or with one or two joints more, some of the joints not clearly separated from the adjoining joints. Thorax dullish reticulate; mesonotum to a great extent punctured with small, closely arranged punctures; metathorax more coarsely reticulate than the pleura, with two blunt spines or projections between the lateral short blunt spines, the extra spines shorter than the lateral ones and near the summit of the segment; equally spaced as far from each other as from the lateral spines; wings with only the basal and median nervures testaceous, the second transverse cubitus whitish. Abdomen dull, finely rugulose and reticulate, somewhat striate near base and with three equidistant longitudinal raised lines on the basal fourth. Thinly sericeous, the pubescence hiding the tegument in no place. Black; anterior femora and tibiæ and middle femora yellowish ferruginous; posterior trochanters and femora ferruginous, the femoral with the apical fourth black; middle and posterior tibiæ with the apical half blackish, the basal half yellowish ferruginous; tarsi blackish; mandibles yellowish ferruginous, black at apex.

Type: University of Kansas. Type locality: Douglas county, Kansas, 900 feet. One specimen. F. H. Snow.

Chelonus texanus Cresson.

Wichita, Sedgwick county, Kansas, September, 1895; sweeping in slough-grass in timber along Arkansas river; E. S. Tucker. Sedgwick county, Kansas, 1300 feet; September, E. S. Tucker. Clark county, Kansas, 1962 feet; June, 1903, F. H. Snow.

Chelonus egregicolor, n. sp.

Male.—Length, 5 mm. Head dull; face rugulose; cheeks closely, rather obscurely punctured, almost appearing reticulate; clypeus shining, distinctly, closely punctured with small punctures, the anterior margin smooth; scape as in texanoides, pedicellum almost as long as wide, first joint of the flagellum distinctly longer than the second, if anything longer than the scape, antennæ sixteen jointed. Thorax dull, coarsely reticulate; superior face of metanotum very coarsely reticulated, with a short coarse ridge at base and a similar one on each side of the middle at the apex; separating the reticulated portion of the metanotum from the scutellum is the strongly striated postscutellum; the lateral spines blunt and diverging; posterior face of metanotum reticulated. Abdomen dullish, reticulated; basal two-thirds rather distinctly longitudinally striate, basal third with a short elevated ridge on each side that diverges towards the base. Sericeous as in texanoides. Black; mandibles except apex and base, anterior femora except base, middle femora except basal half ferruginous, infuscated in part; tibiæ and tarsi brownish testaceous on the four anterior legs, the middle tibiæ blackish at base, tarsi blackish at apex, middle third of posterior tibiæ yellow, basal and apical thirds fuscous; tarsi of posterior legs fuscous, metatarsus brownish at base.

Type: University of Kansas. Type locality: Douglas county, Kansas, 900 feet. One specimen. F. H. Snow.

Chelonus altitudinis, n. sp.

Female.—Length, 4 mm. Head dullish, rugulose; cheeks somewhat striate; face rather shining, reticulate; clypeus shining, minutely punctured; antennæ with the usual proportions, the segmentation of the basal segments of the flagellum not distinct. Thorax dull reticulated; the mesonotum smooth and minutely sculptured laterally; metathorax nearly as in the preceding species, the oblong spaces not so distinct; wings as in exogyrus, the basal, first cubital, recurrent and discoidal nervures pale brown. Abdomen almost exactly as in exogyrus, the basal raised lines nearly obsolete. Black; legs partly yellowish ferruginous, base of anterior femora, middle and posterior femora except apex black, basal and apical fifth of posterior tibiæ blackish, tarsi except part of the metatarsus blackish. Sericeous like exogyrus and most other species of the genus.

Type: University of Kansas. Type locality: Morton county, Kansas, 3200 feet. One specimen. January, 1902, F. H. Snow.

Brachistes nocturnus, n. sp.

Male.—Length, 2.5 mm. Head with vertex, occiput and cheeks polished, apparently impunctate; face elevated, dullish; clypeus smooth, sparsely punctured with indistinct punctures; antennæ about twenty-five jointed, scape nearly as long as the first joint of the flagellum, pedicellum longer than wide. Dorsulum polished, with a central triangular lobe the apex of which almost attains the posterior margin, the lobe bounded by the distinct parapsidal grooves which are quite deep and crenulate; pleura shining, rugulose; scutellum shining, sparsely punctured, a broad depression immediately in front of the scutellum with a longitudinal raised line in it; metathorax moderately and uniformly rugulose, almost distinctly reticulate; first abcissa of the radius almost obsolete, first discoidal cell almost sessile, recurrent nervure interstitial, transverse median nervure received by the median nervure a little beyond the insertion of the basal nervure, median nervure obsolescent between the basal nervure and the base of the wing; wings pale, membrane colorless or nearly, nervures testaceous, stigma and anterior margin brownish. Abdomen with the first segment longitudinally striate, the striæ not very closely arranged, the succeeding segments smooth and polished. Thinly sericeous, the pubescence most abundant on the face between the clypeus and antennæ. Black; antennæ, except scape, and the clypeus brown; scape, mandibles and legs testaceous, the apical joint of the tarsi brown.

Type: University of Kansas. Type locality: Lawrence, Douglas county, Kansas. One specimen. May; taken at night; E. S. Tucker.

Cœnocelius politifrons, n. sp.

Male.—Length, 6 mm. Head shining: face rather closely punctured, the punctures one or two punctures apart, sparsest in the middle; clypeus not clearly defined, longitudinally striate; vertex and cheeks polished, sparsely punctured; scape about as long as the pedicellum and first joint of the flagellum together, first joint of the flagellum a little longer than the second, the second and succeeding segments subequal; antennæ about twenty five jointed (tips broken). Prothorax rugose; dorsulum polished, with distinct crenulate parapsidal grooves; scutellum polished, almost impunctate; mesopleura with the superior, anterior and posterior borders rugose, the disc polished and sparsely, finely punctured, a crenulate furrow separating the pleura from the smooth sternum; metathorax rugose: wings strongly brownish, the stigma and nervures very dark brown, petiole of the first discoidal nervure as long as the second transverse cubitus, the first abcissa of the radius a little shorter than the second transverse cubitus, the second abcissa a little shorter than the first transverse cubitus, transverse median nervure interstitial, likewise the recurrent nervure. Abdomen polished; the first segment rather grooved longitudinally in the middle. Thinly clothed with fine white pubescence. Black; metathorax ferruginous; posterior legs excepting tibiæ and tarsi a paler shade of ferruginous than the metathorax; abdomen yellowish ferruginous; tibiæ and tarsi brownish.

Type: University of Kansas. Type locality: Douglas county, Kansas. Collected in timber along Kansas river, near Lawrence. June, 1892, E. S. Tucker.

Zele crassicalcaratus, n. sp.

Related to Zele mellens, from which it is at once distinguished by the thickened spurs and difference in sculpture.

Male.—Length, 5 mm. Head shining, rather irregularly punctured, the punctures shallow, most distinct on the front; clypeus polished, almost impunctate, with no suture between it and the face; antennæ forty-seven jointed, scape and pedicellum together about as long as the first joint of the flagellum. Thorax shining, sculptured irregularly like the head, but the punctures stronger on the pleura, the pleura also partly smooth and practically impunctate; parapsidal grooves of mesonotum deeply impressed and converging posteriorly, terminating in a semilunar depression which is rugose; metanotum rugulose, not areolated, some ridges or raised lines present; wings slightly darkened, transverse median nervure nearly interstitial with the basal nervure, a little basad of the transverse median nervure, first discoidal cell sessile, second abcissa of the cubitus as long as the first abcissa of the radius, a little shorter than the second transverse cubitus; the second abcissa of the radius as long as the first transverse cubitus. Spurs of posterior tibiæ thickened, not tapering, shaped like a talon. First abdominal segment smooth, shining, with shallow small impressions, with a lateral carina that is nearly straight; the remaining abdominal segments more dullish, somewhat punctured. Thinly pubescent with white pubescence. Testaceous, in part with a castaneous tint; between the ocelli the tegument is nearly black; claws very dark brown; flagellum and tarsi more or less brownish; nervures of the wing brown, stigma testaceous; abdomen beyond the first segment brownish except on the apical margin.

Type: University of Kansas. Type locality: Douglas county, Kansas. One specimen. August, E. S. Tucker.

Macrocentrus delicatus Cresson.

Douglas county, Kansas; August, E. S. Tucker.

Macrocentrus atriceps Cresson.

Douglas county, Kansas; August, E. S. Tucker.

Meteorus relativus, n. sp.

Related to M. communis and M. hyphantriæ, from which it differs in size and sculpture.

MALE.—Length, 4.5 mm. Head, face dullish, with closely arranged indistinct minute punctures; clypeus prominent, decidedly convex, sculptured nearly like the face; malar space practically wanting; front, vertex, occiput and cheeks shining, minutely sculptured; scape about as long as the first joint of the flagellum, pedicellum globular, first joint of the flagellum distinctly a little longer than the second, the second and succeeding joints subequal; antennæ twenty-three jointed. Thorax shining; prothorax with smooth borders and a large, triangular impressed rugulose space on the pleura; dorsulum very closely puncturred, the punctures small and indistinct, posterior half of the dorsulum nearly entirely taken up by a semilunar rugulose impressed space; mesopleura polished. minutely punctured, with a shallow, oblique groove that is partly rugulose and a rugulose impression beneath the insertion of the wings; scutellum polished, rather sparsely punctuted; metanotum rugose, almost reticulate, the superior face bounded posteriorly by a sharp curved ridge, posterior face nearly as coarsely sculptured as the superior face, broadly impressed along the middle line longitudinally; metapleura polished, more or less closely sculptured; wings clear with a brownish tint, stigma testaceous, nervures brown; recurrent nervure received by the second submarginal cell distinctly beyond the first transverse cubitus, the second abcissa of the cubitus nearly as long as the first abcissa of the radius; the transverse median nervure nearly as long as the first joint of the flagellum, the first abcissa of the discoidal nervure nearly as long as the transverse median nervure. Abdomen shining and polished; the first abdominal segment with longitudinal closely arranged striæ; other segments smooth. Covered with short white pubescence which is quite abundant but in no place hides the integument. Testaceous to brownish testaceous; some black around the anterior ocellus and between the anterior ocellus and lateral ocelli; antennæ with the flagellum brownish, scape and pedicellum brownish behind; posterior corners of the dorsulum dark brown; superior face of metanotum very dark brown; first abdominal segment, excepting the petiole, dark brown above; other segments brownish, especially along the edge; posterior tibæ with a brownish band near the base and another at the apex; tarsi brownish, especially the apical joints.

Type: University of Kansas. Type locality: Douglas county, Kansas. One specimen, from lot appearing in cage containing both larvæ and pupæ of Clisiocampa disstria, September, 1902, E. S. Tucker.

Meteorus noctivagus, n. sp.

Related to agilis Cresson.

FEMALE.– Length, 4 mm.; ovipositor, 1.5 mm. Head shining and polished, finely sculptured in part; clypeus prominent, distinctly convex, polished; malar space short, nearly as high as the pedicellum is wide; scape nearly as long as the first joint of the flagellum, pedicellum longer than wide, first joint of the flagellum a little longer than the second, the second and succeeding joints subequal; antennæ twenty-six or twenty seven jointed. Thorax shining, minutely sculptured, parapsidal grooves deeply impressed, converging posteriorly and terminating in a rugulose impressed space which is semilunar and occupies all but the broad lateral margins of the posterior third; mesopleura with an oblique broad, shining, flat band that is almost parallel with the posterior margin of the segment and separating a narrow linear rugulose impressed space along the posterior margin of the segment from a triangular impressed rugulose space on the lower half of the segment; scutellum polished, some reticulations on each side of the disc of the scutellum; postscutellum divided into oblong spaces by longitudinal striæ; metathorax somewhat dullish, almost uniformly rugulose, nearly reticulate; wings tinted with brown, stigma nearly black, the nervures testaceous and blackish; recurrent nervure interstitial or nearly; transverse median nervure interstitial. Abdomen polished and shining; first segment, except the petiole, striate but not regularly and longitudinally except on the posterior margin; the remaining segments smooth and highly polished. Sericeous with short white hairs, nowhere obscuring the integument. Black: antennæ, face below antennæ, cheeks along the eye, a spot on each side of vertex, lower half of propleura and abdominal segments beyond the second excepting the tip of the abdomen more or less dark brown; second abdominal segment brownish testaceous; mandibles, except tips, which are blackish, tegulæ, legs, excepting middle and posterior femora at tip, posterior tibiæ at tip and apical joints of tarsi, all of which are more or less dark brown, testaceous; sheaths of the ovipositor very dark brown, almost black.

Type: University of Kansas. Type locality: Lawrence, Douglas county, Kansas. One specimen. At night, May, E. S. Tucker.

Meteorus campestris, n. sp.

May be the western race of Meteorus communis, to which it is related. The uniformly dullish regulose metapleuræ separate this insect at once from that species.

FEMALE.—Length, 5 mm. Cheeks and vertex shining, apparently impunctate; face dullish, minutely sculptured; scape and pedicellum combined about as long as the first joint of the flagellum, joints of the flagellum subequal. Antennæ (broken) more than eighteen jointed. Dorsulum shining, minutely, rather closely punctured; parapsidal grooves deeply impressed, converging and terminating posteriorly in a semilunar impressed rugulose area, which is dullish; propleura shining, closely sculptured; mesopleura with a broad, shallow rugulose groove traversing the segment diagonally, the upper portion of the segment also rugulose, between these two rugulose spaces is a shining, rather sparsely punctured space; metanotum rugulose, almost reticulate, with an indistinct median raised line, metapleura regularly rugulose, but more finely so than the metanotum, and dullish; wings clear, stigma brown, the anterior and posterior ends yellowish; nervures brown, first discoidal cell petiolate, the petiole very short, shorter than the first abcissa of the radius, which is as long as the first abcissa of the discoidal nervure, second abcissa of the radius shorter than the second transverse cubitus. Abdomen polished; the first segment longitudinally striate, the striæ fine and close together. Thinly sericeous, with short, white pubescence. Ferruginous; head and abdomen inclining to testaceous; tarsi brownish; sheaths of the ovipositor blackish; metanotum dark, rather blackish.

Type: University of Kansas. Type locality: Morton county, Kansas, 3200 feet. One specimen. June, 1902, F. H. Snow.

Lysiphlebus succineus, n. sp.

Related to L. multiarticulatus, from which it may be distinguished at once by the immaculate dorsum of thorax.

MALE—Length, 3 mm. Head shining, almost polished, smooth and apparently impunctate; antennæ nineteen jointed, scape and flagellum together a little longer than the first joint of the flagellum, joints of the flagellum subequal. Thorax shining, almost polished; the dorsulum especially smooth and polished; the parapsidal grooves rather distinct on the anterior half, strongly curved; metanotum roughened, transversely divided by a rather indistinct raised line, apical half longitudinally divided by another indistinct raised line, the basal half longitudinally divided by, apparently, two indistinct raised lines that are very close together; wings transparent with a yellowish-brown tint, stigma testaceous, tinged with black; nervures brown, the stump of the radius beyond the tranverse cubitus distinctly longer than the tranverse cubitus, the stump of the cubitus distinctly shorter than the transverse cubitus, the first abcissa of the radius nearly as long as the transverse cubitus and second abcissa or stump of the radius combined. Brownish testaceous; face with a dark brown spot in the middle; vertex and upper part of occiput black; second, third and fourth abdominal segments partly blackish; legs pale testaceous; flagellum almost black.

Type: University of Kansas. Type locality: Douglas county, Kansas. One specimen. August, E. S. Tucker.

Paratype with eighteen joints to the antennæ. July; same place.

Aspilota columbiana, n. sp.

FEMALE—Length, 1.5 mm. Head polished and smooth; antennæ eighteen jointed, scape and pedicellum together a little longer than the first joint of the flagellum. Thorax smooth and highly polished; a short, oblique, smooth, shallow depression on mesopleura; metathorax perfectly smooth and polished like the dorsulum; wings transparent, almost clear, tinted with brownish yellow; first abcissa of the radius a little longer than the second transverse cubitus, the second transverse cubitus nearly twice as long as the second abcissa of the cubitus, which is a little longer than the transverse median nervure, transverse median nervure and first abcissa of the discoidal nervure equal. Abdomen polished, apparently not sculptured; ovipositor distinctly longer than the abdomen, about one-fourth longer. Very thinly pubescent, almost bare, the hairs fine and whitish; antennæ as usual quite hairy; the legs less hairy than the antennæ. Black; scape, pedicellum, legs and abdomen in part testaceous; abdomen with the first segment almost unicolorous with the legs, the succeeding segment brownish, otherwise black or blackish; ovipositor dark castaneous, sheaths black.

Type: University of Kansas. Type locality: Douglas county, Kansas. One specimen. August, E. S. Tucker.

Aphæreta subtricarinata, n. sp.

Superficially like A. auripes, from which it differs in the absence of a strong transverse ridge on metathorax and in the non-striate posterior face thereof.

FEMALE.—Length, 3 mm. Head smooth, polished, no impressed line between occiput and ocelli; antennæ twenty-four jointed, scape and pedicellum together a little longer than the first joint of the flagellum, joints of the flagellum subequal.

Thorax largely smooth and polished; the parapsidal grooves obsolete except on the anterior third of the mesonotum, where they are quite distinct; mesopleura with a dimple at the middle of the posterior margin, a somewhat crenulate shallow impression on the lower half; scutellum convex, quite elevated, smooth and polished; metathorax with a smooth superior face, that is shining and bisected longitudinally by a distinct, sharp ridge, the posterior face dullish, wrinkled and with two parallel longitudinal raised lines close together, one on each side of the medial line; metapleuræ smooth and polished; wings transparent, faintly tinted with brown, stigma and costal nervure dark brown; other nervures blackish testaceous, first abcissa of the radius about half the length of the second transverse cubitus, the second abcissa about as long as the first transverse cubitus and the first abcissa of the radius together, the first transverse cubitus almost as long as the recurrent nervure, the transverse median nervure almost interstitial, received by the discocubital cell a little beyond the basal nervure. Abdomen smooth and polished, the first segment dullish and wrinkled, the basal third with two diverging, distinct raised lines; ovipositor about three-fourths the length of the abdomen. Almost bare, sparse, fine whitish apparent on the face and end of abdomen. Black; mandibles and part of prothorax brownish testaceous; scape, pedicellum and legs testaceous; terminal joint of the tarsi and claws dark brown; basal joint of abdomen castaneous; ovipositor brownish testaceous, sheaths black or nearly.

Type: University of Kansas. Type locality: Douglas county, Kansas. August. E. S. Tucker.

Paratype with twenty-three joints to the antennæ and 2.5 mm. in length, taken at night, in May; Lawrence, Kan. E. S. Tucker.

Aphæreta delosa, n. sp.

Related to subtricarinata and to muscæ, perhaps identical with muscæ.

FEMALE.—Length, 2 mm. Head and thorax as in subtricarinata; antennæ twenty-one jointed, scape and pedicellum together distinctly longer than the first joint of the flagellum, but not much longer; first joint of the flagellum a little shorter than the third, the second joint distinctly longer than the third, remaining joints subequal; wings nearly as in muscæ; first abcissa as long as the second transverse cubitus, first transverse cubitus a little longer than twice the length of the first abcissa of the radius, second abcissa of the radius twice the length of the first transverse cubitus, transverse median nervure very short, shorter than the second transverse cubitus, received by the discocubital cell a little beyond the basal nervure. Metathorax with a superior smooth shining face bisected longitudinally by a sharp ridge, posterior face apparently coarsely, rather sparsely wrinkled or ridged, no parallel carinæ at all evident. Abdomen smooth and polished; the first segment dullish, longitudinally rugulose; sheaths of the ovipositor as long as the abdomen, ovipositor hidden. Almost bare, pubescent as in subtricarinata. Black and as in subtricarinata, but in this species the following exceptions to that pattern occur: The propleuræ are brownish, the metanotum is brownish to brownish testaceous, the first abdominal segment is brownish testaceous.

MALE.—Length, 2.5 mm. Very much like the female; the posterior face of the metathorax not so coarsely wrinkled, brownish, nearly black. Antennæ twenty-four jointed.

Types: University of Kansas. Type locality: Douglas county, Kansas. Both types taken in August, E. S. Tucker.

Paratype, same place and date, with the metathorax piceous, almost perfectly black; in other respects similar to the type, excepting the antennæ, which are twenty-two jointed.

Agathis wyomingensis, n. sp.

FEMALE.—Length, 7 mm.; ovipositor, 5 mm. Head polished, sparsely punctured with minute punctures; scape clavate, curved, a little shorter than the first joint of the flagellum, pedicellum as long as wide, a little shorter than one-fourth the length of the first joint of the flagellum. Antennæ more than fifteen jointed (tips broken). Thorax polished, sparsely punctured, in some places with minute punctures; junction of the metanotum and metapleura rugulose, metanotum medially on the anterior half with a longitudinal narrow convexity that is bounded by a somewhat crenulate furrows making a kind of oval enclosure which terminates in a raised line that entends to the apex of the metanotum; wings fuscous, nervures and stigma very dark brown, second submarginal cell petiolate, the petiole nearly as long as the exterior side of the triangle. Abdomen polished; first segment with longitudinal ridges that become suddenly obsolete in the middle of the segment, are nearly parallel, and as wide from each other as from the sides, diverging at the base to meet the sides. Almost bare, pubescence white, extremely short and inconspicuous. Red; head black except malar space and part of cheeks and apex of clypeus, which are reddish; four anterior coxæ, trochanters and femora black excepting the apex of femora, which is reddish; four anterior tibiæ reddish brown, dark brownish at apex; posterior trochanters black; tibiæ blackish at base and apex; tarsi blackish; ovipositor and sheaths black; extreme base, and venter of abdomen largely black, dorsum of abdomen with some blackish suffusion on the sides near the middle.

Type: University of Kansas. Type locality: Lusk, Wyo. One specimen. July, 1895, Hugo Kahl.

Vipio erythrus, n. sp.

MALE.—Length, 7 mm. Head polished; front with a median longitudinal impressed line; face with irregularly separated shallow punctures, the clypeus not clearly separated from the adjoining tegument. Antennæ broken, more than forty jointed. Thorax polished; the parapsidal grooves not at all deeply impressed, practically obsolete on the posterior half of the mesonotum; metathorax with the charactetistic longitudinal groove above which the metapleura are minutely punctured; wings as in the preceding species. Abdomen polished; the first segment with a broad, medial, elevated, smooth, convex portion, on each side of which is finely striated space bounded by a fold beyond which is a smooth channel, which in turn is bounded externally by the lateral edge of the segment; the second segment has a triangular smooth space medially at the base of the segment, on each side of which is another triangalar space that merges externally with the smooth lateral margin of the segment; the apical smooth area occupies nearly all of the basal half of the segment and has a sinuate anterior margin: between this margin and the triangles at the base of the segment is a broad striate, sinuate groove or depression; third segment smooth, excepting the crenulate suture, the bifurcation of which is well marked on each side: the remaining abdominal segments smooth, quite convex. Red, tinted with brown and testaceous; posterior face of the scape at apex, pedicellum, flagellum, tibiæ and tarsi more or less brown; posterior edge of the tibiæ of the posterior legs, claws, palpi and tips of the mandibles black. Thinly pubescent with soft, silvery hair.

Type: University of Kansas. Type locality: Bill Williams Fork, Ariz. Type taken in September, 1903; one paratype taken in August at the type locality. F. H. Snow.

The paratype measures 8 mm, and is almost exactly like the type in structure, sculpture, and coloration.

Iphiaulax faustus Cresson.

One example has the third abdominal segment more coarsely sculptured than the cotypes and is maculated with black; the base of the fourth segment is also black, and the second has the lateral depressions dark brown, nearly black.

Bill Williams Fork, Ariz.; August, 1903, F. H. Snow.

Iphiaulax rugator Say.

Bill Williams Fork, Ariz.; August, 1903, F. H. Snow. Congress Junction, Ariz.; July, 1903, F. H. Snow.

Iphiaulax perepicus, n. sp.

Related to epicus, from which it is at once distinguished by the larger size and coarser sculpture of the abdomen.

Female.—Length, 13 mm. Head nearly cubical, depressed and polished between ocelli and antennæ; vertex, occiput and cheeks polished, sparsely, indistinctly punctured; face finely rugulose, appearing somewhat striate, dull, with a median indistinct furrow extending from the clypeus to between the antennæ; anterior margin of the clypeus curved in by the characteristic basin-like depression beneath it, labrum elevated and keeled, appearing like a nose with flat sides, the apex pointed downward and backward; temples not as broad as the eyes: scape polished, sparsely punctured, stout, the margins not appreciably produced, pedicellum about one-third the length of the first joint of the flagellum, the first joint of the flagellum nearly as long as the next two joints together. Antennæ more than eighty-five jointed. Thorax polished; parapsidal grooves of mesonotum not sharply impressed; metathorax with minute sparse punctures and a longitudinal groove on the pleura below the spiracle starting in a pit near the anterior margin of the pleura; wings very dark, neuration almost exactly as in epicus. Abdomen polished; first segment with an oblong, elevated, convex, smooth portion in the middle, two grooves on each side of the middle space, the innermost groove wrinkled transversely and separated from the outermost groove by a straight fold or ridge, the outermost groove ribbed and bounded externally by the edge of the segment; second abdominal segment with an acute triangular fl·t space in the middle at the base of the segment and the apex in the center of the segment where it is continued nearly to the apex as a ridge, a broad, shallow rath (?) V-shaped depression on each side of the middle occupying the space between the edge of the segment and the medial raised portion, the raised portion within this V and the raised portion of the lateral edge of the segment are rather sparsely punctured with smaller regular punctures; third segment with a basal crenulate groove that bifurcates in the middle of each side of the segment at the anterior margin and thus forms two nearly equilateral triangles, which are slightly impressed near the posterior margin, the remainder of the segment is partially keeled medially with a raised line on each side of which, for a short distance, the segment is rather confluently pitted or rugulose beyond this medial rugulose space, to each side, the segment is first irregularly punctured and then impunctate or minutely punctured and polished; the fourth segment is polished and sparsely, irregularly punctured; the fifth, sixth and seventh segments are polished and impunctate or nearly; the ovipositor is nearly as long as the abdomen and metathorax combined. Black; mesothorax, upper half of pleura and abdomen red; the second and third segments partly testaceous, the third and fourth segments brownish, at the junction of the mesopleura with the mesosternum is a castaneous line. Thinly sericeous with short white pubescence, the pubescence on the metathorax longest.

Type: University of Kansas. Type locality: Bill Williams Fork, Ariz. One female. August, 1903, F. H. Snow.

Iphiaulax propinquus, n. sp.

FEMALE.—Length, 8 mm. Agrees very well with I. militaris, but differs in the following important characters: Antennæ fifty-six jointed or nearly. The metanotum has a distinct median furrow; the first abdominal segment is more distinctly sculptured and has a median raised line on the posterior half; the second segment is rather striated, and the triangular smooth space is reduced to a semicircular space or lunule; the ovipositor is as long as the abdomen and metathorax combined.

Type: University of Kansas. Type locality: Oak Creek Canyon, Ariz. One specimen. August, 1902, F. H. Snow.

Iphiaulax cinnabarinus, n. sp.

FEMALE.—Length, 6 mm. Structure very much as in militaris, with the following differences: Face minutely rugulose, the clypeus differentiated and a superclypeal space outlined; parapsidal grooves practically absent; wings pale brownish, nervures and stigma dark brown. Antennæ fifty-two jointed. Abdomen: The elevated portion of the first segment not very high, rugulose, the innermost furrows rather crenulate, the outermost furrows smooth; second segment rugose, appearing rather as if confluently punctured, the diverging, oblique impressed lines shallow aud similarly sculptured; third segment with the bifurcation of the crenulate suture not very distinct, the triangles formed by the bifurcation smooth, punctured at the edge; the fourth and fifth segments sculptured like the second, somewhat coarser; ovipositor a little longer than the last two segments. Red, almost like cinnabar; antennæ, except the scape above, tips of the mandibles, ovipositor and tips of the feet, black.

Type: University of Kansas. Type locality: Bill Williams Fork, Ariz. One specimen. August, 1903, F. H. Snow.

Chelonus texanoides, n. sp.

With the form of C. texanus, to which this species is related.

FEMALE.—Length, 5 mm. Head dull; face shining, face except the clypeus, front, vertex, occiput and cheeks almost uniformly rugulose and somewhat striated; clypeus smooth, closely punctured, the punctures small and not deep, anterior margin of the clypeus impunctuate; scape rather clavate, pedicellum shorter than wide, first joint of the flagellum a little longer than the second joint, nearly as long as the scape. Antennæ twenty-six jointed. Thorax dull, except the metanotum, which is rather shining; mesonotum irregularly reticulate, pleura regularly, distinctly reticulate, mesonotum with coarse longitudinal striæ on the superior face and diverging striæ on the posterior face, the surface between the striæ uneven, lateral spines blunt, prominent, diverging; neuration characteristic, the second abcissa of the radius straight, forming an obtuse angle with the first abcissa; membrane hyaline, costal nervure pale brown, median, submedian and basal nervures testaceous, other nervures and stigma dark brown. Abdomen dull, reticulate, but more moderately than the pleura; basal third of the abdomen with two raised lines that diverge basally and are obsolescent anterior to the basal third of the segment. Uniformly sericeous, the pubescence short and in no place hiding the tegument. Black: anterior femora testaceous, tinted with ferruginous; middle femora ferruginous, black at base; anterior tibiæ and tarsi dull testaceous, somewhat infuscated, terminal joints blackish; posterior femora ferruginous, tibiæ yellow and ferruginous, fuscous at base and apex, posterior tarsi at base and spurs pale yellow, apex of metatarsus and succeeding tarsal joints blackish; abdomen black at base, beyond the black are two testaceous spots separated by a ferruginous broad line which is continuous with the ferruginous color of the remaining portion of the abdomen; abdomen at apex somewhat infuscated.

Type: University of Kansas. Type locality: Bill Williams Fork, Ariz. One specimen. August, 1903, F. H. Snow.

Chelonus nucleolus, n. sp.

FEMALE.—Length, 4 mm. Head dull, minutely, rugulosely sculptured; clypeus as in the preceding species. Antennæ broken. Thorax dull; mesonotum partly obscurely reticulate, partly somewhat shining, rather smooth and minutely sculptured; scutellum, pleura and metathorax reticulated, the latter somewhat shining; the metanotum has two longitudinal ridges rather widely separated, the space between about one-half as great as the space to each side; wings as in the preceding species, the dark nervures and stigma paler. Sericeous as in the preceding species. Abdomen finely rugulose and somewhat striate on basal third, the diverging raised lines on the basal third indistinct. Black; mandibles castaneous except at apex and base; trochanters pale and dark brown; tibiæ of anterior legs pale brown, yellowish, dark brown on basal half; middle tibiæ uniformly yellowish, tinted with brown; posterior tibiæ dark brown at base and on greater part of apical half yellowish, between tarsal joints yellowish tinted with brown, apical joints fuscous; basal third of abdomen with a clearly defined broad testaceous band, extreme base of abdomen dark brown.

Type: University of Kansas. Type locality: Oak creek canyon, Arizona. One specimen. August, 1902, F. H. Snow.

Chelonus exogyrus, n. sp.

FEMALE.—Length, 4 mm. Head dull, rugulose, reticulate; cheeks rather shining and striate; clypeus as in the preceding species; scape a little longer than the first joint of the flagellum, pedicellum wider than long. Antennæ twenty-six jointed. Thorax dull, rather coarsely reticulate; pleura somewhat shining; metanotum with two longitudinally arranged, oblong, rough, shining spaces bounded by salient raised lines, posterior face of metanotum with radiating ridges that are obsolete near the apical edge; lateral spines as in the preceding species; wings as in 653. (?) Abdomen dull, delicately rugulose and reticulate; basal half rather striate, basal raised lines not distinct, diverging as usual.

Black; mandibles castaneous, black at base and apex; coxæ and trochanters black; anterior legs yellowish ferruginous, femora black at base, tarsi blackish at apex; middle legs like the anterior pair, but basal half of femora black and all tarsi except basal two-thirds of metatarsi blackish; posterior femora ferruginous, basal half black, tibiæ yellowish ferruginous, basal and apical fifths blackish; tarsi blackish except basal two-thirds of metatarsus which is yellowish; a band posterior to the basal fifth of the abdomen and as long as the basal fifth, divided nearly into three equal parts by two semicircular lateral spots, one bordering on each lateral edge of the abdomen and curved inward, the space between these spots rather brownish. Sericeous as in the preceding species.

Type: University of Kansas. Type locality: Bill Williams Fork, Ariz. One specimen. August, 1903, F. H. Snow.

Melanobracon montivagus Cresson.

One specimen with the impressions on the second segment shallow; therefore, not typical.

Manitou Park, Colorado; August, 1891. F. H. Snow.

Cardiochiles explorator Say.

Colorado Springs, Colo., 5915 feet; August, 1894. E. S. Tucker.

Crassomicrodus fulvescens Cresson.

Specimen with the first abcissa of the cubitus rather distinct, not decidedly obsolescent.

Colorado Springs, Colo., 5915 feet; August, 1894. E. S. Tucker.

Crassomicrodus? medius Cresson.

Colorado Springs, Colo., 5915 feet; August, 1894. E. S. Tucker.

Crassomicrodus nigricaudus, n. sp.

Male.—Length, 10 mm. Head shining; cheeks indistinctly, sparsely punctured; front with a deep depressed area that is rugose; face minutely sculptured and closely punctured, the punctures small and shallow, a low oval elevation a little below and between the antennæ; clypeus polished, smooth and impunctate anteriorly, punctate posteriorly: scape clavate, pedicellum wider than long, first joint of the flagellum as long as the scape. Antennæ thirty-two jointed. Thorax, except the metathorax, smooth and polished; the segment of the pleura immediately beneath the tegulæ dullish, and closely punctured with small punctures; dorsulum with the parapsidal grooves distinct, medially with a longitudinal narrow welt that extends posteriorly nearly to the junction of the parapsidal grooves; scutellum with sparse moderately large punctures; pleura of metathorax closely punctured; metanotum rugose; spiracles ovoid, nearly round; wings typical; claws with a short tooth half-way within from apex or claw. Abdomen polished and smooth. Thinly sericeous, with yellowish pubescence, pleura partly bare. Black; basal half of antennæ brown, apical half blackish; upper third of prothorax and dorsulum castaneous; basal half of the abdomen and the legs, excepting tarsi, brownish testaceous, the legs inclining to testaceous, tarsi honey color, claws dark brown; wings yellowish, apical half infuscated, nervures and stigma testaceous, except in the infuscated region, where they are dark brown.

Type: University of Kansas. Type locality: Colorado Springs, Colo., 5915 feet. One specimen. August, 1894. E. S. Tucker.

Another specimen, the paratype, from the same place and with the same data as the type, has only the base of the scape and pedicellum brownish and a brownish spot on each side of the dorsulum; there is also a slight difference in the sculpture of the metathorax.

Family Ichneumonidæ.

Phygadeuon (Bathymetis) spinicoxus, n. sp.

Very conspicuous on account of the spined posterior coxæ.

Female.—Length, 6.5 mm. Head shining, somewhat dull; face rather sparsely punctured, elevated between the insertion of the antennæ and clypeus; clypeus sparsely punctured, not separated from the face posteriorly by a groove; malar space about as high as half the width of the mandibles at base; mandibles distinctly bidentate, the lower tooth distinctly shorter than the upper tooth; ocelli forming a low triangle, distance between posterior pair a little greater than the distance between lateral ocellus and nearest eye margin; front, vertex and cheeks almost uniformly punctured, the punctures thereon well separated; antennæ twenty-eight jointed, second joint of the flagellum apparently a little longer than the first, and about as long as the scape or a little shorter. Thorax shining; dorsulum with well-separated punctures, parapsidal grooves present and distinct only on the anterior fourth of the segment; scutellum sparsely punctured, polished; superior face of the metathorax with the basal area practically crowded out and the areola more than a semicircle, posterior with three areas, the petiolarea defined by moderate raised lines, below transversely wrinkled, forming a shallow, broad channel that is as wide as the areola at base and apex and not much wider in the middle, the raised lines or ridges bounding the posterior face nearly produced into sharp angles a little below the middle of the segment, spiracles circular and nearer to the raised line separating the lateral areas than to the suture between metanotum and metapleura, connected with the lateral suture by a straight raised line; metapleura sculptured very much like the mesopleura; posterior coxæ with a strong tooth below near the apical end, pointed inward and backward, posterior femora a little more than three times as long as broad, the posterior tibiæ not much dilated at apex; wings tinted with smoky, the stigma and nervures very dark brown, nearly black: areolet pantangular, the sides nearly of equal length, the discocubital nervure not broken, the transverse median nervure interstitial; the transverse median nervure in the posterior wings broken a little below the junction of the basal with the middle third. Abdomen shining, indistinctly punctured; the second segment with a transverse impressed line in the middle and at base a transverse groove or channel; ridge of the petiole not extending uninterrupted to the apex of the segment. Inconspicuously covered with short, silvery pubescence which is longest and most apparent on the metathorax. Ferruginous; sutures of the thorax more or less black; mandibles brown at apex, edge of antennal foveæ dark brown; antennæ with the first ten joints brownish testaceous, joints 11, 12 and 13 more or less whitish, the joints beyond dark brown; four anterior legs more or less testaceous.

Type: University of Kansas. Type locality: Magdalena mountains, New Mexico. August, 1894, F. H. Snow.

Paniscus geminatus Say.

Female, with the lateral transverse carinæ near apex of metanotum wanting and the transverse striæ of the metanotum obsolescent.

Willow Park, Colo., 7500 to 8000 feet; June, July, 1892, V. L. Kellogg.

Rhyssa persuasoria Linn.

Manitou Park, Colo.; August, 1891, F. H. Snow.

Cryptus (Habrocryptus?) robustus Cresson.

Female. Willow Park, Colo., 7500 to 8000 feet; June, July, 1892, V. L. Kellogg.

Female. Manitou Park, Colo.; August, 1891, F. H. Snow.

The former specimen has the abdomen part rufous on the apical half; the latter has the abdomen, except petiole, almost entirely rufous.

Hemiteles (Diaglypta?) manitouensis, n. sp.

MALE — Length, 5 mm. Head shining and distinctly punctured; face closely punctured; clypeus not separated from the face by a suture and sparsely punctured; malar space about as high as the mandibles are broad at base and sparsely punctured; front, vertex and cheeks polished and sparsely punctured, the punctures on the cheek sparser than on the front, those on the front sparser than on the clypeus; ocelli almost forming an equilateral triangle, distance between the posterior ocelli a little less than the distance between the eye margin and nearest ocellus; scape and pedicellum together a little shorter than the first joint of the flagellum. Thorax shining; dorsulum and mesopleura polished, the dorsulum with the parapsidal grooves impressed only near the anterior margin, the surface sparsely, indistinctly punctured; mesopleura sparsely, rather distinctly punctured, the short transverse fovea adjoining the middle of the posterior margin of the mesopleura present, the cryptine groove distinct, oblique, extending from below the mesopleural mesosternal edge anteriorly to above this edge posteriorly and near the posterior margin of the mesopleura; metanotum rugose, distinctly areolated, the basal area practically crowded out by the high and short areola which is nearly twice as broad as long, and rather imperfectly hexagonal, the petiolarea is nearly twice as long as broad and occupies the greater portion of the middle fourth of the posterior face of the segment, the lateral basal areas large and triangular; metapleura partly polished and sparsely punctured, partly rugose; wings slightly browaish, nearly clear, stigma rather pale brown, the nervures dark brown; transverse cubitus about twice the length of the first abcissa of the cubitus beyond the transverse cubitus; second abcissa of the cubitus beyond the transverse cubitus equal to the length of the transverse cubitus, the first abcissa of the cubitus beyond the transverse cubitus is as long as the flagellum is wide at base; the discocubital nervure with a trace of a stump of a vein in the middle; the transverse median nervure in the anterior wings received by the median nervure a little beyond the insertion of the basal nervure; transverse median nervure in the posterior wings broken a short distance below the middle. Abdomen shining; petiole with the basal two-thirds constricted rather suddenly, parallel-sided or nearly and throughout not much wider than one-half the width of the petiole at apex, the apical margin of the petiole distinctly, longitudinally striate; the segments beyond the petiole smooth and apparently without sculpture. Covered with inconspicuous whitish pubescence, the pleura appearing bare. Black; femora and tibiæ of anterior and middle legs almost entirely brownish testaceous, the tarsi thereof more or less fuscous; posterior legs with the femora and tibiæ almost entirely ferruginous, the femora brownish above in part, the tibiæ brownish at base and apex, the tarsi thereof entirely dark brown; second, third and greater part of fourth abdominal segments ferruginous, the succeeding segments dark brown with pale margins.

Type: University of Kansas. Type locality: Manitou, Colo., 6629 feet. August, 1894, E. S. Tucker.

Ichneumon (Probolus) flavofacialis, n. sp.

Superficially related to I. pedalis but apparently near to I. similaris.

MALE.—Length, 13 mm. Head shining; face and cheeks closely punctured, the cheeks less distinctly and less closely punctured than the face; clypeus almost impunctuate and smooth, bearing only a few good-sized punctures and some scattered minute punctures; malar space a little higher than the mandibles are broad at base (antennæ broken); scape and pedicellum together as long as or a little shorter than the first joint of the flagellum. Thorax shining: the dorsulum closely punctured, the punctures adjoining or nearly, parapsidal grooves faintly, broadly impressed near the anterior margin: punctures of the mesopleura of about the same size as those on the dorsulum and as close together; punctures practically obliterated, areola rugose, nearly twice as wide as long, with the of the scutellum well separated, rather sparse; metanotum with the basal area sides almost parallel, petiolarea not defined by raised lines but distinguished from the adjoining areas by the difference in sculpture, the petiolarea being rather finely rugulose or coarsely granular, nearly as wide at apex as at base, the lateral areas rugose and more like the areola in sculpture, the basal lateral areas are sculptured very much like the petiolarea; the metapleura rugosopunctate; wings distinctly brownish, stigma pale brown, costal margin dark brown, nervures reddish brown; areolet with the first cubital side and the transverse cubiti of equal length, the radial side a little more than half the length of the cubital side. Petiole shining, with the constricted portion rather coarsely sculptured, almost rugosopunctate, the broad portion more dullish and rather finely rugulose, longitudinally divided into three almost equal parts by two distinct ridges; the remaining segments dull, with shallow adjoining punctures, apical segments shining, with the punctures separated and of a different type. Black; face below antennæ, exclusive of the malar spaces, almost entirely yellow, the black of the front extending around the insertion of the antennæ, forming a transverse black area immediately below the antennal foveæ, from this area a band is prolonged down the middle of the face nearly to the base of the clypeus: clypeus anteriorly with a pale brown spot, labrum brown at base, mandibles yellow only along the superior margin, anterior legs, except coxæ and trochanters, middle and posterior legs, except coxæ and basal trochanters, more or less ferruginous; the posterior legs with the tibiæ almost black on the apical fourth, the tarsi fuscous.

Type: University of Kansas. Type locality; Manitou Park, Colo. August, 1891, F. H. Snow.

Ichneumon (Barichneumon) egregiafacialis, n. sp.

Very like the preceding, from which it differs as follows:

MALE.—Length, 12 mm. Face coarsely, closely punctured; clypeus with sparse large and small punctures; vertex and cheeks with well-separated punctures; antennæ forty-five jointed, scape and pedicellum together a little longer than the first joint of the flagellum. Dorsulum with the punctures rather separated; areola about one and a half times as wide as long, hardly quadrangular, more nearly semicircular, with the posterior margin rather distinctly incurved, petiolarea not very perceptibly different in sculpture from the adjoining areas from which it is not separated by distinct raised lines, the petiolarea is constricted below the middle so that it is nearly twice as broad at base as at apex, the petiolarea is granular, the adjoining areas rather rugulose. The petiole of the abdomen is distinctly as broad as thick at base. The legs, excepting basal trochanter and coxæ, are almost entirely yellowish ferruginous, the posterior tibiæ and tarsi without fuscous; face below antennæ almost entirely yellow, the yellow prolonged along the inner eye margin half-way upon the front, three longitudinal brown bands dividing the yellow above the clypeus into four parts nearly of equal width, a very dark brown, nearly black band between the clypeus and face; the clypeus with a large semicircular dark brown mark on the anterior half, this brown being prolonged back to meet the dark brown band between the face and clypeus, thus reducing the yellow of the clypeus to two elongated yellow spots; mandibles brown at apex.

Type: University of Kansas. Type locality: Manitou Park, Colo.; August, 1891, F. H. Snow.

Ichneumon (Barichneumon) limbifrons Cresson.

Manitou Park, Colo.; August, 1891, F. H. Snow.

Ichneumon (Cratichneumon ?) skinneri Viereck.

Male. Bailey, Colo.; August, 1890, F. H. Snow.

Nototrachys reticulatus Cresson.

Two males. The specimens are smaller than the type and one of the specimens has paler legs. They vary somewhat in sculpture, but apparently represent at most only variations of the type, perhaps a separate race.

Oak Creek Canyon, Ariz., 6000 feet; August, 1902, F. H. Snow.

Nototrachys texanus Cresson.

Female. Differs from the type in having the shining space of the mesopleura rather coarsely punctured. Perhaps a distinct race of the Texan form.

Oak Creek Canyon, Ariz.; August, 1902, F. H. Snow.

Bassus lætatarius Fab.

Oak Creek Canyon, Ariz.; August, 1902, F. H. Snow.

Glypta egregiafovea, n. sp.

Remarkable for the transverse apical fovea on the impressed abdominal segments.

Female.—Length, 10 mm. Head shining or polished; face closely punctured, punctures on the front distintly separated; cheeks somewhat excavated, polished and almost impunctate; malar space nearly as high as half the length of the first joint of the flagellum; antennæ forty-eight jointed, scape and pedicellum together a little longer than the second joint of the flagellum. Thorax shining and polished; dorsulum shining, rather closely punctured, the punctures separated and distinct; parapsidal grooves faintly indicated on the anterior half of the dorsulum; propleura rather sparsely punctured; mesopleura highly polished on the posterior half of the sclerite and impunctate, a deep pit near the posterior margin of the sclerite in the middle; metathorax not at all areolated, not even longitudinal carinæ present or indicated, the transverse carina distinct and rather low down; wings with the neuration nearly as in typical Glypta; *i. e.*, as in the preceding species, the first abcissa of the cubitus beyond the transverse cubitus distinctly shorter than the transverse cubitus, discocubital nervure with a slight stump of a vein before the middle. Abdomen rather sparsely, closely punctured; first segment with two short converging carinæ anteriorly, the carinæ not extending to the middle, the surface between highly polished, smooth impunctate; oblique impressions on the second and third abdominal segments forming an almost equilateral triangle with the transverse impression across the segment near the apex; the pattern formed by the impressions on the fourth segment nearly the same as that on the third, but on the fourth segment the impressions are not so distinct and the punctures are smaller and closer together; ovipositor a little longer than the abdomen. Black; clypeus anteriorly, large spot on basal half of mandibles, tubercles, tegulæ, base of wings, anterior coxæ and anterior trochanters white or whitish; otherwise the legs are brownish testaceous, except as follows: The claws are brown, posterior tibiæ and tarsi brownish to a great extent, posteriorly the posterior tibiæ are whitish, except a brown band near the base and a brown band at apex, posterior tarsi pale at base, the metatarsus with the basal fourth pale; ovipositor of the usual color. Middle trochanters also somewhat whitish.

Type: University of Kansas. Type locality: Oak creek canyon, Ariz., 6000 feet. August, 1902, F. H. Snow.

Pimpla annulipes Brulle.

Oak creek canyon, Ariz.; August, 1902, F. H. Snow.

Pimpla pedalis Cresson.

Oak creek canyon, Ariz.; August, 1902, F. H. Snow.

Cryptus (Mansa?) politicalypterus, n. sp.

Generically also like Opisoxestus, except in length of submedian cell and mesonotal furrows, and in the character of the metathorax. Very like the Cressonian interpretation of C. calipterus Say, from which it differs in the more separated sculpture, the shining integument, and in the absence of a transverse carina on the metanotum.

Male.—Length, 11 mm. Head lengthened: face dullish, closely sculptured, clypeus and supraclypeal space distinctly elevated; front, vertex and cheeks more shining, the cheeks and anterior margin of clypeus especially so; space between lateral ocelli greater than the space between a lateral ocellus and the anterior ocellus, less than the distance between lateral ocellus and nearest eye margin; malar space higher than the mandibles are broad at base, about as high as half the length of the first joint of the flagellum; antennæ thirty-nine jointed, scape very broad, together with the pedicellum a little shorter than the first joint of the flagellum. Thorax rather shining; dorsulum with the parapsidal grooves rather shallowly impressed on the anterior half of the sclerite, punctures separated, but not far apart, minute, and rather inconspicuous; scutellum rather strongly punctured in comparison with the dorsulum; pleura with distinct, separated punctures on a shining surface, those of the mesopleura most distinct, the punctures of the metapleura almost adjoining; metanotum separated from metapleura by a shallow furrow in which there is no raised line, metanotum punctured and shining nearly like the metapleura but uneven, the superior face partly flat, the posterior face broadly, shallowly excavated; wings colored as in calipterus; the areolet pentangular, the radial side and the transverse cubiti of nearly equal length, the first cubital side as long or a little longer than the first transverse cubitus, the second cubital side a little more than half the length of the first cubital side; transverse median nervure in posterior wings broken a little below the middle. Abdomen smooth and shining. Head and dorsulum covered with short, rather abundant, golden pubescence; abdomen pubescent, much like the face and dorsulum; clypeus in part and metathorax with long, erect pubescence of a golden tint; antennæ dull and rather densely covered with short pubescence; pleura with erect, rather long, inconspicuous pubescence. Rufotestaceous; inner eye margins yellowish; mandibles at tip, claws and apical tarsal joint more or less brown; abdomen, except petiole, and antennæ to a great extent dark ferruginous, apical fourth of antennæ brownish; posterior legs ferruginous to a great extent, the tibiæ thereof almost black, except the basal third, tarsi of posterior legs, excepting the apical joint, almost entirely yellow, four anterior legs testaceous.

Type: University of Kansas. Type locality: Bill Williams Fork, Ariz. August, 1903, F. H. Snow.

Pezomachus homalommoides, n. sp.

MALE.—Length, 4 mm. Head dullish; cheeks shining, especially below, apparently impunctate; face very dull, closely, minutely sculptured; clypeus shining, with a few rather distinct punctures; malar space about as high as the mandibles are broad at base; antennæ twenty-seven jointed, scape and pedicellum together distinctly shorter than the first joint of the flagellum. Thorax dullish; dorsulum very closely sculptured, with only the faintest indications of parapsidal grooves; mesopleura sculptured very much like the dorsulum, traversed by an oblique, rugulose groove, beneath which the sclerite is to a great extent smooth and polished, the upper sculptured area traversed obliquely by a rugulose linear space that is apparently not impressed; areola hexagonal, the lateral angles below the middle, the upper sides therefore longer than the lower sides, base slightly narrower than apex; basal area not very distinct, nearly quadrate; petiolarea similar in outline to the areola, about as long as the areola and basal area together; metapleura minutely rugulose; wings faintly brownish, stigma and nervures dark brown, stigma with the basal fourth whitish; areolet open behind. If complete it would apparently be pentangular; first abcissa of the radius a little less than one-half the length of the second abcissa; the transverse cubitus about one-half the length of the first abcissa of the radius; first abcissa of the cubitus beyond the transverse cubitus about one-half the length of the transverse cubitus, the second abcissa of the cubitus sinuate at base, nearly straight; second abcissa of the discoidal nervure, the co-called first recurrent nervure, about one-half the length of the true recurrent nervure; discocubital nervure imperfectly broken by the faintest indication of a stump of a vein in the middle; transverse median nervure slightly beyond interstitial, almost exactly interstitial; transverse median nervure of the posterior wings broken where the middle third joins the lower third. Abdomen dullish; the petiole especially dull, rugulose longitudinally, so on the apical half, and nearly distinctly striate; second abdominal segment rugulose, the succeeding segments smooth. Covered with very short whitish pubescence that is nowhere very distinct. Black; scape and pedicellum, mandibles, except tips which are brown, and legs brownish testaceous; apical margin of second abdominal segment and third almost entirely testaceous; flagellum dark brown; part of second abdominal segment not mentioned brown with some blackish.

Type: University of Kansas. Type locality: Oak creek canyon, Ariz. August, 1902. F. H. Snow.

Hemiteles (Diaglypta ?) laphroscopoides, n. sp.

MALE.—Length, 4 mm. Head shining; face minutely sculptured; cheeks smooth and polished, apparently without sculpture of any kind; malar space distinctly higher than the mandibles are broad at base; antennæ twenty-three jointed, the joints distinctly separated, scape and pedicellum together a little shorter than the first joint of the flagellum. Thorax, except the metathorax, polished; dorsulum with rather distinct parapsidal grooves near the anterior margin; mesopleura with an oblique narrow groove on the lower half, the groove almost bisecting the lower half transversely and not attaining the posterier border, a little above the middle of the posterior half of the mesopleura is a short, transverse impression which joins the posterior border of the sclerite; basal area broader than long, areola and petiolarea confluent, parallel-sided, about four times as long as wide, in part coarsely, transversely wrinkled, nearly striate and shining, lateral areas dull rugose; metapleura dull, minutely sculptured; wings faintly brownish, nervures and stigma entirely brown, the stigma paler than the nervures; neuration almost exactly as in Homalomma aloga, the areolet completed, pentangular, not the slightest trace of a stump of a vein to break the discocubital nervure; transverse median nervure of posterior wings faintly broken a little below the middle. Abdomen almost entirely smooth and shining; the petiole with a fine raised line on each side, very inconspicuously covered with short whitish pubescence. Black: mandibles and legs to a great extent almost rufous, tips of the mandibles and tarsi brownish, coxæ of posterior and middle legs black, basal trochanters of middle and posterior legs strongly brownish; second abdominal segment brownish, the third segment, except along the apical margin, yellowish.

Type: University of Kansas. Type locality: Oak creek canyon, Ariz., 6000 feet. August, F. H. Snow.

Ichneumon (Eurylabus) arizonensis, n. sp.

Superficially like I. navus and allied species.

FEMALE.—Length, 10 mm. Head shining: face closely punctured, the punctures adjoining or nearly, prominent elevated between the antennæ and base of clypeus, the elevation separated from the sides of the face by shallow grooves; clypeus with coarse, sparse, very distinct punctures, much larger than the punctures on the face, the anterior margin somewhat turned up, regular; malar space as high or a little higher than the mandibles are broad at base; front, vertex and cheeks almost uniformly, closely punctured, the punctures on these parts smaller and closer than on the face; antennæ thirty-four jointed, the joints of the flagellum subequal, the first joint and pedicellum combined about two-thirds the length of the scape. Thorax mostly shining, partly dull; dorsulum closely punctured, the punctures adjoining or nearly and to some extent confluent, giving a striate appearance; parapsidal grooves very faintly indicated on the anterior third; propleura with distinct separated punctures on the upper portion, below the surface is closely transversely striate punctate: mesopleura rather closely punctured and somewhat striate, on the posterior half of this sclerite a little above the middle is a transverse impression that looks like two pits, one very shallow, the other and posterior one deep; the scutellum shining, sparsely punctured, immargined; postscutellum polished like the scutellum, apparently impunctuate; metathorax dull; superior face of the metanotum with apparently no basal area, the areola occupying nearly all of the middle of the superior face for a width as great as that of the scutellum, about one and a half times as long as wide; posterior face of the metathorax with three distinct areas, the petiolarea nearly parallel-sided and as broad or a little broader than the areola, the lateral areas of the posterior face bounded by strong, coarse ridges, a little above the middle of each side of the posterior face the groove just mentioned is produced into a more or less short, sharp tooth; metapleura very closely punctured, giving a rugulose appearance; wings with distinct yellowish-brown tinge, the stigma nearly black, nervures very dark brown, excepting the second transverse cubitus and the terminal abcissæ of the cubitus and subdisciodal nervures which are more or less testaceous; areolet pentagonal, the first cubital side and the transverse cubiti of equal length, the second cubital side a little shorter than the first and a little longer than the radial side, only the slightest trace of a stump of a vein on the discocubital nervure. Abdomen mostly dull; petiole with lateral ridges that just attain the spiracles, basal third of the petiole largely polished and without sculpture of any kind, the middle and apical thirds of the segment minutely roughened and rather indistinctly, longitudinally striate; the second segment very closely punctured with small, shallow, rather indistinct punctures that give a dullish appearance; the following segments smooth, more shining and apparently impunatate and devoid of appreciable sculpture. Covered with short, inconspicuous, whitish pubescence. Black; joints 10 to 17, inclusive, of the antennæ yellow, the ninth joint partly yellow; orbits, from a little back of the middle of the top of the eye to a little below the insertion of the antennæ within, with a narrow yellow band; superior margin of the prothorax interrupted in the middle, a transverse band below the tegulæ, basal two-thirds of the anterior tibiæ externally, basal half of the middle tibiæ and a little more than the basal third of the posterior tibiæ white; anterior tibiæ beneath, the apical third entirely and the tarsi of anterior legs brown.

Type: University of Kansas. Type locality: Oak creek canyon, Ariz., 6000 feet. August, 1902, F. H. Snow.

Amblyteles hudsonicus Cresson.

One female. Oak creek canyon, Ariz. August, 1902, F. H. Snow.

Ichneumon (Barichneumon) humphreyi, n. sp.

This might be referred to I. ferrugator Kirby, but that is said to have distinct lateral spines or teeth on the metathorax.

MALE.—Length, 14 mm. Head shining; face closely, distinctly punctured, the punctures near the antennæ rather confluent and apparently between striæ; punctures of the cheeks and clypeus more separated than the punctures on the face; malar space about as high as the mandibles are broad at base; scape and pedicellum together as long as the first joint of the flagellum, antennæ forty-three jointed. Thorax mostly shining; dorsulum and mesopleura shining, with separated punctures, many of the punctures separated like the punctures of the clypeus; scutellum more sparsely punctured than the middle of the dorsulum: metathorax dull rugulose, the metapleura excepted where the surface is shining and the punctures close together, adjoining or nearly, basal area of the superior face of the metathorax nearly obliterated, areola distinctly broader than long, rather horse-hoof shaped, but nearly as wide at apex as at base, the petiolarea indistinctly or not at all defined, so it appears to occupy all of the posterior face of the metathorax, the lateral areas not well separated from each other; wings strongly brown, stigma and nervures dark brown; the pentangular areolet with the transverse cubiti and first cubital side of equal length, the radial side two-thirds or a little more the length of the first transverse cubitus and equal or very nearly to the length of the second cubital side. Abdomen dull; petiole rather shining, not coarsely but somewhat longitudinally sculptured, the broad apical portion very uneven, produced into distinct elevations; the succeeding segments with rather distinct adjoining punctures, the apical segments shining with the punctures rather separated and more indistinct than elsewhere. The pubescence is whitish and thin, nowhere very conspicuous, most abundant and apparent on the dorsulum and metathorax. Black; legs, except coxæ and trochanters which are black, abdomen, except petiole which is black, almost entirely yellowish ferruginous to ferruginous; base and sides of second abdominal segment and base of third with blackish, the posterior femora dark brown at apex.

Type: University of Kansas. Type locality: Humphrey's Peak, at base, 9500 feet, Arizona. August, 1902, F. H. Snow.

Ichneumon (Barichneumon) nigrosignatus, n. sp.

Very like I. subcyaneus, of which it may be a race or nearly a variety.

MALE.—Length, 8 mm. Head shining; face with well-defined, distinctly separated punctures; clypeus with very sparse distinct punctures; cheeks more closely, less distinctly punctured than the face; width of the mandibles at base distinctly a little greater than the malar space is high; antennæ thirty-five jointed, the scape and pedicellum together as long as the first joint of the flagellum together with one-third the length of the second joint. Thorax entirely shining; dorsulum, meso- and metapleura almost uniformly closely punctured; scutellum closely punctured; areola ill defined, nearly one and a half times as broad as long, basal area ill defined and if anything a little longer than the areola, lateral and posterior carinæ strong, the petiolarea sharply defined, nearly parallel-sided and forming a shallow channel which is wrinkled, the lateral areas not all present, but the areas that are present are sharply defined and mostly wrinkled. Wings almost clear, faintly blackish, stigma and nervures almost black; the areolet with the same proportions as the areolet in I. humphreyi. Abdomen shining, though somewhat dullish owing to the close punctuation; the petiole very even, with hardly any elevations near the apical margin, finely longitudinally striate in the middle. Covered with pubescence as in humphreyi. Head, thorax and first abdominal segment black or nearly, with the following pale marks: A triangular spot surmounting each eye at the margin, continued along the eye margin within as a narrow band to the lower margin of the antennal fovea, continued below this point as a broad band to the anterior margin of the clypeus, leaving a black band with sinuate margins and as wide as the middle third of the clypeus in the middle of the face, a long mark on each scape beneath, a large spot on basal half of mandibles, a posterior orbital line extending from the middle of the malar space to above the middle of the eye, superior margin of prothorax, except in the middle, tegulæ in part, a transverse line beneath, a longitudinal mark on the anterior face of the mesothorax, coxæ and trochanters of anterior and middle legs with marks, femora and tibiæ of anterior and middle legs in front, faint whitish, citron yellow to whitish, otherwise the legs are dark brown or black, except the anterior tarsi, which are pale brownish beneath; abdomen dark blackish cyaneus.

Type: University of Kansas. Type locality: Oak Creek canyon, Ariz. August, 1902, F. H. Snow.

Ichneumon (Barichneumon) citrinifacialis, n. sp.

Superficially like I. nanus, scibilis and mucronatus, readily distinguished from nanus, to which it is structurally related, by the distinctly defined petiolarea, which is lacking in nanus.

MALE.—Length, 6 mm. Head shining; face and cheeks rather closely, distinctly punctured; clypeus sparsely punctured; malar space nearly as high as the mandibles are broad at base; scape and pedicellum together a little longer than the first joint of the flagellum (remainder of flagellum broken off); ocelli somewhat more separated than usual and approaching the equilateral-triangle disposition. Thorax shining; dorsulum, mesopleura and metapleura with distinct punctures, more separated on the dorsulum than elsewhere, on the pleura almost contiguous; scutellum rather indistinctly, sparsely punctured; metanotum rather distinctly areolated, the basal area not well defined and distinctly broader than long; areola not sharply defined, nearly twice as broad as long, and of the lunate type, petiolarea broader at base than at apex, but nearly parallel-sided, forming a shallow channel, which is indistinctly, traversely wrinkled or striate; wings transparent, nearly colorless, tinted with brown, stigma pale brown, nervures dark brown; areolet with nearly the same proportions as in the preceding species, the radial side, however, distinctly shorter than the second cubital side, which is about one and a half times as long as the radial side of the areolet. Abdomen with the first segment smooth and polished and apparently without sculpture, the succeeding segments dull, with adjoining or nearly adjoining punctures, the apical segments with indistinct and more separated punctures. Pubescence whitish and distributed as usual, very inconspicuous. Ferruginous; greater part of front with a production connecting the ocelli, greater part of propleura, anterior face of mesopleura, a transverse band beneath the wings beneath the superior border of yellow on the mesopleura, furrow in the middle of the posterior half of the mesopleura, a spot on the lower posterior corner of the mesopleura, large portion of the lower half of metapleura and the sutures around the wing, scutellum and postscutellum black; face below antennæ, greater part of mandibles, an orbital line interrupted above and broad on the lower half of the cheeks, tegulæ somewhat, transverse line beneath wing insertion, anterior and middle coxæ and trochanters, scutellum and postscutellum yellow; anterior and middle legs yellowish at the knees; scape and pedicellum beneath yellowish brown, first joint of the flagellum beneath yellowish, scape above brown, pedicellum and first joint of the flagellum brown.

Type: University of Kansas. Type locality: Oak Creek Canyon, Ariz., August, 1902. F. H. Snow.

Sub-family Ophioninæ.

Pristomerus appalachianus, n. sp.

Related to P. pacificus which has a more distinctly areolated metanotum and a shorter ovipositor.

Female.—Length, 6.5 mm. Head largely shining; occiput and cheeks minutely granular, subtle, dullish; vertex, front and face almost uniformly closely punctured and shining, the punctures sparse in the middle of the face, clypeus highly polished with sparse minute punctures, mandibles shining and punctured nearly as closely as the face; scape nearly three times as long as the pedicellum, flagellum missing. Dorsulum shining, more distinctly but nearly as closely punctured as the face, parapsidal grooves indicated only on the anterior third of the dorsulum, obsolete beyond; scutellum shining, less distinctly punctured than the dorsulum; metanotum more closely punctured than the dorsulum, the areola large, hexagonal, nearly twice as long as broad, the basal ridge shorter than the apical ridge, the lateral ridge forming an obtuse angle, the side nearest the base of the segment being shorter than the remaining side, basal area quadrate, petiolarea hexagonal, transversely rugosopunctate, the ridges bounding the petiolarea of nearly equal length, lateral areas irregular but bounded by distinct ridges; propleura partly, closely punctured, partly impunctate, polished; mesopleura shining, closely punctured, obliquely, shallowly impressed; metapleura somewhat dullish compared to the mesopleura, closely punctured; wings clear, iridescent, nervures and stigma brown, first abcissa of the radius a little longer than twice the length of the abcissa between the transverse cubitus and the recurrent nervure, the lateral abcissa a little longer than the transverse cubitus, the distal portion of the cubitus beyond the recurrent nervure nearly as long as the transverse cubitus, the second abcissa of the discoidal nervure distinctly shorter than the transverse cubitus, the third abcissa of the discoidal nervure nearly as long as the transverse cubitus, discocubital cell sessile, tranverse median nervure interstitial, the transverse median nervure in the posterior wings slightly angled above the middle where it is broken by an indistinct nervure. Abdomen shining, segments beyond the petiole very minutely granular, very sparsely, minutely punctured; ovipositor, 4 mm. long; sheaths, 3 mm. long. Thorax and head with rather abundant, somewhat appressed pubescence, metathorax especially abundantly pubescent. Black; region where parapsidal grooves ought to be brownish; face brown, the brown extending all around the eyes, the occiput and vertex black, clypeus somewhat yellowish brown, mandibles yellow, tips dark brown; superior margin of propleura, base of petiole, segments of the abdomen beyond the second largely brownish, the abdominal segments beyond the second with a large black dorsal spot; legs brown to brownish testaceous, posterior coxæ blackish within; base of wings yellow: ovipositor brown, apical third brownish testaceous.

MALE.—Length, 6 mm. Very much like the female; mandibles and propleura brownish, abdomen almost entirely brown: transverse median nervure in posterior wings broken below the middle in the same way as the transverse median nervure is broken in the posterior wing of the female. Antennæ thirty-three jointed.

Types: University of Kansas. Type localities: Female from Morton county, Kansas, 3200 feet; June, 1902, F. H. Snow. Male from Sedgwick county, near Wichita, Kan., in vineyard: September, 1895, E. S. Tucker.

Pristomerus appalachianus var. dorsocastaneus, n. var.

Similar to the preceding, but differs as follows: Head more brown, propleura entirely brown, dorsulum almost entirely brown, the male with a black spot adjoining the anterior margin of the dorsulum, stigma very dark brown, pale yellowish brown at base; transverse median nervure in posterior wings of the male broken as in the female which has it broken as in the female of typical appalachianus.

Types: University of Kansas. Type locality, male and female: Douglas county, Kansas. August, E. S. Tucker.

Thersilochus snowi, n. sp.

Related to hyalinipennis, but smaller and with a distinctly different sculpture and structure of the metanotum, etc.

FEMALE.—Length, 9 mm. Head polished, distinctly punctured, the punctures rather closely arranged, sparse along the eye margin and in the middle of the face; clypeus distinctly convex, more regularly punctured than the face; the cheeks sharply margined; antennæ twenty-seven jointed. Thorax shining; dorsulum more coarsely punctured than the face, the parapsidal grooves replaced by broad shallow depressions that extend about half-way back on the dorsulum, the depressed portion almost rugosopunctate; scutellum not so coarsely, more closely punctured than the dorsulum: propleura rather sparsely punctured; mesopleura with a sharp margin anteriorly continuous with the mesosternal margin, more regularly and closely punctured than the propleura and with an oblique shallow channel that is striate with a smooth superior edge, anterior to this oblique channel is a curved channel extending from the upper portion of the anterior ridge back under the insertion of the wings; metathorax completely areolated, the basal area small quadrate, the areola horse-hoof shaped, slightly angulated anteriorly and laterally, the posterior margin strongly curved in, almost arcuate, areola distinctly punctured, the punctures nearly adjoining, lateral carinæ of the petiolarea angulated below the middle, the petiolarea with large, almost adjoining punctures, and somewhat striate, the striæ apparent only along the lateral carinæ and at the apex of the area, lateral areas similar in sculpture to the areola, except the apical lateral area adjoining the petiolarea which is rugose; wings hyaline, nervures brownish testaceous, stigma dark brown, yellow at base, the nervures of the basal third of the wing largely yellow, first abcissa of the radius about one and a half times as long as the transverse cubitus, the second recurrent nervure almost interstitial, therefore the first abcissa of the cubitus beyond the transverse cubitus nearly obsolete, the second abcissa beyond the transverse cubitus about two-thirds the length of the transverse cubitus, transverse median nervure interstitial, the first recurrent nervure about one-fourth the length of the second recurrent nervure. Abdomen with the first segment shining, the second and succeeding segments dullish or subtle, sparsely, minutely punctured; ovipositor 4.5 mm. long, covered with short whitish pubescence that is uniformly distributed and not sufficiently abundant to be apparent superficially. Black; a yellow orbital line broken along the upper and lower eye margin, mandibles brown and yellow, tegulæ, anterior femora and tibiæ, trochanters partly, base of posterior tibiæ and apex of posterior femora all yellow or yellowish, posterior tibiæ whitish above, except at apical third where the upper surface of the tibiæ are brownish, and at base where a brownish band separates the basal yellow from the whitish, anterior legs, excepting coxæ, largely brownish, tarsi of posterior legs brown, segments of the abdomen beyond the second brownish testaceous with a black spot at base of dorsal and ventral segments; ovipositor brown, sheaths black.

Type: University of Kansas. Type locality: Hamilton county, Kansas, 3350 feet. One specimen. June, 1902, F. H. Snow.

Thersilochus mimeticus, n. sp.

Mimics the T. delicatus Cresson, which is not congeneric.

FEMALE.—Length, 5 mm. Head shining, cheeks rather subtle; face minutely, closely punctured: cheeks sparsely, minutely punctured; clypeus shining, rather sparcely punctured; face distinctly elevated along the middle line; antennæ thirty jointed. Thorax dullish, minutely, closely punctured; parapsidal groove only faintly indicated anteriorly by a very shallow impression of the tegument; scutellum sculptured almost exactly like the dorsulum; metanotum with the basal area oblong and narrow, areola longer than wide, nearly as wide at apex as at base, the apical boundary not developed, the areola apparently pentangular, petiolarea nearly twice as long as wide, the lateral boundary angulate immediately above the middle, petiolarea striatopunctate but not distinctly, areola and basal area rather rugulose, the lateral areas sculptured more like the dorsulum; mesopleura with an oblique, shallow furrow, beneath which the tegument is sculptured like the dorsulum, and above which the surface of the pleura is smooth, polished, almost impunctate; wings hyaline, stigma and nervures almost uniformly pale brown: transverse cubital nervure nearly as long as the first abcissa of the radius, first abcissa of the cubitus beyond the transverse cubitus a little shorter than one-half the length of the transverse cubitus, the second abcissa shorter, second recurrent nervure at least as long as the first abcissa of the radius, first recurrent nervure or second abcissa of the discoidal nervure about one-third the length of the second recurrent nervure, transverse median nervure interstitial. Abdomen rather shining, first and second abdominal segments finely, longitudinally striate, succeeding segments subtle, minutely, sparsely punctured. Thinly sericeous, the pubescence very short and whitish, almost uniformly abundant, not sufficiently dense to hide the tegument. Pale ferruginous; orbits, scape, clypeus and mandibles yellowish or yellow; tegulæ, base of anterior wings yellow; flagellum very dark brown; venter of abdomen yellowish and brownish testaceous; tarsi of posterior legs and tibiæ at base and apex brownish, apical tarsal joint of anterior and middle legs brownish; second and third dorsal abdominal segments blackish at base, ovipositor and sheaths black or very dark brown, ovipositor tipped with brown; legs somewhat testaceous, especially the coxæ and the trochanters; vertex, front and occiput largely black.

Type: University of Kansas. Type locality: Sedgwick county, near Wichita, Kan. Taken in vineyard, September, 1895, E. S. Tucker.

Thersilochus quintilis, n. sp.

Very like the preceding, of which it may prove to be the male. Length, 4.5 mm. Differs from mimeticus as follows: Face all ferruginous, only the mandibles yellowish, no yellowish orbital line; posterior femora, tibiæ and tarsi all decidedly brownish; scutellum paler, more yellowish brown than the dorsulum, tegument around the scutellum with a rather broad border of black; postscutellum, however, largely of the same color as the scutellum; base of metanotum blackish, areola not separated from the petiolarea, the lateral ridges almost parallel, on the apical third of the metanotum the petiolarea broadens suddenly, forming an angle on each side; beyond the petiole the dorsal abdominal segments are black at base; antennæ twenty-eight jointed; second recurrent nervure almost interstitial, the stump of a vein beyond the recurrent nervure about one-half the length of the transverse cubitus.

Type: University of Kansas. Type locality: Douglas county, Kansas. July, E. S. Tucker.

Thersilochus hamiltonensis, n. sp.

Male.—Length, 5.5 mm. Head dullish; face minutely sculptured, rather sparsely, indistinctly punctured; antennæ more than thirty-one jointed (tips broken). Dorsulum dull, closely punctured, the punctures not sharply defined; parapsidal groove indicated only anteriorly by shallow impressions; scutellum somewhat shining, sparsely, indistinctly punctured; metanotum with the basal area nearly obsolete, the areola if completed would be pentagonal, posterior boundary not present, areola, therefore, confluent with the petiolarea, about twice as long as wide, the lateral boundary angulated above the middle, petiolarea nearly a parallelogram, slightly angulated below the middle, transversely striate, somewhat punctured, apical lateral area rugose, areola and lateral areas all shining and more or less distinctly punctured, the areola more distinctly punctured than the lateral areas; mesopleura polished, rather closely, distinctly punctured beneath the oblique channel, which is smooth, highly polished and only rather indistinctly striate in the anterior extremity, above the channel the tegument is chiefly smooth and polish d; metapleura dullish, minutely granular, rather sparsely punctured; wings hyaline, stigma and nervures pale brown; basal and apical abcissæ of cubitus and apical abcissa of subdiscoidal nervure almost hyaline, transverse cubital nervure nearly half the length of the first abcissa of the radius, the cubital abcissa beyond the transverse cubitus half the length of the transverse cubitus, the abcissa beyond equal to the preceding or nearly, second abcissa of the discoidal nervure nearly one third the length of the recurrent nervure. Petiole shining, second segment dullish, very finely, longitudinally wrinkled, almost striate, segments beyonds the second dullish, sparsely, indistinctly punctuate. Head and thorax almost uniformly covered with short, whitish pubescence. Black; face yellow beneath the antennæ except for a median line of black which extends half-way down between the antennæ and the clypeus; clypeus, mandibles and a rather broad continuous orbital line yellow; basal joint of scape pale brownish, remainder of antennæ nearly black; dorsulum with a brownish yellow V on each side, one side of which adjoins the anterior lateral margin of the segment, the other outlines the position of the obsolete parapsidal groove, propleura with a yellowish line along the upper edge, mesopleura with a broad brownish band beneath the shallow impression which it follows; venter of abdomen yellowish, the dorsal segments beyond the second with a brown apical margin black at base; legs yellowish brown, posterior coxæ blackish at base, posterior femora chestnut brown, the tibiæ of posterior legs blackish at base and apex, the tarsi of posterior legs infuscated.

Type: University of Kansas. Type locality: Hamilton county, Kansas, 3350 feet. June, 1902, F. H. Snow.

Thersilochus egregiacolor, n. sp.

Superficially like facilis.

FEMALE.—Length, 9 mm.: ovipositor exserted, 7 mm. Head shining, closely, distinctly punctured; clypeus with sparse, distinct punctures; cheeks rather indistinctly, minutely punctured; antennæ thirty-nine jointed. Dorsulum with almost contiguous distinct punctures, shining, parapsidal groove represented by very shallow broad impressions on the anterior half of the dorsulum; scutellum shining, closely punctured; basal area of metanotum an acute-angled triangle, areola pentagonal, nearly twice as long a broad, the sides angled above the middle, the surface of the areola shining, rather sparsely punctured, petiolarea transversely striate, rugose at base, dullish, lateral areas and metapleura sculptured nearly like the dorsulum, the apical lateral area rugulose; mesopleura beneath and anterior to the oblique depression punctured nearly like the dorsulum, the oblique depression partly finely striate, partly smooth and polished, above the impression the tegument is smooth, shining and minutely, sparsely punctured; wings hyaline, stigma and nervures dark brown, transverse median nervure slightly basad of interstitial, recurrent nervure almost exactly insterstitial, abcissa of cubitus beyond the transverse cubitus about one-third as long as the transverse cubitus, first abcissa of the radius about one and one-half times the length of the transverse cubitus, second abcissa of the discoidal nervure half the length of the recurrent nervure, terminal abcissa of the cubitus, excepting the stump of a vein and terminal abcissa of the subdiscoidal cell, entirely hyaline. First abdominal segment shining, partly smooth, partly delicately striate; second segment dullish, delicately striate; succeeding segments minutely granural, subtle and minutely, sparsely punctured as in the other species of the genus. Pubescent as usual in the genus. Ferruginous; orbital line, malar space, clypeus anteriorly, mandibles except apex, and tegulæ yellow; basal joint of scape brown, remainder of antennæ dark brown, almost black; anterior and middle coxæ and trochanters with some yellow, a narrow stripe on anterior femora and tibiæ and on middle tibiæ yellowish, coxæ and trochanters of anterior and middle legs black in part, the posterior trochanters with some yellow, posterior tibiæ brown with a whitish stripe on the outer side, tarsi brown, except the first three joints of the anterior tarsi, which are rather pale brownish; metanotum at base, mandibles at apex, first and second dorsal abdominal segments almost entirely, and base of third dorsal abdominal segment black, a dark brown spot at base of succeeding segments; ovipositor chestnut brown, sheaths black.

Type: University of Kansas. Type locality: Morton county, Kansas, 3200 feet. June, 1902, F. H. Snow.

Paratype from the type locality (F. H. Snow), with the abdomen darker and mesosternum blackish.

Mesochorus noctivagus, n. sp.

Superficially like agilis, from which it differs in size, sculpture, and color.

FEMALE.—Length, 4.5 mm. Head shining; face somewhat dullish; cheeks closely, distinctly punctured, the punctures thereon regular, face with the orbital margins punctured nearly like the cheeks, middle of the face with a rather cordate elevation, the apex between antennal insertion, the base adjoining the clypeus, the elevated portion punctured nearly like the cheeks, between the orbital margin and middle elevated portion of face the punctures are almost adjoining and smaller than on the cheeks; clypeus polished, very sparsely punctured; antennæ over thirty-five jointed (tip broken off), possibly with one or two joints more, scape and pedicellum together distinctly shorter than the first joint of the flagellum. Dorsulum shining, somewhat dullish, parapsidal grooves represented on anterior half of dorsulum by very faint longitudinal impressions, dorsulum rather indistinctly sculptured, distinct punctures in the parapsidal region and on the greater portion of posterior two-thirds; scutellum almost polished, apparently impunctate; metathorax shining, distinctly areolated, the areolæ bounded by distinct carinæ, areola and basal area confluent, the basal area if completed would apparently be quadrate or nearly, areola if perfect would be hexagonal resembling a diamond with the acute angles cut off, lateral carina of areola angled in the middle or nearly, areola about twice as long as greatest width, smooth, almost polished; petiolarea broader than long, nearly circular, the anterior and lateral margins describing part of a circle, all the areas, except the areola, somewhat roughened; propleura shining, minutely sculptured; mesopleura polished, anterior margin punctured, the punctures not very deep, a broad impression on the inferior portion of the anterior margin, a broad impression on the middle of the posterior margin and another impression on the anterior portion of the superior margin; metapleura with closely arranged shallow punctures; wings iridescent, very faintly brownish, almost clear, stigma dark brown, the proximal and distal corners with a small pale spot, nervures blackish testaceous, first abcissa of the radius as long as the first and second transverse cubiti together, the first transverse cubitus shorter than the second, the first abcissa of the cubitus beyond the first transverse cubitus shorter than the same, the second abcissa almost the same length of the first transverse cubitus, second abcissa of discoidal nervure nearly one fourth the length of the recurrent nervure, transverse median nervure interstitial, areolet sessile, almost quadrate. First abdominal segment subsessile, polished irregularly, rather longitudinally pitted and with a shallow median longitudinal sulcus; succeeding segments polished, sparsely, minutely punctured. Thinly pubescent, the pubescence short and whitish, most abundant on the metathorax. Black; posterior orbital margin brown, anterior orbital margin cream color margined with brown; malar space, clypeus, mandibles, except tips which are brown, tegulæ and base of wings cream color or whitish; antennæ very dark brown; propleuræ brownish along the margins; legs mostly testaceous, posterior coxæ and femora somewhat ferruginous, apical tarsal joints fuscous, posterior tibiæ brownish white, fuscous at tip, metatarsus of posterior legs whitish.

Type: University of Kansas. Type locality: Lawrence, Douglas county, Kansas. At night, May, E. S. Tucker.

Agathobanchus bradleyi, n. n.

Female. Douglas county, Kansas, 900 feet.

This species was described at length in Entomological News, vol. XIV, pp. 144–146, 1903, by Mr. J. Chester Bradley. The two Eastern specimens upon which this description was based, four other specimens, and the above — seven specimens in all—differ from Say's description of Banchus æquatus in having the second submarginal cell petiolate, quadrangular and not pentangular as in Say's species. The Banchus æquatus Say may be an Exetastes as this is now understood. In addition to the neuration, the maculation of the nervures and the color are different from Banchus æquatus Say. The Douglas county specimen differs from the Eastern form as follows: Head yellow, except a broad band extending from immediately in back of the ocelli to the posterior edge of the insertion of the antennæ, the dorsulum and upper edges of the propleura chocolate brown.

Pauiscus geminatus Say.

Douglas county, Kansas; September.

Limnerium perdistinctus, n. sp.

Superficially like perdistincta, congeneric with obscuripes, to which it seems to be more nearly related than to any other species.

Female.—Length, 4.5 mm. Head minutely roughened; cheeks shining; face dull, face below the antennæ and lower half of cheeks with abundant silvery pubescence which, when viewed in certain lights, obscures the tegument; remainder of the head apparently bare, the pubescence inconspicuous; internal margins of the eyes nearly parallel; antennæ twenty-nine jointed, scape distinctly longer than the first joint of the flagellum, but not as long as the first joint together with half the second. Thorax almost uniformly sculptured like the face, the middle of the posterior half of the dorsulum more closely sculptured than the rest; metapleura almost appreciably, closely, minutely punctured; parapsidal grooves very faintly indicated on the anterior half of the dorsulum by nearly parallel, very narrow, longitudinal, slight impressions; mesopleura obliquely bisected by a shallow, sinuate, impressed line that is rugulose, a short impressed line at right angles to the anterior margin of the mesopleura on the lower portion of the sclerite near the mesosternum; basal half of metanotum almost triangular, the apex blunt, areola pentagonal, the sides of nearly equal length, confluent with the petiolarea, the raised line separating the two only faintly and partly indicated; petiolarea angled in the middle, or nearly, somewhat longer than twice the greatest width; areas of metanotum distinctly, more coarsely, sculptured than the dorsulum, rugulose; petiolarea almost rugose; wings clear, faintly yellowish brown, stigma pale brown, nervures dark brown, areolet quadrangular, the sides subequal, petiolate, the petiole about as long as the second abcissa of the cubitus, first abcissa of the radius about three-fourths as long as the second abcissa of the radius, transverse median nervure received a little beyond the basal nervure, the third abcissa of the discoidal nervure nearly two-thirds the length of the recurrent nervure. Abdomen dullish; basal half of the petiole shining and carinate on the sides, the tegument elevated from the spiracle of the petiole to the posterior margin of the segment, forming an indistinct carina; ovipositor exserted for a length a little greater than the width of the abdomen at apex. Abdomen rather abundantly but inconspicuously pubescent, thorax more densely pubescent than the abdomen, the pubescence very apparent only on the metathorax. Black; anterior and middle coxæ brownish; mandibles, except tips, tegulæ, base of wings, anterior and middle trochanters and distal joint of posterior trochanters yellow; femora and middle tibiæ rufous, anterior tibiæ yellowish, posterior tibiæ brownish, dark brown at base and apex; tarsi somewhat brownish, the apical joints and claws decidedly brown; abdomen with the apical margins of the segments beyond the petiole, excepting the apical segment, rufous, sides of the segments beyond the second largely rufous, venter yellowish, ovipositor brown, sheaths black.

Type: University of Kansas. Type locality: Douglas county, Kansas. August, E. S. Tucker.

Paratype from Clark county, Kansas, 1962 feet (May, 1903, F. H. Snow), with apparently no impressions on mesopleura, the anterior tibiæ paler and pale portion of posterior tibiæ paler, and the rufous of abdomen nearly absent, absent, or changed to brownish. Paratype from Morton county, Kansas, 3200 feet (June, 1902, F. H. Snow), like paratype from Clark county. These specimens are ½ to 1 mm. smaller than the type.

Limnerium sp.

Douglas county, Kansas, July, E. S. Tucker.

Ischnoscopus tæniatus, n. sp.

Related to plena, which differs in structure and in having the posterior coxæ rufous.

FEMALE.—Length, 6.5 mm. Head and thorax to a great extent dullish and uniformly, finely roughened or granular; cheeks shining; internal margins of the eyes nearly parallel; antennæ thirty jointed, scape and pedicellum together as long as the first joint of the flagellum. Dorsulum with scarcely a trace of parapsidal grooves; mesopleura with a faint, oblique channel bisecting the sclerite, above which is another indistinct, oblique impression, on the lower portion of the mesopleura on the anterior half and near the mesosternum is another short impression; metathorax rather coarsely sculptured, almost rugose, basal area apparently rectangular, almost obsolete, areola pentagonal, almost triangular, the apical sides very short, almost obsolete, apical margin only partly indicated; petiolarea broad angled below the middle, less than twice as long as the greatest width in spite of the shortened areola: metapleura more finely sculptured than the areas, apparently punctured; wings faintly brownish, almost clear, stigma and nervures dark brown, the stigma paler than the nervures, first abcissa of the radius not quite two-thirds the length of the second abcissa, areolet quadrangular, the sides subequal, petiolate, the petiole shorter than the shortest side of the areolet; transverse median nervure received beyond the basal nervure, third abcissa of the discoidal nervure more than half the length of the recurrent nervure. Abdomen dullish, petiole shining on the sides. Rather thinly pubescent with short, silvery hairs that are most abundant on the metathorax; face appearing bare superficially; ovipositor exserted over one-third the length of the abdomen. Black; mandibles, except at tip, and the four anterior legs to a great extent yellowish rufous; anterior and middle tibiæ whitish posteriorly, tarsi also whitish, the tarsi of the middle legs tipped with brown, apical tarsal joint and claws of both anterior and middle tarsi brown, posterior legs with coxæ and femora rufous, first joint of trochanters largely black, second joint yellow, posterior femora brown at tip, posterior tibiæ whitish at base, then a narrow brown band, then a broad white band as broad as half the length of the tibia, metatarsus of posterior legs whitish on basal two-thirds, apical third brown, most of the succeeding tarsal joints whitish or pale at extreme base, otherwise dark brown; ovipositor brown.

Type: University of Kansas. Type locality: Douglas county, Kansas. July, E. S. Tucker.

Olesicampa melanerythrogastra, n. sp.

Apparently closely related to L. (Olesicampa?) brachyura, of which it may prove to be the male.

MALE.—Length, 7 mm. Head minutely roughened and indistinctly punctured; cheeks dullish; face dull, rather densely covered with pubescence that is tinted with golden brown; antennæ thirty-nine jointed or forty jointed, scape and pedicellum together a little shorter than the first joint of the flagellum. Thorax almost uniformly dull, finely sculptured; dorsulum with the faintest impressions to indicate where the parapsidal grooves would be impressed, area more densely sculptured and duller than the adjoining area: mesopleura with an almost triangular, smooth, shining, impressed area occupying the region above the oblique impression or groove, the area beneath closely, rather distinctly punctured, the surface between the punctures minutely roughened; metathorax distinctly areolated, the ridges separating the areas very distinct, areola and petiolarea confluent, basal area very narrow, about twice as long as wide at base, forming an acute-angled triangle, areola more than twice as long as its greatest width, the lateral ridges of the areola angled at the basal third, basal third of the areola wrinkled beyond, the surface is roughened, petiolarea angled a little above the middle, roughened and with rather coarse transverse striæ, lateral areas sculptured somewhat like the dorsulum except the apical lateral area which is rugose; metapleura rather rugosopunctate, very closely sculptured; wings pale brownish, stigma and nervures rather brownish testaceous with a blackish tinge, first abcissa of the radius a little more than two-thirds the length of the second abcissa, areolet quadrangular, petiolate, the petiole as short as the shortest side of the areolet, first abcissa of the cubitus beyond the first transverse cubitus about as long as the second transverse cubitus between the petiole and the cubitus, the first transverse cubitus between the petiole and the cubitus shorter than either of the last two sides, of the areolet mentioned, being next in size to the shortest side, discocubital nervure with a trace of a stump a little before the middle, transverse median nervure received a little beyond the basal nervure, second abcissa of the discoidal nervure nearly two-thirds the length of the recurrent nervure. Abdomen somewhat dullish, minutely, rather subtly sculptured; petiole nearly smooth, with no distinct elevated line extending from the spiracles to the posterior margin. Almost uniformly pubescent, the pubescence to a great extent of the same color as that on the face, but shorter and not so conspicuous; the smooth area of mesopleura, most of the lateral areas of the metathorax and the areola and petiolarea appearing bare. Black; scape and pedicellum ochreous beneath, brownish above; mandibles, tegulæ and base of wings yellow, mandibles tipped with brown which shades from pale to dark, almost black; palpi rather ochreous; legs testaceous, the posterior pair somewhat ferruginous, claws, apical tarsal joint of anterior legs, tarsal joints of middle legs posteriorly, posterior tibiæ above and tarsi all brownish; abdomen with a rufous band at apex of petiole, the remainder of the abdomen rufous, except the margins of the second segment, a broad apical margin of the third, a narrow apical margin on the fifth, the sixth dorsally and a large portion of the seventh which are black.

Type: University of Kansas. Type locality: Clark county, Kansas, 1962 feet. June, F. H. Snow.

FEMALE.—Similar to the male; petiole of areolet shorter, as long as the shortest side of the areolet or a little shorter; exserted portion of the ovipositor a little longer than the abdomen, sheaths about three-fourths the length of the abdomen; abdomen rufous, a narrow black band at apex of petiole, basal two-thirds of petiole and a narrow lateral streak on the second abdominal segment black; ovipositor very dark brown, nearly black, sheaths of the ovipositor black.

Type: University of Kansas. Type locality: Clark county, Kansas, 1962 feet. May, 1903, F. H. Snow.

Amorphota relativa, n. sp.

Closely related to L. (A.) montana, which has the areola and petiolarea bounded laterally by distinct raised lines.

FEMALE.—Length, 7.5 mm. Head rather shining, somewhat dullish, with indistinctly impressed, separated punctures, less distinct and sparser on the clypeus than elsewhere; cheeks rather shallowly channeled; antennæ thirty-six jointed. Thorax with the dorsum dullish, sides rather shining; dorsulum very dull, rather closely punctured, the parapsidal grooves hardly indicated by slight impressions anteriorly; mesopleura distinctly punctured and shining beneath the somewhat triangular impressed area which is smooth and shining and almost impunctate, the shallow channel deeply impressed in the middle, forming a pit; basal area of metanotum almost quadrate, the areola margined only at the base, the channel which occupies the areola and petiolarea shallow, its sides gently excavated, the margins not at all sharp but gently rounded, lateral areas closely pitted, almost punctured; metapleura distinctively, closely punctured and shining; wings faintly brownish, nearly clear, stigma and nervures dark brown, first abcissa of the radius a little longer than two-thirds of the second abcissa, areolet practically sessile, the petiole almost obsolete, the areolet quadrangular, the first transverse cubitus as long as the second, first abcissa of the cubitus beyond the first transverse cubitus distinctly longer than the succeeding abcissa, transverse median nervure almost exactly interstitial with the basal nervure, second abcissa of the discoidal nervure about two-thirds the length of the recurrent nervúre. Abdomen uniformly dullish, very minutely, inconspicuously punctured, the petiole very smooth, no indication of a raised line between the spiracle and the apical margin; exserted portion of ovipositor half as long as the abdomen, the sheaths about a millimeter shorter. Uniformly covered with fine, short, silvery pubescence, longest and most abundant on the face and metathorax. Black; mandibles yellow, brown at tip, palpi cream color; tegulæ and base of wings yellowish; anterior and middle legs testaceous, middle femora somewhat rufous, anterior and middle trochanters with the distal joint whitish or yellowish, the tibæ of the four anterior legs whitish on the outer side, tarsi pale, apical joints and claws brownish, posterior legs with the proximal trochanter largely black, the distal trochanter ochreous, femora rufous, tibiæ almost whitish with a narrow brownish band near base, the apical third of the joint brown, metatarsus whitish with the apical third brown, two succeeding joints brown, whitish at extreme base, terminal joints entirely brown, all claws brown and pectinate; ovipositor dark reddish brown, translucent.

Type: University of Kansas. Type locality: Clark county, Kansas, 1962 feet. June, 1903, F. H. Snow.

Amorphota perrivalis, n. sp.

Nearly as in L. (A.) major, but areola partly outlined by a basal carina. Related to L. (A.) rivalis, which is smaller and different in various details.

FEMALE.—Length, 7 mm. Head minutely sculptured; face dull, rather rugulose, indistinctly punctured; cheeks shining, closely, indistinctly punctured; antennæ thirty-four jointed, scape and pedicellum distinctly shorter than the first joint of the flagellum. Thorax uniformly dull; dorsulum with the parapsidal grooves represented by faint, rugulose, longitudinal impressions that terminate posteriorly in a rugulose area in the middle of the posterior third of the segment, the adjoining areas very minutely sculptured; mesopleura sculptured like the greater part of the dorsulum, with a very shallow oblique groove that is finely striate and dull like the adjoining areas, a small pit in the middle of the posterior half of the segment; metanotum rather coarsely rugulose, basal area forming almost an equilateral triangle, areola pentagonal if completed, the lateral angles very near the base, the sides parallel, the areola a little more than twice as long as wide, petiolarea ill defined, very broad angled above the middle, almost as broad as long; wings nearly as in the preceding species, areolet petiolate, quadrangular, the petiole as long as the shortest side of the areolet, first transverse cubitus a little shorter than the second, first abcissa of the cubitus beyond the first transverse cubitus as long as the transverse cubitus between the petiole and the cubitus, cubito-discoidal nervure with a slight elbow just before the middle, transverse median nervure a little beyond interstitial with the basal nervure, second abcissa of the discoidal nervure nearly two thirds the length of the recurrent nervure. Abdomen sculptured as in the preceding species. Uniformly covered with short, fine, silvery hairs which are tinted with golden on the dorsum. Black; scape and pedicellum ochreous beneath, brown above; mandibles yellow brown at tip; palpi, tegulæ and base of wings yellowish; coxæ and trochanters of anterior legs and trochanters of middle legs yellowish, remainder of anterior and middle legs testaceous, except the outer side of the tibiæ which are whitish, the apical tarsal joint and claws of anterior and middle legs brown, tibiæ and femora of the middle legs with a rufous tint, posterior legs rufous, the tibiæ more or less brownish, the tarsi and claws dark brown; abdomen rufous, basal half of petiole blackish, venter yellowish, exserted portion of ovipositor about as long as the second abdominal segment, the sheaths a little shorter, ovipositor translucent, brown, sheaths black.

Type: University of Kansas. Type locality: Douglas county, Kansas. August, E. S. Tucker.

Paratype with the areola not quite twice as long as greatest width, the sides angled farther from the base and not parallel. Lawrence, Douglas county, Kansas, 900 feet. May, E. S. Tucker.

Male.—Almost exactly as in the type; antennæ thirty-nine jointed.

Type: University of Kansas. Type locality: Douglas county, Kansas. July, E. S. Tucker.

Amorphota nocturna, n. sp.

Superficially like dubitatus, from which it differs in the structure of the metanotum.

Male.—Length, 5.5 mm. Head minutely sculptured; cheeks somewhat shining, very minutely roughened; face dull, very closely sculptured; antennæ thirty-three jointed, scape and pedicellum together as long as the first joint of the flagellum, or a little longer. Thorax largely dull; dorsulum very closely sculptured, the parapsidal grooves represented by very shallow grooves that are more coarsely sculptured than the adjoining area, mesopleura almost bisected by a transverse, faint, sinuate, roughened impression or groove, the depressed portion of the superior half of the segment largely smooth and shining; scutellum and metathorax sculptured much like the dorsulum, basal area nearly quadrate, shining, areola pentagonal, the sides almost equal in length; petiolarea confluent with the areola, about twice as long as broad, angled near the middle, the sides below the middle not well defined, the lower half of the petiolarea and the apical lateral area rugulose; metapleura closely, indistinctly punctured and somewhat shining; wings faintly brownish, stigma pale brown, nervures darker, first abcissa of the radius a little more than two-thirds the length of the second abcissa, areolet petiolate, quadrangular, almost a perfect square, petiole shorter than any side of the areolet, transverse median nervure interstitial, the second abcissa of the discoidal nervure almost two-thirds the length of the recurrent nervure. Abdomen as in perrivalis. Pubescence as in perrivalis. Black; mandibles yellow, brown at tip; tegulæ, base of winge and trochanters yellow; proximal trochanters of posterior legs largely black, yellow only at apex, four anterior legs, coxæ included, brownish testaceous, apical tarsi and claws brown or brownish, posterior femora rufous, posterior tibiæ above with a broad brown band at base and apex, brownish yellow between, beneath somewhat rufous, the tarsi and claws dark brown, coxæ black.

Type: University of Kansas. Type locality: Lawrence, Douglas county, Kansas. May, at night, E. S. Tucker.

Amorphota pænexareolata, n. sp.

Superficially like tibiator, which is more distinctly areolated.

MALE.—Length, 5 mm. Head sculptured very much as in the preceding species; antennæ thirty one jointed. Thorax largely dull or dullish; dorsulum with broad, faintly impressed parapsidal grooves, very closely rugulose, the surface between the parapsidal grooves closely sculptured, dull, the surface between the parapsidal grooves and the sides of the dorsulum more shining and rather distinctly, closely punctured; scutellum rather shining, closely, distinctly punctured; mesopleura largely shining and closely punctured, the depressed area of the superior half of the posterior half of the segment smooth and shining to a great extent, the smooth, shining area bounded by rugulose areas, a slight shelf at its lower posterior margin; basal area of metanotum nearly quadrate, the areola if complete would form an irregular circle, petiolarea about twice as long as greatest width, angled above the middle, not much wider than the areola; metapleura rather shining, very closely punctured; wings almost clear, stigma testaceous, nervures almost blackish testaceous; first abcissa of the radius a little more than two-thirds the length of the second abcissa, areolet petiolate, quadrangular, the petiole nearly as long as the longest side of the areolet, first transverse cubitus a little shorter than the second, the two lower sides of the areolet almost equal, second abcissa of the discoidal nervure about half the length of the recurrent nervure, transverse median nervure received a little beyond the basal nervure. Abdomen as in perrivalis. The pubesence also as in that species. Black; basal joint of the scape with a triangular yellow area; mandibles yellow, brown at apex; tegulæ, base of wings and trochanters as in nocturna; anterior and middle coxæ largely yellowish, posterior coxæ black, four anterior legs otherwise testaceous, the apical tarsal joint and claws brown or brownish, posterior legs rufous, tibiæ brownish above, tarsi brown, claws dark brown.

Type: University of Kansas. Type locality: Douglas county, Kansas. August, E. S. Tucker.

Campoplex expertus Cresson.

Douglas county, Kansas, 900 feet; F. H. Snow.

Campoplex photomorphus, n. sp.

Related to C. bellus, in which the pubescence of the metanotum is sparser and the median groove deeper.

FEMALE.—Length, 12 mm. Head very closely sculptured; cheeks rather shining with shallow, almost adjoining punctures; face dull, with shallow adjoining punctures giving a reticulate or rugulose appearance; antennæ over thirty jointed (tips broken), scape and pedicellum together nearly as long as the first joint plus one-half of the second joint of the flagellum. Dorsulum dull, sculptured nearly like the face, the punctures rather distinct; scutellum like the dorsulum; mesopleura sculptured like the cheeks, the punctures more separated, a broad oblique shallow groove near the posterior border on the upper half, the groove and the area back of it largely smooth and polished, the upper end of the groove transversely striate, the lower end terminating in a pit; metathorax appearing regularly reticulate with adjoining, shallow, indistinctly defined punctures, the median groove of the metanotum shallow, not at all sharply impressed, the surface of the metanotum almost obscured by silvery pubescence; wings hyaline, stigma pale brown, nervures dark brown; first abcissa of the radius a little more than two-thirds the length of the second abcissa; areolet petiolate, quadrangular, the petiole as long as the shortest side of the areolet; first transverse cubitus a little shorter than the second; first abcissa of the cubitus beyond the first transverse cubitus a little shorter than the first transverse cubitus; transverse median nervure received a little beyond the basal nervure, the abcissa between it and the basal nervure about as long as the petiole of the areolet; third abcissa of the discoidal nervure nearly one-half as long as the recurrent nervure; transverse median nervure of the posterior wings broken or elbowed where the middle third joins the lower third. Abdomen smooth, very minutely sculptured, rather subtle and shining. Pubescence silvery, very conspicuous only on the metanotum and scutellum, uniformly distributed elsewhere, shortest and least conspicuous on the mesopleura, legs, and abdomen. Black; mandibles dirty yellow, apex dark brown; tegulæ, base of wings, anterior legs, excepting coxæ entirely, trochanters and base of femora beneath, apical half of middle femora in part, tibiæ and tarsi of middle legs, base of posterior tibiæ and metatarsi yellow; apical tarsal joints of anterior and middle legs and tarsal joints of posterior legs, excepting base of second and third joints which are pale, and basal third of metatarsus, brown; abdomen rufous, except the petiole and greater portion of second and apical segments and apex of penultimate segment, all of which are black; ovipositor exserted not much more than one millimeter, pale castaneous, sheaths nearly black.

Type: University of Kansas. Type locality: Hamilton county, Kansas, 3350 feet. June, 1902, F. H. Snow.

Exochilum mundum Say.

Morton county, Kansas, 3200 feet; June, 1902. F. H. Snow.

Anomolon fulvescens Cresson var. hemimelas, n. var.

Readily distinguished from the typical form in the nearly entirely black thorax and the black ultimate and penultimate abdominal segments.

Type: University of Kansas. Type locality: Douglas county, Kansas, 900 feet. October.

Paratypes from Colorado are in the collection of the American Entomological Society.

Anomalon pæneferrugineum, n. sp.

Resembles edwardsii and nigriceps in the coarse sculpture of the metanotum.

Female.—Length, 21 mm. Head shining; cheeks rather sparsely, indistinctly punctured; face roughened, closely punctured, the punctures small, eye margins sparsely, indistinctly punctured; point of the clypeus short; antennæ over forty jointed (broken). Dorsulum shining, covered with distinct, separated punctures; parapsidal grooves distinct, deeply impressed, terminating before the posterior margin of the dorsulum, which is transversely striate; scutellum uneven, covered with large shallow, more or less separated punctures; pro- and meso-pleura shining, smooth, rather closely punctured, the upper fourth of the meso-pleura rugose; metathorax very coarsely reticulate, the pits more or less, nearly a millimeter in width; three nearly semicircular ridges on the apical third of the metanotum; wings strongly brown, nervures and stigma dark brown; recurrent nervure received a little beyond the transverse cubitus, almost interstitial; the apical side of the third discoidal cell a little more than twice the width of the basal side of the cell; transverse median nervure in posterior wings broken in the middle. Abdomen smooth, petiole polished, succeeding segments dullish, minutely, sparsely punctured. Brownish ferruginous; face and lower half of cheeks largely yellow; a spot between the ocelli, sternum, basal margin of metathorax, posterior coxæ and basal trochanter of posterior legs and apical third of posterior tibiæ black or very nearly black; dorsum of second, ultimate and penultimate abdominal segments more or less black; dorsal edge of prothorax and a small spot on anterior edge of dorsulum blackish; exserted portion of ovipositor brown, translucent, as long as the dorsal aspect of the third segment of the abdomen.

Type: University of Kansas. Type locality: Wallace county, Kansas, 3000 feet. June, 1878, F. H. Snow.

Atrometus angitioides, n. sp.

FEMALE.—Length, 9 mm. Head dullish; cheeks apparently impunctate; face with small separated punctures; antennæ about forty-two jointed, scape and pedicellum together shorter than the first joint of the flagellum. Thorax largely dullish; the parapsidal grooves represented only by very shallow channels on the anterior half of the dorsulum; the dorsulum punctured nearly like the face; mesopleura more shining than any other portion of the insect, with a rather broad oblique groove that is transversely striate, separating a triangular polished, almost impunctate area from the lower anterior portion of the sclerite; scutellum more sparsely punctured than the dorsulum; metanotum divided into areas by strong, raised lines or ridges, basal area nearly quadrate, areola confluent with the petiolarea, forming a long, nearly parallel-sided enclosure, the areola, if completed, would be pentagonal and about one and a half times as long as broad, the lateral angles far above the middle, areola smooth and shining, minutely sculptured, the petiolarea transversely striate, the striæ not very distinct; metapleura rather closely, distinctly punctured, the tegument between minutely sculptured; wings with a brownish tinge, nearly clear, stigma pale yellowish, nervures dark brown; nearly all of the apical abcissa of the radius and the apical abcissa of the cubitus very pale testaceous; first abcissa of the radius about two-thirds the length of the second abcissa; transverse cubital nervure a little less than one-half of the basal abcissa of the radius; recurrent nervure nearly twice the length of the transverse cubitus, the abcissa between the two very short, the recurrent nervure almost interstitial; the stump of a distinct nervure beyond the recurrent nervure is about one-half the length of the transverse cubitus; transverse median nervure interstitial; the second abcissa of the discoidal nervure a little shorter than the transverse cubitus, the disco-cubital nervure nearly straight, not broken or bent. Abdomen smooth; petiole polished, succeeding segments subtle, rather sparsely, minutely punctured, the second abdominal segment finely, longitudinally striate. Covered with short, fine, whitish pubescence, nowhere conspicuous. Ferruginous; an orbital line, scape, clypeus, mandibles, coxæ of four anterior legs and second ventral abdominal segment more or less yellowish; large part of occiput, vertex, front, flagellum, base of metanotum, base of petiole, basal half of second abdominal segment, base of third, apex of fourth, and all of fifth and sixth segments dark brown or black; ovipositor very dark brown, sheaths black; four anterior legs rather testaceous, posterior tibiæ and tarsi brownish.

Type: University of Kansas. Type locality: Douglas county, Kansas. June.

Eiphosoma pyralidis Ashmead.

This species is very distinct from its congeners in having a perfect areola which is rather oval in outline and nearly three times as long as wide.

Male. Douglas county, Kansas, 900 feet.

Erymotylus felti, n. sp.

In the length of the recurrent nervures and in the pectination of the claws this species is like macrurus; in the hooklets of the posterior wings like arctiæ.

FEMALE.—Length, 15 mm. Head nearly circular; the ocelli well separated, the distance between them and between them and the eye nearly equal to the width of an ocellus; eyes gently emarginate within the inner margin barely sinuate; malar space nearly as high as the space between the lateral ocellus and the eye margin; head shining; cheeks apparently impunctate; the face closely punctured, sparsely along the eyes; clypeus rather sparsely, much more coarsely punctured than the face; antennæ fifty-two jointed, the scape and pedicellum together a little shorter than the first joint of the flagellum. Thorax shining; dorsulum sparsely to closely punctured with small punctures; parapsidal grooves absent, indicated only by shallow impressions near the anterior margin, mesopleura closely, distinctly punctured, with a short oblique impression near and nearly parallel with the posterior margin of the sclerite; scutellum sparsely punctured; metanotum rather indistinctly, closely punctured laterally, sparsely above, the disc also somewhat wrinkled and with a shallow longitudinal channel; metapleura more closely punctured than the mesopleura; wings faintly brown, almost clear, stigma brownish testaceous, nervures dark brown; abcissa between the basal nervure and the transverse median nervure about as long as the penultimate joint of the flagellum; transverse median nervure in the posterior wings broken two-thirds the length of the nervure above the base. Head and thorax covered with short, white pubescence, nowhere sufficiently abundant to hide the surface. Abdomen polished, all the segments except the petiole with rather sparse microscopic setigerous punctures. Yellow; eyes and ocelli black; tips of mandibles dark brown; flagellum nearly orange, but darker; dorsulum with broad testaceous stripes; sternum, legs, venter of abdomen, second dorsal segment, and margins of the remaining segments more or less brownish testaceous.

Type: University of Kansas. Type locality: Hamilton county, Kansas, 3350 feet. June, 1902, F. H. Snow.

Paratype from Denver, Colo., collected in June, is in the collection of the American Entomological Society.

Named in honor of Prof. E. P. Felt.

Ophion idoneum, n. sp.

Related to tityri, from which it differs in the more separated ocelli, the not strongly appendiculate subdiscoidal nervure, and in the sculpture of the metanotum, which has but one quadrangular area, the areola.

MALE.—Length, 14 mm. Structure of the head nearly as in E. felti; cheeks rather sparsely punctured; face closely punctured, even to the eye margins; punctures of the clypeus more separated than on the face; mandibles deeply punctured; antennæ over fifty-four jointed (apical joints broken off). Dorsulum shining; with the parapsidal grooves rather distinct on the anterior third, the dorsulum minutely, closely, indistinctly punctured; scutellum sparsely punctured; mesopleura shining, closely punctured, with two grooves on the superior half, the posterior groove nearly parallel with the posterior margin of the sclerite and nearly at right angles to the broader anterior groove, which attains the anterior margin of the sclerite. Metanotum rather shining, somewhat roughened with a transverse carina near the base and a longitudinal Y-shaped carina in the middle, forming with the basal carina the medial area or areola, which is nearly quadrangular, an inverted V-shaped carina on each side of the basal half of the metanotum; metapleura, with separated punctures, dullish; wings faintly brownish, nearly clear, stigma brownish testaceous, nervures dark brown; cubito-discoidal nervure broken in the middle; the first recurrent nervure less than one-half the length of the second recurrent nervure; transverse median nervure interstitial; transverse median nervure in posterior wings broken a trifle below the middle. Claspers rather broadly rounded at apex. Pubescence and abdomen as in E. felti. Ferruginous; orbits yellow; mandibles black at tip; legs paler, more testaceous than the thorax; venter more or less black; flagellum dull pale brown.

Type: University of Kansas. Type locality: Douglas county, Kansas, 900 feet. May, 1893, W. A. Snow and S. W. Williston.

Ophion bilineatum Say.

Hamilton county, Kansas, 3350 feet: F. H. Snow. Douglas county, Kansas; August, E. S. Tucker; April, W. J. Coleman.

Thyreodon morio Fab.

Douglas county, Kansas; V. L. Kellogg.

Thyreodon snowi, n. sp.

Female.— Length, 25 mm. Head somewhat broader than in morio; the face more even, a small tubercle in the middle of the face a little below the insertion of the antennæ, face with adjoining punctures, giving a rugulose appearance, punctures along the eye margin distinct; clypeus sparsely, deeply punctured; cheeks shining, distinctly, closely punctured; antennæ sixty-one jointed, scape and pedicellum together a little longer than the first joint of the flagellum. Dorsum shining, closely punctured, especially on the anterior margin where the punctures are so close as to give a rugulose agpearance; parapsidal grooves distinct, rugose, forming a U and not attaiuing the posterior border; scutellum closely punctured, traversed by an arcuated raised line describing a semicircle; mesopleura closely punctured, nearly rugulose below, area along the upper half of the posterior border of the mesopleura polished, impunctate; metanotum rugulose, the posterior face with a median transversely striate groove; metapleura distinctly, closely punctured, wings fuscous, not as dark as in morio, a broad bare yellow area in the middle of the anterior half of the posterior wings; neuration nearly as in morio, the transverse median nervure of the posterior wings broken nearer the median nervure than in morio. Petiole smooth and shining, sparsely, minutely punctured, the remaining segments of the abdomen as in morio. Covered with inconspicuous pubescence, blackish or brownish on the dark portions, golden brown on the pale parts. Black; orbits, cheeks, anterior margin of the dorsulum, superior anterior and posterior margin of the mesopleura brownish; antennæ orange as in morio, scape and pedicellum brown: four anterior legs with the terminal trochanter, femora, tibiæ and tarsi almost entirely and posterior tibiæ and tarsi brownish testaceous, middle and posterior legs with the apical tarsal joint brown.

Type: University of Kansas. Type locality: Wallace county, Kansas, 3000 feet. June, 1878, F. H. Snow.

Metopius grandior, n. sp.

Related to M. montanus, from which it differs in size, color, and sculpture.

FEMALE.—Length, 15 mm. Head typical; cheeks minutely, closely sculptured and sparsely punctured; shield of the face as broad as long, with a faint median longitudinal elevation, closely punctured, the anterior margin almost pointed in the middle; antennæ fifty-four jointed, scape and pedicellum together about as long as the first joint of the flagellum plus the second. Thorax very much as in montanus, the dorsulum dull and very closely punctured; propleura partly striate, partly punctured; mesopleura with adjoining punctures; metanotum dull, with a median funnel-shaped enclosure, which has the narrow portion nearly as wide as one-half the widest portion; wings as in montanus, more fuscous along the anterior borders. Abdomen closely punctured, the punctures not distinctly tending to become confluent, the segments not appearing coarsely, longitudinally striate, the elevated portion of the first abdominal segment bounded by a strong carina laterally, the carina not extending much beyond the middle of the segment. Almost uniformly covered with short, golden brown pubescence. Ferruginous: shield of face with a narrow prolongation on the front between the antennæ and along each eye margin, a spot on malar space, a spot at base of mandibles, a narrow band at base of labrum, coxæ and trochanters of four anterior legs, most of posterior coxæ and femora, apical margin of scutellum, postscutellum, basal abdominal segment, median and lateral spots on apex of third abdominal segment, the fourth, fifth, sixth and seventh segments, except at base, yellow; head, except as mentioned, a median band on the dorsulum, base of scutellum, lower half of propleura and mesopleura more or less, metapleura partly along the anterior margin and base of abdominal segments, the third broadly black; antennæ brown, blackish above; posterior femora blackish posteriorly, legs, except as mentioned, brownish testaceous.

Type: University of Kansas. Type locality: Hamilton county, Kansas, 3350 feet. June, 1902, F. H. Snow.

Bœthus ænigmaticus, n. sp.

In color this species is related to B. howardi.

MALE.—Length, 5.5 mm. Head normal, polished, smooth, tubercles on the clypeus thick and prominent; scape and pedicellum together as long as the first joint of the flagellum. Thorax smooth and polished; parapsidal grooves not impressed; mesopleura with a small, shallow, puncture-like impression in the middle of the sclerite near the posterior margin; metapleura with a short, oblique groove directed forward and downward, and attaining the anterior margin; wings fuscous, stigma and nervures very dark brown; the first abcissa of the radius about one-half the length of the second; transverse cubitus about one third the length of the first abcissa of the radius, the abcissa of the cubitus beyond the transverse cubitus as long or very nearly as long as the transverse cubitus, the terminal abcissa of the cubitus nearly straight; transverse median nervure interstitial, though not exactly, being a trifle beyond interstitial; first recurrent nervure straight, almost as long as the second recurrent nervure which is curved; discocubital nervure not at all broken, with not even a trace of a stump of a vein; transverse median nervure in the posterior wings broken where the basal fourth joins the succeeding fourth. Abdomen smooth and shining, the thyridia of the second segment close to the lateral margin and parallel therewith, not attaining the middle of the segment, though terminating near the middle. Obscurely pubescent, the pubescence long and conspicuous only on the metanotum. Black; anterior margin of the face, clypeus, greater portion of the second abdominal segment, part of the third, brownish; mandibles yellowish; dorsulum, scutellum, propleura and upper portion of mesopleura ferruginous; apical two-thirds of anterior tibiæ, anterior tibiæ and tarsi brownish ferruginous; middle tibiæ brownish; venter of abdomen pale beneath.

Type: University of Kansas. Type locality: Douglas county, Kansas, 900 feet. F. H. Snow.

Sychnoporthus tuckeri, n. sp.

Female.—Length, 4 mm. Head dullish, minutely sculptured; malar space high, as high as the scape is broad; antennæ twenty-five jointed, the scape and pedicellum together about as long as the fourth joint of the flagellum. Thorax dullish; dorsulum nearly like the face; parapsidal grooves rather distinct on the anterior third of the dorsulum; mesopleura finely coriaceous, the upper posterior angle smooth and polished, a small pit in the middle of the sclerite at the posterior border; metanotum coriaceous with a large pentangular areola which has the sides of equal length or nearly, basal area wanting, petiolarea occupying nearly all of the posterior face of the metathorax, a strong ridge bounding the posterior face of the metathorax, produced into a rather sharp angle above the middle on each side; metapleura distinctly separated from the metanotum and coriaceous; wings very faintly brownish, nearly clear, stigma and nervures dark brown, the nervures not as dark as the stigma: areolet if complete would be pentangular, open behind, sides almost equal; transverse median nervure nearly interstitial, received by the median nervure a little beyond a basal nervure; transverse median nervure in the posterior wings broken about one-third the length of the transverse median nervure above its base. Abdomen nearly smooth; first, second and third segments coriaceous, except the apical margin, which is polished; the segments beyond the third entirely polished; ovipositor exserted about as long as the first two abdominal segments together. Black: scape and posterior coxæ brownish testaceous, the anterior and middle coxæ testaceous and whitish, the trochanters of the four anterior legs white or whitish, of the posterior legs testaceous, rest of the legs nearly entirely testaceous and somewhat brownish, posterior tibiæ especially brownish at base and apex, yellowish between, apical tarsal joint and claws brown; ovipositor brown, translucent, sheaths black.

Type: University of Kansas. Type locality: Douglas county, Kansas. August, E. S. Tucker.

Glypta succineipennis, n. sp.

Closely related to varipes, from which it differs in sulpture, size, and color.

Female.—Length, 10 mm. Head shining; front closely punctured, the punctures confluent, giving a transverse rugose appearance; cheeks polished, sparsely punctured; clypeus indistinctly punctured: antennæ thirty-seven jointed, scape and pedicellum together distinctly shorter than the first joint of the flagellum; malar space about as high as half the length of the scape. Dorsulum shining, distinctly punctured, the punctures close together, only the width of a puncture between them; parapsidal grooves represented on the anterior two-thirds of the dorsulum by shallow impressions, converging and terminating in a very closely punctured area; scutellum punctured like the dorsulum; mesopleura punctured very like the dorsulum, with a transverse impression in the middle of the posterior half, the impression attaining the posterior margin; metanotum shining, with well-separated punctures, bounded posteriorly by a transverse carina, a longitudinal carina down the disc each side of the middle, these carinæ nearly parallel at least on the posterior half and forming an oblong or nearly oblong area, lateral areas partly defined by short, imperfect carinæ; metapleura more closely punctured than the mesopleura; wings distinctly yellowish, nervures and stigma pale brown, the stigma paler than the nervures; discocubical nervure without a vein; transverse cubitus a little longer than the abcissa of the cubitus beyond it; transverse median nervure in the posterior wings broken only by an indistinct nervure. Abdomen very closely punctured; the first segment with two longitudinal carinæ, with a transverse groove to each side of the carinæ at the apex of the segment; the impressed abdominal segments almost uniformly punctured throughout, the oblique impressions punctured like the raised portion, forming an angle of about sixty degrees with the base of the segment, attaining the base but not the apex, rather abruptly diverted to the sides near the apex of the segment; no indication of an apical transverse ridge on the segments, sides of the impressed segments somewhat impressed near the middle; ovipositor about 10 mm. long. Inconspicuously sericeous. Black; greater part of clypeus and mandibles dark chestnut; a spot on metapleura and apical margins of abdomen colored like the clypeus and mandibles; legs to a great extent testaceous, tinted with ferruginous; part of anterior coxæ, anterior and middle trochanters whitish yellow; tegulæ and lateral edge of prothorax on posterior half whitish; anterior and middle tarsi ferruginous, posterior tibiæ and tarsi brown, the former whitish on the outer side, except at apex, the tarsal joints whitish at base; ovipositor dark brown, the sheaths black.

Type: University of Kansas. Type locality: Wallace county, Kansas, 3000 feet. June, 1878, F. H. Snow.

Glypta aprilis, n. sp.

FEMALE.—Length, 9 mm. Head shining; face almost uniformly, very closely punctured; the clypeus sparsely, indistinctly pitted; cheeks more shining than the face, rather sparsely, indistinctly punctured; malar space about as high as half the length of the first joint of the flagellum; antennæ over twenty-seven jointed (broken), scape and pedicellum together distinctly shorter than the first joint of the flagellum. Dorsulum nearly as in succineipennis; mesopleura nearly as in succineipennis; metapleura rather sparsely punctured; the disc of the metanotum about as in succineipennis, the longitudinal carinæ not well defined, sides of metanotum rather sparsely, coarsely punctured; wings blackish, nervures and stigma dark brown, blackish; neuration almost exactly as in succineipennis. Abdomen very nearly as in succineipennis, duller; ovipositor a little longer than the abdomen. Pubescence as in succineipennis. Black; clypeus largely, tubercles, tegulæ and base of wings white; legs brownish testaceous, except as follows: Claws of four anterior legs brown, tibiæ of posterior legs whitish, brownish behind, a broad brown band at apex and a brown band near the base, tarsi of posterior legs brown, the basal joints whitish at base; lower posterior portion of mesopleura castaneous; metapleura colored nearly like the legs, but with a distinct rufous tint: ovipositor and sheaths colored as usual.

Type: University of Kansas. Type locality: Douglas county, Kansas, 900 feet. April 23, 1892, north bank of Kansas river, E. S. Tucker.

Glypta brunneisigna, n. sp.

FEMALE.—Length, 6.5 mm. Head as in aprilis; the malar space distinctly a little less in height than half the length of the first joint of the flagellum; antennæ over thirty-four jointed (broken). Thorax nearly as in aprilis; the dorsulum rather dullish and very closely punctured; metanotum very closely punctured, the transverse carina distinct, the longitudinal carinæ on the disc rather indistinct, widely separated and nearly parallel on the apical half; neuration of wings as in succineipennis, yellowish, stigma and nervures pale brown, nearly testaceous. Abdomen very much as in aprilis; ovipositor as long as the abdomen. Pubescence as usual. Black; antennæ brown; clypeus with a brown mark anteriorly; superior edge of prothorax yellow, tegulæ whitish, base of wings yellow; lower half of mesopleura, mesosternum and metapleura ferruginous; legs to a great extent testaceous to brownish testaceous, trochanters and anterior coxæ whitish, claws brown, tarsal joints of middle legs whitish, brown at tip, tibiæ and tarsi of posterior legs brown and whitish, apical fourth of the posterior tibiæ brown, and a brown band near the base, basal joint of the posterior tarsi with the apical third brown, the four succeeding joints with the apical half brown, the apical joint entirely brown; ovipositor and sheaths of the usual color.

Type: University of Kansas. Type locality: Douglas county, Kansas. F. H. Snow.

Pimpla annulipes Brullé.

Lawrence, Douglas county, Kansas, 900 feet; June, E. S. Tucker.

Ephialtes irritator Fabricius.

Lawrence, Douglas county, Kansas; November 20, 1897.

Thalessa atrata Fabricius.

Lawrence, Douglas county, Kansas; May 27, 1901, Hugo Kahl.

Harrimaniella pæneimitatrix, n. sp.

Closely related to immitatrix, from which it differs in sculpture and color.

Female.—Length, 9 mm. Head dull, very minutely sculptured, and with adjoining shallow punctures; face distinctly elevated in the middle; clypeus rather shining, sparsely punctured, separated from the face by a rather distinct, shallow, broad impression; malar space a little shorter than half the length of the first joint of the flagellum; antennæ forty-two jointed, scape and pedicellum about as long as the second joint of the flagellum. Thorax almost uniformly dull and punctured like the face; dorsulum with parapsidal grooves not even indicated by faint grooves; the mesopleura have a shining pit a little above the middle near the posterior margin of the sclerite; metanotum without longitudinal carinæ, more coarsely punctured than the mesopleura, almost rugulosely punctate; wings tinted with dark brownish, nearly blackish, nervures and stigma dark brown; areolet quadrangular, petiolate, the petiole shorter than the shortest side of the areolet, but variable in length. Abdomen smooth and impunctate, except the first segment which is roughened and indistinctly punctured in part; ovipositor, 8.5 mm. long. Uniformly sericeous, pubescence short and whitish, nowhere conspicuous. Black; clypeus anteriorly testaceous; wings at base yellowish; legs yellowish rufous, except as follows: Trochanters with some fuscous, posterior tibiæ brown, rufous only on the inner side, tarsi and claws brownish, the posterior tarsi very dark brown; a broad apical margin of first abdominal segment, second and third segments, except narrow lateral margin, fourth segment, except narrow lateral margin and broad apical margin, deep reddish ferruginous; ovipositor brown, sheaths black.

Type: University of Kansas. Type locality: Douglas county, Kansas, 900 feet. F. H. Snow.

Arenetra leucotænia, n. sp.

Closely related to rufipes, from which it differs in color and structure.

FEMALE.—Length, 10 mm. Head and thorax almost uniformly dull, closely punctured, nearly rugoso-punctate, the punctures shallow and not sharply defined; antennæ forty-four jointed, scape and pedicellum together distinctly longer than the third joint of the flagellum, but shorter than the first joint. Dorsulum rather shining and with some well-separated punctures, hardly an indication of parapsidal grooves present; mesopleura with a small, shining, sparsely punctured space above the middle of the sclerite and at the posterior border: carina separating metanotum from metapleura very faint, apparently no carina between the spiracles and the metanotal metapleural carina, an indistinct carina between the spiracles and the posterior carina of the metathorax; wings almost exactly as in nigrita, the discocubital nervure not broken. Abdomen with the first segment almost rugosopunctate, the second segment roughened, the third dullish, the segments beyond polished. Pubescence typical. Black; femora at tip yellowish, tibiæ brownish, tarsi of four anterior legs pale brownish, the posterior tarsi dark brown; second and third abdominal segments with a narrow whitish apical and lateral margin, fifth, sixth and seventh segments with an apical whitish margin which extends more or less to the sides; ovipositor and sheaths of about equal length, nearly as long as the first two abdominal segments, ovipositor dark brown, sheaths black; first five ventral segments brownish with a broad apical margin yellowish.

Type: University of Kansas. Type locality: Douglas county, Kansas, March, F. H. Snow.

Nematopodius exclamans, n. sp.

Related to N. (Mesostenus) gracilipes and longicaudus.

FEMALE.—Length, 13 mm.; ovipositor, 29 mm. Head shining; face rather dullish, very closely punctured on the median elevated portion, sides of the face along the edges polished, sparsely punctured; cheeks polished, apparently impunctate; clypeus distinctly bulged, apparently more coarsely punctured than the raised portion of the face; labrum sparsely and rather indistinctly pitted, deeply emarginate on the anterior margin; mandibles rather sparsely, coarsely punctured, some of the punctures confluent; malar space not much higher than the flagellum is wide at base; antennæ thirty-four jointed, the scape and pedicellum together as long or nearly as the fourth joint of the flagellum; an elongated low tubercle between the antennæ. Thorax shining; dorsulum with distinct parapsidal grooves that terminate in or near the middle of the posterior half, the middle lobe with rather sparse punctures, the lateral lobes with the punctures close together, but to a great extent well separated, some nearly adjoining; scutellum polished, rather sparsely punctured; metanotum rugulose, dullish, except the basal lateral area which is to a great extent polished and sparsely punctured, the outer portion shining and closely punctured, metanotum rather distinctly areolated, basal area small, nearly quadrate, areola pentagonal, lateral sides equal or nearly, basal side less than one-half the length of the apical side; petiolarea not distinctly defined, broad, angled below the middle, and occupying the greater part of the metathorax; metapleura rugulose, punctate and closely so, dullish; mesopleura sculptured nearly like the lateral lobes of the dorsulum; mesopleura separated from the mesosternum by a distinct, narrow, crenate, undulate groove the mesosternum with a longitudinal, crenate, medial groove that is about as narrow but not so deep as the pleurosternal groove; wings strongly brownish, stigma and nervures dark brown, the stigma pale at base;

areolet nearly oblong, more than twice as broad as high; the recurrent nervure a little before interstitial with the second transverse cubitus; disco-cubital nervure nearly straight, the so-called first recurrent nervure nearly two-thirds the length of the true recurrent nervure; transverse median nervure a little basad of interstitial with the basal nervure; transverse median nervure in the posterior wings broken in the middle. Abdomen entirely smooth and highly polished; the petiole slender with a few punctures dorsally and nearly as long as the abdomen beyond the second segment, the petiole not much broader at apex than at base; the second segment nearly as long as the petiole, more than twice as wide at apex as at base. Very thinly, inconspicuously covered with short whitish hairs. Ferruginous; apex of mandibles, mesosternum anteriorly and posteriorly, margins around the scutellum and lateral ventral margins of metathorax black or blackish: flagellum almost entirely black or blackish, basal joint beneath brown, joints 6, 7, 8 and base of 9 white above, scape and pedicellum nearly concolorous with the face; ovipositor translucent brown, sheaths black.

Type: University of Kansas. Type locality: Clark county, Kansas, 1962 feet. May, 1903, F. H. Snow.

Paratype from Morton county, Kansas, 3200 feet. June, 1902, F. H. Snow.

Nematopodius macilentus Cresson.

One male. Douglas county, Kansas, 900 feet: F. H. Snow.

Mesostenus thoracicus Cresson.

One female, small form. Clark county, Kansas, 1962 feet; June, F. H. Snow.

Mesostenus discoidaloides, n. sp.

Superficially very like discoidlais, from which it differs in structure and color details.

Female.—Length, 10 mm. Head shining: front polished, almost impunctate, punctured along the eye margin; face sparsely, indistinctly punctured: clypeus polished, almost impunctate; cheeks polished, apparently impunctate; malar space distinct, as high as two-thirds the width of the mandibles at base; antennæ twenty-five jointed, scape and pedicellum together distinctly shorter than the first joint of the flagellum, about as long as the fourth joint of the flagellum. Thorax shining; dorsulum distinctly, rather closely punctured and with distinctly impressed parapsidal grooves that extend back at least two-thirds the length of the dorsulum; mesopleura in greater part punctured like the dorsulum, an oblique shallow groove that is largely smooth and impunctate separates a small, polished, convex area in the upper posterior angle of the mesopleura from the rest of the sclerite, a pit near the middle of the sclerite (a little above the middle), and close to the posterior margin, the characteristic cryptine groove extending back from the anterior margin for about two-thirds the length of the sclerite and gently curved upward; scutellum polished, rather sparsely punctured; metathorax more closely puncturad than the dorsulum, the metathorax rounded and almost precisely divided into thirds, by transverse carinæ, the basal carina moderate, the apical carina rather indistinct, apparently absent in the middle, spiracles oval, nearly round, no sharp angles whatever; wings almost clear, colorless, the apical margins narrowly infuscated, stigma pale brown, nervures dark brown; areolet pentangular, almost quadrate, the recurrent nervure received in the middle of the areolet; transverse median nervure in posterior wings bent to form an obtuse angle, with the angle a little above the middle and receiving the discoidal nervure. Abdomen shining; the first segment polished and rather sparsely punctured; succeeding segments distinctly punctured, the punctures almost adjoining and giving a dullish appearance; the apical segments not so punctured, rather indistinctly punctured; exserted portion of ovipositor as long as the abdomen less the first segment, the sheaths shorter. Inconspicuously covered with fine silvery pubescence. Black; face almost entirely yellowish, two brown spots on each side of the clypeus, mandibles brownish at apical half, front, vertex, occipital margin of white, scape brownish with a yellowish spot beneath, flagellum black or nearly, except the sixth joint all but at base, seventh, eighth, ninth, tenth, eleventh joints entirely and twelfth joint at base pure white or nearly white; a broad band on the superior margin of prothorax, not uniting anteriorly, collar, coxæ and first trochanter of anterior legs, tegulæ, extreme base of wings, spot beneath wing insertion, polished convex area of mesopleura, a broad oblique band extending from very near the anterior border of the mesopleura to the posterior border, joining the pale color of mesosternum, from which it is separated only anteriorly by the brownish of the cryptine groove, mesosternum almost entirely, except the fine median brownish groove, scutellum, part of postscutellum, a lunate mark between insertion of posterior wings and metathorax, posterior thirds of metanotum with a trilobed mark, the anterior lobe occupying the middle of the middle third, *i. e.*, between the transverse carinæ, the posterior lobes and body of the mark occupying nearly all of the posterior face of the metanotum, metapleura almost entirely, coxæ and first trochanter of medial legs, coxæ of posterior legs, except a large mark internally, a smaller mark externally, and a longitudinal, sharply defined band posteriorly, first abdominal segment at base and apex, the succeeding segments with a more or less narrow lateral margin and a broad apical margin, margins of ventral segments more or less, posterior legs with the metatarsus, except basal half, second and third tarsal joints entirely, fourth tarsal joint, except at apex, white; otherwise the legs are brownish testaceous, except the apical tarsal joints which are more or less brown, and the claws which are dark brown.

Type: University of Kansas. Type locality: Douglas county, Kansas, 900 feet, at Rock Creek. Roy L. Moodie.

Cryptus (Callicryptus) calipterus Say.

MALE.—Differs from Callicryptus as follows: Transverse median nervure of posterior wings broken near the middle, only one transverse carina present, the upper hind angles of metathorax not toothed, fourth tarsal joint not strongly emarginate or bilobed.

Clark county, Kansas, 1962 feet. June, 1903, F. H. Snow.

Cryptus (Itamoplex) americanus Cresson.

MALE.—Douglas county, Kansas, 900 feet. June, 1892, W. J. Coleman.

Cryptus citrinimaculatus, n. sp.

Superficially like C. (Itamoplex) americanus, and, judging from the description, very like mellicoxus.

MALE.—Length, 9 mm. Head rather broad; face dullish, closely sculptured, distance between posterior ocelli greater than distance between lateral ocellus, about equal to the distance between the lateral ocellus and nearest eye margin; malar space equal in height to the width of the mandibles at base; cheeks shining, with minute well-separated punctures; antennæ thirty-five jointed, scape and pedicellum together distinctly shorter than the first joint of the flagellum, about equal to the length of the second joint. Thorax almost uniformly dullish and rugulose, punctate, the punctures of the dorsulum well separated, small and to some extent indistinct, anteriorly the dorsulum is closely, indistinctly sculptured;

metanotum rugulose, with two distinct transverse carinæ, not connected by longitudinal carinæ on the superior face, therefore no areola, no distinct basal area, the petiolarea about as broad as long, occupying practically all of the posterior face of the segment; the metapleura duller and more densely rugulosopunctate than the mesopleura; wings moderately smoky, the nervures dark brown, the stigma pale brown: transverse median nervure received by the median nervure a little basad of the basal nervure, the so-called discocubital nervure broken by a short abcissa in the middle; areolet pentangular, the second cubital side about equal to the radial side, the other sides subequal, transverse median nervure broken where the lower third of the nervure meets the middle third. Abdomen smooth and shining, covered with whitish pubescence, rather appressed and abundant on the face, dorsulum and abdomen; clypeus anteriorly and metathorax with erect, rather sparse pubescence; pleura with appressed, inconspicuous pubescence. Black; scape with a line in front, inner orbital margin entirely, a very narrow orbital line occupying the middle third of the orbital margin of the cheeks, the supraclypeal protuberance, the clypeus, mandibles, except base and apex, prolongation of the orbital band on the malar space, anterior coxæ with a small spot anteriorly, anterior trochanters beneath more or less, basal trochanter of middle legs with a stripe beneath, lemon yellow; distal trochanters, tibiæ and femora largely testaceo-ferruginous to ferruginous, the apical fourth of the posterior tibiæ fuscous, tarsi of the four anterior legs concolorous with the tibiæ thereof, except the apical joint and claws which are brown, tarsi of posterior legs almost entirely fuscous.

Type: University of Kansas. Type locality: Douglas county, Kansas, 900 feet. F. H. Snow.

Pezomachus alogus, n. sp.

MALE.—Length, 3.5 mm. Head dullish, subtle, minutely and indistinctly sculptured; clypeus conspicuously separated from the face; malar space about as high as the mandibles are broad at base; distance between anterior ocellus and lateral ocellus nearly as great as the distance between the lateral ocelli, the latter distance a little greater than the distance between the lateral ocellus and nearest eye margin; antennæ twenty-three jointed, scape and pedicellum together about two-thirds the length of the first joint of the flagellum. Thorax with the pleura rather shining, the dorsulum more dullish with no indication of parapsidal grooves; metanotum rather evenly rounded, exareolate, and dullish, a short transverse groove at the middle of the posterior margin of the mesopleura; metapleura more shining than the metanotum, but subtle. Abdomen dullish; petiole nearly parallel sided, the apex not much wider than the base, sculpture of the first two segments not coarse, similar to the succeeding segments which are smooth and apparently impunctate. Wings nearly clear, faintly smoky, with a faint brownish band beneath the stigma and some brownish in the vicinity of the junction of the basal nervure with the median and transverse median nervures, stigma and nervures dark brown, the proximal angle of the stigma whitish; sides of the open areolet equal or nearly, discocubital nervure not broken; transverse median nervure interstitial with the basal nervure; the transverse median nervure in the posterior wings broken distinctly below the middle but not quite as far down as the upper end of the basal third of the nervure. Inconspicuously covered with whitish pubesence. Black; scape, pedicellum, mandibles, except tips, labrum, prothorax, legs and first three abdominal segments almost entirely testaceous; first joint of the flagellum at base, anterior lateral edges of the dorsulum, mesopleura anteriorly, suture between meso- and metapleura, and fourth abdominal segments in part, more or less brown.

Type: University of Kansas. Type locality: Lawrence, Douglas county, Kansas. May, at electric light, E. S. Tucker.

Pezomachus testaceicoxus, n. sp.

MALE.—Length, 6 mm. Head dullish, minutely, densely sculptured, apparently microscopically rugulose; ocelli as in P. alogus; the clypeus not conspicuously separated from the face; malar space distinctly higher than the mandibles are broad at base; antennæ broken, scape and pedicellum together about three-fourths the length of the first joint of the flagellum. Thorax almost uniformly dull, minutely sculptured; parapsidal grooves distinctly impressed on the anterior half of the dorsulum; propleura shining, rugulose; mesopleura with the greater part of the upper posterior fourth polished, a short transverse groove which attains the posterior margin of the sclerite separates the polished area from the area beneath; the cryptine groove distinct from the anterior margin of the lateral edge of the mesosternum to near the posterior edge of the sclerite, extending up somewhat on the lower portion of the mesopleura; scutellum rather shining compared to the mesonotum; metanotum shining, rugose, distinctly areolated, the raised lines very distinct, basal area nearly quadrate, areola hexagonal, a little longer than wide, the basal side a little shorter than the apical side, the lateral middle angles a little below the middle of the areola, the four sides not mentioned of nearly equal length; petiolariea broad, occupying practically the entire posterior face of the segment; the metapleura minutely sculptured, dull; wings faintly brownish, almost clear, stigma and nervures dark brown, the basal angle of the stigma whitish; the open areolet with the sides nearly equal; the transverse median nervure a little beyond interstitial with the basal nervure; the transverse median nervure in the posterior wings broken distinctly below the middle, a little below the junction of the basal third of the nervure with the middle third. Abdomen dullish; the petiole nearly twice as broad at apex as at base, longitudinally striate on the apical half, rather rugose on the basal half, the basal half with a distinct raised line on each side, the raised lines parallel and forming the inner boundary of a shallow groove: the second segment is longitudinally rugulosostriate; the succeeding segments are apparently minutely, microscopically sculptured. The pubescence is whitish and nowhere conspicuous. Black; scape, pedicellum, basal spot on mandibles and margin of second abdominal segment brownish testaceous; legs almost entirely testaceous, posterior legs with apex of femora, tibiæ and tarsi almost entirely fuscous; second abdominal segment entirely pale brownish testaceous, the succeeding segments at apex concolorous with the second segment, otherwise more or less fuscous with some brownish testaceous in the middle.

Type: University of Kansas. Type locality: Douglas county, Kansas, 900 feet. May, F. H. Snow.

Platylabus (Colocnema ?) omniferrugineus, n. sp.

Superficially like Phæogenes lævigatus.

FEMALE.—Head quadrate; face dull and closely, almost rugulosely, punctured; the clypeus not at all separated, the anterior margin of the clypeus smooth, impunctate, and shining, anterior margin of the clypeus straight; labrum polished, roughened on the anterior margin, which also has a few punctures; front rather flat, slightly elevated, rather shining, and with well-separated punctures; distance between the posterior ocelli about as great as the distance between a lateral ocellus and the nearest eye margin, the ocelli forming a low triangle; cheeks shining, distinctly punctured, the punctures well separated; mandibles shaped like a cornucopia, the tips blunt and not touching, broader at base than the malar space is high; antennæ thirty-two jointed, scape and pedicellum together easily as long as the first two joints of the flagellum combined, first joint of the flagellum nearly twice as long as wide, the two succeeding joints longer than wide, the joints following these, excepting the ultimate joint, wider than long. Thorax shining and distinctly punctured; dorsulum with no parapsidal grooves whatever, most of the punctures well separated; mesopleura punctured very like the dorsulum, impressed above the middle along the posterior margin, a faint indication of a cryptine groove on the anterior half of the sclerite close to where it joins the mesosternum; scutellum sparsely punctured, almost rigid laterally by the prolongation of a fold of the posterior lateral margin of the mesonotum; the postscutellum more finely punctured than the scutellum; metanotum closely, almost rugulosely punctuate; superior face of the mesonotum bounded posteriorly by a rather sharp curved ridge, with a very short basal area confluent with the lateral areas and with a spade-shaped areola, the spiracles in the lateral areas very long and extending obliquely backward and outward, the posterior face of the metathorax divided into three areas by rather strong ridges, the petiolarea a little wider than the areola, occupying the middle; metapleura with well-separated distinct punctures on a polished surface; wings faintly smoky, tinged with yellowish especially at base; areolet pentagonal, the radial side on half the length of the transverse cubitus, and equal to the length of the second side formed by the cubitus, the first side formed by the cubitis and the transverse cubiti of equal length; the recurrent nervure broken a little below the middle by a short stump of a vein externally; the discocubital nervure broken by a short stump of a vein a little before the middle; transverse median nervure interstitial with the basal nervure; transverse median nervure of the posterior wings broken well below the middle about at the junction of the basal third with the middle third; legs very robust, the posterior coxæ rather pear-shaped, nearly globular, the anterior femora less than three times as long as broad, the middle femora about three times as long as broad, the posterior femora a little more than three times as long as broad, the tibiæ of posterior legs normal at base or nearly, at apex nearly as broad as the posterior femora in the middle. Abdomen distinctly punctured; the petiole infundibuliform, more than twice as wide at apex as at base, shining and with well-separated punctures, laterally with a groove and with a ridge from the spiracles to the posterior margin; the second, third and fourth segments with smaller, closer punctures than the petiole, appearing dullish; the fifth segment and beyond shining and indistinctly punctured or sculptured. Inconspicuously covered with silvery pubescence which is long and most apparent on the clypeus, anterior margin of the labrum and the metathorax. Ferruginous: sutures around the insertion of the wings laterally and posteriorly, around the scutellum and postscutellum and more or less of the apical third of antennæ black; middle third of antennæ more or less whitish above, brownish beneath, basal third brownish above and below; mandibles with brown margins, claws brown, tarsi brownish.

Type: University of Kansas. Type locality: Douglas county, Kansas, 900 feet. May, F. H. Snow.

Phygadeuon (Pezoporus?) fungor Norton.

This species has previously been placed in the Ichneumoninæ, Phæogenes, but it has a distinct cryptine groove. Two specimens have the scutellum and dorsulum entirely black, as in the type from New York state; in the third specimen the scutellum is largely rufous and the dorsulum has a broad brownish stripe down the middle.

Three males from Douglas county, Kansas, 900 feet. June and July, 1892, W. J. Coleman.

Ichneumon ? (Stiboscopus ?) oryxicornis, n. sp.

Related to Ichneumon ? honestus Cresson.

MALE.—Length, 11 mm. Head shining, the cheeks especially; face closely punctured, space between clypeus and antennæ moderately elevated; clypeus not separated posteriorly by a groove, the anterior margin entire, straight; malar space less than half the width of the mandibles at base; front punctured very much like the face; vertex and cheeks similarly punctured, the punctures distinctly more separated than on the face; ocelli almost forming an equilateral triangle, distance between the posterior ocelli distinctly greater than the distance between lateral ocellus and nearest eye margin; antennæ thirty-five jointed, scape and pedicellum together about as long as the first joint of the flagellum or a little shorter. Thorax almost uniformly shining, the dorsulum alone somewhat dullish; dorsulum with distinct, well-separated punctures and parapsidal grooves, the parapsidal grooves moderately impressed and present only on the anterior third of the sclerite; scutellum convex, sparsely punctured, and not margined laterally; postscutellum apparently impunctate; superior face of metathorax with the basal area nearly crowded out and not defined laterally, and with an areola that is little more than a semicircle, posterior face with three areas; the petiolarea central, as wide as the areola, nearly parallel sided and broadly, shallowly channeled, the spiracles occupying the upper portion of the lateral area, near the metanotal-metapleural suture very narrow and long, directed obliquely backward and outward; mesopleura with distinct, closely arranged punctures and a transverse impression across the middle of the posterior half of the sclerite, the impression joining the posterior margin in a kind of pit, the cryptine groove appears as a crenulate, impressed, narrow groove on the anterior half of the mesosternum, close to and parallel with the junction between the mesopleuron and mesosternum; metapleura more closely, regularly punctured than the mesopleura; wings tinted rather moderately with brown, the nervures dark brown, stigma pale brown; areolet pentagonal, nearly quadrangular, distinctly longer than the greatest width, the radial side of the areolet about as long as the pedicellum is high and a little less than half the length of a transverse cubitus, the first cubital side longer than the second which is a little more than half the length of a transverse cubitus, discocubital nervure with a faint trace of a stump of a vein near the middle, the transverse median nervure interstitial, in the posterior wings the transverse median nervure is broken distinctly below the middle, a little below the junction of the lower third with the middle third. Abdomen dullish, except the petiole which is shining; sides of the petiole with a groove bounded above by a ridge that is interrupted at the spiracles and continues a little beyond the spiracles to the posterior margin; the second segment polished at base and distinctly, sparsely punctured, remainder closely punctured; succeeding segments closely, more or less distinctly punctured. Covered with inconspicuous short pubescence which is to a great extent whitish, tinted with golden on the dorsulum. Black; more or lese broad orbital line, all of face below antennæ, mandibles, except apical portion, superior border of propleura and a transverse line below insertion of wings lemon yellow; antennæ brown below, black above, except joints 15, 16, 17, 18, 19, 20, which are more or less cream color; palpi whitish; inferior margin of propleura, tegulæ, oblique line and spot on lower half of mesopleura, a large part of anterior and middle coxæ, anterior, middle and posterior trochanters, posterior coxæ above, greater part of posterior face of metathorax, and a spot on metapleura, yellow; femora more or less ferrugineous, tibiæ of anterior and middle legs brownish, whitish and testaceous, posterior tibiæ dark brown at extreme base, apical half more or less brown, between the basal and apical dark portion the joint is whitish, tarsi testaceous, tinted with dull ferruginous in part, claws brownish.

Type: University of Kansas. Type locality: Douglas county, Kansas. July, E. S. Tucker.

Ichneumon (Eurylabus) extrematatis Cresson.

Female. Douglas county, Kansas, 900 feet; May, E. S. Tucker.

Ichneumon (Barichneumon) unifasciatarius Say.

Male. Douglas county, Kansas: September.

Ichneumon (Stenichneumon) centrator Say.

Female. Hamilton county, Kansas; S. J. Hunter.

Trogus atrox Cresson.

Male. Clark county, Kansas, 1962 feet: June, F. H. Snow.

Male with same data as preceding and with the wings uniformly fuliginous, excepting the stigma, areolet distinctly pentangular, abdomen entirely black.

Male specimen from Hamilton county, Kansas, 3350 feet (June, 1902, F. H. Snow), with the wings as in the preceding specimen, but the areolet hardly pentangular, almost precisely quadrangular, the second abdominal segment obscurely maculated.

Trogus marginipennis Cresson.

This may be only a variety of atrox.

Male. Hamilton county, Kansas, 3350 feet; June, 1902, F. H. Snow.

Family STEPHANIDÆ.

Stephanus acutus Lepet Serv.

FEMALE.—Length, 14 mm. Head rather globular, the cheeks nearly as broad as the eyes; front with coarse, almost transverse rugæ, nearly rugose; vertex with three prominent teeth, the anterior tooth nearly as far from the anterior ocellus as from the eye margin, the posterior teeth on a line with the anterior ocellus, the teeth short and directed upward and backward, between the anterior ocellus and the posterior ocelli the sculpture is very much like the sculpture of the front, and nearly as coarse, back of the posterior ocelli the head is transversely, rather finely striate: the cheeks are polished and sparsely punctured, the malar space very much like the cheeks in sculpture and about as high as the scape is wide; pedicellum about half as wide and long as the scape, first joint of the flagellum about three-fourths the length of the second joint and about three-fourths the length of the scape and pedicellum together. Prothorax conical, dorsum transversely striate, pleura obliquely striate: dorsulum rugose, mesopleura with strong separated punctures; metanotum punctured somewhat like the mesopleura, the punctures more shallow, metapleura punctured and striate; posterior femora with two large and about six small teeth on the lower margin, the largest tooth stout, triangnlar, and situated a little before the middle, the next largest tooth slender and situated half-way between the largest tooth and the apex of the femur. Abdomen with the petiole more or less completely girdled with striæ, the basal half of the petiole more nearly rugulose; remaining segments smooth and subtle, the petiole is about two-thirds the length of the remaining portion of the abdomen. The ovipositor is as long as the insect and brownish, the sheaths black with a broad white annulus near the apex, almost as long as the ovipositor. The insect is shining and black and inconspicuously clothed with whitish or silvery pubescence; flagellum at base, middle and anterior legs, except the coxæ, posterior legs with trochanters, femora at base and apex, and tarsi more or less, brownish; tegulæ, malar space in part and mandibles on basal half more or less brownish. This is much smaller than the smallest size given by Schletterer in his monograph, but the size is undoubtedly the most unstable feature of this species.

Type: University of Kansas. Type locality: Kansas City, Jackson county, Missouri. Geo. C. Mackenzie, 1899.

V.

MISCELLANEOUS PAPERS.

"Notes on the Archæology of Butler County."
By J. R. Mead, Wichita.

"The Culture Emergence of Man."
By Dr. Alton Howard Thompson, Topeka.

"Sanitary Science."
By Dr. J. M. McWharf, Ottawa.

"The Need of Investigations in Human Nutrition."
By J. T. Willard, Kansas Agricultural College, Manhattan.

"Physical Development and School Life."
By Dr. J. M. McWharf, Ottawa.

"The Use and Care of Reflecting Telescopes."
By W. F. Hoyt, Kansas Wesleyan University, Salina.

"Recent Advances in Astronomy."
By W. F. Hoyt, Kansas Wesleyan University, Salina.

"The Non-Euclidean Geometry."
By E. Miller, University of Kansas, Lawrence.

"What Rights Have Educational Institutions to Duty-free Importations?"
By E. H. S. Bailey, University of Kansas, Lawrence.

"The Genesis and Development of Human Instincts."
By L. C. Wooster, State Normal School, Emporia.

"Instinct."
By H. L. Miller, Principal High School, Topeka.

"Observations on Mirages."
By Bernard B. Smyth, Topeka.

"Physical Properties of Water, and its Relation to Tree Growth."
By Bernard B. Smyth, Topeka.

"Notes on Collecting Cincindelidæ."
By Eugene G. Smyth, Topeka.

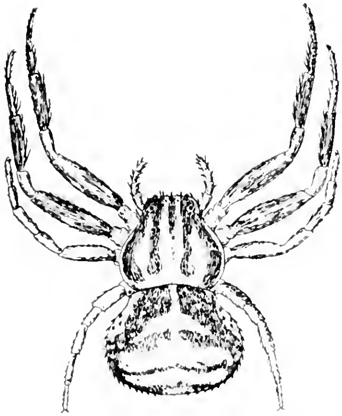

Fig. 1.

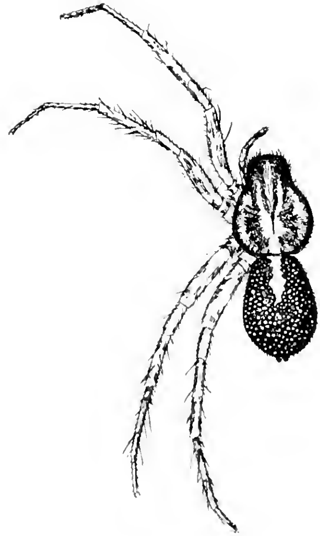

Fig. 7.

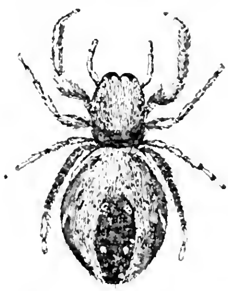

Fig. 2.

Fig. 3.

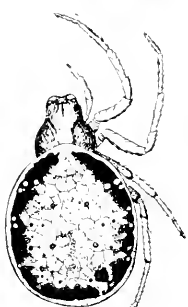

Fig. 4.

Fig. 6.

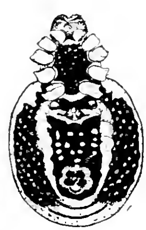

Fig. 5.

Plate XXIX.—Kansas Spiders.

NOTES ON THE ARCHÆOLOGY OF BUTLER COUNTY.

By J. R. MEAD, Wichita.

Read before the Academy, at Manhattan, November 27, 1903.

IN the summer of 1863 I noticed on the bluffs along the Walnut and Whitewater rivers and their tributaries, in Butler county, Kansas, frequent low mounds from six inches to two feet in height and from fifteen to twenty-five feet in diameter. They were usually overgrown with the same coat of short buffalo-grass which at that time covered the highlands and were as compact and solid as the surrounding land; originally they may have been higher. They evidently were made long before historic times, as the Osages and other Indians, who at times occupied the county since Kansas was known, did not bury their dead in mounds.

Some of these mounds have been explored, and proven to be burial-places. Several bodies were sometimes found in one mound, and with them were placed various articles of their belongings; heavy stone axes of granite or other stone not found in the vicinity, occasionally flint spades, and always flint arrow- and spear-points, knives, etc.; sometimes bones of animals and shells. The writer opened one of these mounds the past summer, situated on a rocky point of bluff overlooking Four Mile creek. The earth and stone had been excavated to a depth of two feet. There were found portions of the hard, dry bones of three persons, two adults and a child, with them a buffalo bone, and a few *Unio;* the excellent drainage aiding in preserving them. Some arrow- and spear-points were found, of dark bluish chert, of fairly good workmanship, and covered with a hard lime deposit.

It must be remembered that very few of the articles which are originally buried in a mound remain after the lapse of ages—usually nothing but stone, bone, or pottery. Such articles as buckskin clothing, furs, buffalo-robes in which the dead were wrapped, head-dress, the ornamented shafts of lances, bows and arrows, all disappear in time; so that what we find is but a small remainder of the orignal burial, almost nothing remaining by which to judge of the dress, food or customs of the people. Then, burrowing animals nearly always have invaded the mounds, and small articles, such as ornaments or beads of stone, bone, or shell, are scattered, mixed with the earth, or thrown out, and difficult to find. In these mounds everything had disappeared save some of the larger bones and whatever implements of stone or pottery may have been placed in them.

Stone implements similar to those found in the mounds have been picked up over the country, some of them fine specimens of hammers, axes, grinding-stones, pipes, spear-points, etc. Probably a wagon-load has been gathered, and several fine collections shipped out of the state.

The junction of Whitewater and Walnut rivers seems to have been the center of a considerable population of these ancient and unknown people. On the high bluff coming abruptly to the Walnut on the east are numerous low mounds and camp sites; under the rocky bluff is a big spring, and in the vicinity are sink-holes. On the high prairie, in a cavity in the rocky sides of one of these mounds, were found four Indian pipes, peculiar, unique, skilfully carved, and drilled from red quartzite, only found in Kansas along the southern limit of the Glacial ice-sheet.

A fine example of the pink and red quartzite can be seen in a field of boulders just west of the Wakarusa, in Douglas county, near Clinton. Other pipes, duplicates of these, have been found in the same county. These pipes were exceedingly hard; it would seem that nothing but a diamond would cut them.

The washing down of the side of a clay bank disclosed some large pottery vessels of excellent make, and there were found also a cache of spear- and arrow-points.

In the narrow strip of valley between the two rivers where they join many implements were found on the surface by the first settlers of the country. About 1870 Daniel Strine took it as a claim. He plowed up many more implements, and later sold to another party who, with a strong plow and four big horses, turned up the ground much deeper than before, and brought to view a third lot of stone implements. Among these were well-shaped hammers, weighing five or six pounds, with a groove around the center, cut from the same red quartzite.

This black gumbo land has not increased perceptibly by surface deposit in the forty years I have known it.

These mounds extend down the Walnut to near its mouth. I think it probable that this valley long ago was the home of a numerous people antedating the roving tribes found in Kansas when first explored. The abundant streams and springs of pure water, rich soil, abounding in game of all kinds—buffalo, elk, deer, antelope, otter, and wild turkeys—and bearing abundant timber, combined to make a primitive man's ideal home.

THE CULTURE EMERGENCE OF MAN.

By Dr. Alton Howard Thompson, Topeka.

Read before the Academy, at Topeka, December 29, 1904.

THE word "culture" is here used in the purely anthropological sense, as relating to the artificial products of man merely, and not to the higher intellectual accomplishments with which we usually associate the word. In the anthropological meaning it refers to the manual arts, industrial and esthetic, which distinguish man from the lower animals.

The science of anthropology is divided into two great divisions. The first is physical anthropology or somatology, which considers man as a biological unit — a species of animal; his racial varieties; his external chracteristics; his anatomy, physiology, and pathology. The second division is cultural anthropology, which includes the vast range of essentially human activities. As Prof. W. H. Holmes says (*Science*, September 26, 1902, page 487): "If the physical powers of man include all that connect man *with* the brute, his cultural powers include all that distinguish him *from* the brute. If we wish to realize more fully the latter division of the subject, which includes the objective evidences of culture, we have only to sweep away in imagination the myriads of things that it has brought into the world — destroy every city, town, and dwelling; every article made by man; every trace of human handiwork; set aside the use of fire and cooked food; banish all language, social organization, government, religion — and when this has been done we may behold the real man standing in his original nakedness among his fellows of the brute world."

To begin before the beginning, so to speak, the writer made some investigations as to the uses that lower animals make of tools and weapons, which, by the way, opened up a most interesting and promising field of research. Many animals seize objects that can be grasped and employed by the various powers of prehension, but we must notice that such actions are mainly automatic, instinctive, and imitative, and do not display any original invention or precision. The psychic flash, that suggests a new purpose as a constructive action, never occurs to them.

We have been told by many travelers that the apes and monkeys employ sticks for clubs and stones and nuts for missiles, etc. Even the Standard Natural History says that baboons employ stones as offensive weapons, and make attacks in concert; that the orang breaks off limbs of trees to throw at enemies; that the chimpanzee cracks nuts with stones, etc.

In order to make definite investigations, the essayist addressed the managers of several zoological gardens, to ask if the keepers had ever observed the natural, unaided use that monkeys made of clubs, missiles, or hammers, or other objects, as tools or weapons. The keeper of the zoological garden of Philadelphia courteously replied that "The whole subject of the psychology of the lower animals, to which your letter has reference, is one on which trustworthy evidence is very scarce. Personally, in twenty years of observation of wild animals I have seen no case of the apparent use of such means to an end as stones for weapons, etc., on the part of a monkey which could be believed to show intelligent conception of a purpose. I am inclined to think that the recorded cases are largely accidental or the result of misrepresentation or imagination." Dr. Frank Baker, of the National Zoological Park, at Washington, kindly wrote that "One monkey in our collection, when annoyed by visitors, will throw anything, from a feed-pan to a handful of sawdust, at an offender. One *Cebus* tries to pick cockroaches out of the cracks in the floor with a straw, when too small for his fingers; but beyond this there has been nothing observed that could be considered as the using of an object as a tool or weapon." Other correspondents said the same thing—there were no actions on the part of the quadrumana, that they had observed, that could be taken as indicative of intelligent action. Prof. R. L. Garner, in his most interesting book on the "Speech of Apes and Monkeys," who spent some time in the wild country of the Gaboon on purpose to pursue his studies, observes that "Animals may be taught to do many things in a mechanical way and without any motives that relate to the actions." His pet chimpanzee tried to drive nails, use the saw, etc., but could not manage it, nor even the use of the club to crush his sugar-cane. Of the gorilla he says: "As to his throwing sticks or stones at enemies, there is nothing to verify it and much to contradict it. It is a mere freak of fancy. Neither the chimpanzee nor the gorilla close the hand to strike nor use any weapon but the hands and teeth."

From this evidence at first hand, we must conclude that the use of extraneous substances by animals, especially the quadrumana, is purely automatic and imitative, and not to be considered as rational action at all. Whatever they have learned has been by reason of contact with man and the result of imitation and training. We must conclude, further, that the use of tools and weapons, even preceding the intelligent conformation of them for definite purposes, marked the differentiation of primitive man from the animal branch, and accompanied—

indeed was the cause of—the psychic emergence. The moment that the primitive man-ape employed extraneous substances intelligently, with a purpose, he ceased to be an ape and became a man. We must believe that the use of tools and the psychic emergence were coincident and interdependent.

As M. de Pressense says, in his "Study of Origins" (352): "The first tool fashioned by man asserted his royalty over nature. Thus the tool is man's true scepter; whether made of flint or wood or anything else—it is the result of thought. This is why the animal, guided by instinct, can effect marvels of construction by the use of its own limbs, but it never makes a tool. A monkey may have chanced one day to lean upon a stick, but he did not cut nor shape the stick nor hand it down to posterity, that they might improve upon it."

The struggles of the first ape-man to maintain life amid the hostile surroundings in which he found himself are fraught with peculiar interest, and are indeed almost pathetic when we consider the great odds that were against him in the fight. His natural weapons of defense, the jaws and teeth, were being reduced with a rapidity that must soon have brought about his extinction but for the correlative development of the grasping powers of the hand, which enabled him to employ and supplement his natural organs with the extranatural resources around him. And then it followed, as this grasping power enabled him to use a club or a stone, that some superior individual made a conscious effort to employ these weapons with more precision and initiate new purposes, and that he thereby learned to think. This was the divine spark that awakened mental life, which acted as a stimulus on the motor nerve centers, and these centers were enlarged by the effort to think. Then, as the brain grew, he could think more, and as he thought more his brain grew, and he became a man. If you will pardon the solecism, this primeval man might have said with Descartes (much to Descartes's surprise, probably, by the application), "*Cogite: ergo sum*"—I think; therefore I exist. It is an old and true saying that "Man is the wisest of animals because of his hands"—a pre-Darwinian appreciation of correlated development that was prophetic.

We must begin, then, with the first efforts of primitive man to isolate himself from the animal world by the use of his hands, and the exercise of that manual power which distinguishes him from the rest of the animal kingdom and made him its master. We must consider, however, that primeval man was at first incapable of manufacturing implements and weapons from the materials around him, and was only capable of using in a simple way the gifts of nature as they came from her hands without any modification whatever. Kindly nature furnished him with these resources to supplement the waning powers of his natural organs, which were being rapidly modified in the process of his evolution. Primitive man utilized the simple things that nature furnished ready to his hand and they were sufficient for his needs. The primeval life of the human race must therefore be considered first in the light of what nature provided for practical use and which was of vital importance in the struggle for existence. But these were sufficient to give him the balance of power, and he lived. To this primeval man nature was kind and beneficent, and nursed and nurtured him to the full development of the maturity of the race, in his civilized descendants. From a mere animal she enabled him to develop into the godlike being who dominates the earth.

The arboreal life of primitive man taught him the uses of the club. The club, either for throwing or striking, was a natural weapon, and his survival as a species probably depended more upon his discovery of the club and its uses at this critical stage of his existence than upon any other agency. The evolution of the club down to our own times, with all of its modifications, is a most interesting history, and shows the eventful role that this great weapon has played in the development of the race. Conversely, the uses of the club stimulated initiative powers which led to greater brain and mental growth, and this to further advancement and evolution of the race.

Next to the club came the stick for throwing, which would early suggest itself by accidental discovery in the first place, in the first struggles with wild beasts and wilder men. From this was evolved the boomerang, the knob-kerrie, and other throwing sticks, which are constructed on scientific principles that are surprising among the primitive peoples where they are found. Primitive man would soon discover the difference between a sharp stick and a blunt one. With a sharp stick he could better pierce animals to kill them, and dig in the ground to reach roots and grubs. With a very slight advance in intelligence he learned to sharpen the stick, but that important step placed him beyond the stage even of the man-apes, and he was a man. The very first step in the direction of the artificial modification of natural products indicated his complete emergence from the animal stage of life. With further advancement he hardened the point of the stick in fire, and still later attached to it harder points of stone, and from this simple weapon were developed the spear and arrow and their relatives, but all originated from the sharp stick found ready to the hand. Stones of various forms were furnished by kind nature ready to the hand of the primitive man, which could be used for hammers or for missiles. These ready-made weapons he necessarily adopted at a very early stage, and when he attained the power of modifying and shaping stones to make them more effective as implements and weapons he began to sustain life more easily, and even to acquire some luxuries. When we consider the multifarious forms of stone implements and weapons and their innumerable uses, we must acknowledge a debt of gratitude to Old Mother Nature for her beneficence in placing such a very useful material in the hands of primitive man. Without the indispensable mineral substances, he could have progressed but little beyond the merest savagery. If the vegetable kingdom supplied the first resources for the preservation of life at the first emergence from the animal stage, then did the mineral kingdom supply the means for the next step, the advancement to the stage of improved savagery or barbarism.

The stone as a hammer developed great possibilities in the process of its evolution from the mere natural pounding implement. With the birth of inventive and mechanical powers, it was early modified to meet various purposes by chipping and grinding into many and varied forms to serve the demands of life. The hammer is still important as a tool, but, with all of its elaborate modifications, its relationship to the primitive pounding-stone can be readily traced. As Prof. E. B. Tylor says in "Early History of Mankind," "Mere natural stones, picked up and used without any artificial shaping at all, are implements of a very low order," and yet from this lowly origin all hammering implements are derived. As a missile the stone did not undergo as great an evolution as the hammer in early savage life, but in modern warfare the missile has become by far the most important and effective weapon.

Another most important tool, the knife, was the gift of the mineral kingdom. A flint chip picked up on a hillside, where an accidentally broken rock produced it, was probably the first knife. Another accident disclosed how it could be made, and from that start its evolution was assured. The discovery of the cutting flint was a great boon to primitive man. It opened up a vast field of resources, not only of means for procuring necessities, but for comforts and luxuries as well. As his inventive powers developed, modifications of the knife arose, but at a later period, for they indicated a psychic advance considerably beyond that primitive stage in which the unmodified products of nature were first employed.

While the animal world, after the vegetable, contributed greatly to the maintenance and survival of primeval man, it comes next after the mineral kingdom in its ability to furnish ready-made materials which could be used for tools, such as bones, teeth, horn, shell, etc. Bone was one of the most useful of materials to primitive man, and is yet to savages. It furnished weapons and tools and lent itself readily to modification. Doubtless some peoples in primitive times (as the Eskimos do down to our own day) depended entirely upon the resources of the animal world for their weapons, tools, and utensils, as well as for food and clothing. Indeed, this is more than probable, for very early man, in Glacial times, was a creature of the cold. Without animal resources, in cold climates life would be impossible, as with the Eskimos before the advent of the Europeans.

Thus it was that from her stores of varied resources nature presented primeval man such things ready to his hand as were most essential to the maintenance of life in his first struggle for existence as he emerged from the animal stage. As Chas. Morris says, in "Man and his Ancestor": "Whenever primitive man began to add to his natural powers those of surrounding nature by the use of artificial weapons, the first step in the new and illimitable range of evolution was taken. A crude and simple use of weapons gave him in time supremacy over lower animals, and an advanced use of tools and weapons has given him supremacy over nature herself."

The first long, long chapter in the history of human effort and progress is written in stone. Our knowledge of these earlier phases of human activity would be very meager, save that the ruder peoples of to-day are found practicing similar forms of art. Dr. C. C. Abbot, in his "Primitive Industry," says: "The use of a water-worn pebble as a hammer simply held in the hand, was among the first acts of primitive man." But as Tylor says: "Mere natural stones picked up and used without any shaping at all, are implements of a very low order. Such natural tools are often found yet in use, being for the most part slabs, water-worn pebbles and other stones used for hammer and anvil. In ancient shell heaps such stones are found which were used to crush shells."

As regards the use of unmodified stone — which the older writers believed that no tribe ever did exclusively — no better example of such low culture can be found in illustration of our studies in the first achievements of primitive man than the Seri Indians, of the island of Tiburon and the adjoining coast of Sonora, in the Gulf of California. Prof. W. J. Magee, of the Bureau of Ethnology, spent two years in the study of these low people, and his wonderful description of them is found in the seventeenth report of the bureau. They are, in many respects, as low or lower than the Australians or Tasmanians. He says: "Perhaps the most conspicuous general fact in connection with Seri tools and their uses is the prevalence of natural objects employed. After the mandibles of birds and the spines and bones of fishes, came the thorns of cacti and mimosa, and the bones and teeth of mammals. Two conspicuous classes were marine shells and beach pebbles, both used without modification or any artificial preparation whatever. The beach cobbles were used for innumerable purposes—pounding, cutting by bruising, grinding, and as a resource in warfare. There was no attempt at modification, and if one became chipped by use so as to make an edge, it was quickly discarded. The art of making implements from stones, a world-wide art, never occurred to them. These stones are the same from the bottom to the top, in a shell heap ninety feet in thickness, where they have been accumulating shells for centuries, for the Seris seem to have been the only occupants of this desert land for untold ages." So here we have almost at our doors a people so low and primitive as not to be possessed of the art of chipping stones. The older ethnologists declared that no people ever existed who could not chip stones, but here we have a living example of such degradation. They are indeed but little above their pithecanthropic ancestors.

Perhaps the earliest effort at the modification of substances to better adapt them to practical use was that of chipping stones. Primitive man may have shaped sticks and bones, etc., to render them more efficient, but the modified stones are the only examples that have come down to us. As Tylor says, "The art of implement making is in a very low stage among some tribes who use stone implements, who are not in the habit of grinding or polishing them. The crude flint implements found in the Drift gravels of the Quarternary series of strata belong to the earliest productions of human art. These are very unlike the chipped implements of a comparatively later period in the cremlochs of France and England. The flake knives of the Drift gravels are very crude, but taken the world over there is no break in the series which begins with the Drift implements and ends with the beautiful specimens of Scandinavia or the obsidian knives of Mexico."

Prof. W. H. Holmes says, in "History of Flaked Stone Implements" (International Congress of Anthropology 1893, p. 121): "The flaking of stone is a primeval art, and flaked implements are probably the most ancient and elemental existing representations of human handiwork. The first flake was probably made by casting one stone against another, and from this primal step there was gradual progress by infinitesimal advances in technique through countless ages."

The Tasmanians, at the time of their discovery, were of the very lowest of peoples, ancient or modern, and their customs and arts throw much light upon the life of primitive man. Mr. H. Ling Roth, in his "Aborigines of Tasmania," gives much interesting information in regard to their low skill in stone chipping, but which illustrates the art in primitive man. He says: "The rudely chipped flints of the

Tasmanian aborigines are of the simplest character, rarely symmetrical, and more like the earliest Paleolithic flint implements of Europe. He could do no more than strike the flakes off from one side only of a stone, but there was some skill exhibited even in this crude method. Those stones were immediately grasped in the hand and never fixed in any sort of a handle." They were in the next stage to that of the Seris, who used the natural pebbles without any modification whatever. The Tasmanians had not yet attained the stage of the elaborate and artistic chipping of stone, to say nothing of polishing stone. They had but taken the first step in the artificial modification of this material.

What impresses all observers is the enormous amount of the remains of the stone art that are scattered all over the world. Every one is aware of the great quantities of stone arrow- and spear-points, hatchets and hammers that have been found all over this country, from the north to the south, from the east to the west. Hundreds of private collections and the great public museums attest the industry of the pro-European Americans. Doctor Abbot collected from the gravel banks of the Delaware over 20,000 rough-chipped implements, and deposits of 100 or more were not uncommon. As the Marquise de Naidailac well says, in his "Prehistoric Peoples": "When we consider the discoveries connected with the stone age as a whole, we are struck with the immense number of weapons of every kind and of every variety of form found in different regions of the globe. The Roman domination extended over a great part of the old world, lasting for many centuries, and left tokens of its presence and industry. But numerous as are these relics of the Romans, they are far inferior in number to objects dating from prehistoric times; for flints worked by the hand of man have been picked up by thousands." Throughout Europe, which has been the best explored, of course, worked flints are often found in large numbers in one place, either in workshops or in caches of deposit, attesting to specialists in manufacture, and that extensive trade was carried on in such commodities. Besides these deposits, other thousands have been picked up on the surface or plowed up in the fields or dug from the earth. The skill exhibited in the working of flint, and in such quantities, when we consider that these early men had no knowledge of metals, is very remarkable. No metal was known till bronze came in, after thousands of years of the polished-stone period. And this is the more remarkable when we consider the stone carvings of the temples of Mexico, Yucatan, and Peru, which were done with flint implements, for the few copper tools found would have been quite unequal to the task. There was thus very early developed a skill that excites our astonishment and admiration, and the more so as we follow out the details and learn more of the practical knowledge they exhibited.

Between the Paleolithic, or rough-chipped-stone age, and the Neolithic, or polished-stone age, there was a long, hard path which represents an important period of development. The polished stone is a much more artistic production than the chipped stone, and indicates a higher plane of culture and greater manual skill. For practical purposes, however, the ground-stone ax is no better than the chipped one, as has been demonstrated. These ground-stone implements are very numerous in all collections and must have been produced in enormous quantities. They are associated with a more advanced stage of culture in all the customs of living, so that they are not to be placed at the beginning of culture. Sir John Evans, in his classic work on the "Ancient Stone Implements of Great Britain," says that "For the sake of illustration we will divide the stone period into four subperiods. First, the Paleolithic or Drift period, when implements were produced by chipping merely, and not ground or polished. Second, the reindeer or cavern period, when grinding was not yet used but greater skill was exhibited in flaking flint and in working flints into serviceable tools. Third, the Neolithic or surface-stone period of western Europe, when grinding on the edge and surface was generally practiced.* Fourth, the bronze period, when axes and celts were highly polished and of graceful form, evincing the highest degree of manual skill. Thus," as has been said, "the first long chapter in the history of human effort and progress has been written in stone." And how wonderful it is—from the first rude beginnings to the highly finished stone ax or knife—a history of growth that is not equaled by any other material!

Coming to the arts proper as an evidence of culture, we enter a most interesting field, but one which is also difficult and dangerous. It is not for us now to attempt the discussion of the motives of art, nor the analysis of the symbolism of the first productions of primitive man. Suffice it, then, that we will take such examples as we can find in the earliest stages as indicative of the beginnings of art culture. It was Herman Grimm who said that "art, taken in its broadest sense, is always the life-giving principle," and the concept would apply as well to primitive man as to his modern descendant. With the race, as with the individual, the awakening of the art instinct is fraught with momentous interest.

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* As Prof. A. J. Conant says, in his "Footprints of Vanished Races" (11): "In this period a new civilization dawns. Polished implements of stone and bone take the place of rude chips and splinters of silex. Pottery is manufactured and ornamented with various devices; and all that man does displays the awakening of his sense of beauty. From this time the race proceeds with slow but steady development. How long the Neolithic or polished-stone period lasted, we have no means of judging, nor when men learned to smelt the more yielding ores and to make bronze by the alloy of copper and tin."

To begin with sculpture: we must go very far back in the history of art to find its beginning. In a most interesting article by Prof. Flinders Petrie, in the November *Harper's Monthly*, 1903, he tells of the wonderful finds he made of primitive sculpture in the "Ten Temples of Abydos." He says (837): "The most curious and probably the oldest objects here were some very elementary figures of baboons and other purely natural stones. The figures were very slightly worked. Rude lumps of limestone had been picked up having a slight resemblance to the form of the sacred animal; and then a little pounding away of the surface had improved the shape into an unmistakable likeness, helped out in some cases by a few scratches of flint. We cannot but see here the primitive fetish stones such as the Papuans now reverence. Thus we touch the Egyptian behind all art and civilization, back in the time when the strong resemblances of nature caught the attention of the mind as yet untrained to disentangle the connections of things. But these stones found far below the polished statues of an Egyptian temple open our eyes to the source of sculpture. Man did not at first carve a statue from a block of stone, but he picked up some weird form that seemed that it must be something else than all the rest of the stones around it; he venerated it, he treasured it and improved it so as to piously help nature; and little by little he became bolder, until the finished statue did not need the least resemblance of the block to start with. Such are the glimpses of the rise of art that these studies give us, but these were by no means the earliest examples of such notions as prehistoric man in Egypt had long existed, though we here touch a survival of primitive ideas in these rude, untouched fetish stones set up in the first and lowest temple of Abydos."

But this is not early enough for us. We want to grope in the dark, beyond the beginnings of history, and see if we cannot find indications of still earlier efforts—the very first stirrings of the artistic instinct. Perhaps the earliest examples of sculpture obtainable are those found in the caves of France and Switzerland, deep down under masses of stalagmite, associated with animals of the reindeer period which are now extinct or far removed from those locations, where they have lain for untold thousands of years, as those deposits were probably made at the close of the Glacial period. While these people lived at a later period than the glacial man whose remains are found in the river gravel of the Somme, they are not yet in the Neolithic stage, for they did not have polished-stone implements, but only roughly chipped Paleolithic knives. With these alone they made some marvelous carvings on horn and bone. As Charles Rau says ("Early Man in Europe"): "These people evinced, notwithstanding their otherwise low condition, a decided taste for drawing, and even for carving. Their delineations, traced with a pointed flint on horn, bone, ivory, or slate, consist of geometrical figures, but mostly of outlines of fishes, or of the horse, reindeer, stag, ibex, auroch, mammoth, etc. These animals appear singly or in groups, and often exhibit their characteristic features in a degree to render them recognizable almost at first glance. On a baton of reindeer horn are drawings of two fishes and a horse; on a stag horn a dying stag, sitting on its haunches; a reindeer horn has the heads of two aurochs; on another are two horses and a man, also a large eel; on another are two reindeers in line. An interesting carving is the handle of a dagger, like a leaping reindeer, with the legs drawn under the body and the horns thrown back. None of the representations afford as much interest, however, as those of the mammoth, of which several were discovered, engraved as well as carved. The most remarkable one, traced on a plate of ivory — mammoth ivory — was found in the cave of La Madeline, in the south of France. The drawing on this specimen is characteristic and bold, and the peculiarities of the mammoth are faithfully depicted — the full forehead, the long, curved tusks, the pendent trunk, and the long mane of the neck. All these go to prove that man lived contemporaneous with the mammoth. This artistic tendency among a people that occupied in other respects a very low position is indeed a perfect anomaly. At a much later period of the stone age, when he devoted himself to agricultural pursuits, early man produced nothing in the line of art that can be compared with the drawings and carvings of those historic people of the south of France." M. Broca said that "It was with profound astonishment that we learned that long, long before the artists of Egypt the men of the reindeer period cultivated design and sculpture, and were good observers of nature. At the French exposition of 1867 there was a case in the ethnological department containing a most wonderful collection (fifty-one pieces) of the art of the reindeer period in France. They were undoubtedly the oldest and most original works on exhibition."

Pottery was one of the earliest manifestations of primitive culture and one of the first mediums for the expression of the artistic instinct. Earthenware spoons date from the Neolithic or polished-stone period, and are not as old as the Paleolithic times nor the bone carvings. Spoons were, of course, derived from the simple bivalve shells used to convey food to the mouth, and the form was reproduced in wood and horn and bone before being produced in pottery. It was long a mooted question as to the comparative date of the origin of baked pottery, whether Paleolithic or Neolithic, but the preference is for the latter among anthropologists now. M. de Naidailac gives some evidences of crude pottery, which was associated with Paleolithic implements and the accompaning extinct animals. He says, however, that "many eminent archæologists maintain that pottery was completely unknown in Paleolithic times, and they do not hesitate to attribute to a later period any deposit in which it occurs. The pottery of the Seris, as a low example, is very primitive and without ornamentation. Their ollas are delicately formed, but there is no painting or design on them, save only a few upright marks which have no signification. Small cups are also made and figurines, which are mere caricatures or obscene statuettes, with no artistic suggestions whatever. There is not the least artistic idea in their pottery, which is curiously like the first crude pottery efforts of primitive man."

Prof. W. H. Holmes suggests, in describing the pottery of the Pueblos (Fourth Report of the Bureau of Ethnology), "that ceramic forms are to a great extent derivative, and in nature are found many of the originals, in both the vegetable and animal kingdoms. The shells of the seashore were probably the first receptacles of food and drink. In the mounds of the Mississippi valley are found pottery forms reproducing many varieties of shells. The shell of the turtle and horn of the buffalo were used as models. The gourd was utilized at a very early date, and its forms, being very varied, have given rise to many primitive vessels, and perhaps also in wood- and wickerwork. To the gourd can be traced the bowl, the olla, the jar, the vase, etc., as well as the handled cup or ladle. While the shape of pottery is to an extent ornamental, pure ornament was an artistic evolution. The ceramic art has exercised a powerful influence upon existing culture, in the cultivation of taste for the beautiful, and its study is therefore of the first importance in an artistic sense." In the transmission of designs by inheritance from generation to generation, all the original forms of ornamentation undergo change. At the end of a long period we find the styles of decoration so modified as to be scarcely recognizable as the work of the same people. Yet rapid changes would not occur in the uninterrupted couse of evolution, for there is wonderful stability about the arts, institutions and beliefs of primitive races. In the early stages of art, the elements used in embellishments are chiefly geometric. The elements or motives are limited in numbers, and are, in a measure, common to all archaic art, such as dots, lines, curvilinear figures, etc.; while in a higher stage we have checkers, zigzags, chevrons, meanders, the Greek fret, scrolls, etc., in infinite variety. The next stage is marked by the free introduction of ideographic elements of pictorial origin into decoration, and are drawn from the mythology of the people. The next and succeeding steps are the decorative and purely artistic, of beauty for beauty's sake, and mark the attainment of true artistic power. So the marking of pottery and its influence upon the evolution of the art sense is very apparent, and its origin and development are fraught with great interest to the student who tries to follow it back to its birth in the dim vista of the unrecorded past. As a very primitive art, both industrial and artistic, pottery-making is of great interest and throws much light upon human cultural development.

These examples indicate also the dawn of drawing, and were the forerunners of artistic sketching and painting later on. Such sketches were found in many of the caves of Europe, in drawings and engravings of men and animals upon stones, bone, horn, slate, etc, which are readily recognizable and exhibit no little natural artistic instinct. Wall and rock carvings represent a very early stage of art, but these were intended as signs or symbols, or contained a story without much reference to art. The symbolic idea came first, and the artistic conception of beauty was born much later. The artistic idea is the one that persists, while the symbol is first lost, and the art conception as a thing of beauty passes on and becomes part of the life of the race as an inheritance.

To the desire for ornamentation because of innate vanity must be attributed the first attempts at coloring. Perhaps the earliest of these attempts at painting was that of ornamenting the body with colors, made from natural coloring materials found everywhere. Some ancient carvings indicate that tattooing was early practiced, and Naidailac says that "it is probable that our savage ancestors were tattooed or colored their bodies. Indeed, a picture of the head and arm of a man carved upon a bone have been found in a cave with a tattoo mark upon the arm, and amongst the earliest remains are found coloring materials and paint pots." The Seris, who are so low in all culture, industrial and artistic, present a striking illustration of the low birth of the desire for ornamenting the body. "The Seris are characterized," Professor Magee says, "by extreme æsthetic poverty. The people are pathetically poor in an industrial sense. Their equipment in implements, wagons, utensils, etc., is meager, perhaps beyond any parallel in America; yet their æsthetic equipment, practically limited as it is to a single line of symbolic portrayal, is still more degraded and meager. The only artistic attempt among the Seris is that of face-painting of the female, which is quite elaborate. This decoration is symbolic and has reference to the clan totems. It is confined to the females, as descent is reckoned only through the female line. This is the one sole attempt at art found among this degraded people. From such low beginnings modern art was developed by segregation and elaboration, and led by gradual steps from symbolic face-painting and tattooing to the art of the old masters in Italy, who made the art of our civilization.

These brief studies will suffice for our purpose—the presentation, in a necessarily limited way and imperfect manner, of some of the evidences of the dawn of culture and of the beginnings of the industrial and artistic life of humanity. The investigation could be extended into every branch of human activity, but these illustrations will suffice to show our debt to that first man, who, after the psychic emergence, began to prepare the way for his wonder-working descendant, modern man. As we are undoubtedly the physical heirs of primitive man, so we are in a broad sense his cultural heirs; his institutions, his discoveries of the simple secrets of nature, we have inherited, and on them have builded our boasted civilization. Considering his meager equipment in mental and manual ability, we cannot but wonder that he did as well as he did. As we boast of our greatness in art and civilization, let us not forget our debt to primeval man, who first invented the modification of natural products to adapt them to his wants. All honor to that ancient man, clad in skins, armed only with a club, a cobblestone, and a flint chip, who first invented manual skill, and thereby laid the foundations of civilization, and made life for us possible!

SANITARY SCIENCE.

By Dr. J. M. McWharf, Ottawa.

Read before the Academy, at Manhattan, November 26, 1903.

WE shall define sanitary science to be a recognition of the conditions of health, and the application of the means necessary to its protection as well as its preservation.

The principles of sanitary science are not modern in origin; in fact, they are as old as the Mosaic code, and their unerring rewards and penalties have marked the life-history of all nations of the earth; in scope they are wide enough to embrace all humanity, and just as applicable to communities of to-day as they were to the Jewish race thousands of years ago. We can say, of a truth, that the business of sanitary science begins and ends with man; its varied relations, its social forces and necessities to human life and human society end in the growth of an improved race, a healthy, useful and happy life. Every influence of food, drink, clothing, exercise, education, soil and climate come within its domain.

Good health confers on the individual, happiness, dignity, and a thousand advantages in the struggle of life; it gives to the state wealth, power, and freedom. Public health and true liberty go hand in hand; they are the companions of orderly habits and pure morals. That man is a benefactor to his race who contributes to the prolongation of human life and the enlargement of human capabilities. To fulfil this assertion, one of the first questions for consideration is health or hygiene in its various relations to society. We are surrounded by the elements of disease and dissolution; our lives are hourly in jeopardy from pernicious and destructive influences; the food that we eat and the air that we breathe are often laden with agencies to mar or destroy the harmony of our being. The infant in its mother's arms, as well as youth, with its bright hopes and gilded visions of the future, strong and vigorous manhood, with its broad sphere of usefulness and its highly cultured powers, alike pay the penalty of a violation of the laws of nature.

In the fourteenth century vice and misrule had their greatest sway in Europe. It was then that the fruits of civilization were trampled beneath the feet of the barbarian; acquisitions that had cost ages of toil and millions of money were lost in a general wreck.

When ignorance and human degradation were at the lowest ebb, then hygiene was neglected and plagues numerous rested upon the people. Extreme poverty, combined with neglect of the things necessary to health and an enervated constitution, induces moral turpitude, thus preparing the way for vice and crime. In a public calamity, as the plague, cholera or yellow fever, vice and crime are always much increased, and evil passions run riot in all kinds of vicious and sinful excesses.

The wealthy and refined cannot escape with impunity when the physical and moral atmosphere is tainted; they may enjoy well-ventilated, airy apartments, with spacious grounds, isolated from the poor, with a proper observance of the laws of health, yet they cannot shield themselves from typhus, generated in the lanes and hovels of the city, nor from the darker stain, the moral contamination which is so often the outgrowth of a proximity to and familiarity with the ways of moral degradation. Greece, with the loss of her liberty, and the ruin of her cities, has an altered climate, dating back, perhaps, from the years of the Peloponnesian war, more than 400 years before the Christian era, when polished and populous Athens was devastated by fire, and sword, and plagues which completed her downfall.

In the middle of the sixteenth century London had an estimated population of 500,000, and the average duration of life was twenty-five years. Her streets were narrow, scarcely paved; imperfectly constructed sewers, as receptacles of all manner of filth; dwellings, mostly of wood, were overcrowded, and no attention was given to their ventilation; water poorly supplied, and cleanliness was neither encouraged nor enforced. In A. D. 1665, 3000 people perished from the plague in a single night. From 1665 to 1679, the mortality from that source alone reached the enormous figure of 100,000. Let us contrast that with her improved sanitation, her stupendous sewers, completed at a cost of $20,000,000, and her population increased to millions, with the rate of mortality changed from fifty to twenty-four in 1000.

Calcutta was built in a swamp a few miles east of the river Hoogly, and surrounded by lakes whose water-supply was furnished from overflows of the river. By careful and proper drainage this city has become as healthy as any of the same latitude on earth. On the contrary, Stockholm, situated on an island at the entrance of Lake Malar, possessing all the requisite natural advantages of one of the healthiest cities in Europe, is, because of a gross disregard of sanitary laws, with imperfect drainage and bad water-supply, one of the unhealthiest in that quarter of the globe.

Sanitary science, of a necessity, must become a part of our political economy, receiving encouragement from the statesman as well as the philanthropist. We are daily made cognizant of the fact that every state in this Union must recognize the beneficial effects of sanitary laws. The tyrannical law of necessity must no longer subject the children of the poorer classes to its relentless thraldom. Pure air, abundant light, a suitable quantity of nutritious food and cleanliness are, in a degree, denied them. They carry in their faces enduring traces of want, privation, and suffering, which have set their seal on the youthful brow. The listless face with vacant eyes speak with more emphasis than words of the fearful neglect or violation of the physical laws of nature. This does not end the evil, for the enervated body and blunted intellect become a matter of hereditary transmission. It may be truly said: "The fathers have eaten sour grapes, and the children's teeth are set on edge."

We are forced to recognize the fact that the loss of every human life from preventable disease is not only a tax upon the wealth of a state but a great sorrow to the family. It is claimed that at least one-third of all the cases of sickness and deaths that occur are preventable. What suffering, to say nothing of the continual tax on health and life, which are in direct antagonism to a general prosperity. Its ill effects are far-reaching; the tendency a deterioration of the race. Let Asiatic cholera come, smiting the young and the old, withering the pride of manhood and the beauty of youth, robbing the social circle. and the family in the garments of grief, spreading gloom and striking the panic of sudden death; then, for a time, the value of public health, and the legal statutes to protect it, will be observed; but the sacrifice has been made; you cannot retrace; you can and must submit.

How can we best subserve the welfare of the state, of the community and of the citizen in the promotion of sanitary measures? I feel certain that I have no hearers in this intellectual audience so supremely selfish that they can ask without the blush of shame, "Am I my brother's keeper?" I pity the man, I care not how high his position in society, who is unconscious of his obligations to his fellow beings: he is losing the life-giving, sanctifying influence of an approving conscience, that well-spring of moral vitality by which man is distinguished from the brute.

"That man may last, but never lives,
Who much receives, but nothing gives;
Whom none can love, whom none can thank,
Creation's blot, creation's blank."

Political economy will calculate the money value of a human life and compute the loss to society by an untimely death: hence we claim the state has a right to assume control over the factors involved in the preservation of health and the prolongation of human life.

It is an axiom that "knowledge is power." It is eqally true that ignorance is power; it stalks through the land freighted with calamities; it scatters broadcast germs of disease: it leaves sickness, death and woe in its train; it demoralizes the social, commercial and religious interests of whole communities. We therefore believe our duty to the state, to the community, to the citizen, demands an adoption of sanitary methods that will secure the greatest good to the greatest number. The principles of sanitary science should be inculcated and disseminated in the public-school system. In this intellectual nursery of humanity are contained the brightest hopes for the future of this republic. In its cradle are to be rocked the statesman, philosopher, scientist, and patriot. Physiology and hygiene are not ornamental branches of education, but essential, and should be thoroughly instilled into the minds of the children. The public schools furnish representatives from all classes and conditions of society, and they reflect in a degree the physical, mental and moral characteristics of the home. The opportunity for reaching those homes is afforded in the schoolroom through efficient teachers. By the inventive mind of the teacher every power is utilized and made subservient to the principles inculcated in sanitary science. If the people are once intelligently informed with regard to their interest in these matters, they will readily acquiesce—in fact, demand restrictive sanitary legislation.

I cannot refrain from quoting, at this point, from an address by Doctor Gihon, medical director, U. S. A.: "So long, however, as society, in its highest development of rank and culture, ignorantly jostles and wedges itself in contracted parlors and drawing-rooms, already defiled by blazing gas jets and defective furnaces, where hundreds of lavishly dressed human machines befoul the air and poison one another with the noxious gases and their own effete animal products in deadlier quantity than the ragged rabble which herd in the open street, and call this pleasure; so long as godly people drowse and yawn in badly ventilated churches, surcharging their brains and impairing their minds with blood not half aerated, and ungodly ones exhaust their whole reserve force to resist the insanitary influence of the no less badly ventilated theater and exhibition hall, and call the one pious worship and the other rational amusement; so long as men toil to amass riches and then build residences palatial, or sham palatial, and, in the name of luxury and estheticism, flood them with artificial light and heat, to consume the oxygen which prince and beggar must breathe, and admit the invisible filth by the sumptuously decorated closet and bath-room, by which they think to exclude the vile necessities of humanity, which prince and beggar alike cannot escape, and call this comfort and refinement; so long as our children are sent to overcrowded and unwholesome schools, where their eyes are bleared, their hearing dulled, their plastic bodies distorted, and their brains fuddled, and call this education; so long as men and women violate daily, in themselves and in their children, the simplest precepts of hygiene, parents countenancing half-dressed daughters wearing out their strength in unwholesome ballrooms, seeking their slumber that cannot refresh only when dawn appears; sons launched upon the world to encounter physical wreck in a thousand channels where no beacon warns of danger; old men, senators, judges, divines, perchance learned doctors, uncomplainingly breathing the foul air of public conveyances and apartments, in which every door and window has been carefully closed and ventilation carelessly ignored; streets reeking with filth which decrepit laborers play the farce of sweeping in broad daylight—what can state medicine hope to accomplish in legislative chambers and halls of Congress, which are themselves even evidences of sanitary ignorance, sanitary neglect, and sanitary indifference?"

Universal knowledge is our only safety, as effect must follow cause. The time is not far distant when its exalted influence will compel obedience of legislators to public sentiment, and every state have a law for the protection of public health.

Moral suasion has been suggested to encourage respect for sanitary laws. More than this is required. The strong arm of the law, followed by severe penalty, will make it a success. It is gratifying that during the last decade there has been great activity along the line of the diffusion of sanitary knowledge. I trust that not far down the line in the future we may see in prophetic vision a country fair and beautiful; a heavenly country situated on this side of Jordan. A river flows through it and its waters are not polluted by the sewage of the cities of the plain; they are clear like crystal and carry nothing but health and life-giving principles to its inhabitants, being guarded upon either side by the ramparts of sanitary laws. The streets are clean and free from defilement. Its temples, palaces, institutions of learning are not of precious stones, but they are erected upon an uncontaminated soil, with perfect sanitation. From its seminaries, colleges, and universities, as well as its public schools, and, may I not add, from its halls of legislation, and the public press will come forth a flood of light and knowledge, instructing the people in the principles of sanitary science. Disease will then be prevented and life prolonged. Let us put forth every effort at our command to rid this country of all obstructions to health or anything that will abridge in the slightest degree the natural duration of man's life.

In closing, let me say, that it has been my aim to avoid specifications, as time and space would not permit going into detail, as detail here means legion.

THE NEED OF INVESTIGATIONS IN HUMAN NUTRITION.

J. T. WILLARD, Kansas Agricultural College, Manhattan.

Read before the Academy, at Topeka, December 31, 1904.

FOR the last seven years it has been the duty of the writer to deliver a course of lectures to junior students on the chemistry of food and nutrition. In respect to dietary standards, these words were used seven years ago: "We are safe in saying that while many good dietaries are in use, we still lack exact knowledge as to food *requirements* of men and women in the several occupations of life. We have indeed a considerable mass of information in regard to dietaries in actual use which are giving good or bad results, as the case may be; but these are all the results of local conditions as modified by the tastes of the people or the notions of those who are feeding them. Most of the standard dietaries are based on observations of food actually consumed by certain people or classes of people, rather than on their requirements for good work." These words have remained true almost up to the present, if, indeed, they are not still so. In the meantime large amounts of work have been given to the study of food actually consumed by various groups of people, but there has been a singular lack of appreciation of the necessity for the study of the actual bodily needs in respect to food. Considerations of the pocketbook have long since determined the execution of experiments of this kind bearing upon the nutrition of domestic animals, but when man comes to consider his own case he seems to prefer to be guided by the results of following appetite, except as its sway has been limited by conditions. Until recently almost no results have been available bearing directly on the question of bodily needs. Even though the physiological fact had been amply demonstrated nearly forty years ago that the metabolism of proteid tissue is not the necessary or even the chief source of muscular energy, we still find, universally prevalent, the view that severe muscular exertion requires large quantities of meat—so firmly fixed have previously conceived notions become.

I had hoped to present the results of experiments looking to a greater knowledge in respect to food requirements at this meeting, but have not been able to complete the analyses. Since undertaking this, knowledge of experiments by Russell H. Chittenden, director of the Sheffield Scientific School, of Yale University, has come to me; also certain other earlier observations by Mr. Horace Fletcher. These observations are of the deepest interest and of prime economic importance, and in the hands of such a distinguished authority as Professor Chittenden we may expect a continuation of the experiments, with corresponding additions to the knowledge obtained.

As illustrating the great need that had existed for such investigations, it may be briefly stated that the generally accepted standard of Voit for an adult man of average bodily weight (70–75 kilos), doing moderate muscular work, called for 118 grams of protein, or albuminous food, daily, of which 105 grams should be absorbable, 56 grams of fat, and 500 grams of carbohydrates, with a total fuel value of over 3000 large calories. The standards recommended by others were not less, and Atwater, in this country, has recommended a distinctly higher proteid factor and fuel value. Experiments by Siven had indicated that nitrogen equilibrium might be obtained on a much smaller allowance of nitrogenous nutrients, of which a large proportion might be non-proteid. He was able gradually to reduce the total nitrogen of his food to 4.52 grams, or 0.08 of a gram of nitrogen per kilogram, live weight, which corresponds to about 28 grams of proteids instead of 118. Jaffa had also, in a dietary study of a child on a diet of fruit and nuts, observed a gain of nitrogen by the subject with only 0.041 gram of food nitrogen per kilogram, body weight These results, standing alone, could scarcely be expected to revolutionize a well-settled judgment, but they certainly pointed strongly to the possibility of making great dietary changes.

Within a few years Mr. Horace Fletcher, in experiments on himself, demonstrated to his own satisfaction, and later to the satisfaction of a number of distinguished physiologists, that he was able to maintain himself in perfect health upon a much smaller allowance of food than the standard calls for, including a great reduction of proteids. His experience, and the observations of Professor Chittenden on him, seem to have furnished the initiative for experiments conducted during the last year and a half by Professor Chittenden, and described in a book issued last month, entitled "Physiological Economy in Nutrition, with Special Reference to the Minimal Proteid Requirement of the Healthy Man." It is not my purpose to review this book, but its perusal since handing in my title for this paper furnishes the most ample proof of the necessity for investigation contended for. Professor Chittenden and four other professional men, thirteen men of the United States hospital corps, and eight of the Yale University athletes, engaged in active training, were subjects for these experiments, which extended over periods of time measured by months, or even over a year in some instances. While there were certain individual differences, the exceedingly significant result was demonstrated in every instance that the food taken could be so reduced in quantity and composition as to possess a fuel value of about one-half to three-fourths that required by the so-called standards, with the reduction of the protein content to in many cases less than one-half or one-third that previously supposed to be necessary. These results, coming from so unquestionable an authority as Professor Chittenden, ought to be revolutionary, and awaken the thinking public to the truth that the natural appetite under present conditions is not a safe guide as to the quantity of food required. It should be emphasized that in all of the cases experimented upon the subjects remained in perfect mental and bodily health and vigor, and in a number of instances experienced marked improvement in these respects. It may also be remarked that the appetite for larger quantities of food rapidly disappeared, and that the attainment of these conditions seems to be materially promoted by thorough mastication and insalivation of the food.

PHYSICAL DEVELOPMENT AND SCHOOL LIFE.

By Dr. J. M. McWharf, Ottawa.

Read before the Academy, at Topeka, December 30, 1904.

PHYSICAL culture is necessary at the present day. The merchant, the professional man, the clerk and the artisan feel it their duty to atone for sins against their personality; hence gymnasiums and facilities for athletic sports of various kinds are placed at his command, giving him an opportunity to indulge in physical culture according to his taste or fancy. We have a profusion of learned dissertations upon the necessity of exercise to overcome the direful effects of our enervated life. In perusing them we are led to believe that in exercise alone is to be found the universal remedy for the violation of nature's laws. I have no desire to underestimate the good that may be accomplished by properly regulated exercise; and yet, it may not be out of place to halt and consider the natural physical development in contradistinction to the artificial. It is an axiom that the early years of life are preeminently the ones in which the body may and should be developed in a natural way. But is it not the period when a proper physical development is most easily interfered with? During early life nature is usually allowed to have her sway, and is not hampered in her efforts to gradually bring about a nicely adjusted coordination of the functions of the body. As this child of nature advances in years the time of artificial education arrives, which means that it must be subjected to conditions entirely at variance with its former habits of life—one which may or may not exert a deleterious influence upon its physical development.

In this connection the question of school life and its effects upon physical development confront us. It is not an easy matter to determine to what extent premature or close mental application is or may be responsible for defective bodily vigor. Investigations with this object in view must of necessity be general in character; hence cannot take into account the individual.

The school is composed of children in all stations of life, thus presenting an average of a given community. By a study of this average we are enabled to arrive at a conclusion with reference to the perfection or imperfection of a system of education, in so far as it affects the health of the child. It is charged against our present school system that it imposes too great a demand upon the young organism in the critical period of its growth; that it seeks to stimulate mental growth at the expense of physical; hence great danger arises to both body and mental health.

If we should desire correct statistics with regard to the health and physical development of school children, they must include a large number of them. Investigations of this character have been made in several foreign countries. A fundamental research was made in Copenhagen, giving results so significant that a special hygenic commission was appointed in all the schools of that country.

The commission did examine nearly 18,000 children — 15,000 boys and 3000 girls. The boys came from the middle to the preparatory schools, and the girls from private schools. Cognizance was taken of their health, and they were measured and weighed. The commission found by this research that the boys pass through three separate and distinct periods of growth. In their seventh and eighth years there was a moderate increase; from their ninth to thirteenth years a weaker growth, and from fourteen to sixteen years, or during the period of puberty, a much more rapid increase. The girls in their development also presented three separate and distinct periods, but the changes occurred a few years earlier. It was found that well-to-do classes began to develop a year earlier; that the scanty and hard conditions of life retarded this growth. It was also found that while this development of puberty was delayed in the poorer classes, when it began it went on with increased rapidity, and its completion was in the same years of their much more favored companions.

A suggestive question, or at least one of vast moment in relation to education, confronts us at this time. Is this growth evenly made during the different seasons of the year? We find by close research that there is a light growth from November 30 to March 31. This period is followed by a term from March 31 until August 31 that shows rapid growth in height, and a small increase in weight. We pass now to the third period, which extends to the end of November, in which the increase in height is small, but the gain in weight is large; sometimes this gain daily is three times as great as during the winter months.

This commission found among the schoolboys a greater per cent. of illness during the period of weak growth, which precedes the coming of puberty, and during their passage through the preparatory classes of the schools they found the percentage of illness among the girls much greater than among the boys. Nearly sixty-one per cent. of the girls, all of whom belong to the better class, were ill or afflicted with serious chronic disorders. Such a condition of affairs, growing worse in the years preceding puberty and during its beginning, certainly deserves careful attention. Professor Key, of Stockholm, commenting upon this condition, says: "The amount of work, sitting still, etc., exacted of the girls, is not consistent with their health during the growing period. Without going into detail as to the influences injurious to the health of growing children which proceed from their home, or may be brought out in connection with the school and school work, it is still manifest that the burden of work that children have to bear under the present school regulation far exceeds what is permissible, and is, to a large extent, responsible for the liability of school children to illness."

It may be a mooted question as regards the condition of children in some foreign countries, as applied to American boys and girls; that the social surroundings and general mode of life are better here. It is claimed that we are better fed and better housed. Be this as it may, we cannot deny the fact that the nervous strain to which children are subjected in this country, both in and out of school, more than counterbalances our boasted advantages in other directions. In this country there has not been an extensive research, properly conducted, which might enable us to arrive at a fair conclusion of the relation of school life to growth and health. Investigations have been made with the object of obtaining data for special purposes only. I think that I am not presuming too much in suggesting that physicians institute inquiries in a systematic and thorough manner, so that eventually we may be able to determine in what manner physical development and growth are influenced by school life. Research of this character made in rural districts would be valuable for a comparative study of the influence of city and country life. We would suggest that this work be extended to the child life in reformatories and other institutions, where the daily routine of life is, perhaps, painfully regular.

Doubtless in these reformatories we would find a class of children who have grown up under less restraint, and in whom the natural propensities and impulses have been to a large extent unchecked; we would, as a rule, find in this class a better physical development. There are special points to be considered in the collection of data: age, sex, weight, rate of growth as between boys and girls of the same age, rate of growth at different periods of school life, the percentage of illness, and its nature, whether functional or organic, etc , etc. By collecting observations bearing upon these points, we will at some future time be able to pass judgment upon the merits and value of our system of education, and determine to what extent the health of the child is or may be affected by it. In another statement Professor Key says: "It is incumbent on us to see with all possible care that the growth of youth during their years of puberty, which is so full of importance, is not disturbed or distorted by any influence adverse to nature. But as instruction is now arranged at school and home, we should first of all direct attention to the phase of a child's age immediately preceding the period of puberty. When the growth is at the lowest the child's capacity for resistance is weakened, and his liability to illness increases from year to year. We must learn how to obviate this liability to illness, and it is for science to forge the weapons with which to do it."

It is not our purpose to dilate upon the various diseases and malformations for which the exactions of the schoolroom are responsible; doubtless you are familiar with them. We desire to say a few words upon the subject of prophylaxis. As stated before, there exists a popular notion that physical exercise is the universal remedy, the panacea to the child and the adult. Educators seem to realize that the health of the child is affected by long-continued mental application, and attempt to provide relaxation by the introduction of physical exercise, in the shape of calisthenics, or some other gymnastics. As generally practiced, these exercises fall far short of actual requirement, and may be termed a farce. It is a fact that the child who needs physical exercise the most takes the least interest in what is intended for their physical well-being. This may be due to the fact that the methods adopted are not sufficiently recreative or are difficult of execution. Difficult exercises cannot be recreative. This is a reproach to our gymnastics, when it is applied to children subjected to school work, and who have so great need of amusement in the interval between their studies. It is not a relaxation to the brain of a child, but rather one more lesson added. Our gymnastic movements are not hard enough to discourage the child, but so destitute of interest that they repel by their monotony. Take, for illustration, the floor exercise. Twenty or more children are arranged in three lines, and wait with body erect and fixed eye the command of the master. At his order they turn the head first to the right, then to the left; they count aloud one, two, three; and while they count extend their arms, bend them, raise them, drop them; then the legs have their turn, and finally the trunk and loins. We concede these motions are hygienic; but where does the child find a place for transport and joy in that cold discipline—a discipline that fixes the features and effaces the smile in those insipid gestures, of which the slightest distraction would destroy the grouping?

Pleasure is not only a moral satisfaction, but a hygienic element that is indispensable to its health. To impose an exercise of this character, one in which it finds no pleasure, is an offense against hygiene. Those artificial gymnastics do not favor the physical education of the child, because they are athletic and not hygienic methods. Those methods are for strong subjects, making champions of them. We must not lose sight of the fact that the weak form a large per cent. of the children of the present generation. The children advanced in their mental development are far behind in physical growth. Our methods of education must be adapted to their weak physical aptitudes. Artificial and difficult methods do not bring proper exercise within the reach of the child. They subject it to a sort of trial, and leave the weakest, or a great majority of them, to all the physical and moral woes that are derived from want of exercise. Artificial and difficult exercises are to natural exercises what, in mental education, the higher instructions are to primary and secondary instructions. Physical education has its grades, as well as mental education, and we commit an error when we reverse them. We do not sufficiently appreciate the true relation that exists between the muscular and nervous systems. Long ago Dubois Raymond called our attention to the fact that all bodily exercises are really exercises of the central nervous system—the brain and spinal cord. We admit that a certain amount of muscular action is necessary for exercise, but this is not all. You may have the muscles of a Hercules, and yet cannot stand or work, nor can you execute the more complicated movements. Simple intoxication will deprive you of the power to coordinate your movements correctly. Every action of our bodies, as a locomotive apparatus, depends upon a correct coordination of the muscles, rather than upon the strength of their contraction. The real mechanism is located in the central nervous system; therefore, the exercise of muscle is essentially an exercise of the nervous system. There must be a harmonious development of the two systems, for if you are not capable of guiding the muscles you cannot concentrate the mind.

If we thoroughly recognize the applicability of artificial gymnastics, the machine variety, it will be a question as to the advisability of educational boards adding this as a part of a school outfit, or engaging teachers of gymnastics, who are an expensive and unnecessary luxury. We have plenty of lawns, shady streets, and public parks, where children may indulge in gymnastics best suited to them; that is, natural, unrestrained movements. I believe that you will agree with me when I say that a half-hour of this class of open-air exercise will accomplish more than any amount of artificial work. In all natural movements a large number of muscles are brought into action at the same time—even those which are remote from the point where the work appears to be located. Active games tend to a division of the work among a large number of muscles, and it is the consequence of natural exercise. The hygienic quality of exercise is not effort, but rather work. The more work accomplished, the more we stimulate the great vital functions, notably, respiration, and the circulation of the blood. In order that the child may indulge in physical exercise of any nature or character whatever a certain amount of muscular power is necessary. Occasionally we find a child so exhausted, both physically and mentally, that it is utterly impossible for it to make any muscular effort, its nervous system having been subjected to such a degree of tension, that any form of exercise would throw an additional burden upon it. Such children are never at rest, not even during sleep; they toss about the whole night, and arise in the morning exhausted and not refreshed. They have indulged in involuntary exercise at a time when nature intended them to be at rest. In such cases a mode of life which would place the child to a certain extent in a passive condition would be far more beneficial than enforced activity. The American method of living is one of ceaseless activity, and the time may come when we will be forced to acquire ability to rest, which we so much need. This subject is a prolific one, and there is a vast amount of misconception connected with it. By investigation, we may be better able to fit the demands of the child's organization to its strength and capacity of resistance during the different periods of growth; better able than we are now to devise means to promote its health and physical development. Over a century has come and gone since the author of "School Hygiene" introduced his warning against a too early and too sudden strain upon the physical powers of the mind and body, with the words: "Yet, spare their fibers, spare their minds' strength; waste not upon the child the vigor of the man that is to be."

Nature and humanity are the two great sources from which we are to expect the inspiration essential to the highest development and usefulness of mankind. Every form of elementary education has a physical side. In every normal brain reaction is produced by some form of muscular activity. In fact, every life is made up of present and past experiences, and this signifies activity. We must not check this force, for it means development. Nature demands it. In the study of nature we must seek to relieve the present conditions or difficulties. The humane teacher admits the fact that our graded-school system is not only defective but cruel and heartless. Take, for an example, the children as they enter the schoolroom in the morning filled with energy and enthusiasim, eager for an opportunity to enter into the work of the hour. In a very short period of time every normal desire may be repressed and every physical impulse chained. The day of pleasure turned to one of suffering. In a degree or sense the environments may be correct, yet there is a feeling of confinement, and the child soon wears the look of a prisoner. I believe this picture is not overdrawn; in fact, is it not familiar to every teacher present? One single element is lacking; have we not a substitute? Cannot our present school system be so arranged that the physical and mental powers may move forward in perfect harmony, perfect accord, and with unerring correctness? This is the great problem that confronts us to-day. Every element of our education should be along the line of physical and mental development. Under such favorable conditions character is made manifest, and the health of the child improved, to say nothing as regards its disposition. This will secure the best efforts of the child each day. Healthful exercises tend to produce self-reliant men. Intelligence, culture and character are secured by and depend upon activity, and this activity is far-reaching and vital to education and to the civilization of the people. Give the children free and unlimited outdoor exercise, and do not attempt to restrain them unless a form of brutality is apparent. During their absence thoroughly ventilate the room. This work will secure a good physical and mental condition. "We should strive to make education the seed of good thoughts; to train the young so to use every power that man may be ennobled and life made higher and holier."

THE USE AND CARE OF REFLECTING TELESCOPES.

By W. F. Hoyt, Kansas Wesleyan University, Salina.

Read before the Academy, at Topeka, December 30, 1904.

IN the precision of its adjustments, in the wealth of mechanical details, in the number and intrinsic value of its attachments, the modern telescope is the prince among human instruments. There are two main kinds of telescopes, each with its fundamental advantages and disadvantages. The power of an instrument is determined largely by its light-gathering ability. Since the surface of a lens varies as the square of its diameter, the greater the aperture, other things being equal, the better the telescope. The refractor excels the reflector somewhat in light-gathering efficiency, because a lens intercepts less light than is lost by two reflections, as is necessary in modern reflectors. The small diagonal mirror, too, intercepts a considerable percentage of the light before it reaches the large speculum. The definition of refracting telescopes is usually superior, owing to slight possible distortion of mirrors, or to the unevenness of the silver coating. Refracting telescopes are but slightly affected by time or usage, while reflectors are tarnished after a few years, and must be repolished or resilvered, or both. On the other hand, a good reflector is absolutely achromatic, while chromatic aberration is inevitable in the best refractors. The aberration of the violet and other actinic rays in refractors render them undesirable for photographic work, for which reflectors are especially adapted. Owing to this, every well-equipped observatory has one or more reflectors as general working instruments. It was the two-foot reflector in the Yerkes observatory, for instance, instead of the great forty-inch refractor, that made the famous discoveries concerning Nova Persei recently. Mr. Schaeberle, of Ann Arbor, Mich., has constructed a large reflector with only an eighteen-inch focus, with which he claims to have performed marvels of photography, securing in a few seconds images of faint objects which have heretofore required hours of exposure.

We have probably reached the limit of size in refractors, but if we may believe Mr. Ritchie, of the Yerkes observatory, we have not begun to develop the possibilities of the reflector. He not only claims that a ten-foot reflector is possible, but he offers to construct one if funds are secured. Such an instrument would extend the area of the visible universe a thousand fold. Cheapness of construction and ease of management, however, are prime arguments in favor of reflecting telescopes. A good modern reflector, of twelve-inch aperture, mounted

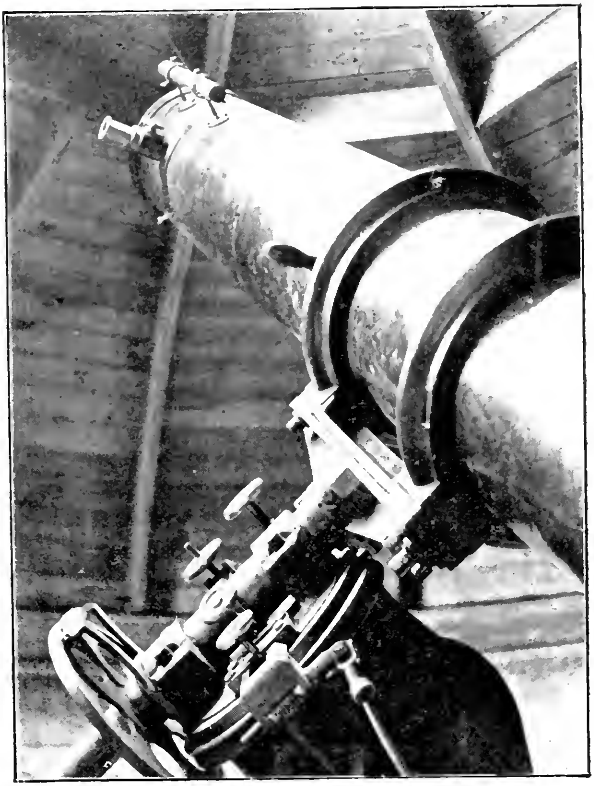


PLATE XXX.—Peate Telescope. A twelve-inch reflector at the Kansas Wesleyan University.

in the usual equatorial style, with right ascension and declination circles and adjusting rods, but without a driving clock and other costly attachments, can be secured for about $500. Such an instrument would bear, with ease, powers ranging from 100 to 500 diameters—a range ample for all practical purposes. When freshly resilvered, this glass would bear a power of 1000. The mounting of such an instrument in a neat observatory need not cost more than $500, and might be brought within $250. The total cost, therefore, need not be more than $750 to $1000. This is not beyond the reach of any moderately thriving educational institution; and yet how few of them have anything approaching such an equipment? Indeed, not longer ago than three years, there was not a single such instrument in the state, and but few telescopes of even moderate pretensions.

The care of such a telescope is not beyond the person of average ability and training. The glass should, of course, be protected by a dust-proof covering of oilcloth or tarpaulin, and, in addition, the open end and eyepiece tube should be securely capped. If carefully protected in this manner, it would be advisable to let the telescope rest in a vertical position, so that the mirror may lie flat, thus avoiding unnecessary strain in the intervals of usage.

A tarnished mirror may sometimes be brightened by rubbing it lightly with a soft chamois skin padded with cotton. A good silver surface can be repolished several times. Sometimes a little rouge upon the pad will aid in polishing. If this does not suffice, the mirror must be resilvered. If the glass is sent away, resilvering and repolishing a twelve-inch mirror will cost about ten dollars, and proportionately for other sizes. If the work is done in the home laboratory, the materials need not cost over fifty cents, and the whole operation can be completed in a half-day. It is better to have the reagents prepared before beginning with the mirror. The directions given below are for a twelve-inch glass, following the process given by Doctor Brashear, of Allegheny, Pa.

Reducing Solution (prepare at least a week before using; the solution improves with age): $2\frac{1}{4}$ oz. white sugar or rock candy; $\frac{1}{20}$ oz. nitric acid; $3\frac{1}{4}$ oz. alcohol; 19 oz. distilled water. Mix, and keep in a well-stoppered bottle. This solution will be sufficient for several operations.

DIRECTIONS FOR SILVERING A TWELVE-INCH MIRROR.

Reagents: $\frac{3}{10}$ oz. potassium hydroxide, dissolved in about 13 oz. distilled water; $\frac{6}{10}$ oz. silver nitrate, dissolved in 13 oz. distilled water (reserve about one-sixth of the silver nitrate for later use); a half pint of dilute (about 25 per cent.) ammonia; a bottle of dilute nitric acid. Too much care cannot be taken to have pure reagents. The potassium hydroxide should be "pure by alcohol," the ammonia dilute, and the distilled water clean as well as chemically pure. A little caution here may save trouble later.

The mirror may now be cleaned. A little nitric acid poured upon the face of the speculum may be directed to all portions of the glass by tipping it carefully this way and that. This will quickly clear the surface of the tarnished silver. A little more acid should be used to completely dispose of materials that may be dissolved by acid. Potassium hydroxide may now be used (not that mentioned above, which is reserved for silvering) and distributed as was the nitric acid. Further washing may be performed with clean water, and, last of all, with distilled water. This should be continued till the surface of the glass when dried looks clear by light reflected at an acute angle. Avoid touching the surface of the mirror if possible. If, however, the surface cannot otherwise be cleaned, it may be lightly and carefully wiped with a perfectly clean, soft towel, moved in circular and spiral strokes. The glass should be washed again two or three times after such wiping. When perfectly clean, the mirror should be put aside till ready to silver. This may be done by placing it face down in clean water, being careful to keep the surface from contact with hard objects. A better way is to wrap the mirror tightly with paraffined paper, letting the paper project three or four inches above the surface to be silvered. If this is well done, the papered basin, with the mirror at the bottom, should be water-tight. Pour enough distilled water to cover the surface of the glass and lay a paper or towel over the paper edges to keep out the dust. The mirror can be silvered face up in this condition, or face down in a large vessel, if preferred.

Pour the remaining silver-nitrate solution, after making the reserve, into a clean vessel, such as a wash-bowl. Add, drop by drop, the dilute ammonia, stirring briskly all the time with a glass rod. The silver solution will soon change to a light brown color, and finally begin to clear up again. As soon as it shows signs of clearing, stop adding the ammonia and stir a moment. Now pour in the potassium hydroxide. The mixture will now have a muddy brown color. Again drop in carefully and slowly the ammonia, stirring vigorously.

When it begins to clear up again, stop dropping in ammonia and stir briskly. *Beware of excess of ammonia.* Sometimes there are floating particles that refuse to dissolve, but this does not matter if the liquid is clear. Now pour in slowly the reserve silver nitrate, stirring continuously. Just when the liquid changes to a light brown or straw color, add a few drops more to avoid excess of ammonia. If, after stirring two or three minutes, the solution does not clear up, it is ready for the filter. If the solution clears, however, more of the reserve silver must be added, as it is useless to attempt to silver with an excess of ammonia.

In filtering, a little cotton may be placed in the funnel instead of filter-paper, which is slower and no more efficient than the cotton. Having filtered into the vessel for final mixing, pour in about three and one-half ounces of the reducing solution and wait a few moments until it begins to turn a dark or black color. Meanwhile, pour into the paraffined mirror-vessel as much distilled water as is thought necessary to cover the surface the required depth. About a pint and a half to a quart is sufficient. Pour in the silvering solution, and move the glass near the edge of the table, where it may be tipped this way and that, to keep the sediment of the silvering solution from settling upon the surface, and thus interfering with the silvering. Within five or six minutes the silver will begin to deposit, and in from ten to fifteen minutes the process will be complete. If the ammonia has not been in excess, the coat should be so thick as not to admit the light when held before a window. If left in too long, the coat may receive a tarnish that will be difficult to polish away. If the process has been completely successful, this coating will be thick and brilliant.

Pour the solution into a vessel and throw away, or precipitate as a harmless chloride by adding common salt. A dangerous explosive may form from this mixture, especially if the solutions be too warm. A temperature of about 60 or 65 deg. F. is best for solutions and vessels, as the silver will not deposit well if too cold.

Cut the cords binding the paraffined paper and wash the sediment carefully from the silvered surface with clean water. The surplus water may be allowed to drain away. The drying process may be hastened by absorbing the moisture from the silver by carefully applying clean blotting paper, being careful not to slide the paper. After ten or fifteen minutes the surface should be ready to polish, but the operator must be certain no moisture remains. Three or four pads of the softest and smoothest chamois skin should be at hand, stuffed lightly with cotton. Taking one of these in the hand, rub lightly at first, in spiral strokes over the surface, gradually increasing the firmness of the pressure. This polishing is simply to clear away the loose foreign substances remaining from the washing, and to give a firmness to the silver surface. It should, however, give a fairly good mirror surface from this rubbing. For the final polishing rub into another pad a little polishing rouge, brushing off the surplus rouge. Now go over the surface with the rouged pad until a brilliant surface is obtained. As long as the silver coating remains it will not injure the glass to polish, but care must be taken not to rub any exposed surface.

The diagonal or some small glass surface should be silvered before the large mirror to test the purity and efficiency of the silvering mixtures. The diagonal may be silvered face down in any vessel not too small to receive it. Care should be taken in this not to immerse the mirror until the bubbles have disappeared, and the glass should be held in a slanting position to prevent the lodgment of stray bubbles or floating sediment on the surface.

COLLIMATION.

The mounting and collimation of the mirrors is not difficult, with proper caution. An assistant is necessary for this, and indeed very convenient.

After a tentative fastening of the mirrors, the operator should take his place before the eye tube, at a distance of several inches from it, and, by working the adjustment screws, get the center of the speculum, which may be previously marked by a little disk of white paper pasted on the silvered surface of the large glass, to coincide with the center of the diagonal glass, when that mirror is placed so as to show the same length of the supporting wires on each side. A few minutes will usually suffice for this. Care should be taken not to have any undue pressure upon any part of the speculum. A test of this is that the glass should lie loosely in position. Pressure upon any part will result in an annoying flare of a star image, or even a double image. Since this glass lies free in its place, it is better to manipulate the telescope so as to have the large mirror always at the lower part of the tube.

While these directions may sound formidable to the amateur, they are really simple and easily followed, and the result should be a renewed telescope, ready for satisfactory work. A good test of accurate collimation is to let an astronomical object travel across the field of view and if the definition is equally good in all positions, the mirrors are properly set.

RECENT ADVANCES IN ASTRONOMY.

By W. F. Hoyt, Kansas Wesleyan University, Salina.

Read before the Academy, at Manhattan, November 27, 1903.

ASTRONOMY is the most ancient among the sciences. Five thousand years ago the builders of the pyramids had considerable accurate knowledge of the starry heavens. Antedating this, possibly, the oriental shepherds and the priestly magi of Babylon knew the first five or six planets and the principal stars and constellations. The patriarch Job mentions Arcturus, Orion, Draco, the Pleiades, and the zodiac. Astronomy was not only the first science mastered, but at the opening of the nineteenth century it was thought to be completed as far as human genius could perfect it, excepting as better instruments should reveal certain details as yet beyond reach. Any intimate knowledge of the constitution, conditions and movements of the stars, so far away that motions from ten to two hundred times as swift as a cannon-ball do not show any perceptible displacement in a century, was thought to be chimerical. Discoveries might be possible in physics, chemistry, biology, geology, etc., but the human intellect had reached its *ultima thule* in astronomy. During the last half of the past century, however, science, which seemed to be hardening into a permanent, finished form, suddenly became plastic again by the injection of marvelous discoveries, and the revolutionary hypotheses founded upon them. In no one of the sciences have greater discoveries or more revolutionary changes been made. Instead of being the most barren field for scientific research, astronomy quickly became one of the most fertile. One cause for satisfaction is the fact that America now leads the world in astronomical equipment and investigation.

The exciting cause for this activity and success in the astronomical field has been the invention and improvement of instruments of research. With all its attachments and improvements, the modern telescope, perhaps, in its mechanical perfection alone, represents the most splendid product of human thought and skill. It is a far cry from the spectacle-lens instrument with which Galileo startled the world to the forty-inch Yerkes refractor, and the sixty-two-inch reflector recently made for the American University, at Washington, D. C. There are now about fifty great telescopes mounted in more or less well-equipped observatories in the United States. There were none until about the middle of the last century, when Professor Mitchell secured and mounted a twelve-inch instrument at Cincinnati, Ohio. This became the center from which numerous observatories radiated, until now one-fourth of all the great telescopes of the world are in America, and of these by far the most powerful and efficient. Armed with this magnificent equipment, our investigators are outstripping those of other countries. Scores of such men as the two Pickerings, Newcomb, Young, Keeler, Mitchell, Proctor, Barnard, Burnham, Chandler, Gould, Lowell, Ritchey and others have assisted in placing the astronomical bays upon Columbia's brow. We should not forget the Clarkes, Brashear, Swazy, etc.—the Herreschoffs of astronomy.

Hardly a generation ago, Alvan Clarke, of Cambridge, Mass., was possessed with the foolish and presumptuous idea that Europe had no perpetual patent upon telescope-making, and that he, a mere nobody, could grind a lens. Despite the kindly discouragement of the Harvard professor whom he consulted, he ground away until he had perfected a six-inch lens which stood every test that he could apply. He carefully wrapped the precious glass and carried it to the professor's laboratory. Alas for his pride and presumption against the gods of precedent, the lens miserably failed to respond to the very tests he had applied in his workshop! The professor kindly intimated that he had told him so; and, although Clarke had made a really good glass for an amateur, no astronomer would think of mounting it in an observatory. Nearly heart-broken with disappointment, Clarke carried his disgraced lens back home, and again tried the tests, without success. The next morning he tested the lens again, and it stood magnificently every trial the professor had made. It slowly dawned upon Clarke that the lens had been warped by the heat of his body and the strain of transportation. He was more careful the next trip, and the professor forgot his references to amateurs in his admiration of a perfect glass made in America.

Perhaps we have nearly reached the limit of the size and efficiency of refractors, because of the difficulty of polishing large lenses and because of the increased length of the tube required. These difficulties do not obtain, however, with reflectors, and there is no insuperable barrier against the construction of a ten-foot speculum, at least. Such an instrument would cost but a mere fraction of the expense of a battle-ship or an abortive polar expedition, and would extend enormously the range of vision. If there are limits to our stellar universe, and if there are other similar universes beyond, such a telescope might possibly reveal them.

Within recent years the camera has become the efficient handmaiden of the telescope. Photography has indeed worked a revolution in astronomical methods. Heretofore we have had to rely upon more or less defective drawings to represent astronomical phenomena. What the imagination may depict, let an ancient sketch of a comet, with its hideous train of swords, knives, and bloody heads, attest. The modern astronomer is not so unreliable as that, but an inspection of various drawings of the sun's corona, or the nebula of Orion, will show that the personal equation must be taken into account. The camera, however, is absolutely without prejudice or predilection. Photographs are of inestimable value for future reference in making comparisons to detect possible changes. In addition to this, the photographic plate is more sensitive than the eye, and is able to accumulate the impressions received from hours of exposure, while the eye tires after a few minutes of close observation. The photographic chart of the whole heavens, now being prepared, will accurately locate and give the comparative magnitudes of many millions of stars. The supposed 8000 or 9000 nebulæ, visible with the best telescopes, have been increased twentyfold by a happy experiment of Professor Keeler in photographing without the eyepiece.

The spectroscope, the plaything of the physicist a half-century ago, has become the magic wand of the astronomer. With it he analyzes the constituents of stars away out on the fringe of the universe, so distant that fleet-footed light takes hundreds and even thousands of years to traverse the vast gulf, and he does it as easily and accurately as if they were on his laboratory table. The unseen atmospheres and the physical conditions of these bodies are also revealed. In this way the wondrous unity and identity of the universe have been established, perhaps the greatest single feat of modern astronomy. Many of these stars are shown to be unfinished suns, whose vast bulks are due to the uncondensed nebulæ or "fire-mist" or meteoric matter of which they are composed. Giant Arcturus, for instance, has been estimated to be a million times the size of our sun. If this estimate is correct, and the earth were represented by a sand grain, and the Omnipotent should pour out of His mighty hand ten such world sand grains per second, it would take over 4000 years for enough earths to trickle out to make one Arcturus!

A few stars had been suspected of having dark companions or satellites revolving around them even before the advent of the spectroscope, but this instrument has definitely shown that a considerable fraction of the stars have such planetary bodies of notable size circling about them, thus completing the analogy with our own solar system. By implication, most if not all of the hundreds of millions of such luminaries are attended by such invisible satellites. This revelation of unseen worlds is little short of miraculous. The human conception fails to grasp the magnitude of such a starry universe.

Hundreds of other stars are spectroscopic doubles, as shown by the periodic doubling of their lines. These may be embryo solar systems. The periods of these are so short as to suggest this. The theory of the younger Darwin, that tidal waves of the nebulous and molten matter, in the new-made world, and the aqueous surface of cooler bodies, regulate the distances and periods of stellar companions. These tides retard the rotation and increase the velocity of revolution until a balance is established between the tangential and gravitational forces. According to this theory, planets and other satellites began their career with much less periods and shorter distance from their centers of revolution than they now occupy. A short period, therefore, probably indicates a new-born world, and a large orbit and long period, maturity.

It has long been known that many stars have a proper motion at right angles to the line of vision. Motion directly toward or away from the solar system was thought to be beyond our ken. The spectroscope, however, shows in a moment of time whether the star is approaching or receding from us, and even the rate can be accurately computed from the displacement of its lines in the spectroscope. Nearly all, if not entirely all, so-called "fixed stars" are shown to be in rapid motion, varying from 10 to 300 times as swift as a projectile from a modern gun; 1830 Goombridge and 243 Cordalea, sometimes called "the runaway stars," have such trememendous velocities that the gravitation of the stellar universe is not sufficient to account for them. Possibly these are stellar missiles swiftly traversing our universe from the infinite depths beyond.

Our own sun is found to be moving like its neighbor stars. It is drifting at a rate of from twelve to sixteen miles per second toward a point some thirty degrees from the pole of the ecliptic. The earth and other planets are thus tracing out mighty spiral courses through the universe, never returning to the same point again, unless the sun's motion be an orbital one. If this is true, the curve is probably around the common center of the galaxy, or possibly a spiral one due to the common form of nebulæ. One investigator says the concept of this swift but silent flight of the sun, with his attendant planets, is the most overwhelming thought the human mind can grasp.

We should not leave out of our category of telescopic aids the chronograph and the bolometer and radiometer. The two latter instruments are inventions of Americans, and are invaluable in measuring the heat radiations of the stars, the moon (over its dark surface), and planets. These instruments are so delicate as to give accurate data, after making due allowance for absorption from the atmosphere. They are said to be able to detect and measure the radiations of a candle several miles distant, or of even a human face a mile away.

Taking a hasty survey of some of the accomplishments of the past forty years, we note that the earth has been more accurately measured and weighed. The sun, which was supposed during the early part of the last century to be inhabited, and even the abode of the blessed, according to one philosopher, is definitely demonstrated not to be a fit heaven, however much it may fill the requirements of "the other place." All our electric and magnetic storms are probably traceable to solar disturbances. Serious efforts are also being made to found weather prognostications upon well-known cycles of solar conditions.

The moon, our nearest neighbor, or only child, as you choose, has been awakened out of a supposed sleep of death by Professor Pickering. We have been teaching with parrot-like volubility and assurance that the moon is a dead world, without a trace of atmosphere or water in either liquid or gaseous form, and that, as a consequence, it was a rugged, barren waste, utterly devoid of any life whatsoever. The above conditions were definitely proven by occulted stars shining with undimmed splendor until blotted out by the moon's disk. This was yesterday. Professor Pickering says that an occulted star *is* dimmed upon approach to the moon, as any close observer can see. He thinks that there is unquestionably a rare atmosphere, and he believes that certain changes in hues about and within certain craters are due to a low form of vegetable life, perhaps like our fungi. The brilliant white spots, so prominent a feature of lunography, Mr. Pickering thinks are due to snow. The average astronomer dislikes to be caught napping, but when Professor Pickering speaks the astronomical world listens and takes notes. He has had unusual opportunity to verify his observations and strengthen his conclusions under the most favorable conditions.

Mercury and Venus still hide their mysteries of topography under a thick veil of dense atmosphere. It is still uncertain whether they rotate faster than the period of their revolution or not. Upon the answer to this question hangs the possibility of their being inhabited. It is probable, however, they are dead worlds which always present the same face to the sun. Mars continues the observed of all observers, because of the wealth of detail visible under favorable conditions. The war of theories as to the nature and meaning of the so-called canals is still being waged. Some insist they are mere optical illusions, and cite traces of similar appearances upon other planets and the moon, and the fact that some of them enter or cross the supposed seas. Others as stoutly assert they are not only real entities, but are water-courses or possibly lines of vegetation accompanying such irrigation ditches. This latter view is supported by Mr. Lowell, who has closely observed the planet at the observatory at

Flagstaff, Ariz. This much seems reasonably certain: there is a polar cap of snow that waxes and wanes with the round of seasons, and these canals and seas increase with the melting of this snowy mantle. What are thought to be clouds have been observed in the Martian atmosphere, and some claim to have seen the actual deposition of snow from these clouds. Mars is undoubtedly the most like our earth of any of the easily observed planets, and very probably furnishes suitable conditions for some kind of life. Professor Hall, of Washington, D. C., made the remarkable discovery of the two tiny satellites, which Swift, in "Gulliver," so wonderfully predicted, as to size and distance. This feat of astronomical detective work is said to be as difficult as the recognition of a tennis-ball at the distance separating Boston and New York.

The curious little planetoids have been multiplied until they number about 500, and the discovery of a new one is treated with indifference, unless, like one of the last, Eros by name, it presents some anomaly of position or motion. The plane of this planetoid's orbit makes an unusually large angle with the ecliptic, and it passes in one part of its path within the orbit of Mars, thus becoming our nearest visitor, excepting the moon. Concerning the outer planets, not much has been added within recent years. Barnard signalized the excellence of the Lick telescope by ferreting out the fifth satellite of Jupiter; and one of the Pickerings has found the ninth satellite of Saturn, naming it Phœbe. Professor Keeler, who succeeded Barnard definitely proved by the spectroscope that the rings of Saturn are neither solid nor liquid, but meteoric in form. These rings are practically annular masses of tiny satellites circling about the planet. They are supposed by some to be moons in process of formation. If so, we are witnessing the manufacture of worlds in God's workshop. This was thought at one time to be the normal form assumed by the primal nebulæ in all cases of world-formation, but, as we shall note later on, it is probably an anomalous condition. Saturn itself is still in embryonic state, as shown by its low specific gravity, and the other major planets are in the infant stage of development. The famous red spot of Jupiter has greatly diminished in size and brilliancy.

During the early half of the nineteenth century it was gravely suggested that the cometary visitors to our system were "excursion trains" for the especial delectation of those astronomers who had "come up through great tribulation," and who wished to inspect the stellar universe at closer range. These supposed trains, with their gala-day banners, went whisking now through this and then that solar system. These excursion trains, through good telescopes and in the spectroscope, look strangely like the other commonly distributed nebulous masses. The relation of comets to meteoric showers has been established within recent years.

The radiometer and spectroscope have given us valuable data regarding the condition and stages of the so-called fixed stars. There are at least three well-defined classes—those of the Sirian, the solar and the *a Herculis* types. The first are whitish stars, whose spectra are marked by bright lines, the dark lines indicating hydrogen, or by the violet and ultraviolet colors. This represents an early stage of stellar development, some indeed seeming to be mere aggregations of nebulous matter. Those of the solar type have spectra rich in dark lines of many elements, and represent a maturer condition. Those of the last type indicate rapidly cooling suns, and are marked by reddish or other pronounced spectral tints. There has not been much advance made along the line of measurement of distances, the parallaxes of hardly a hundred stars being definitely determined. Enough has been accomplished, however, to give us the general distances and to show that there is no definite relation between size and proper movements and distance.

The temporary stars that occasionally flash out brilliantly and then die down to invisibility have long been subjects of interest and speculation. During the fall of 1899 a new star appeared in Perseus and rapidly grew in brightness until it reached the first magnitude. It then faded away, but, luckily for the interests of science, has been followed assiduously and its various changes carefully recorded and photographed. Nova Persei was thus found to have developed into a rapidly swelling nebulous mass whose swift centrifugal motion resembled, and even surpassed that of an explosion. It is believed that it arose from the collision of two so-called dark stars whose impact not only shattered them, but transformed them into lambent gases. It is believed by many that this nebulous mass will in time cease its expansion, and then begin to condense under the effect of gravity, giving rise to a new stellar system, under the working of the laws of the modified nebular hypothesis. Perhaps this may represent one stage in an endless cycle of stellar evolution, which normally includes collision, nebulous mass, rotating spiral, a central mass with various attendant satellites, and finally a darkened star. This at least is believed by many notable investigators.

Until within the latter half of the past century, the nebulous masses revealed here and there were considered star clusters, too far away for our telescopes to resolve into their constituent stars. The spectroscope, however, proves most of the persistent nebulous masses to be really gaseous and meteoric in form. They are probably the world-stuff from which suns and planets are made. This is somethin more than hypothetical, since many constellations, such as Orion, still have wisps of nebulæ trailing after the principal stars, as if they were not yet the finished products of creative efforts. Most of the well-known constellations, too, show other evidences of close relationship —common spectral lines and similar proper motion. Most of the star clusters have unresolved nebulous masses within them. The six bright stars lying in an empty space in the heart of the great nebula of Orion, like diamond eggs in a world-nest, strongly suggest their origin from that nebula. Recent photographs show that the normal shape of nebulous masses is spiral, as if under the influence of tangential and gravitational forces. This may lead to a modification of La Place's hypothesis, whereby attendant stars and planets arise from masses switched off from such rotating nebulæ, instead of collecting first in the form of rings like those of Saturn. If this be true, this planet and such annular nebulæ as that in Lyra are anomalies. It is suspected also that the galaxy conforms to the prevailing spiral type. Some nebulæ show but very few spectral lines, as if made up of those elements only. If there is an identity in structure and nature throughout the universe, all the elements, or most of them, ought to show in the spectrum. This has given rise to the theory that these masses are truly embryonic, most of the elements being as yet undifferentiated. Professor Haeckel believes that matter arises from condensations of ether, hydrogen being the simplest sensible matter, or perhaps a hypothetical substance he calls prothyl. From differentiations of this all the other elements arise. Other astronomers think that the reason only two or three elements appear in the spectrum is that the lightest gases are thrown out to the periphery of the masses by whatever forces generated the nebulæ, but that after a time these settle so as to reveal the heavier substances. In any case, we are witnessing the processes of world-formation in nebulæ.

Perhaps you will pardon, in closing, the mention of a curious hypothesis proposed by Wallace, the codiscoverer with Darwin of evolution. He believes that the earth is the only inhabited world in the universe, citing as proofs the almost central position of the sun in the galaxy, and the peculiar balance of gravitational and other forces thus arising, and from the particular position of our planet in the solar system. There can be no doubt that the position of the earth is unique, and must necessarily be, because of the principle that two bodies cannot occupy the same space at the same time. It is also incapable of proof that any other member of the solar system is inhabited, as it is equally impossible to prove the negative. The argument of peculiar position and delicate balance of forces, however, seems comparable to the reasons that a shark inhabiting the Caribbean sea might advance that "the multitudinous seas" outside his especial preserve must necessarily be uninhabited, because that sea occupies a peculiarly central position with respect to the American continents and the Atlantic and Pacific oceans, and because its temperature, depth and degree of saltness must be different from other parts of the earth's water surface. This theory has been argued *pro* and *con*, however, although it must be admitted that astronomers are decidedly *con*. Nikola Tesla has made himself the target of humor by asserting his belief that he had received "Teslagrams," so to speak, from the inhabitants of Venus and Mars.

To summarize even this brief survey of the advances astronomy has made within recent years is to mention most of what is taught in modern text-books. In other words, astronomy, in common with other sciences, has been revolutionized with the past fifty years. The doors to original research and discovery, heretofore almost closed, have been flung wide open, and invite to most fruitful fields of investigation. Armed with the most perfect instruments ever devised by human ingenuity, and supported by an interminable line of wonderful discoveries, nothing seems impossible to the astronomer.

The poet has voiced not only the expectation of the unscientific, but of the astronomer himself in his address to the telescope:

"Through thee will holy Science, putting off
Earth's dusty sandals from her radiant feet,
Survey God's beauteous firmament unrolled
Like to a book new-writ in golden words,
And turning the azure scroll with reverent hand,
Read to man the wonders God hath wrought."

THE NON-EUCLIDEAN GEOMETRY.

By E. MILLER, University of Kansas, Lawrence.

Read (by title) before the Academy, at Topeka, December 31, 1904.

IN the third century before Christ there lived the three greatest mathematicians of antiquity—Euclid, Archimedes, and Apollonius. The earliest of the three was Euclid, who was born in the city of Tyre, about 330 B. C., and died about 275 B. C. He was the first professor of mathematics, and at the same time one of the most famous professors in the University of Alexandria, Egypt. There was current in his day an old saying that has appeared almost everywhere and in every age since. Among the French it has taken the form of question and answer. In a discussion of the merits of geometry, one Frenchman puts the question: "Who the devil can learn this?" to which the other replies: "It is the devil who has patience." Euclid's "Elements of Geometry" has been for nearly 2100 years the chief text-book among mathematical teachers. His axioms and propositions have been accepted without question or criticism. But during the last 100 years there has gradually crept into the minds of the greatest thinkers the thought that Euclid is lame in spots. One writer says: "The defects of Euclid as a text-book of geometry have been often stated, and are summed up in de Morgan's article in the "Dictionary of Greek and Roman Biography." The most prominent defects are these: (1) The definitions and axioms contain many assumptions which are not obvious, and in particular the so-called axiom about parallel lines is not self-evident. (2) No explanation is given as to the reason why the proofs take the form in which they are presented; *i. e.*, the synthetical proof is given, but not the analysis by which it was obtained. (3) There is no attempt made to generalize the results arrived at; *e. g.*, the idea of an angle is never extended so as to cover the case where it is equal to or greater than two right angles. (4) The sparing use of superposition as a method of proof. (5) The classification is very imperfect. (6) The work is unnecessarily long and verbose." Hence there has grown up during the last 100 years a demand for axioms and demonstrations that shall be free from objection. The effort has been crowned with success.

It has been conceded in the past that the axioms of geometry could neither be denied nor investigated. Men everywhere found them to agree with their experience, believing that the most rigid reasoning would fail to show any of them untrue. There is no question now that a set of axioms may be taken contradicting in whole or part those of Euclid, and a geometry be built thereon as consistent and as logical as his. Take, for example, one axiom of Euclid, the complicated and unwieldly one whose statement is: "If two lines are cut by a third, and the sum of the interior angles on the same side of the cutting line is less than two right angles, the lines will meet on that side when sufficiently produced." Euclid proved that lines making with a transversal equal alternate angles are parallel; and then, in order to prove that parallels cut by a transversal make alternate angles he used the complicated axiom previously given. Many were the attempts to accomplish this by reasoning about the nature of the straight line and plane angle. Legendre, a celebrated French geometer, attempted it, and in the course of his reasoning proved that the sum of the angles of a triangle can never exceed two right angles, but could not prove that there exists a triangle the sum of whose angles is two right angles.

The time came when some mathematicians began to believe that Euclid's axiom was not capable of proof, and that a geometry could be constructed on the supposition that the axiom is not always true.

As early as 1766 a paper was written by Lambert, in which he maintains that the parallel axiom needs proof, and gives some of the characteristics of geometries in which this axiom does not hold. The greatest mathematician of the nineteenth century, Gauss, sought to prove the axiom of parallels for years, but he never published anything on the subject.

About the year 1830, two men — one a Russian, Lobachevsky, the other a Hungarian. Johann Bolyai — first asserted and then proved that the axiom of parallels is not necessarily true. Thirty years passed before any attention was given to the work of the Russian and the Hungarian. Clifford, an Englishman, one of the most brilliant of mathematicians, in 1870, wrote that "several new ideas have come to me lately: First, I have procured Lobachevsky's 'Geometrical Studies upon the Theory of Parallels,' a small tract, of which Gauss says: 'The author has treated the matter with the hand of a master, and with the true geometrical spirit. I must call your attention to this book, the reading of which will not fail to cause you the most lively pleasure.'"

The "Theory of Parallels" is not a very high-sounding title, but it reveals to us a "new kind of universal space." Gauss, in 1846, says: "The non-Euclidean geometry contains nothing in it that is contradictory, although at first view very many of the results have the air of paradoxes. These apparent contradictions must be regarded as the effect of an illusion, due to the habit we have of considering the Euclidean geometry as rigorous."

From these statements it must not be concluded that because the Euclidean geometry is rigorous that the non-Euclidean is less so. The difficulty with Euclid is in the assumption of axioms or statements that were not capable of proof. Of the non-Euclidean geometries, there are now two well-defined ones: First, that discovered by Lobachevsky, sometimes called the hyperbolic geometry, and second, the elliptic geometry, discovered by Riemann. Riemann studied the foundations of geometry "from a very different point of view, an abstract algebraic point of view, considering not our space and geometrical figures, but a system of variables." He investigated the question, "What is the nature of a function of these variables which can be called element of length or distance? and found that in the simplest cases it must be the square root of a quadratic function of the differentials of the variables whose coefficients may themselves be functions of the variables." To Clifford "we owe the theory of parallels in elliptic space." The lesson to be learned from non-Euclidean geometry is, "that the axioms of geometry are only deductions from our experience, like the theories of physical science." "The assumptions which distinguish the three kinds of geometry, Euclidean, the hyperbolic, and the elliptic, may be expressed in different forms. We may say that one, or two, or no parallels can be drawn through a point; or, that the sum of the angles of a triangle is equal to, less than, or greater than two right angles; or, that a straight line has two real points, one real point, or no real point at infinity; or, that in a plane we can have similar figures, and that a straight line is of finite or infinite length, etc." Any of these forms points out the nature of the geometry.

To illustrate the non-Euclidean geometry of Lobachevsky, let us take his theorem: A straight line maintains its parallelism at all points.

Let AB be parallel to CD at E, and let F be any other point of AB on either side of E, to prove that AB is parallel to CD at F.

Demonstration: To H, on CD, draw EH and FH. If H move off indefinitely on CD, these two lines will approach positions of parallelism with CD. But the limiting position of EH is the line passing through F, and if the limiting position of FH were some other line, FK, F would be the limiting position of H, the intersection of EH and FH.

Another theorem is: If one line is parallel to another, the second is parallel to the first.

Given AB parallel to CD, to prove that CD is parallel to AB.

Demonstration: Draw AC perpendicular to CD. The angle CAB will be acute; therefore, the perpendicular CE from C to AB must fall on that side of A towards which the line AB is parallel to CD (this statement depends on a former proposition not given here). The angle ECD is then acute and less than CEB, which is a right angle. That is, we have CAB less than ACD, and CEB greater than ECD. If the line CE revolve about the point C to the position of CA, the angle at E will decrease to the angle A, and the angle at C will increase to a right angle. There will be some position, say CF, where these two angles become equal; that is CFB = FCD. Draw MN perpendicular to CF at its middle point and revolve the figure about MN as an axis. CD will fall upon the original position of AB, and AB will fall upon the original of CD. Therefore CD is parallel to AB.

Another theorem: In a rectilineal triangle the sum of the three angles cannot be greater than the two right angles.

Demonstration: Suppose in the triangle ABC the sum of the three angles is equal to $180°+a$; then choose in case of the inequality of the sides the smallest BC, halve it in D; draw from A through D the line AD, and make the prolongation of it DE, equal to AD; then join the point E to the point C by the straight line EC. In the congruent triangles ADB and CDE, the angle ABD = DCE,and BAD = DEC; whence follows that in the triangle ACE the sum of the three angles must be equal to $180°+a$; but also the smallest angle BAC of the triangle ABC in passing over into the new triangle ACE has been cut into the two parts EAC and AEC. Continuing this process, continually halving the side opposite the smallest angle we must finally attain to a triangle in which the sum of the three angles is $180° + a$, but wherein are two angles, each of which in absolute magnitude is less than $\frac{1}{2}a$; since now, however, the third angle cannot be greater than $180°$, so must a be either null or negative.

Such are some of the methods of demonstration used in the non-Euclidean geometry of Lobachevsky. On the other hand, if we take the non-Euclidean geometry of Riemann, it may be shown that if a straight line is determined by two points, but take the contradictory of the axiom that a straight line is of infinite size; then the straight line returns into itself; but two having intersected get back to that intersection point without ever again meeting. Two intersecting complete straight lines enclose a plane figure, and two such plane figures are congruent if their angles are equal. All complete straight lines are of the same length l. In a given plane all the perpendiculars to a given straight line intersect in a single point, whose distance from the straight line is $\frac{1}{2}l$. Inversely, the locus of all, the points at a distance $\frac{1}{2}l$ on straight lines passing through a given point and lying in a given plane, is a straight line perpendicular to all the radiating lines.

The total volume of the universe, therefore, is equal to l^3/π. The sum of the angles of a plane triangle is greater than a straight angle by an excess proportional to its area.

The greater the area of a triangle, the greater the excess or difference of the angle from 180°.

In conclusion, it may be said that the geometry of Euclid is in no danger of being superseded by either the hyperbolic or the elliptic geometry. The Euclidean geometry, ever since it was given to the world by its author, has been accepted as a geometrical bible, from which the truth, the whole truth and nothing but the truth could be obtained. But as the years rolled on, and the nineteenth century unfolded its years, exceptions began to be taken to Euclid's axioms. The Euclidean axioms are all accepted by the non-Euclidean, excepting the last, which the latter denies and replaces "by its contradictory—that the sum of the angles made on the same side of a transversal by two straight lines may be less than a straight angle without the lines meeting." All of the foregoing is given to illustrate the subject of non-Euclidean geometry, and to call the attention of teachers of geometry to the wonderful method of overcoming the objectionable axiom of Euclid.

Quotations have been made from various writers on the subject, some unchanged and others modified to suit the views of the writer of this paper.

WHAT RIGHTS HAVE EDUCATIONAL INSTITUTIONS TO DUTY-FREE IMPORTATIONS?

By E. H. S. BAILEY, University of Kansas, Lawrence.

Read before the Academy, at Manhattan, November 27, 1903.

IT is beginning to be a serious question, nowadays, to what extent educational institutions can import goods for the use solely of the universities and the students duty free. It was evidently the intention of Congress, when the law was framed, that all institutions which were founded for educational purposes, and not for profit, should have this special advantage. Various decisions of the courts, however, hamper the importer, till he hardly knows whether it is worth the while to take the trouble to try to avail himself of the advantage which the law has intended to confer. Shall we import directly, or through a New York house, or shall we buy goods of home manufacture? It often happens, especially in the case of a chemical laboratory, that the goods and chemicals obtainable from the manufacturers in this country are inferior to those which we import. There may not be much difference in price, but chemists cannot afford to sacrifice quality to any other consideration. The glassware and porcelain must be first class, and the chemicals must be pure—as pure as it is possible to obtain them.

We are in the position of our forefathers in the early colony days—"our rights have been trampled upon." How can our wrongs be redressed? To state the matter a little more in detail:

The University of Kansas imports in its own name annually a large order of chemicals, chemical apparatus, and glassware. This for a number of years has amounted to 10,000 marks. Other purchases amounting to nearly this sum are made through agents at various ports of the United States. For many years our business was done through the port of New York. Some ten years ago, on account of excessive freight charged on these importations from New York to Lawrence, it was decided to ship in bond to Kansas City. We have found the surveyors at the port of Kansas City uniformly very broad-gaged and obliging gentlemen. Until 1901 no customs duty was charged our University on any of its chemicals and scientific apparatus. Only fifty dollars was charged at this time. This charge was applied on mortars and pestles, thermometers and such articles as are in common use. We recognized the injustice of this, but the amount being small, it was paid rather than go to the expense of protest.

The invoice of glassware and apparatus in 1902 amounted to over 9000 marks, and chemicals to some 1300 marks. These were entered duty free by the surveyor of the port at Kansas City, but his decision was reversed by the auditor of the treasury department, with instructions to reliquidate the entries and charge duties on designated articles. We were required to pay $704 on the apparatus, and $122 on chemicals. We protested in no uncertain terms. Our case was heard by the board of United States appraisers in New York on the 5th instant. Though it cost good money, we put up a strong fight. The secretary and purchasing agent of the University, Mr. Willis K. Folks, engaged the attention of the board two days. The board gave our matters close attention and decided one case entirely duty free, returning the entire $122, and the apparatus was cleared on about seventy per cent. of the articles. This we are glad of; but schools and colleges ought not to be compelled to protest and to go to great expense to secure the privileges Congress intended they should enjoy.

There are three tribunals in front of each importation, viz., the surveyor of the port, the United States board of general appraisers, and the United States circuit court. The duty-free importations are not just now known by these arbiters by list or in any agreed schedule. Because a beaker or casserole may pass free to an educational institution to-day at New York does not indicate that it will pass next spring at New York or to-day at Philadelphia. The attitude of the board of general appraisers seems now to be more favorable to colleges than either the treasury department or the United States courts. We also believe that some agents in New York or Philadelphia are more successful in getting articles passed than the colleges are. It is charged that the American Tariff League are urging the treasury department and the surveyors of the ports of entry to restrict importations for colleges. There have been some very liberal affidavits filed by officers of these colleges requesting duty-free privileges on household and farm implements.

Several colleges and universities which have had difficulty in securing the benefit of the duty-free privileges have suggested to us that we combine in request to Congress to change the wording of the phrase, "philosophical and scientific instruments and preparations," to cover all needed importations for use of laboratories and other scientific work.

It is about time, then, to importune Congress to change the law so that no decision of a court can misinterpret it. This could perhaps be done readily, for the educational institutions of each state could depend on the support of their senators and congressmen, were it not for the fact that in the game of politics, which they are all playing, just now they may be afraid to tinker with the tariff. The American Chemical Society has an efficient committee on this subject, and, with the support of all the educational institutions, it is hoped that something definite can be done very soon. Just now it is difficult to answer the question, "Who owns the government, the educational institutions of the country or the protected manufacturers?"

THE GENESIS AND DEVELOPMENT OF HUMAN INSTINCTS.

By L. C. WOOSTER, Ph. D., State Normal School, Emporia.

Read before the Academy, at Topeka, December 30, 1904.

INSTINCT has been defined as the ability possessed by an animal or plant to perform, without foresight of the ends, those acts by which the development and preservation of the individual or species is secured. It is an inherited tendency or a racial instinct-memory that causes each plant and animal to do blindly all things needful for the growth and security of the organism.

Above and beyond those activities which are instinctive are those which are characteristic of the individual and are performed under the direction of the will. The organism is fully conscious of these activities and of the ends to be attained by them.

Between those bodily movements and mental processes which are performed instinctively and those which are done consciously is a connecting set of activities, part of which have become habitual from conscious repetition, and part are racial tendencies which induce subconscious activities. The habits of body and of mind lie in the nearer borderland of conscious activities and are established by a conscious repetition of a bodily movement or a mental process. Farther out on the fringe of consciousness are the inherited, semiinstinctive tendencies to activity which have for centuries been a puzzle to the philosophers and have but recently yielded some of their secrets to the psychologists. These are the subconscious or subliminal activities which are exhibited in panics or stampedes of people and horses, of mob violence induced by suggestion, in the frenzy for collecting strange and rare things shown by crows, magpies, and naturalists, and in a host of uncanny manifestations of the subliminal self in trances and hypnotic states.

There is no question but what conscious activities repeated many times become unconscious activities or habits; but there is a hesitancy on the part of many to take the next step, and believe that habits persisted in by many generations of individuals become inherited, subconscious activities, and that these in time are established as instincts.

In my opinion this hesitancy arises from an incorrect method of study of the question, in a failure to grasp the full significance of the theory of evolution in its applicability to all phases of plant and animal life, and in neglecting the most important factor of all life, and its possibilities.

All who are interested in this problem will at least agree that all the activities of the mind, of the body as a whole, of each organ and tissue, and of each protoplasmic cell may be grouped under one or the other of a connected series of heads:

1. Conscious activities.
2. Habits.
3. Subconscious activities.
4. Instincts.

The attitude of the evolutionist towards a consistent theory of development of these four forms of activity and the exceeding importance of the life factor in them all will receive due attention in the course of this discussion; but the proper method to be employed in studying any problem in which life is the chief factor demands immediate consideration.

The methods that have been employed in the solution of biological problems are two in number, the mathematical method and the life method.

The mathematician is concerned with the investigation of the logical consequences of certain exactly statable postulates or hypotheses. The method of the mathematician may be used with the greatest propriety in all investigations in chemistry, physics, engineering, and dynamical geology, for the factors in these subjects obey physical laws and each cause is followed by its logical effect.

In biology, on the contrary, the one who uses the method of the mathematician can meet only with wrong results, for life obeys no law other than its own highest good, and this cannot be stated in mathematically exact terms. Life observes physical laws so far as it is needful to do so to attain to its own best success in the struggle for existence on earth and no further, and, therefore, where life intervenes, causes are not followed by their full, logical effects.

Doctor Loeb, in his theory of tropism, says that an organism when unequally stimulated is caused by the stimulus to so orient itself that its parts are equally stimulated. He seems to mean that an organism orients itself just as does the magnetic needle when under the influence of a parallel current of electricity.

Doctor Jennings, of Pennsylvania University, has demonstrated in a remarkable series of experiments that the amœba, for example, does not orient itself in accordance with the theory of tropism. In these experiments Doctor Jennings found that the amœba invariably moves in accordance with an influence exerted from within, that trial and failure are important factors in determining what it will do. The external cause was not followed by its logical effect, for life intervened and determined for itself the direction of motion.

Doctor Hibben, of Princeton, says, in his "Problems of Philosophy," that there is present in every organism a self which preserves its identity through all the successive stages of progressive psychical experience, and acts as a unifying principle in coordinating all the several stages of development within the sphere of permanent personality.

All in every-day experience agree that it is futile to attempt to express life values in terms of mathematical units. No one would try to sell ideas to the publishers by the pound, nor to express the skill of an engineer by the yard unit, nor to extract the cube root of a theory in science. Then why should a biologist attempt to establish a physical explanation for tropism, as does Doctor Loeb, a mathematical basis for heredity, as did Doctor Weismann and his followers in their germ-plasm theory, or make heredity a problem in physics, as did Mendel and DeVries in their manipulation of chromosomes in the egg and sperm?

I maintain that the only method a biologist should use in studying life processes is one that harmonizes with the method used by life itself in developing its higher powers in the individual and in the race. This life method has been studied by biologists along four different lines of research; and the fact that these four lines of study, pursued in fields so widely diverse, harmonize in their results so perfectly, is one of the chief arguments for the validity of the method.

Four submethods for studying the plant and animal kingdoms are:

1. That of the systematic botanist and zoologist.
2. That of the evolutionist.
3. That of the embryologist (ontogeny).
4. That of the paleontologist (phylogeny).

The biologist has long known that plants and animals may be grouped in a tree-like ascending series, made up of branches, classes, orders, genera, and species. This work of the systematist serves as a standard of comparison in ranking activities.

The evolutionist holds, as a basic principle of his theory, that life has always had a general upward tendency, and consequently the later and higher organisms and processes have been evolved from earlier and lower organisms and processes.

The embryologist has learned that the life of each higher organism, in the course of its development from the egg, repeats in a general way the history of its race. This discovery evidently harmonizes with the theory of evolution.

The paleontologist, in arranging the fossil life forms in their chronological sequence, has found that the lower forms of life of the systematist appeared on earth first, and that the higher forms appeared successively later.

The systematic biologist, the evolutionist, the embryologist and the paleontologist agree in concluding that life on earth, in its mode of development, proceeded from the simple to the complex, from the undifferentiated to the differentiated, and from the unpleasant to the better. I would add as a probable hypothesis, in harmony with the preceding, that in the development of the race conscious activities preceded the habitual, the habitual preceded the subconscious, and the subconscious the instinctive activities. By heredity the individual acquires in the beginning a large store of instinctive tendencies; later the subconscious activities appear; and finally, when independent existence is reached, the conscious and habitual activities give the possessor freedom in his environment.

No attempt will be made to prove this hypothesis by a course of logical reasoning, for life is a variable factor, and the syllogism does not apply in the life method, A few illustrative examples will be taken here and there merely to show the general harmony of the hypothesis with life methods.

The mammalian egg, when fertilized by a sperm cell, begins at once the work of segmentation, and the cells divide and subdivide till sixteen or thirty-two cells are produced, arranged in the form of a sphere.

This process of segmentation of the mammalian egg is entirely instinctive, for it takes place blindly, after a fixed plan. It divides first into two cells; these two cells subdivide by a plane at right angles to the first plane, forming four cells; then these four cells subdivide by planes at right angles to the other two planes and eight cells result. This regular order of division planes is one of the distinguishing differences between complex plants and animals. In all complex plants the second, third and fourth planes are essentially parallel with the first plane, and greatly elongated forms result.

In the segmenting mammalian egg the first eight cells are arranged roughly in the form of a cube; then, as the segmentation continues, a solid sphere is produced, the morula; next a hollow sphere, the blastula; and then, by a process of unequal cell growth and invagination of the blastula, a hollow cup is formed, the gastrula.

We shall possibly find the nearest analogues of the mammalian egg among the mouthless mastigophora. Ninety-nine one-hundredths of the protozoa are provided with mouths, or have no cell-walls, or have very thin places in their cell-walls for the ingestion of solid food. A mouth or its equivalent gives its possessor such an advantage in the struggle for protozoan existence that its fortunate or, better, unfortunate possessor lacks strong incentives for developing a structurally more complex type of existence.

The mouthless one-celled organism must live all his days as a plant by absorbing carbon dioxide, water, and certain mineral salts, and from these prepare starch, sugar, and proteids, or he may get part of his nutriment this way and prepare digestive ferments, as do his

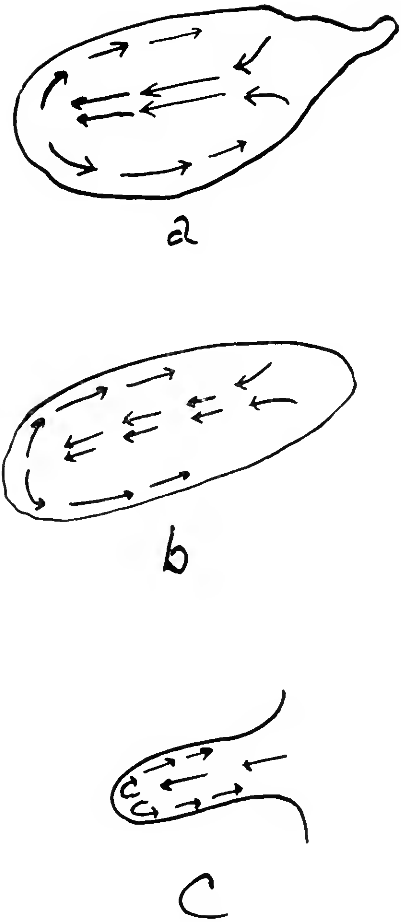


FIGURE 12.

Figure 12 shows the direction of currents in the Amœba required by the tropism theory and claimed to have been seen by Bütschli and Rhumbler.

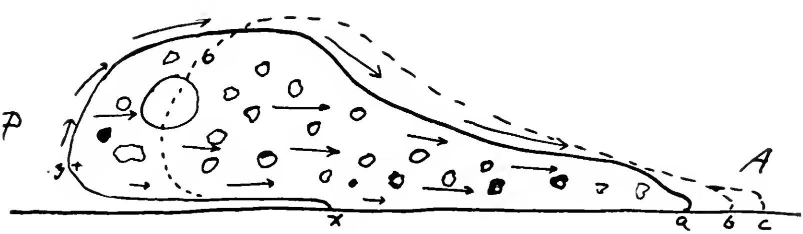


FIGURE 13.

Figure 13 shows the direction of currents reported to have been seen in the Amœba by Jennings. The figures are taken from an article by Doctor Jennings in *The American Naturalist* for September, 1904. A criticism of Doctor Jennings's book, "Contributions to the Study of the Behavior of Lower Organisms," by Doctor Yerkes, of Harvard, may be found in *Science* for December 2, 1904.

fellows with mouths, and excrete them, so as to dissolve solid food which may have been captured by his flagellum. This is the condition of our mouthless mastigophore. He digests and absorbs just enough solid food, we may believe, to serve as a proper stimulus to get more; and this stimulus, we may imagine, led some ancient mastigophora to form solid spheres, the morulæ, or hollow spheres, the blastulæ, or double-walled cups, the gastrulæ. Fairly good examples of these we find in the eudorina and pandorina, which stop development at the solid sphere and then begin conscious activity; in the volvox, which develops till it becomes a hollow sphere and then takes upon itself full conscious activity; and in the fresh-water hydra, which develops from the fertilized egg, passing through the morula and blastula stages and reaches the gastrula stage, where it takes to itself all the conscious activities of an independent organism.

If it is hard to believe that these simple organisms may form habits, be subconsciously active, and have these modes of activity finally established as instincts, we should recall some of the wonderful things learned about the bacteria, those tiny, one-celled plants which divide and subdivide so as to form new generations every few hours, and are much simpler in many ways than the mastigophora and yet much like them in being provided with flagella.

It has long been known that, among the pathogenic bacteria, the same species may at one time be exceedingly virulent, and, at other times, be mild and even almost innocuous.

It has lately been discovered that the nitrogen-fixing bacteria bury their instincts beneath new habits with the greatest ease. Doctor Nobbe, an eminent German bacteriologist, conceived that it would be possible to make a fortune selling nitrogen-fixing bacteria to the farmers, so he prepared cultures of these bacteria to sell at a dollar a bottle. Doctor Nobbe's "nitragin," as he called it, was worthless, for he had so satiated the bacteria with rich, nitrogenous foods that they had lost their desire and, indeed, their ability, to use free nitrogen. It remained for an American, Dr. Geo. T. Moore, to discover this fact and to devise a way by which our department of agriculture could supply to the American farmer, at a cost of only a few cents a cake, nitrogen-fixing bacteria that are so hungry for atmospheric nitrogen that they are doubly efficient.

Of higher mold than the hydra, the mammalian embryo does not stop at the gastrula stage of growth, but, by cell multiplication and differentiation and a series of secondary and tertiary invaginations and a few evaginations, it next develops the tissues, organs and cavities which characterize the adult animal. To the time of independence of the mother, these activities are all instinctively performed; but from this time forward some are instinctive, some are subconsciously done, some are the result of habits, and most are consciously guided and controlled by the will.

Among those animals which reach stages of complexity higher than the gastrula, but come short of the complexity attained by civilized man, some enter the conscious stage of development as worms and remain such all their lives; others become fish; others are conscious first as tadpoles and go a step farther and become frogs; some, possibly, are marsupials; some are herbivores or carnivores; some are apes, and some are barbarian bipeds.

The embryo of man forms in its development peculiar structures which show various places where instincts became buried. At one stage it exhibits gill slits and a well-developed tail; later it cannot be distinguished from the embryo of a fellow mammal; and even in adult life man carries in his body dozens of structures, inside and out, which are no longer functional or consciously used by him.

In the mind are various functions not so deeply buried beneath later acquisitions of race experience. Some are of service in food-getting, others are useful in defense, and others, as do rudders to ships, serve to guide the wavering mind to a safe harbor. The presence of these inherited race tendencies, serving as promptings from the subconscious self to conscious activity, may have led Plato to suppose a previous, personal existence of the human soul, may have caused Buddha to teach the possibility of soul transmigration, and may have caused Kant, who had only faint glimmerings of the doctrine of evolution and of the transmission of the wisdom of the race through heredity, to maintain that man knows many things *a priori*—that is, previous to individual experience.

In conclusion, I merely repeat what I have maintained in this paper, that heredity, instinct, subconscious promptings, habits and conscious activity are all related problems of life, not of matter, force, or energy, and are incapable of solution except by using the method taken by life in solving the problems of its own existence on earth. Following this method, we must conclude that the first activities of life were consciously performed, and that in the course of the ages these became in turn habits, subconscious activities, and then instincts. This is true of all life, including man, the king of creation.

INSTINCT.

By H. L. MILLER, High School, Topeka.

Read before the Academy, at Topeka, December 30, 1904.

NO better subject than instinct could be found to demonstrate that knowledge begins and ends in mystery. The biologist amuses himself in observing the battle waged between the physiologist and the psychologist, the one attributing reactions in lower organisms to mechanical stimuli; the other accepting the indisputable states of consciousness in the higher forms of life; the two approaching each other by traveling in parallel lines. The common-sense view attributes all activities to the nature of the animal. It is only the mind debauched with learning that finds difficulty in explaining common things. The sophomore can write a breezy paper on a subject that would tax to the utmost the mind of a candidate for the doctor's degree. Lack of agreement in terminology affords a wide field for the savant and the neophyte.

The doctrine of "parallelism" seems to be reasonable—"every psychic phenomenon has a determinate physical concomitant." If there could be established an objective criterion of consciousness, there might be some information obtained on animal intelligence. Certainly mental states are conditioned or accompanied by physical states, and there are numerous well-defined physical signs of mental life. But even introspective psychology reaches the point where silence is the highest manifestation of reason. A sensation of red perceived by me has no imaginable community either with vibrations of ether or with physico-chemical modifications of retinal or cerebral cells. My perception of space, surface, volume has no conceivable community of nature with that of objective surface or extent. My perception of five miles will not have anything like extensiveness in consciousness. No distance in perception separates objective realities. The "impassable chasm" is fixed. The law is absolute and fundamental. The metaphysician may have a theory that will satisfy any one but the scientist. The tendency is to get away from any anthropomorphic conception of instincts. The physiological method begins with the lowest forms of life and by a series of experiments through the ascending scale would explain motor manifestations by referring them to physico-chemical mechanisms.

Possibly the realm of consciousness and intelligence is reached somewhere about the dividing line between the invertebrates and the vertebrates. The following experiment is mentioned in introducing the physiological method: Place a small quantity of acidulated water in a vessel, a bit of mercury, and a crystal of bichromate of potash. In a moment the mercury becomes the seat of little tremors; then it spreads itself around the crystal and dances excitedly. It may withdraw for a short time and then make a fresh attack. The activity ceases when the crystal is dissolved. Here one almost says it exercises choice. The movements appear spontaneous. The resting state that follows the battle seems to be a state of satisfaction.

Doctor Loeb has performed a large number of experiments upon starfish, medusæ, worms, and insects, from which he concludes that so-called instinctive acts are nothing more than mechanical effects of such general forces as light, gravity, etc., acting in common upon plants and animals. When the moth flies into the flame it is not necessary to speak of its love of light; or of danger when the mollusk withdraws into its shell; or of discomfort when the crab is turned on its back; or predilection for the dark when an animal avoids the light; or of intelligent forethought when the fly lays its egg on objects which serve the hatching larvæ as food. The so-called purposeful character of instincts does not distinguish them from reflexes. Nature may say to her fishy children, "Bite at every worm, for there are fewer impaled on hooks than not," and to the fly, "Try the web of the wily spider." Instinct is usually defined as "the faculty of acting in such a way as to produce certain ends without foresight of the ends and without previous education in the performance." The conventional discrimination between reflex and instinctive reaction does not aid us in the understanding of these phenomena, for both are concerned with reactions to external stimuli and conditions. The latter is usually thought of as a chain of reflexes causing the whole organism to react. It may be congenital. An organism replete with motion behaves instinctively, and the nervous system serves as a protoplasmic bridge or conductor from sense organs and muscles.

The results of a few experiments by Loeb will better convey the meaning of these statements. His conception of "tropisms" will explain the reactions in simple organisms and may be applied to some of the more complex reactions of higher animals; at any rate, there is a chance for such inference.

The moth flying in the region of a strong light is drawn into it, not through curiosity nor by attraction. The muscles on the side toward the light are positively heliotropic, and the moth, a symmetrical thing, is turned in a medial line for the light, and, if flying swiftly, has momentum to carry it into the flame. This kind of orientation is familiar to the botanist. The udendrium in its stem relations to the window illustrates the same principle. Simple chem-al and mechanical effects on muscles turn the moth into the flame.

The movement is heliotropic. The assumption is that chemical substances are acted upon by the light in such a way as to produce changes of tension in the contractile tissue. Symmetry of form is necessary.

Again, a galvanic current is passed through a medium in which are placed a number of Palæmonetes. The movement of these animals is toward the annode. Hence, galvanotropism is the term used to explain the orientation.

Another illustration is that of contact instinct. The crawling of animals into crevices is shown not to be for the purpose of self-preservation, but rather to get the body in solid contact as extensively as possible. No center theory is necessary. A peculiar species of butterfly, *amphipyra*, will run about until it finds a corner or crack into which it can creep. These animals were placed in a box, one-half of which was covered with glass, the other half with a non-transparent body. Small glass plates were placed in the bottom of the box, raised just enough to allow the butterflies to creep under. They collected without any choice of light effects. As soon as their bodies were brought in contact with solid bodies they became quiet, even when exposed to direct sunlight. It is not necessary to look for a center of self-concealment in these animals. The reaction is common to plants. Loeb has given this kind of irritability the name of stereotropism.

It is a wonderful arrangement in nature that in some species the female lays her eggs in places where the larvæ will find just the kind of food they require, decaying meat, cheese, and refuse of animals. The fly lays the eggs on lean meat and not on fat. The larvæ will die if fed on fat meat. Further study of larvæ showed that they are oriented by certain substances which radiate from a center—the center of diffusion. The chemical effects of the diffusing molecules on certain elements of the skin influence tension of muscles. Such orientation is termed chemotropism, and if the organism shows the positive kind it is led to those substances which are capable of furnishing appropriate stimuli. Such substances are the volatile nitrogenous compounds. The eggs are deposited in response to a "tropism" and not in response to experience or volition. The presence in the skin of a substance which is altered by the above-mentioned volatile compounds, together with bilateral symmetry of the animal, explains the reaction.

Caterpillars of Corthesia (butterflies) are oriented by the light. Until they have taken food they are positively heliotropic, and this leads them to the tips of the branches, where they find their food; and as soon as they have eaten they crawl downward. The taking of food destroys the susbtances in the skin which are sensitive to light.

Migrations of certain pelagic animals were observed, and the conclusion was reached as above. Positive and negative heliotropism causes the upward and downward migrations. Geotropism enters into the explanation of periodic depth migrations.

These experiments, given somewhat at length, will be sufficient to show Doctor Loeb's view. The analysis of instincts is purely from a physiological point of view. He rests his case with the belief that ultimately data will be furnished for a scientific ethics. The theory that instincts can be explained on the basis of the physical and chemical qualities of protoplasm may give us a scientific phylogeny. He says that man does not work in the fear of poverty, but from the instinct of workmanship. We are instinctively forced to be active.

Applying this concept of "tropisms" to our activities. I suppose we should say, then, that there is a negative heliotropism among bakers and actresses who turn night into day; and that people are led to the beer-gardens by the bright lights, through a positive heliotropism. And there would be nosotropism for physicians, necrotopism for undertakers, plytotropism for gardeners, and geotropism for field laborers. Everything depends upon the definition of a tropism, which is growing more complicated than instincts. The action of the organic mechanism is explained by the theory. If we define instinct on the physical basis as in inherited mechanism replete with motion, two problems arise: First, the origin of the mechanism; second, the motion and the stimulus that are contained in the explanation of the action immediately. No one but the cock-sure evolutionist would attempt to account for the former. Toward the explanation of the latter it seems to me Doctor Loeb has made a valuable contribution. The mechanism is an arrangement of nervous tissue, or possibly in some cases muscular tissue such that the energy which it contains finds a way of discharge that is generally regular and determinate. Individual experience must be considered in determinate actions, however. When the precise organization is inherited then the invarying action is instinctive, as we understand that term; while if acquired during the lifetime of the individual the action is said to be automatic or reflex. Natural selection may explain a vast number of the higher human instincts, such as self-preservation, honesty, fear, love, socialization, and many others enumerated by James.

But it would seem in the process of adaptation that the larvæ, flies and all, would have perished before the instinct or tropism was planted. But this is the query of a boy, and the satisfaction is in the asking, not in the answer that might be given.

Millions of birds migrate together. The nesting habits are essentially alike. Do they all respond to a climatic stimulus at the same instant, and is there some chemical or physical contact with objects out of which materials are selected for nests?

The spider without previous instruction spins a web of mechanical perfection, scaffolding for the structure, weaving the geometrical figure with mathematical exactness, taking up the groundwork, and if disturbed the whole process is repeated.

The cooperative incubating industry existing among the brush turkeys of Australia (*Megapodes*) is even more wonderful. Contrary to maternal instinct, these birds gather a great heap of earth and leaves, sometimes fifteen feet high, in which they lay their eggs, and leave them to be hatched by the heat produced by the fermentation and decay of the vegetable matter. The young shift for themselves at once, and may never come in contact with the mother bird. It might be, though it sounds like a fairy tale, that a fortuitous heap was made as a result of the scraping propensity evidenced by the very large shanks of this bird, and, by another fortuitous coincidence, the eggs were left in the said heap and hatched, sending forth a brood congenitally prepared to establish this custom, so that the drudgery of sitting for days on those uninteresting, never-to-be-too-much-sat-upon objects might be foregone.

To all these and a thousand more, given by Mr. Morgan and others, we must say, when asked why and wherefore, *ignorabimus*.

Doctor Loeb has made a valuable contribution in the explanation of reactions in unicellular organisms. How far this theory can be extended with reference to more complex organisms remains for future investigation.

OBSERVATIONS ON MIRAGES.

By Bernard B. Smyth, Topeka.

Read before the Academy, at Manhattan, November 28, 1903.

MIRAGES are of two kinds—reflecting and refracting. They are both so well known I need not define them here. Both occur in western Kansas, where the air is clear and distant vision is possible Reflecting mirage is again of two kinds, always more or less associated with refraction. The most noticeable form is the ground mirage, which always occurs in the heat of the day when the sun shines brightly and the air next the ground becomes superheated. A broad level or slightly depressed area is necessary for its best development. On such occasions the earth becomes invisible and the sky is reflected from the ground as from a sheet of water. The action of a slight breeze enhances the deception by causing waves on the surface of the mirage as on a lake of water. Small objects, as weeds on a slight elevation beyond the mirage, are magnified and distorted into trees and living forms, often appearing to move with great rapidity. This kind of mirage has been described so often I will not dwell upon it. I only mention a single occurrence that took place in Barton county, Kansas, during the summer of 1876. The Santa Fe railroad passed in front of my house, about one-third of a mile distant toward the south. My house, from which I viewed the phenomenon, stood on a slight eminence, raising me about fifteen feet above the prairie intervening between me and the railroad.

One afternoon, with the wind gentle from the southeast, a passenger-train came from the west, making no audible sound. The ground mirage was like a sheet of water or dense fog, reflecting the sky between me and the train so as to completely hide the ground, the wheels, and a depth of about a foot of the lower part of the cars. The entire train, very distinctly to be seen except its lower part, sailed along silently on top of the fog-like mirage as though floating through the air. No visible smoke just then came from the engine; no rumble of the train could be felt; and, except the faces at the windows and one or two persons standing on the platforms, there was no evidence of life and no activity. The whole presented a most remarkable sight—the silence of the train; the invisibility of its lower part; the quiet, majestic movement; the spectral appearance of the engine and cars—the whole made an impressive scene that lasted while the train was traveling nearly a mile, or say a little more than a minute. On reaching a point toward the wind, half a mile to the southeast, a gentle rumble began to be felt and heard. The noise increased to a loud roar as the train sped away to the east and only ceased when the train stopped at Ellinwood, four miles distant. Even after the train started up again the rumble could be heard, though gradually growing fainter as the train neared Raymond, twelve or fifteen miles distant.

The other form of reflecting mirage is where objects on the earth are reflected into the sky. This is caused by the air becoming stratified. On such occasions distant objects in the observer's stratum are seen inverted in the sky, reflected at a very high angle of incidence and reflection from the surface of the stratum overhead. The angle of reflection on such occasions is usually 89½ degrees, or even more.

A far more important form of mirage—one that occurs always in clear, cold weather, and all over Kansas—is of the pure refracting kind. This usually occurs in the evening, at night, or in the morning, when the air is comparatively still and the cold air settles down into the valleys. On such occasions the cold air flows, like water, from its own gravity, down into the lower ground. The rate of flow, whenever noticed, is about 2 miles per hour. When the rate exceeds 4 miles per hour, the proper refraction of the rays of light is disturbed and the beauty of the vision is destroyed. I say "beauty of the vision," because it is always beautiful, grand, exalting, entrancing. To be able to see, when you are living in a broad, shallow valley, across the distant hills into another valley, and to see distinctly the houses, with the smoke arising gently from them, and to see the young groves and other large objects in their natural positions, when you know that the elevated prairie between you and the objects seen is at least 100 feet above your level, is exhilarating beyond conception.

For six years—from 1874 to 1880—I lived in Barton county, Kansas, and kept a weather record during all that time. Observations were recorded thrice daily on temperature, humidity, rainfall, wind direction and velocity, and clouds. On looking up my old record for notes concerning mirage, I find during winter, on an average of about twice a week, this note: "Mirage at sunrise." Notes like these: "Strong refracting and reflecting mirage at sunrise," etc., "mirage to north at sunrise," "mirage at sunset," "very strong mirage," etc., occur about once a month or less frequent. Ellinwood is in the middle of the Arkansas valley, about 10 feet above water-level in the river, with a horizon so low to the north and south and west that it seems like being on a dead-level prairie or an ocean of grass. Very low upland is to be seen northwest and east, and higher sand-dunes to the southwest. The first mirage of the refracting kind within my observation was in the fall of 1874, while teaching at Ellinwood.

The occasion was before sunrise on a calm, clear, frosty morning. The sight was most beautiful and inspiring. The land to the north seemed to be raised slightly; and the high divide in Russell county, just south of the Smoky Hill river, and about 25 miles distant, was plainly to be seen above the ordinary horizon. Great Bend, to the west, was in plain view; though ordinarily only the tower of the court-house could be seen. Looking farther up the valley and somewhat to the south of Great Bend, the few houses at Pawnee Rock, 24 miles distant, could be seen and readily distinguished by the smoke rising from the chimneys. Some one said: "Look over toward the salt marsh." That was about 10 miles distant to the south. The few low sand-dunes between Ellinwood and the salt marsh dwindled into insignificance. A few houses in a group, with columns of smoke rising from the flues, a small grove of trees and a church or schoolhouse could be seen. There were no houses on the salt marsh, and none in the sand-hills south of Ellinwood; nothing but a dugout or two and surely no schoolhouse. There were probably not less than twenty people standing in the streets of Ellinwood looking at the scene. Presently some one who had been to Stafford began to recognize places and declared he could identify various buildings. This though doubted at first was soon accepted. Then, for a few minutes, other houses and a church further west came into view. Judging from the position and direction the group of houses was considered to be the village of Zion Valley, a Mormon settlement then existing south of Rattlesnake creek, in Stafford county. Farther west only sand-hills could be seen.

The distance to Stafford in an air-line was 27 miles; to Zion Valley, 29 miles. The intervening highest ground in the direction of Stafford was about 80 feet above the level of the river at Ellinwood, 17 miles south of Ellinwood and 10 miles north of Stafford. Stafford itself was and is about 70 feet above the level of the Arkansas river at Ellinwood. The highest ground between Ellinwood and Zion Valley was about 100 feet above the Ellinwood level, 19 miles south of Ellinwood and 10 miles north of Zion Valley. These highest points are ordinarily hidden from view at Ellinwood, by dunes 50 to 70 feet high about 6 miles south of Ellinwood. The elevation of Zion Valley was about 110 feet above the Ellinwood level. And still, to all appearances, the hills and the town of Zion Valley scarcely looked higher than Stafford and the hills in front of it.

Considering the curvature of the earth and the height of the intervening hills, the necessary apparent elevation of Stafford above its normal position in order to be seen at Ellinwood would be about 490 feet, equivalent to an elevation of 12′ of arc. This is equal to two-fifths the diameter of the full moon at rising. The elevation of distant objects appeared to be more than that; though probably was not. In fact, the entire horizon appeared to be elevated more than half the diameter of the full moon, or about one-third of a degree. In about 20 minutes the sun came up; the air began to be tremulous with warmth and the unusual sights disappeared.

My homestead was at "Red Rocks," 4 miles west of Ellinwood, where the high table-land north of the Arkansas makes its closest approach to the river. This is the narrowest part of the valley in Kansas, being not more than 3 miles wide. This was a noted camping-place for Santa Fe freighters and emigrants. Wood and water were plentiful, especially the water. After two years' teaching at Ellinwood and Raymond, I built on a shelf of red Dakota sandstone near the base of the bluff and about 25 feet above a low part of the valley near by. My instrument shelter was on another shelf back of the house about 15 feet higher. My view from the house to the north was cut off by the bluff back of the house, the summit of which was 85 feet above the river; to the south was interrupted about 6 miles distant by barren sand-hills, probably 200 feet high, south of the river. The river itself was half a mile distant, and ran straight east from Great Bend for a distance of 8 or 9 miles along the township line. The view eastward was over a broad, level valley terminated by a low range of sand-dunes in Rice county. The horizon westward was limited by the high plains of Rush county, 24 miles distant, terminating southward at Pawnee Rock, about the same distance. This Rush county plain was a little higher above the river than the bluff back of my house. From my point of observation it gave a perfectly level sky line.

Observations in the morning were taken at seven o'clock, or a few minutes before, which, during winter, was always at or before sunrise. Observations on temperature at the summit, middle and base of the hill were frequently made, especially if there were any mirage. I quote from the record made during a remarkable mirage that occurred on the morning of January 28, 1877: Temperature at station on hillside back of the house, at 6:50 A. M., 15°. Taking a thermometer graded exactly like the one in the shelter, I found the temperature of the valley, 25 feet lower, at 6:51, to be 6°; at bottom of watercourse, 10 feet lower still, at 6:52, 2°.

Returning to the station quickly, the temperature rose as the hill was ascended. At the station, at 6:55, the instrument in hand at first showed 16.5° while the instrument in the shelter stood at 18°. Both instruments, however, soon stood at 18°. It was then noticed that Great Bend, 6 miles distant, was unusually distinct and near, and the hills of Rush county appeared over the roof of the court-house at Great Bend, something never before seen. It was realized that something unusual was occurring right then; but, intent upon taking an observation on temperature at the summit and getting back to the station at seven o'clock, I started up without dwelling on the scenes.

However, 25 feet further up I was interrupted by a most unusual phenomenon.

Just over my head I approached a level crystal surface, as though I were walking in a sea of liquid air and about to emerge from it. This extended out over the valley to the west as far as the eye could reach, and seemed to cut the court-house at Great Bend at its middle elevation. Part of the court-house and other buildings were reflected in the sky and upside down. The city was also partly reflected from below, showing that there was another stratum surface of cold air in the bottom of the valley.

As soon as my head emerged above the surface of the cold-air stratum the city disappeared as if by magic; but the hills beyond could be seen still more clearly than before. The tower of the court-house and two or three church steeples and the belfry of the school-house were about all that could be seen of the city. Stooping a little so as to look from under the stratum surface, Great Bend was there as before, triply to be seen; but on straightening up, every time it would immediately vanish. On standing up, Larned, 28 miles distant, immediately came into view and was easily recognized; and even Garfield, 8 miles further, could be made out. Standing thus and holding the thermometer overhead, the temperature was noted at 25°. Placing it at the feet it dropped to 20°. This performance was repeated several times, always with the same result or with only slight variation.

Hurrying to the top of the bluff, the temperature was found to be 32°; and, on climbing to the top of a heap of stones on the summit and holding the instrument at arm's length overhead, the temperature was found to be 33°.

Then a most extraordinary phenomenon presented itself. The city of Atlanta, in Rice county, about a mile south of the present city of Lyons, 24 miles distant, and the hills to the north and east, were all in plain view over the tops of Plum Butte and other sand-hills in Rice county. Superintendent Stephenson's great big shell of a house on the high prairie, 8 miles north of Atlanta, was identified. A long rift of sky appeared in the eastern horizon; and what at first appeared to be a cloud, but quickly appeared to be land much farther away than Rice county, lay in a low flat cloud half a degree or so in diameter, about one-third of a degree above the eastern horizon. The roseate glow of both horizons showed that the sun was very close to the edge. The upper horizon was the redder.

It still lacked nearly ten minutes of sunrise; and I watched, forgetting all else, to see the sun appear in the rift between the two horizons. To my surprise he began to appear over the upper horizon, fully eight minutes before his time, and looking like a long line of prairie fire extending north and south along the horizon. He soon appeared fully above the horizon and looked like an enormous elongated red football lying on its side with the ends north and south.

Three minutes of time had passed. Eight minutes of time is equivalent to 2° of longitude, amounting in the latitude of Great Bend to 109 miles. Hence the sun was seen at a time when it must have been fully 2° below the horizon and ought to be just rising in eastern Marion county, or even Chase or Butler. Presently the rift of sky and the upper horizon disappeared altogether, sun and all, and the true sun began to rise a second time, still about one and one-half minutes before his stated time; but this time only slightly flattened.

Looking to the north over Cheyenne Bottom the entire plain was alive with a wavy, tremulous motion, like hot air rising from a furnace. Atlanta and Larned had now disappeared. The temperature was 34° and the show was over.

Passing down to the surface of the upper stratum of cold air, the mirrored appearance was still faintly to be seen; but it was being broken up by a slight breeze flowing from the northwest. At the station at 7:20 the temperature was 22°, a rise of 7° in about half an hour. Passing on down into the valley the temperature was found to be 15°, a rise of 9°. Continuing into the creek bottom the mercury dropped to 10°, a rise of 8° from the first observation. This showed that the breezes stirring on the hill had not yet reached the bottom.

Mirage of this character is usually most noticeable, not when the temperature is so low as in the case noted, but when the temperature is close to the freezing-point. Then the cold frosty air flows into the valley, leaving the warm air on the high lands. That is why frost appears first in valleys and low grounds, and why there is less frost in spring and fall on a hilltop. Perhaps that was true in the case noted, as shown by the temperature taken from the stone heap on the summit.

One of the most notable cases of refracting mirage that has come under my observation was one that occurred on the night of November 2, 1899, at Topeka. This was not known as a mirage. It would have passed entirely unnoticed had not a preconcerted arrangement been made over a wide extent of territory in order to determine the visibility of certain phenomena.

There were to be some fireworks burned in Topeka in honor of the return of the Twentieth Kansas from the Philippines. At my solicitation, the Topeka *Capital* offered a series of prizes to the ladies of the country surrounding Topeka who should be fortunate enough to see the fireworks at the greatest distance. Therefore, thousands of people in the counties surrounding Shawnee were on the watch at the appointed hour.

Hundreds of letters were sent in in the next two days, and some of them from astonishing distances. The farthest was from a lady at Salina, 104 miles distant in an air-line, who claimed to have seen reflections in the sky. The letters were all turned over to me for digestion and disposal. This required my best mathematical ability in order to do justice to all and wrong to none.

The topographical maps of the United States Geological Survey were used to determine altitudes.

Topeka lies in a platter-like valley, whose rim is from 10 to 25 miles distant and raised from 200 to 370 feet above the city. The city itself is located on several gentle ridges, averaging about 75 feet above the level of the Kaw river. The base of the capitol building is about 90 feet above the river.

The fireworks were "let loose" from the capitol building and state grounds at 8:20 to 8:45 P. M. They consisted mainly of Roman candles, red fire, sky-rockets, and bombs. The candle balls were fired to an elevation of 75 to 150 feet from the landing at the base of the cupola on top of the dome of the state-house, 280 feet from the ground, being an elevation of 350 to 430 feet. The red fire was burned on a ledge at the base of the dome, 190 feet from the ground. The rockets were fired from a balcony 30 feet lower, and, while fired at somewhat of an angle, were supposed to reach an elevation of 650 to 700 feet. The bombs, which were called "thousand-foot," were fired from the ground, and were supposed to reach an elevation of 650 to 800 feet. The bombs on bursting displayed fires of various colors.

Ordinarily the bombs and rockets should be seen to a distance of 25 to 30 miles. They were seen in every direction very much farther than that. Colors were generally distinguishable to a distance of 27 miles. The greatest distance from which colors were distinguished was 29 miles. This, however, did not depend upon mirage, but upon personal peculiarities.

Toward the northeast the fireworks were seen at Nortonville, 34 miles distant, north 38° east. Horizon toward Topeka dead level or depressed 1′ of arc below a level. Height of fireworks required, 700 feet. This showed no evidence of mirage, or at most only very slight.

Toward the northwest the greatest distance reported was Soldier, 39 miles distant, north 27° west. Horizon toward Topeka depressed 4′ of arc below a level. Height of fireworks required, 754 feet. This was normal; the fireworks should have been seen farther in the same direction but for the intervention of the hills.

They were seen at Edgerton, Johnson county, 42 miles distant, south 60° east. From here the fire-balls were seen to rise just barely above the horizon, rest for a moment or move in a curve, then fall back. This observer was not the farthest.

They were seen from an upstairs window of the poor-farm at Garnett, Anderson county, 56 miles distant in an air-line, south 27½° east. Horizon toward Topeka elevated 2′ of arc above a level. Necessary height of fireworks, 2210 feet. This is a most astonishing thing, and is what caused the question of mirage to be instituted. The reliability of the observers had to be first established; then the chance of their seeing something else, as shooting stars or fireworks at some intermediate point, was considered and rejected; finally the question of mirage was considered and established beyond question. The conditions were favorable: A clear sky; a lulling of the wind to about one to two miles per hour; a slight frost; temperature 34° to 28°; rapid radiation from the earth and consequent settling of the cold air into the valleys. Under these conditions there surely was mirage; though it could not have been known or noticed except under the peculiar combination of circumstances that then prevailed. The accounts of these observers were confirmed by numerous other letters received from Lyndon, Quenemo, Pomona, Williamsburg, Waverly, and Lebo, from 30 to 48 miles distant.

Greatest distance southwest was at Ottumwa, 6 miles northwest of Burlington, Coffey county, 52 miles distant, south 5° west. Horizon toward Topeka elevated 2′ of arc. Necessary height of fireworks, 2034 feet. This is another case that shows the effect of mirage. This place happens to be in the same end of the oval of vision and is governed by the same conditions as Garnett.

Whether this mirage was of the pure refracting kind cannot be told. A ball of fire may be inverted without changing its appearance. It is probable, however, that to observers in Anderson and Coffey counties, some low-lying, light, fleecy clouds, not visible at Topeka, overhung Osage and western Franklin counties, and reflected the fireworks into the lower counties. This is the more probable from the statements of the observers, who were almost unanimous in saying the fireworks appeared at a height of 2° to 3°. The fireworks were not seen at Ottawa or Princeton, well within the circle of vision.

A full description of this remarkable phenomenon may be seen in the Topeka *Daily Capital* of November 19, 1899.

This map shows the area over which the fireworks could be seen in favorable localities. This area covers 6000 square miles, equal to about ten counties. (Map not reproduced.)

It is to be observed that the longest diameter of this oval (87 miles) lies precisely in the direction that the wind blew that night;

and the longest extension of it (56 miles) is with the wind. How much the wind has to do with modifying the form of the circle of vision I do not know. Ordinarily I would expect the longest diameter of this circle to be east and west, in accordance with the valley of the Kaw.

These observations show that mirage occurs often; always occurs at night, when the wind is calm, the sky clear, radiation strong, and the temperature falling. It usually disappears as soon as the temperature begins to rise in the morning.

Ordinarily in Kansas, with its lovely skies and transparent air, we do not have to "wait until the mists gang awa'" in order to be able to "see as far as the mune."

PHYSICAL PROPERTIES OF WATER, AND ITS RELATION TO TREE GROWTH.

By BERNARD B. SMYTH, Topeka, Kan.

Read before the Academy, at Topeka, December 29, 1904.

CONSTITUENTS OF WATER.

TEXT-BOOKS on chemistry and physics give us the quantity of hydrogen and of oxygen it takes to constitute a molecule of water; but they do not tell us what part of a millidyne of potential energy, how many millionths of a microcalory of latent heat, what fraction of a millimicrofarad of static electricity, enter into its make-up. It is certain, however, that light, heat, electricity, and other forms of radiant energy, are all stored up in measurable quantities in that same little molecule of water. These are physical elements, and are just as essential to the formation of water as are the chemical elements hydrogen and oxygen. These factors are all essential elements in the constitution of water, and both physical and chemical elements are transferred according to fixed laws to other forms of matter.

CHARACTERISTICS OF WATER.

Water is the great universal solvent of nature. It dissolves and combines with nearly everything in nature, though with varying degrees of force. It has in all cases an ameliorating, a softening, a dissolving influence. Even the hardest rocks finally succumb to its persistent and powerful attacks. Naturally all substances do not yield with equal alacrity to its magic influence. Some substances even have an antipathy for water. Oil, for instance, resists successfully its most powerful onslaughts. And yet water can, with time, destroy an oil film; and in combination with or in presence of other substances, as alcohol, for example, may destroy and absorb the oil itself.

Water is also a ready absorbent of odors and gases. It thus becomes the great purifier of nature.

Pure water is neutral. It is neither acid nor alkaline. It of itself it has neither taste, odor, nor color. All these are readily imparted to it by the substances it holds in solution. Therein lies the secret of good cooking. Taste, odor or flavor, and color are all imparted to it at will.

Water at one place dissolves minerals and takes them up; runs to another carrying the minerals with it; is evaporated and dried up, leaving the minerals behind; returns empty-handed to the starting-point in the form of vapor; is there reconverted into water; returns to the earth and repeats the performance.

Water is the great leveler, not of men but of mountains. In this direction it does a vast amount of work. If the mountains are high, there is much to do; so the water runs swiftly and carries a large amount of material, both in solution and suspension, and hurries away to the sea with its load. Unlike men, the faster it runs the heavier the load it carries. If the land is broad and the mountains and hills are low, there is little to be done; so the water runs leisurely and carries little material except in solution.

Water is the great universal carrier that conveys to every living being, whether plant or animal, the heat, electricity, and chemical elements necessary to its well-being, happiness, and full development. Every drop of water carries with it, wherever it goes, a force that is necessary for the building up of new tissues and new forms. In this respect water is the most important element on the face of the earth. Its constituents also are the most abundant. Hydrogen is one of the most abundant elements; and oxygen is said to compose half the mineral material of the earth and two-thirds of all the animal and vegetable matter.

FORMS OF WATER.

Water, like most substances, may have either of three forms—liquid, solid, or gaseous. There is a fourth form, resulting from the solidifying of the vaporous form without liquefaction and in combination with a large amount of atmospheric air. This we call snow. The air may be squeezed out of it at any time by simple compression. It then becomes true ice.

At ordinary temperatures, between 32° and 212° of the common Fahrenheit thermometer, water is a liquid composed of the two gases named. Hydrogen, the basis, is supposed to be the gaseous condition of a metal, gaseous at all earthly temperatures. It is the lightest of all known gases. It has been liquefied at 400° below zero F., under a very high pressure. No cold has been produced sufficient to liquefy hydrogen at ordinary atmospheric pressure. No cold can be produced on earth that will solidify hydrogen without pressure. Oxygen, the life-giving element, is a gas at all ordinary temperatures. It may be liquefied, but at a very low temperature and under an enormous pressure.

Below 32° F. water becomes solid, and is then called ice. When ice is floating in ice-water it has the same temperature as the water. Before the ice can change to water it must absorb as much heat as is necessary to raise ice-water to 176° F., four-fifths the amount of heat required to boil ice-water with all the ice removed from it.

Conversely, water in freezing gives out four-fifths as much heat as is necessary to raise the same amount of water from the freezing-point to the boiling-point. This explains the mildness of the fall and winter in regions surrounded by lakes or other large bodies of water. This is a case where the air, which is deficient in natural heat, borrows in the fall and winter large quantities of heat which it must repay next spring and summer from its surplus stock of heat. Does it repay any interest on the borrowed heat? I think not; there appears to be a mutual benefit.

The changing of vapor into rain or snow always causes a large amount of heat to be set free in the air. That explains one of the reasons why, during a snow-storm, with the wind in a damp quarter, as east or northeast, the thermometer never records so low a temperature as it does when the wind is in a dry quarter, as west or northwest.

Snow is a beneficent thing. While in itself it is cold to the ordinary senses, it is an excellent non-conductor of heat and prevents to a large degree the passage of heat from and cold into the underlying earth. It also melts slowly and thus the water becomes absorbed by the soil instead of running off to the sea.

The third natural form of water is as vapor or steam. Steam is the true gaseous condition. Above a temperature of 212° F., liquid water cannot exist except under an increased pressure. Water in being converted into steam absorbs an enormous amount of heat. The heat that water at 212° F. absorbs, in being converted into steam at the same temperature, is sufficient to raise five and one-half times the same quantity of water from the freezing-point to the boiling-point.

Steam is converted into vapor simply by loss of heat on its escape from confinement into the open air. The condition of vapor depends on the amount of heat combined with it. The greater the amount of heat combined with it, the smaller the particles. The amount of heat combined with water accords with the amount of surface. In steam, which contains the greatest possible amount of heat in its composition, the particles are probably reduced to molecules, thus having the greatest possible amount of surface. When steam is superheated—heated above 212° F.—the repulsion of the particles for each other and the distance of the molecules apart are both greatly increased.

On the other hand, as heat is given out in the open air, the particles unite and thus surface is reduced. When much of the heat has been parted with, the vapor particles are large enough to become visible and clouds are formed. With the loss of more heat, mist is formed. When the surplus heat is about all gone, rain is formed.

Water may be converted into vapor at all temperatures below the boiling-point. The amount of heat absorbed by water on conversion into vapor is always great. The greatest evaporation is in the hottest regions and where there is the greatest water surface. This vapor with its contained heat is borne by the winds to cooler regions, where it is condensed into rain or snow and its surplus heat liberated in the air. Thus is the climate ameliorated at both ends of its journey.

After all, we discover, on reflection, that water, after carrying its load of earth from the mountains to the sea, does not return empty handed. On the contrary, it serves a useful purpose wherever it goes; for, after carrying its load of earth from the mountains to the sea, it carries back with it a load of heat from the sea to the mountains.

Snow and ice, too, may be evaporated and all dried up without liquefaction. This is in case dry winds from the interior blow over them. Evaporation of snow, of course, abstracts heat from the surroundings; but dry cold air is less keenly felt than damp cold air. Besides, the heat taken up is sooner or later returned to the air.

OTHER PROPERTIES OF WATER.

Water has its greatest density at 3.9° C., equivalent to 39.2° F. Above that it expands slightly for every increase of heat up to 212°. It then suddenly absorbs a very large quantity of heat; increases vastly in size; and is converted into steam. So far as water is concerned, 39.2° F., might be called its zero of temperature, where it is neither hot nor cold. Below 39° water increases in size for every increment of cold until 32° is reached in fresh water. At 32° it absorbs enough cold to reduce the same quantity of water from 176° down to the freezing point, increases one-eleventh in size, and takes the solid form.

Pure water holds to salt, as in sea-water, with a tenacity equal to four degrees of temperature; that is, sea-water does not freeze at 32° but continues liquid and to increase in size till 28° is reached; then the water freezes, squeezing out the salt. As the amount of salt increases, the degree of cold required to freeze the water necessarily increases. Ice, being only eleven-twelfths the weight of water, floats on the surface of the water.

Then, while ice may and does transmit radiant heat from the sun, as glass does, permitting objects under the ice to become slightly warmed by solar heat, it is a very effective barrier against the admission from the air of cold that comes through convection. It thus acts as a protecting blanket, permitting passage of heat from the sun, yet effectually preventing the escape of heat from the water and preventing the cold above from passing into the water, thus conserving the life below.

The change of form from water to ice is progressive, not sudden like the solidifying of melted lead, iron, or mercury. This is on account of the very large amount of cold which the water must absorb from the air in order to be converted into ice. These are all very important features, upon which the well-being and happiness of all forms of life depend.

For, if the water continued indefinitely to shrink on parting with its heat, and to shrink still further on being solidified, as lard and very many elements and compounds do, all bodies of water must freeze up from the bottom and continue to freeze upward to a level within the influence of the sun's radiation. Whether this freezing would extend to all bodies of water underground suggests an appalling thought.

At the present time the temperature of the water in the great deeps of the Atlantic, South Pacific and Indian oceans is 39.2°, which is water of the greatest density and gravity. The temperature cannot get lower than that without the water at the surface first freezing. If the temperature of the water in the great deeps of the North Pacific is not so low as 39.2° throughout the entire year, it is because there is not sufficient arctic current through Bering strait to cool the entire North Pacific; the antarctic currents have too far to travel, and a great warm stream, the *kuroshiwo* or black current of Japan, passes directly over Kurile Deep, the deepest part of the North Pacific.

And if there were a zone in the ocean where the water should be 39.2° F. at the surface, then all the water along that zone, from surface to bottom, as a wall, would be 39.2°. This is impossible, for then along such a zone the water would be heavier than either north or south of it. It would immediately sink, and the lighter waters from both north and south would flow into its place.

Yet this is precisely what does happen, not as a wall, but as an anticlinal ridge with a gently-falling surface, along a zone from Cape Breton, northeasterly past Newfoundland and Iceland, to the northern coast of Norway; from Sitka, along the Aleutian and Kurile islands, to Yezo; and in the southern ocean all around the earth in the latitude of Cape Horn Both of those zones are farther northward in July, farther southward in January. They are the zones of frequent storms. Along those zones the lighter waters of 40° F. and upward from the equatorial regions meet and commingle with the lighter waters of 38° and less from the polar regions, becoming an average temperature of 39° or thereabouts. Then, by reason of the increased density and gravity, the waters sink, making room for new waters to flow in from both directions, thus keeping up constant, wide-spread surface currents toward the zones. This is the undoubted cause of both the Gulf stream and the *kuroshiwo*, and the principal cause of all oceanic currents.

TEMPERATURE OF WATER IN OCEANS.

At the bottom, along those zones of greatest density, the water spreads out over the floor of the ocean and flows (1) toward the poles, warming the waters there, melting the ice on its under surface, and displacing the colder, lighter water, which in turn flows back, loose ice and all, toward the baryhydric (or heavy-water) zone; and (2) toward the equator, where it meets a similar current from the opposite pole, and must eventually become warmed itself in turn. There it underruns and lifts all the waters, rising itself as it becomes warmed and displacing the very warm waters at the surface, which must of necessity flow away in both directions toward the poles. Thus is circulation in the oceans maintained.

What a beneficent provision of the Creator! Could anything be arranged more admirably or with greater wisdom for the welfare and happiness of mankind and all animate creation?

For, suppose for a moment that the greatest density of water were at 60° instead of 39°. The zones of greatest density and most frequent storms, instead of being near the polar circles, as at present, would be near the tropics; in the North Atlantic, say from Florida to North Africa, and in the South Atlantic from Rio de Janeiro to South Africa. Between those zones the surface currents would be from the deepest equatorial or hottest seas. Outside of those zones, in the oceans, all surface currents near the shores would be from the poles; the land on either side would experience arctic weather whenever the wind blew from the ocean.

But there would be no polar ice cap unless the pole were in the heart of a continent. The temperature of the water at the bottom of even a polar sea would be about 60°; and as the waters there must rapidly cool and come to the surface, the shores of a polar ocean would be more habitable than the interior of a great continent above latitude 50°, or say up to 3000 miles from the pole.

The equatorial seas, by reason of the circulation being restricted to little more than half the quantity of water, would have nearly double the difference in temperature between the bottom and surface that they now have.

The temperature of the bottom of the equatorial seas at present is about 39.2° F.; of the surface about 84.2°. That makes a difference of 45°; double that would be, say 90°. If, then, the bottom of the seas near the equator were 60°, which would have to be the case, and the surface were 90° higher, the surface would be 150°, too great to support life such as we now know. All oceanic currents, too, would be furious instead of gentle, as at present. Evaporation would be much more rapid than at present and condensation more swift and sudden. There would be no temperate climate on the earth; all would be either frigid or torrid, or both together. The tropics would be the abiding-place of violent storms.

How much, then, must we admire the superlative, the infinite wisdom and goodness of the great Creator in so fashioning us that everything as made is for our greatest enjoyment and welfare.

CAPILLARITY.

Water is the vehicle by which mineral foods of all necessary kinds are carried even to the tops of the tallest trees. There is a power connected with water that is greater within certain limits than the attraction of gravitation. That is capillarity, or, as it is often called, capillary attraction. This depends on two powers—first, *adhesion*, or the attraction of wood or vegetable fiber for water; second, *cohesion*, or the attraction of the particles of water for each other, so that the surface never becomes broken. Every housewife knows that if a wet cloth be left hanging over the edge of a tub the water will creep over and run out. In the case of the cloth there is a great deal of surface for the water to cling to with little space between the various thread surfaces; so that in that case capillarity is stronger than gravitation. I have seen an old cottonwood stump four feet high, its roots in the water during a freshet, two years after the tree had been cut, with the soured water creeping out over the top of the stump, being fed upon by numerous insects, and the water flowing over in such quantity as to trickle down the sides of the stump after some of it had been evaporated.

I do not know the limit where there is a balance between gravity and capillarity; but the diameter of such a capillary tube must be greater than the largest sap duct in wood and much less than half the diameter of a drop of water. The size of the largest capillary tube must depend upon the nature of the material of which the tube is composed and its power of adhesion to water. Of several substances the relative power of attraction for water is as follows, the one having the greatest attraction being first: Salt, wood or carbon fiber, sand, glass, loam, chalk, iron filings, shale, unburnt clay, tin. Clay and shale may even repel water and be impervious to it if they contain oil in any quantity and no sand. A small percentage of salt in earth greatly increases its capacity to admit water.

The power of capillarity also depends much on temperature. Thus, water that will scarcely enter or flow in capillary tubes just above the freezing-point will flow readily at 50° F., and still more rapidly at 80°.

STRUCTURE OF WOOD IN TREES.

The wood of trees is constructed in the form of cells. Wood cells are from a fraction of a millimeter up to several inches in length, and very small, even microscopic, being 10 to 50 microns in diameter, equivalent to 500 to 2500 transversely to the linear inch. They usually taper to points and lap over so as to break joints; but sometimes they end in the same plane so as to form a joint, in stems, as in grasses and polygonums; at the ground, as in tumbleweeds; at the insertion of a leaf, leaflet, stem of a flower, fruit, etc., so as to break off at maturity; or at the end of a year's growth in the twigs of trees, as in cottonwood or elm. Except in the main branches of such trees the cells often continue for a few years to end at the same place, the joint or ring. Eventually, if the twig be not shed with the leaves, the cells lap over and the ring disappears.

STRUCTURE OF EVERGREEN TREES.

In all the evergreens (conifers) the cells are comparatively large, uniform, and arranged in remarkably straight rows radially; the radial rows of cells are very close together, making all cell-walls thin. In many species the wood cells are formed at all seasons of the year with about the same rapidity; yet the wood of winter is decidedly harder, more compact, and of a higher color than that of spring and summer, thus making the rings quite as easily counted as in deciduous trees, or those having annual leaves. The resin ducts are much larger than the cells, being from 80 to 160 microns in diameter; are scattered and irregular, and most generally in the outer though sometimes in the inner part of the rings. The radial plates or medullary rays are very narrow and thin, consisting of two to fifteen or more horizontal parallelepipedal cells radially extended and laid in a single series vertically, like bricks set on edge lengthwise in a wall, rarely two or three series together, and extending from the pith or from some place in the interior of the tree to and sometimes slightly into the bark. These cells carry food from the elaborated sap in the space between the wood and bark and from the inner layers of bark to the interior of the tree, to feed and strengthen the cells previously formed. They also strengthen the wood of the tree by crossing the regular grain and binding the rings.

In megacellular trees, such as common hemlock, bald cypress, noble fir, coast redwood, and sugar pine, which have the largest cells of any of the evergreen trees, the cells measure thirty-five to forty-five microns in cross section tangentially to the tree, and from thirty to fifty microns radially; and there are from 300,000 to 600,000 cells to the square inch. These can be readily seen, but not readily counted, with the unaided eye.

In mesocellular trees, such as giant redwood, Monterey cypress, most of the firs, the spruces, and nearly all the pines, the cells measure twenty-five to thirty-five microns tangentially, and twenty to forty microns radially; and are 600,000 to 1,200,000 cells to the square inch. These cannot be counted without a lens.

In microcellular trees, such as mountain hemlock, Pacific coast cypress, California red and white fir, Pacific yew, and all the cedars and junipers, the cells measure fourteen to twenty-eight microns in diameter either way; and are 1,200,000 to 2,500,000 cells to the square inch. One of the finest-grained woods of all is sweet-fruited juniper, whose cells measure twelve to sixteen microns across, either radially or tangentially; and there are from 2,500,000 to 3,000,000 cells to the square inch. These can scarcely be seen with the naked eye and cannot be counted without the aid of a good compound microscope.

The tallest trees are those having medium-sized cells, capillarity being less in the larger cells, and trees with finer cells, such as the cedars and junipers, having less capacity and requiring a highly specialized food, which is taken only in small quantity. Besides, the sap is very heavy to start with in such trees, requiring and receiving very little evaporation in elaboration. This accounts, too, for the smallness of the leaves and the exceedingly slow growth of such trees.

In almost all spring and summer wood of coniferous trees the cells are extended or broadened radially; in autumn and winter wood, on the other hand, the cells are compressed radially, being less than half the breadth of the early cells. The breadth of the cells tangentially to the tree is limited by the distance apart of the radial plates. This is very uniform, though slowly increasing from year to year until a limit is reached; then a cell divides radially and a new radial row of cells and a new set of radial plates appear. Usually there are from two to five or six radial rows of cells at any horizon between two radial plates; in the latter case the formation of a new radial plate reduces the number of rows between plates to two or three. One-fourth of an inch higher up or lower down in the tree the radial plates are in new positions relatively to the vertical cells.

The following table gives (1) the number of cells, (*a*) tangentially and (*b*) radially, across the field of the microscope in cross-sections of the various species of woods named. From these data are calculated (2) the measurements, (*a*) tangentially and (*b*) radially, of the cells, in microns or thousandths of a millimeter; (3) the number of cells in a square millimeter; (4) the number of cells in a square inch, and (5) the grade of fineness of the grain of the wood, "(1)" being coarse or megacellular, "(2)" medium or mesocellular, and "(3)" fine or microcellular. Numerous examples were taken of each kind of wood and a general average taken. Measurements of cells are of the cells complete, including walls; measurements of ducts are of the passages only.

Instrument used: Bausch & Lomb compound, with substage condenser and no micrometer; eyepiece, one inch; objective, three-fourths of an inch; draw-tube closed; diameter of field, 1,587 to 1,610 microns, almost exactly one-sixteenth of an inch. Woods used: Hough's sections of American woods.

COMPARISON OF CELLS OF VARIOUS EVERGREENS.

(Diameter of field, 1.6 mm.=.0625 inch.)	Number of cells across field.		Diameters of cells, in microns.		Number of cells to square millimeter.	Number of cells to square inch.	Grade..........
	Tang.	Rad.	Tang.	Rad.			
No.							
1. Abies amabilis, red silver fir..............	54 60 69	54 62 67	29 26 23	29 25 23	1,492	962,576	(2)
2. Abies balsamea, balsam fir. (Pits: outer diameter, 16 microns; inner diam., 4 mic., approx.)	52 55 57	42 48 54	30 29 27	38 33 29	1,388	895,840	(2)
3. Abies concolor, white fir. (Depth of annual rings from 10 cells radially =.2 mm. to 330 cells = 7 mm.)	60 70 80	60 80 93	26 23 20	26 21 17	2,198	1,417,760	(3)
4. Abies grandis, great silver fir.............	43 50 64	40 54 75	37 32 25	40 29 21	1,182	763,904	(2)
5. Abies magnifica, great red fir. (Pits: outer diam., 16 mic.; inner, 5 mic.; diam. of resin ducts, 78 mic.)	58 64 72	68 74 78	27 25 23	23 21 20	2,083	1,342,976	(3)
6. Abies nobilis, noble fir	40 45 48	38 41 46	40 35 33	42 39 34	732	472,320	(1)
7. Chamæcyparis lawsoniana, Lawson cypress, "Port Orford cedar."	51 66 72	52 60 69	31 24 22	30 27 23	1,504	969,680	(2)
8. Chamæcyparis nutkatensis, Nootka cypress, "yellow cedar." (Depth of annual rings often 4 cells only = .07 mm.; 32 to 144 rings to the linear inch.)	78 88 96	78 97 106	20 18 16	20 17 15	3,177	2,049,024	(3)
9. Chamæcyparis sphæroidea, white cedar. (Pits small, about 18 mic. in diam.)	63 69 77	64 70 81	25 23 21	25 23 20	2,002	1,290,240	(3)
10. Cupressus arizonica, Arizona cypress......	87 95 106	75 85 96	18 16 15	21 18 16	3,229	2,089,000	(3)
11. Cupressus macnabiana, cypress	65 70 75	65 76 94	24 23 21	24 21 17	2,196	1,419,760	(3)
12. Cupressus macrocarpa, Monterey cypress. (Pits: inner diam., 3 to 5 mic.; outer, 13 mic.; average diam. of resin ducts, 112 mic.)	56 60 65	56 63 70	28 26 24	28 25 23	1,500	967,680	(2)
13. Juniperus californica, sweet-fruited juniper. (Pits: inner diam., 3 mic.; outer, 11 mic.; interspaces, 0 to 6 mic.)	80 97 112	95 103 112	20 16 14	17 15 14	3,925	2,531,328	(3)
14. Juniperus occidentalis, Western juniper. (Pits: inner diam., 3 mic.; outer, 11 mic.; interspaces, 0 to 6 mic.)	84 94 104	84 100 103	19 17 15	19 16 15	3,588	2,310,144	(3)
15. Juniperus pachyphlœa, thick-barked juniper. (Pits: inner diam., 3 mic.; outer, 12 mic.; interspaces, 0 to 12 mic.)	87 94 104	84 100 108	18 17 15	19 16 15	3,660	2,359,040	(3)
16. Juniperus virginiana, red cedar. (Pits: inner diam., 3 mic.; outer, 12 mic.; interspaces, various.)	82 85 95	72 80 87	19 19 17	22 20 18	2,760	1,781,760	(3)
17. Larix americana, tamarack. (Pits: outer diam., 17 mic.; inner, 3 to 5 mic.; interspaces, 4 mic.)	52 57 65	46 56 72	30 28 24	34 28 22	1,384	890,024	(2)
18. Larix occidentalis, Western tamarack. (Pits: inner diam., 3 to 6 mic.; outer, 16 to 22 mic.; interspaces, 3 mic. or more.)	44 51 55	48 51 55	36 30 29	33 30 29	1,012	652,800	(2)

COMPARISON OF CELLS OF VARIOUS EVERGREENS—CONTINUED.

(Diameter of field, 1.6 mm.=.0625 inch.)	Number of cells across field.		Diameters of cells, in microns.		Number of cells to square millimeter.	Number of cells to square inch.	Grade..........
	Tang.	Rad.	Tang.	Rad.			
No.							
19. Libocedrus decurrens, incense cedar.......	48 58 68	65 75 90	33 27 23	24 21 18	1,770	1,143,300	(2)
20. Picea alba, white spruce..................	47 56 62	52 62 69	34 29 25	30 25 23	1,334	858,880	(2)
21. Picea engelmanni, Arizona spruce.........	63 69 79	56 69 82	25 23 20	28 23 19	1,940	1,254,144	(2)
22. Picea nigra, black spruce. (Pits: outer diam., 13 mic.; inner, 4 mic.; resin ducts, 80 mic.)	53 58 60	54 62 73	30 27 26	29 25 22	1,210	780,160	(2)
23. Picea sitkensis, Sitka (tideland) spruce. (Pits: inner diam., 4 mic.; outer, 19 mic.; interspaces, 0 to 10 mic.; pits occasionally overlap.)	40 45 50	45 60 68	40 35 32	35 26 23	1,328	885,660	(2)
24. Pinus attenuata, knob-cone pine. (Resin ducts, 100 mic. in diam., mostly in autumn and winter part of the rings.)	54 69 74	55 66 78	29 23 21	26 23 20	1,728	1,115,136	(2)
25. Pinus clausa, sand pine. (Resin ducts numerous, brown, mainly in inner part of annual rings.)	60 61 64	60 62 64	27 26 25	27 26 25	1,500	968,192	(2)
26. Pinus contorta, twisted pine. (Resin ducts light brown, mainly in outer part of annual rings.)	50 64 68	61 63 65	31 25 23	26 25 24	1,520	983,808	(2)
27. Pinus coulteri, big-cone pine. (Cell-walls very thin; resin ducts, 120 mic., in autumn wood.)	45 50 60	45 55 62	35 32 26	35 29 25	1,134	732,160	(2)
28. Pinus echinata, short-leaf yellow pine. (Resin ducts amber, in middle of rings.)	44 50 56	54 59 62	36 32 28	29 27 25	1,150	742,400	(2)
29. Pinus lambertiana, sugar pine............	44 50 55	42 54 59	36 32 29	38 29 27	1,032	665,600	(2)
30. Pinus monophylla, single-leaf pinon.......	50 54 60	61 79 87	32 29 26	26 20 18	1,660	1,070,080	(2)
31. Pinus monticola, mountain pine. (Resin ducts white, in outer part of rings.)	45 53 61	50 55 60	35 30 26	32 29 26	1,156	746,240	(2)
32. Pinus muricata, pickle-cone pine..........	54 58 61	52 59 66	29 27 26	30 27 24	1,358	876,032	(2)
33. Pinus palustris, long-leaf yellow pine. (Pits: outer diam., 20 to 24 mic.; inner, 4 to 7 mic. Resin ducts, 80 to 160 mic.)	44 52 58	48 53 60	36 30 27	34 30 26	1,092	705,024	(2)
34. Pinus ponderosa, bull pine. (Resin ducts, 140 mic. diam., burnt-sugar color.)	40 44 54	48 55 61	40 36 30	33 29 26	1,005	647,680	(2)
35. Pinus radiata, Monterey pine. (Resin ducts, 130 mic. diam., brown; resin in ducts, yellow.)	48 52 64	60 66 76	33 30 25	26 24 21	1,464	943,360	(2)
36. Pinus resinosa, "Norway" pine. (Resin ducts, 95 mic., numerous, yellow.)	56 68 83	51 62 88	28 23 19	31 25 18	1,833	1,183,488	(2)

COMPARISON OF CELLS OF VARIOUS EVERGREENS — CONCLUDED.

(Diameter of field, 1.6 mm. = .0625 inch.)	Number of cells across field.		Diameters of cells, in microns.		Number of cells to square millimeter.	Number of cells to square inch.	Grade........
	Tang.	Rad.	Tang.	Rad.			
No.							
37. Pinus rigida, pitch pine. (Pits: inner diam., 4 mic.; outer, 21 mic.)	54 59 66	54 61 67	29 27 24	29 26 24	1,450	934,460	(2)
38. Pinus sabiniana, gray-leaf pine. Annual growth, 6 to 12 mm. One radial row of $\frac{7}{16}$ in. in an an. ring contained cells as follow, in seven successive fields, counting outward: 44, 46, 49, 53, 60, 70, 83; total, 405.)	48 58 68	46 65 76	33 27 23	34 25 21	1,436	920,576	(2)
39. Pinus strobus, white pine. (Resin ducts small, 100 mic., white.)	48 51 54	47 50 55	33 31 29	34 32 28	1,034	665,856	(2)
40. Pinus virginiana, scrub pine..............	60 63 66	62 70 78	26 25 24	26 22 20	1,750	1,128,960	(2)
41. Pseudotsuga douglasii, Douglas spruce...	52 63 79	57 75 112	30 25 20	28 21 14	2,084	1,347,840	(3)
42. Pseudotsuga macrocarpa, big-cone spruce,	45 51 57	55 59 63	35 31 28	29 27 25	1,196	770,303	(2)
43. Sequoia gigantea, giant redwood.........	44 48 52	40 48 57	36 33 30	40 33 28	914	589,824	(1)
44. Sequoia sempervirens, coast redwood.....	31 33 35	31 35 41	51 48 45	51 45 39	472	304,128	(1)
45. Taxodium distichum, bald cypress. (Pits: inner diam., 4 mic.; outer diam., 12 mic.)	47 54 60	45 50 54	34 29 26	35 32 29	1,072	691,200	(2)
46. Taxus brevifolia, Pacific yew.............	62 75 90	73 80 84	25 21 18	22 20 19	2,382	1,537,024	(3)
47. Thuya occidentalis, arbor-vitæ............	69 84 94	64 78 83	23 19 17	25 21 19	2,293	1,480,576	(3)
48. Thuya plicata, Pacific arbor-vitæ..........	63 68 72	65 71 76	25 23 22	23 22 21	1,914	1,235,968	(3)
49. Tsuga canadensis, hemlock. (Depth of annual ring, 240 cells, averaging one cell a day for eight months, in each radial row of cells.)	48 55 60	50 55 58	33 29 26	32 29 27	1,180	760,320	(2)
50. Tsuga heterophylla, Western hemlock.....	47 54 60	51 66 84	34 30 25	31 24 19	1,464	943,360	(2)
51. Tsuga pattoniana, mountain hemlock.....	61 72 84	59 76 94	26 22 19	27 21 17	2,204	1,420,832	(3)
52. Tumion californica, California nutmeg ...	44 50 54	40 46 50	36 32 29	40 34 32	876	564,480	(1)
53. Tumion taxifolia, stinking cedar	44 51 55	54 57 68	36 31 29	29 28 23	1,192	768,000	(2)

STRUCTURE OF DECIDUOUS TREES.

Deciduous trees have very fine cells, even microscopic. They range in size from 12 to 25 microns in diameter, and are from 1000 to 2100 to the linear inch. Besides the cells proper, or microcells as they really are, all deciduous trees have larger pores or crude sap ducts, which vary greatly in size in the different kinds of wood, being very large in oak, hickory, ash, and elm, and small in maple, poplar, apple, boxwood, and horse-chestnut.

The ducts, although differing greatly in diameter, are all well within the limits of capillarity. The larger ducts are provided at short intervals with valves to prevent sagging of the sap.

Among the woods having ducts above the average in size are willow, the diameters of whose ducts are from 50 to 110 microns, with much intervening cellular tissue: hickory, in which the spring ducts are 230 microns across and the ducts of the summer and autumn wood 60. In summer grape, in which the spring ducts are very large and oval, they measure 240 microns tangentially and 300 radially. These occupy apparently about one-third the space of the wood.

In many trees there are two sorts of ducts, the full philosophy of which I have not studied. In the spring formation of wood the ducts are very large, and may be one or several between each two successive radial plates. These ducts are usually well supplied with valves. The valves are often squarely across a duct, but oftener stand through the tube at every conceivable angle and are by no means always a uniform plane, but are frequently a spherical segment. They occasionally run parallel with the walls of the duct and subdivide it into several smaller tubes. Valves contain no pits; they are thin and require none. When straight across a duct they are usually at nearly regular distances. Frequently two ducts are side by side for a short distance, separated by a septum. Septa are provided with pits for the free transmission of liquids from one duct to another. In the summer and autumn wood the ducts are small, though varying much in size. These are sometimes solitary, sometimes grouped regularly and separated by pitted septa. These tubes contain no valves. Woods having the two kinds of ducts will be distinguished nominally by calling them heterotracheal, and the two kinds of ducts will be called macropores and micropores.

As examples of heterotracheal wood may be cited oak, hickory, chestnut, and catalpa. In white oak, for example, as in hickory, the larger ducts, or macropores, which occur in the spring growth of the wood, are 200 to 300 microns in diameter; the smaller ducts, or micropores, which are in the solider summer and autumn part of the rings, are 40 to 80 microns. In catalpa, also, the sizes vary much; the macropores average 200 microns; the micropores vary from 25 to 80 microns. The true cells, or microcells, are unusually large, about 21 microns. In chestnut the ducts are strongly oval in cross-section, with the longer diameter radial to the tree, as usual in deciduous trees; the macropores measure 320 microns the shorter way and 400 the longer way; the micropores average about 50 microns. The cells are 20 microns, which is very large.

In another group of trees the pores or ducts are all of one kind, though manifestly there are great differences of size. As prominent examples of one division of these may be cited maple, sycamore, cottonwood, and willow. In these the ducts are grouped into sets separated by thin cellular walls or septa. The number of ducts in a group varies from two to about five or six, seldom more. The distance between groups is usually much more than the breadth of a group. These are close-grained woods. In maple the ducts seldom exceed 75 microns, and occupy apparently about one-ninth of the wood. In sycamore the ducts are somewhat larger, but are crowded between the very strong plates; they occupy about one-seventh of the space of the wood. In cottonwood and willow the ducts are more uniformly distributed, are more numerous, and occupy about one-sixth of the wood. As a distinction for this class of woods they will be called gamotracheal.

In a third group, which comprises all our fruit-trees and some others, the ducts are all small, solitary, and very uniformly distributed. These are our closest-grained woods. For distinction, they will be called dialytracheal. In apple the ducts are elliptic to oval, measure 40 microns radially and four-fifths as much tangentially, and occupy about one-eighth of the space. In cherry the ducts are 30 to 60 microns, and occupy one-seventh to one-sixth of the space. In plum the ducts are quite equidistant; they vary in size from 30 to 50 microns tangentially and 30 to 60 radially, and occupy one-seventh of the wood. The rays are strong in plum. In pear the ducts vary from 25 to 45 microns and occupy one-eighth of the space. The wood is therefore about as close-grained and solid as apple wood. The cells proper, which are exceedingly fine, not exceeding 12 to 14 microns, are 1800 to 2100 to the linear inch, making possible 3,750,000 cells to the square inch. But, as there are 50,000 ducts to the square inch, occupying the space of ten times as many cells, it will be necessary to deduct about half a million from this estimate, still leaving 3,250,000 cells and 50,000 ducts to the square inch.

The rays or radial plates in the deciduous trees consist of strong, thin, lenticular, horizontal, radial bundles of cylindrical, cylindroidal, parallelepipedal, or even tabular cells placed on edge, and superposed either in straight vertical rows or promiscuously, the lenticels being from one cell thick at the lower and upper edges to 6, 10, 15 or more cells in the thickest part, and from 50 to 500 or more cells in height. Rays are sometimes one-fourth of an inch or more in breadth (height), and often contain several thousand cells in a radial bundle or plate. Such plates are very large and strong and hard, as in oak, sycamore, chestnut, water locust. As in evergreen trees, the primary rays originate in the pith. All rays end in the bark.

The comparative size of the ducts in a tree in any year seem to be inversely proportional to the leafage for that year. The number or size of the macropores does not vary much from year to year; but greater leafage in any year causes a greater thickness of summer and autumn wood with its accompanying micropores to be formed. Less leafage causes less solid wood to be built up; so that the relative amount of spring wood is greater. In trees that live near or by the edge of water, where the food supply is unvarying at all seasons, the ducts are of uniform size and the wood of uniform texture throughout the year. The same is true of trees that grow on mountain sides, where the supply is constant and uniform, though never superabundant.

MICROSCOPIC STRUCTURE OF DECIDUOUS TREES.

The following tables show to some extent the microscopic structure of the several kinds of wood named. The character of the ducts, radial plates and pits are sometimes shown. Diameters of the ducts and cells, both tangentially and radially, and the proportionate space occupied by the ducts and empty cells, are generally shown. The specific gravity of the various woods are shown for purposes of comparison. Measurements are given in microns, of which there are 25,400 to the linear inch. Measurements are not absolute, but only approximate and comparative. Minor and major figures are usually given, not absolute extremes. Magnification the same as in studying the evergreens.

HETEROTRACHEAL WOODS. (Woods in which the spring and summer ducts are unlike; macropores generally filled with valves.)	Diameters of macropores or spring ducts, in microns.		Diameters of micropores or summer ducts, in microns.		Relative space occupied by ducts.	Diameters of cells, in microns.		Specific gravity......
No.	Tang.	Rad.	Tang.	Rad.		Tang.	Rad.	
1. Ailanthus glandulosa, ailanthus. (Autumn cells solid; pits minute, very numerous, generally scattered).	160 250	200 300	26 40	24 46	10:76	10	15	.65
2. Castanea dentata, chestnut. (Pores and cells large; pits small, in straight longitudinal lines.)	120 320	180 380	25 45	30 70	10:64	16	22	.59
3. Catalpa bignonioides, catalpa. (All ducts full of valves in every direction; pits areolate, numerous, scattered.)	100 160	120 220	30 60	25 80	10:54	14 17	18 22	.45
4. Chilopsis saligna, "desert willow" (a sort of catalpa). (Pits areolate, scattered)............	100 150	120 180	50 75	60 90	10:56	12	18	.46
5. Fagus americana, (white) beech. (Rays strong, slightly reddish; micropores few, macropores running into autumn; pits small, scattered.)	30 50	30 70	20 30	20 30	10:90	14	16	.69
6. Fraxinus americana, white ash. (Pits large, irregular)......................................	120 210	150 250	25 50	30 60	10:68	16 18	20 24	.65
7. Fraxinus nigra, black ash. (Pits minute, irregular)..	100 150	120 170	25 40	25 50	10:64	16 18	18 22	.63
8. Hicoria alba (Raf.), shagbark hickory. (Micropores few; pits about 5 microns, in rectilinear rows; tangential brown lines in autumn wood.)	100 200	150 300	25 40	25 60	10:84	15	16	.83
9. Hicoria amara (Raf.), bitternut. (Micropores few; summer and autumn wood filled with continuous tangential brown lines, as in all the hickories.)	120 220	230 350	25 50	30 60	10:76	15	16	.75
10. Hicoria maxima (Raf.), mockernut. (Pores filled with valves; tangential lines and pits as in *H. alba*.)	100 150	120 180	20 50	25 60	10:84	15	16	.82
11. Hicoria porcina (Raf.), pignut. (Lines and pits as in *H. alba*)............................	120 210	200 330	30 50	30 65	10:82			.82

MICROSCOPIC STRUCTURE OF DECIDUOUS TREES—CONTINUED.

HETEROTRACHEAL WOODS. (Woods in which the spring and summer ducts are unlike; macropores generally filled with valves.)	Diameters of macropores or spring ducts, in microns.		Diameters of micropores or summer ducts, in microns.		Relative space occupied by ducts.	Diameters of cells, in microns.		Specific gravity......
	Tang.	Rad.	Tang.	Rad.		Tang.	Rad.	
No. 12. Hicoria sulcata (Britt.), big shellbark hickory. (Markings and pits as in *H. alba*)..........	150 220	220 340	30 50	30 70	10 : 80			.80
13. Juglans cinerea, butternut. (Radial plates weak; pits large, scattered; tangential brown lines broken.)	100 180	140 280	35 80	40 90	10 : 48			.45
14. Juglans nigra, black walnut. (Macropores filled with valves; micropores very few; pits trapezoidal, lunate, etc., 10 by 7 microns; tangential lines broken.)	90 180	110 220	40 100	45 120	10 : 64			.61
15. Morus rubra, red mulberry. (Ducts compound, practically filled with valves; pits 7, microns, regularly arranged.)	120 200	120 250	25 60	25 75	10 : 64			.59
16. Quercus alba, white oak. (Rays white, very strong, primary rays fully 20 cells thick in middle of plates; macropores filled with valves in all the oaks.)	110 230	180 290	30 65	35 75	10 : 70	15	16	.74
17. Quercus coccinea, scarlet oak. (Pits between ducts oval, areolate, 9 by 7 microns; against the rays about 4 microns, in rectilinear rows, as in all the oaks.)	100 230	180 290	25 50	30 60	10 : 68	14	15	.74
18. Quercus macrocarpa, bur oak. (Micropores grouped in radial areas, growing gradually less toward autumn, as in other oaks; duct pits, 10 microns; ray pits, 4 microns.)	80 230	100 290	25 50	30 55	10 : 72	15	16	.75
19. Quercus prinus, chestnut oak. (Duct pits oval, areolate, 12 by 9 microns; ray pits oblong to lunate, 6 by 4 microns.)	90 230	120 290	25 55	30 70	10 : 72	16	18	.75
20. Quercus rubra, red oak. (Rays and ducts as in other oaks; duct pits, 10 by 8; ray pits, 5 to 6 by 4 microns.)	100 240	130 300	25 50	25 60	10 : 62	14	15	.66
21. Quercus velutina, yellow oak. (Rays reddish brown; pits oval, 10 microns, somewhat regularly arranged.)	100 250	120 300	20 55	20 60	10 : 68	14	14	.71
22. Sassafras officinale, sassafras. (Rays brownish; pits oval, areolate, 12 by 10 microns, arranged regularly.	100 180	130 240	25 50	30 60	10 : 44	14	16	.50
23. Ulmus americana, (white) elm. (Macropores in single series each year; micropores in tangential groups, forming connectedly tangential or diagonal lines.)	80 150	100 180	30 50	30 55	10 : 58	11 14	11 15	.65
24. Ulmus pubescens, slippery elm, ("red" elm). (Pits oval, areolate, about 9 by 7 microns, in rectangular rows.)	90 180	100 210	25 50	25 50	10 : 62	12 15	12 15	.69
25. Vitis æstivalis, summer grape. (Macropores oval, in one or more distinct tangential rows each year; abundantly furnished with valves; septa between micropores tangential, numerous; pits very large, often 30 by 10 microns.)	160 320	200 400	45 50	40 80	10 : 28			.41

MICROSCOPIC STRUCTURE OF DECIDUOUS TREES—CONTINUED.

GAMOTRACHEAL WOODS. Ducts usually in radial groups, with septa tangential and more or less longitudinal (vertical).	Diameters of ducts, in microns.		Relative space occupied by ducts.	Diameters of cells, in microns.		Specific gravity ....
No.	Tang.	Rad.		Tang.	Rad.	
26. Acer negundo, box-elder. (Rays white; pits areolate, irregular)	32 64	35 75	10:92	18	19	.73
27. Acer saccharinum, white maple. (Ducts one to five in each group; rays numerous, thin, narrow, and close together; pits rhombic, areolate, 6 microns across, somewhat regularly arrauged.)	36 63	38 76	10:79	17	20	.63
28. Acer saccharum, sugar maple. (Ducts usually single; rays red; pits areolate, variously shaped)	35 70	35 75	10:85	17	19	.69
29. Betula lutea, yellow birch. (Pits minute, very numerous)	60 130	70 150	10:69	18	19	.58
30. Betula papyracea, canoe birch. (Ducts mostly in pairs at any cross-section)	35 85	45 95	10:78	18	19	.69
31. Carpinus caroliniana, "blue beech," hornbeam. (Cells solid)	25 70	30 80	10:95	15	17	.73
32. Ilex opaca, holly. (Ducts occasionally solitary)	20 40	20 45	10:72	16	18	.58
33. Liriodendron tulipifera, "whitewood," tulip tree. (Cells large; pits oval to oblong, 6 to 18 by 6 microns, regular as the grains of corn on a cob.)	42 84	54 98	10:50	19 21	21 23	.42
34. Magnolia acuminata, cucumber tree. (Cells very large, empty; pits scalariform, 6 to 60 by 5 microns; interspaces, 3 microns.)	50 100	60 120	10:46	21 25	24 30	.40
35. Magnolia grandiflora, magnolia. (Valves numerous; pîts scalariform, 5 to 40 by 5 microns, regularly arranged.)	30 65	35 60	10:68	20	22	.64
36. Ostrya virginica, "ironwood," hop hornbeam. (Cells solid; pits oblong, 8 by 5 microns, scattered)	30 50	30 60	10:105	15	17	.83
37. Platanus occidentalis, sycamore. (Rays very strong, reddish; pits oblong, 6 by 4 microns, in regular transverse rows.)	60 90	60 100	10:73			.57
38. Platanus wrightii, Arizona sycamore. (Rays very strong, fully equal in thickness to the interradial spaces, reddish.)	50 80	50 90	10:75			.58
39. Populus grandidentata, poplar. (Pits large, 10 microns, nearly round, areolate, quincuncially arranged in longitudinal rows.)	45 80	45 90	10:56	18	20	.38

MICROSCOPIC STRUCTURE OF DECIDUOUS TREES — CONTINUED.

GAMOTRACHEAL WOODS. Ducts usually in radial groups, with septa tangential and more or less longitudinal (vertical).	Diameters of ducts, in microns.		Relative space occupied by ducts.	Diameters of cells, in microns.		Specific gravity ....
	Tang.	Rad.		Tang.	Rad.	
No.						
40. Populus monilifera, cottonwood. (Pits obscurely hexagonal, areolate, 10 by 9 microns, close together, quincuncially arranged.)	40 64	40 72	10:58	17	20	.39
41. Populus tremuloides, aspen. (Pits oval, 9 by 7 microns, not close together, quincuncially arranged in rows lengthwise.)	30 70	30 75	10:59	18	20	.40
42. Salix alba, white willow. (Pits areolate, 8 microns diam., quincuncially arranged in rows)...............	40 100	50 120	10:61	18	21	.41
43. Salix nigra, black willow. (Pits quincuncially arranged in longitudinal rows)..	45 100	50 110	10:62	17	21	.43
44. Tilia americana, basswood. (Ducts subdivided by radial and tangential septa; valves frequent; pits small, scattered; ducts with many transverse threads.)	30 75	30 80	10:64	17	21	.45

MICROSCOPIC STRUCTURE OF DECIDUOUS TREES—CONCLUDED.

DIALYTRACHEAL WOODS. Ducts solitary; valves transverse.	Diameters of ducts, in microns.		Relative space occupied by ducts.	Diameters of cells, in microns.		Specific gravity....
No.	Tang.	Rad.		Tang.	Rad.	
45. Cerasus vulgaris, garden cherry	25 50	30 60	10:64	18	21	.61
46. Cercocarpus parviflorus, mountain mahogany. (Rays numerous, highly colored; pits rectangularly arranged.)	20 50	20 60	10:76	14	16	.74
47. Cratægus coccinea, scarlet thorn. (Spring ducts larger than summer; pits lunate, 15 by 5 microns)	30 50	30 60	10:76	16	18	.72
48. Cornus alternifolia, (blue) dogwood. (Cells solid; pits oval, rectangularly arranged; certain ovoid ducts with scalariform vessels instead of pits.)	30 50	30 55	10:74	19	22	.67
49. Cornus florida, flowering dogwood. (Rays white; pits rectangularly arranged; certain ovoid ducts furnished with scalariform vessels and no pits.)	25 45	25 50	10:84	17	19	.80
50. Malus communis, apple. (Ducts oval to elliptic; pits small, in regular lines)	25 40	30 50	10:82	17	19	.80
51. Malus coronaria, crab-apple. (Pits oval, 8 microns, rectangularly arranged)	25 45	25 55	10:76	15	18	.71
52. Padus serotina, wild black choke-cherry. (Ducts normally double or multiple; pits areolate, 9 to 10 by 6 to 7 microns, in regular rows.)	30 60	30 70	10:60	20	25	.58
53. Prunus americana, wild plum. (Spring ducts larger but of same character as summer ducts; pits somewhat regular.)	30 55	35 60	10:70	18	21	.69
54. Pyrus communis, pear. (Ducts oval to elliptic; pits small, regular)	25 40	25 48	10:80	12	14	.81
55. Sorbus americana, mountain ash	30 50	30 70	10:64			.60

CIRCULATION OF THE SAP.

Sap passes from cell to cell through minute oval or circular windows, quite regularly placed, in rectilinear rows when in a duct beside vertical cells; transverse rows when beside the horizontal cells of the radial plates; scattered or in somewhat spiral or diagonal rows when beside a similar duct, and yet differing in character in the different families of trees.

These windows are minute pits with a thin transparent or translucent film of cellulose stretched across. Greatly magnified, a section of duct looks like a section of well-point of a driven well, or like a section of perforated boiler-iron with soap-bubble films across the perforations. Each cell has from four to six rows of these pits communicating with the adjacent cells, being one row to each adjoining cell.

The number of these pits to the inch in a straight line is about the same as of cells of the deciduous trees, say 2000. The diameter of a pit when circular is about four microns; when oblong is about six microns the longer way, four the shorter way. With the marginal ring, or frame of the window, the measurement across a pit is about nine to twelve microns. The ducts often have 50 to 100 or more vertical rows of pits communicating with adjoining cells and ducts. The size, shape and distance apart of the pits in the ducts of any tree is precisely the same as in the vertical cells, but usually much larger than in the ray cells.

Sap flows upward in the ducts of deciduous trees and the cells of coniferous trees, mainly in the sap-wood; downward between the bark and wood and through the inner layers of bark; inward in the radial plates; and permeates all through the cells of deciduous trees, except some of the heart cells, which are filled with wood fiber and various organic substances.

Whatever the diameter of the cell, or whatever its length, water will percolate or creep to the extreme end, even against gravitation, by simple capillarity, aided by osmotic pressure. The bud or leaf of the plant or tree has no such sucking power as has been ascribed to it. It has no sucking power at all. The food comes to the bud or leaf by processes over which it has no control and cannot aid in any way except by making use of the materials that come to it as food. And that it does and does it well.

OSMOSIS.

From cell to cell, water, carrying with it its mineral contents, always of a crystalline nature, leaving bacteria, fungi spores, and albuminoids and colloids behind, passes by a molecular process called osmose, always from a cell containing water of any gravity to a cell containing water of a greater gravity. A difference of less than one-millionth of the weight of water between two cells is sufficient to cause osmose from cell to cell. This feature, together with the principle of capillarity, as shown in the size of the cell, explains why there is a limit to the height of any tree.

The heaviest water, or sap as we call it, is always in the leaves and bark: because evaporation is there constantly going on and the gravity of the sap thus increased. The sap is prepared in the leaves and bark.

The spongioles, the roots, the pith, the wood, the leaves, the bark, and the fruit of every tree and plant constitute the several departments of a chemical laboratory, in which the sap received is elaborated and converted into the productions peculiar to that plant or that portion of the tree or plant. Carbonic-acid gas is absorbed from the air and combined with the mineralized water taken from the earth to form the various carbohydrates from which all the products of the tree or plant are formed. In case of the tree cacti, as Opuntia arborescens, Cereus giganteus, etc., much of the water needed is not from the earth, but is absorbed from the air through especially-constructed cells. The sectored clusters of wood cells or vascular tissue are arranged at regular intervals within and completely surrounded, bark and all, by the soft, cellular, parenchymatous tissue of the stem, which is abundantly supplied with chlorophyl, and performs the functions of both leaves and roots. The roots themselves, while they do absorb some moisture and minerals from the earth, are mainly for the purpose of keeping the plants in an erect position.

The spongioles and root-hairs are always hungry and absorb more than the cells can hold. The surplus is pushed back into the cells above, thus aiding the osmotic pressure. They have a selective capacity, and take from the soil, not everything in it, nor everything in the water in the soil, but only those mineral ingredients which are needed for use in the tree or plant. This they do by a faculty analogous to what we call taste in animals. For example, asparagus, the Russian thistle, the atriplexes, some of the goosefoots, and some of the grasses, such as Distichlis spicata, Spartina gracilis, and finetop salt-grass, thrive in a saline soil, where most other plants could not live. Any plant will live in any soil where the food that it likes is abundant and the food that it dislikes is not too plentiful.

It often happens that two very dissimilar plants grow in the same soil in close proximity without interfering with each other; in fact, they are mutually helpful, for the reason that each one takes from the soil materials that the other does not like and does not want. Beech and maple trees are a case in point. Totally different in their natures, they live harmoniously together and are mutually helpful. It might be supposed that apple and cedar trees, belonging as they do to totally different families, would be mutually helpful; but in this case there happen to be other biological reasons why they should not be cultivated together. Apple and cherry, apple and peach, or apple and pear should not be cultivated close together, as they both belong to the same botanical family, both secrete prussic acid, and both exhaust the soil of the same chemical ingredients, materials not in the soil in too great abundance, and not at all in some soils. That explains, too, why apple or fruit-trees do not do well in certain soils, and why orchards die out, and why young apple trees will not grow where an old apple tree has died out. Other crops may do well there. It also explains why, in Maryland and eastern Virginia, after the original hardwood forests have been cleared away, or after the land has been cropped to exhaustion, nothing but pines grow; and why, in Michigan and elsewhere, after the native pine forests are cleared away, the land quickly becomes covered with a luxuriant growth of oaks, maple, beech, and other deciduous trees.

WATER FOR POTABLE USES.

Spring- or well-water, containing a small percentage of lime, the smaller the better, so that there is some, seems to be best for potable and culinary uses. Rain-water is not best unless well filtered, for the reason that it contains much that is deleterious, such as decaying insects and their remains; decaying pollen, spores, and other vegeable particles; sand, chalk, and other earthy substances; ammonia, smoke, carbonic acid, and other noxious gases; bacteria, parasites, and the germs of numerous diseases, besides the unspeakable filth that accumulates on roofs between rains. These are all beneficial to vegetation, but are filtered out of it by the earth largely before it sinks eight inches, and almost wholly before it sinks eighteen feet, into the earth. Water falling at the close of a prolonged rain is purer; but water standing in rain barrels, cisterns, etc., generally teems with microscopic plants and microzoa.

Water containing much soda, potash, gypsum or salt, is not good; but usually it is not necessary to drink such waters, as there are few places in the Missouri and upper Mississippi valleys where good potable water may not be obtained. Surface-water that has stood for several days should not be used. Creek or river waters may be used if far enough below any source of pollution for the waters to become thoroughly aerated in transit; otherwise boiling is beneficial or may even be necessary. Water obtained from shallow wells, or from within three feet of the surface, should not be used unless the source be subterranean, as in a spring.

If there be any source of contamination in a neighborhood, the danger zone in the ground is in the form of a truncated cone with its summit at the surface of the danger source, and its sides falling off at an angle of thirty degrees from the horizontal all around, but at a less and broader angle in the direction of waterflow. The area of safety beyond such a source is not less than 100 feet; even 150 feet is better, especially in direction of waterflow, or if the soil be sandy or porous. A well in the vicinity of such a source of danger draws the danger toward it, and extends the danger area in that direction. A driven well in such a place is not necessarily unsafe unless the soil should be very porous and the well too shallow, or not remote enough. An open well should have its wall cemented from bedrock up, or at least for eighteen feet from the surface down, so as to exclude all surface-water.

To sum up: Every tree seed contains a chemical laboratory upon a small scale, the capacity of which is increased according to its environments. Water carries, by aid of the ordinary forces of nature, such as surface-tension, cohesion, adhesion, capillarity, and osmosis, under control of temperature and electrical conditions, the food necessary for the full development of any tree, and carries it to the spot needed, even to the summit of the tallest tree. The tree itself adapts itself to its requirements and surroundings, thus enabling the water to fulfil its mission.

NOTES ON COLLECTING CICINDELIDÆ.

By EUGENE G. SMYTH, Topeka.

Read before the Academy, at Manhattan, November 27, 1903.

FOR the past three years my chum, LeRoy Rauch, and I have collected and carefully studied the habits of the species of this family, especially those found in the vicinity of Topeka.

In the spring of 1901, about the 8th of March, we took our first specimens of Cicindela splendida and amœna, on a clay bank at the edge of timber, and throughout March, April and May we found repanda and vulgaris common in sandy fields near the river.

In the early part of June we enjoyed a week of most successful collecting on Middle creek, near Ottawa, Kan. There, among numerous other species, we found C. sexguttata in its many forms; first on a rocky, wooded bluff on the east bank of the creek, and later throughout the woods, especially along the unused roads and wood paths. Those taken were all green, bearing not the least tendency toward the blue form, violacea. A few types were taken. Early in the morning, when the underbrush in the woods was wet with dew, these insects, being unable to fly, were easily taken as they ran through the grass. But as the day advanced and the grass dried they became more active, so that by ten o'clock they would take wing with ease. A single splendida and a few repanda were taken there on the creek bank.

Upon our return home on the 15th of June, the sand-bars in the Kaw river, which had been slightly flooded during our absence, were covered with a thin layer of wet mud, and with numerous pools of water. Around the pools, and where the mud was wettest, ponderosa, cuprascens, and macra swarmed. They were all difficult of capture; ponderosa because of its extreme wariness, and the other two because of the fact that they fly so close to the ground. These three species remained numerous on the sand-bars for the rest of June, July, and August, a few stragglers staying into September. On account of the very high water during the two following years, 1902 and 1903, these species have not since been taken here in such plenty.

In addition to these we found a form of formosa, familiar to eastern Kansas collectors, intermediate between formosa and generosa, common in sandy fields on the first bottom of the Kaw. With it we found punctulata, and a form of scutellaris approaching lecontei. The formosa variety remained common the rest of the summer and autumn, while the scutellaris variety soon disappeared, but reappeared again in September, and flourished from then till frost.

These species of Cicindela — punctulata, cuprascens, and macra — are found quite often in eastern Kansas at electric lights; but a fourth kind, lepida, is a rare visitant at the lights, and is seldom seen by day. On the evening of June 22 I took at the arc lights at Topeka three specimens of this beautiful white insect, the first I had seen. A few more were taken under like conditions in July.

July 4 was spent at Lakeview, near Lawrence, where we found macra in extreme abundance along the edge of the lake. With it we found repanda, plentiful as usual, and a single specimen each of duodecimguttata and vulgaris, the last rather out of season. We also found punctulata and formosa var. on sand by the station.

On the 12th of July, while collecting along the creek bed at Vinewood park, near Topeka, we came across numbers of duodecimguttata by the edge of the water at the foot of a high clay bank on the east side of the stream. They associated with repanda, but seemed much inclined to stay upon the bank, where the clay was barely moist, while the latter was restricted to the wet mud.

In the latter part of the month we took a number of Tetracha virginica in an open meadow under cow-chips, where they had hidden to pass the day.

Probably the most valuable catch of the season was made at Leona, in Doniphan county, August 10, 11, and 12. While walking through the woods, at about eight o'clock in the morning, we ran across a specimen of violacea, the beautiful blue or violet variety of sexguttata. It was running along the road, unable to fly because of the morning dampness. We at once set in careful search, and took with ease a few more of the beauties, with thrice as many of the green forms of sexguttata. We repeated the performance the two following days with equally good success. During the three days' stay we each took fifty of the forms of sexguttata, including a few types, and about ten of the brilliant violacea. The percentage here was one blue one to every five of the green, while at Ottawa among nearly three hundred greens not a single blue one was taken, thus indicating that violacea is rather a local race. A number of Tetracha virginica were taken in the same woods under sticks and chips, and a few more crawling along roads in the evening.

Much time was spent in the fall of 1901, especially October, in collecting the numerous forms of scutellaris, formosa, and vulgaris, amongst the stunted Kafir-corn in the sandy bottom lands of the Kaw. One vulgaris taken was so green in color that it was at first mistaken for graminea.

During the same month we found our first examples of purpurea, and the western forms of limbalis and transversa, which differ from amoena and splendida only by the red head and thorax.

In the spring of 1902, during the month of March, a very few more of these abnormal forms were taken in company with the commoner species, amœna and splendida, on banks of gullies through the prairie. In the month of April over 330 specimens of scutellaris and varieties were taken, of which 135 were collected in a single afternoon, April 5. The most productive spot was amongst the grass and plantain at the edge of a sand-drift, in open timber by the river. In this place, as elsewhere, they were common until about the middle of May, when they gradually gave place to the formosa varieties.

A number of duodecimguttata were found along the foot of a clay bank on the Wakarusa creek, on April 26, in company with splendida, and more were taken, as in the previous year, at Vinewood park, on July 10. Because of high water, there was no chance for ponderosa to put in its appearance in its accustomed habitat on the sandbars; but on May 24 they were discovered in abundance on a high sand-bank near the river, in company with formosa var. and repanda.

One of the most interesting discoveries of the season was made on June 21, in the low sand-hills near the river, northeast of Topeka. The sand in this place is especially white, and at about half-past two I began a search there for C. lepida, which had never been taken by day at Topeka. Formosa var. was abundant, with now and then a scutellaris. Suddenly, while in pursuit of formosa, a small white insect arose from under a bunch of grass, flew weakly for a short distance, and alit near another bunch of sand-bur grass, keeping very still. It took close inspection to detect it from the surrounding sand, and it remained still, even under the net, causing some anxiety on the part of the collector. Their habits once learned, it was found that they were more plentiful than at first supposed. Their apparent increase in numbers as evening drew near was not entirely without grounds; for, though at first quite scarce, at four o'clock, as the collector was leaving the grounds, a number of specimens were easily taken on the wing as they arose from the sunny sides of the sand ridges. About forty specimens were taken during the day, one with green head and thorax. Eleven more were taken at the same place on June 24 and four on July 19.

In the month of July seven specimens of lepida were taken at the electric lights in the city, with punctulata, cuprascens, and macra. A single specimen of micans, the green form of punctulata, was similarly taken on July 14, and a Tetracha virginica on the 15th.

During the same month macra and cuprascens were abundant by the river on mud flats caused by the June floods. On July 19 sixty-two specimens of each were taken under such circumstances, and intermingling as they did, a careful investigation on that occasion showed that these closely related species *always* breed true to themselves. A comparison of the numbers of each species taken during the summer months turns out the following: June, 3 cuprascens and 21 macra; July, 202 cuprascens and 122 macra; August, 26 cuprascens and 10 macra. Many of these were taken at the electric lights.

In the fall of 1902 I had the privilege of taking a trip into western Kansas with my father. We found cuprascens, punctulata and micans at the lights at Dodge City, August 31. The next day, September 1, we found the type formosa in abundance in the sand-hills across the river south of town, and the closely-related venusta in much less numbers. One or two scutellaris were also taken. In an alkali ditch near the river three examples of fulgida were found, in company with vulgaris. A few cuprascens were taken on the sand-bars, and a fine specimen of micans was found on a dry road across the prairie on the hills north of town.

At Coolidge, September 2, over forty specimens of pulchra were taken on bare clay flats on the high prairie. Near the river two specimens of nigrocærulea, the first taken in the state, were found amongst the salt-grass by irrigating ditches. On September 3 a number of fulgida were taken on saline spots near a slough in the low prairie; on sand-bars in the Arkansas were taken a pulchra, a few vulgaris, some very close to obliquata, and several each of venusta, ponderosa, micans, and cuprascens. The venusta chose the fine drifting sand in the hot shelter of the bank, the vulgaris and ponderosa the flat open sand-bar, and the micans and cuprascens the wet sand next the water.

On September 4, at Coolidge a single prasina was taken in the dried bed of a rain pool, several micans at the edge of fresh rain pools, and a number more of pulchra on the bare ground near the pools, on the high prairie north of town. At Ness City, September 5, was taken a single formosa with markings similar to the variety manitoba.

A second trip to western Kansas, toward the last of September, gave the following results:

At Oakley, September 24, graminea and audubonii were found in plenty along unused roads across the prairie, averaging about three of the former to one of the latter. When frightened they would often rise to a great height, and fly far off with the wind. It was noticed that audubonii generally chose depressions in the prairie, where the road was damp and the ground dark. A single specimen each of pulchra, scutellaris, and formosa, and several micans and vulgaris were also taken. The next day, at Salina, September 25, we found a few purpurea, graminea, splendida, and amœna, along an earth-ballasted railroad-track, on the path between the rails.

In an hour's collecting, September 27, at Clearwater, south of Wichita, over sixty specimens of scutellaris, all immaculate, were collected in a sandy field near the Ninnescah river. Several formosa, vulgaris and repanda were found along a sandy road by the river, between high weeds. On sand-bars in the stream, repanda swarmed by thousands, and several macra and cuprascens, and one duodecimguttata, were taken.

At Wichita, September 28, a number of purpurea and graminea were found on bare spots in the high prairie; and in a railroad cut east of town the same species, with the addition of splendida, amœna, and vulgaris were taken in numbers.

At Topeka, in March, 1903, a dozen specimens of purpurea and graminea, a single audubonii (a female, in copula with a male purpureo-graminea), and two of the western limbalis, were found on a clay bank in company with splendida.

On the 19th of May my chum and I had the good fortune to accompany Dr. F. H. Snow on a trip to Englewood, Clark county, Kansas, where six weeks were devoted entirely to collecting insects.

During the first two weeks there we found fulgida in abundance on bare spots along a salt creek, where it was common until the last week of June, being gradually replaced by circumpicta. Several specimens of denverensis, the bright green form of splendida, were taken in May on a clay bank; and three or four graminea, with a single audubonii, were found on the prairie; while scutellaris and formosa were quite common in May and early June in sandy localities. With the latter was taken a specimen of venusta. It might be remarked that the scutellaris and formosa were nearly all found along low, sandy roads, practically none being seen in the barren sand-hills, where one would most expect to find them.

One of the best discoveries of the season was the finding of C. knausii, a variety of nevadica recently named for a well-known Kansas collector by Mr. Chas. W. Leng, in his "Revision of the N. A. Cicindelidæ." On the 6th of June this species appeared along the muddy margins of the creek, becoming more abundant each day, until inside of a week it fairly swarmed. A few green or blue specimens were taken, at an average of about one green to a hundred or more of the brown.

In a week's time after the appearance of knausii, apicalis, W. Horn's variety of togata, was found on a broad alkali flat about a mile from the creek. This also became very common; and on June 20, a week after the appearance of apicalis, the first specimens of circumpicta were taken in company with it on the white saline flat. By June 26 circumpicta was the more abundant of the two. It appeared in two forms, the green and the cupreous, which were about equal in abundance. The intense heat and dazzling sunlight reflected by the smooth white ground made it difficult to collect these two species.

Moreover, both were swift runners, and apicalis was quite hard to see because of its light color. Knausii was sometimes found near the center of the flat, where the ground was moist, and fulgida was very common along the margin, amongst the buffalo-grass. During the last few days of June apicalis and circumpicta both appeared along the salt creek, where fulgida had swarmed in May and early June.

Vulgaris, repanda, punctulata and micans were more or less common everywhere about Englewood on bare ground. On sand-bars in the Cimarron river ponderosa and knausii were quite plentiful, though the latter seemed more at home along the muddy creeks and ponds. With these a few specimens of cuprascens were also taken.

A second Kansas University entomological expedition for 1903 made collections in Arizona during the months of July and August, and, though very few cicindelids were taken as compared with the preceding trip, a few are well worth mention.

On July 21 a number of the beautiful green form of sperata were taken, during a short delay on the way, at Caddoa, Colo. The first one was found on the dry prairie with pulchra and micans. A few more were taken near wet spots along a road by the river, in company with micans. The most of the specimens, however, were found in a large alkali mud-hole back of the station. The depression was about six feet deep, and three or four rods long, with a floor of perfectly white alkaline mud half an inch thick. Near the center were several shallow pools of water, and around these ran the green sperata, conspicuous amongst the more somber brown forms of knausii, which greatly outnumbered them. The finding of these two species together was rather unusual; but still more striking was the total absence of the brown or cupreous forms of sperata, which usually predominate, and in contrast the absence of the blue or green forms of knausii.

Later, during the night, while the train changed crews at Albuquerque, a number of the normal brown form of sperata, and one cupreous, were picked up at the arc lights in front of the depot.

At Martinez, or Congress Junction, Ariz., 3000 feet a. t., where our journey ended, we took two very interesting species of "tigers," an aberrant green form of nigrocærulea, and the dainty little desert-loving lemniscata. Both kinds occurred by the margins of ponds, the one preferably on very wet mud, the other on any damp soil.

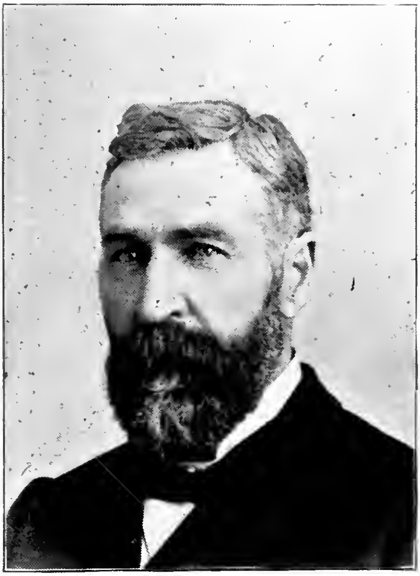
Nigrocærulea was the less common of the two; and though taken in numbers on July 24 and 25, by the 1st of August the pond around which it had occurred most abundantly was nearly dried up, and no more of the desired beetles were to be found. This remarkable insect somewhat perplexed the collectors. The females were quite robust, of a rather dull green color, touched with brown on the head and thorax, and with brilliant opalescent green reflections on the elytra, exhibiting many of the characteristics of nigrocærulea; the males were narrower, smaller, and more convex, with the elytra somewhat polished and lacking the opalescent reflections, thus placing them closer to the western form of micans. The specimens also varied in markings: some were almost immaculate; some had only apical and median dots; others had humeral, post-humeral, marginal and median dots, and apical lunule. One male was taken with complete apical and humeral lunules and marginal line, all very much dilated, the last broadly confluent with the humeral lunule, forming a nearly complete marginal band, after the manner of C. bowditchii Leng. I sent some specimens of it to Mr. Edward D. Harris, of New York city, and he wrote the following regarding it, under date of September 29, 1903:

"Your box with the specimens came safely. The lemniscatas are little beauties, and the nigrocæruleas (if they are such) very interesting. I have spent a number of hours over these last, and must confess my want of confidence in placing them. Apparently it is a local race of Leconte's insect. My own specimens of nigrocærulea (=robusta Leng; for Leng admits to me that the name is a synonym) are nine in number, thus: Two from Robinson, Colo., dark indigo blue, one immaculate, one with apical dot. Four from La Junta, Colo.; two blue immaculate: one blue, with a green suffusion, large apical lunule entire, marginal and humeral dots; one green, apical dot abnormally prolonged. One from Bent county, Colorado, yellowish green immaculate. Two from Alpine, Tex.; one black with indigo reflections, immaculate; one dark bronze green, immaculate. The two specimens you send differ from the above in two respects only, so far as I can discover — first, in the form, being not so robust in the outline of the elytra toward the apex, and second in preserving a sharply-developed metallic luster of head and thorax, absent in all my specimens of the Leconte insect. Both respects bring it closer to micans; but the pilosity is that of nigrocærulea, rather than of the punctulata group. With your large series it would be a very interesting study to see just how far the differences extend. One of your specimens is immaculate; the other has obscurely-marked marginal spots, in position and shape like those of nigrocærulea. I shall be greatly interested to know where Professor Snow places it, and how much importance, if any, he attaches to its differences."

Then, under date of November 2, he writes: "I received promptly both your boxes, the first containing five of the very interesting and valuable variety of nigrocærulea, safely and in the best of condition. I have seized the opportunity of another study of the Arizona beetle, with the seven specimens to refer to. They are all very close to one form, indicative of the existence of a very well-defined local variety, separable instantly from the Fort Bent insect, and from that of Alpine, Tex., which Leng called robusta. I look to its varietal designation by some one of your Western entomologists. I thank you very much for the opportunity of possessing so interesting an insect."

None of the lemniscata were seen around the shallow and muddy "nigrocærulea pond"; but on the steeper banks of another pond near by, where only two or three nigrocærulea had been previously taken, they were found in profusion. They are very inconspicuous insects, very much like small mud-flies as they arise from the water's edge, fly low for a few feet, and alight as abruptly as they arise. They were very common throughout the week that we were at Martinez and came quite frequently to the lamplight at night. A few were taken by light in the middle of the broad Martinez wash, indicating that they must have occurred on the dry sand as well.

The month of August was spent collecting on the Bill Williams Fork, fifty miles westward, at a point about eight miles south of the Rio Santa Maria, elevation 1000 feet. Here cicindelids were unusually scarce. Two specimens of lemniscata only were taken. Tetracha carolina were found commonly under stones along the stream, in company with Brachynus, Oodes, and other carabids. They are exceedingly swift runners, gaining a yard or more before the stone were fairly turned over. Several fruitless efforts were made to find them hunting for food in the evening, as virginica is so often found in the East. The remains of a green Cicindela, presumably maricopa, were found buried in the sand; but we left a little too early (September 4) to greet its fall appearance.



Dr. PETER McVICAR.

Plate XXXI.

VI.

NECROLOGY.

Dr. Peter McVicar,

S. A. Baldwin,

Mrs. Mary E. Mudge.

PETER McVICAR.

By G. P. Grimsley.

REV. PETER McVICAR was born in New Brunswick, Canada, in 1829. When thirteen years of age he moved to Waukesha, Wis., where he lived until 1860, when he became one of the pioneers of Kansas, to work for the welfare and progress of this state.

He graduated with honor from Beloit College in 1856 and took a course in theology at Union and Andover Seminaries, graduating in 1860. In 1863 he was married, at Waukesha, Wis., to Miss Martha Porter Dana, who survives him, with one son, Dana Collins McVicar, and one daughter, Mary McVicar Morris. His first charge was that of the First Congregational Church of Topeka. In 1866 he resigned his pastorate and entered the educational field, where he achieved such great success, and that year was elected the fourth superintendent of public instruction of Kansas, a position held for four years. His bold perseverance and strong courage established the school funds of the state on a firm basis in the face of the strongest opposition, and as a result 500,000 acres of valuable land were saved for a permanent school fund.

In 1865 Doctor McVicar aided materially in the organization of a Congregational college, and was made president of its board of trustees from the beginning. In 1871 he was elected to the presidency of the college, succeeding Doctor Butterfield. At this time there were two professors and a small number of students. This position he held until compelled to resign by ill health in 1896, when he was made president emeritus.

During this quarter-century of active work in Washburn College, Doctor McVicar, mainly by his own efforts, established an endowment fund of $100,000, and added $160,000 in buildings, located on a campus valued at $200,000. Washburn College to-day in its prosperous condition, with its very bright future, stands as a fitting memorial to this man.

After the failure of health his interest continued in the welfare of this institution, and he remained as a member of the board of trustees taking part in its meetings up to the time of his death, June 5, 1903, having reached the age of seventy-four years.

Doctor McVicar was not only a pioneer in the public schools and colleges of Kansas, but also in our Academy. In the original call for "all persons interested in natural science to meet in Topeka on the first Tuesday of September next (1868), at the college building, for the purpose of organizing a state natural history society," we find among the signatures on this paper, Peter McVicar. From that day on, he was interested in the growth of the Kansas Academy of Science, and in 1898 he was elected a life member of the Academy.

In the death of Doctor McVicar the state has lost a useful citizen, education a self-sacrificing and sturdy supporter, the Academy of Science a devoted friend; but there remains for each of us, the noble example of a life simple yet strong, consecrated to the welfare of fellow mankind, an example to be studied and followed for our advancement in all the paths that lead to a successful career.

S. A. BALDWIN.

Plate XXXII.

S. A. BALDWIN.

By J. T. Willard.

SHERMAN A. BALDWIN was born in Meriden, Conn., June 29, 1827. When but three years of age his parents moved to New Britain, Conn. He attended school there until sixteen years of age, when he accepted a position as clerk and bookkeeper for his uncle, J. G. Baldwin, in his store at Middletown. He remained with his uncle four years, when he purchased an interest in a manufacturing concern located at Branford, Conn., having charge of the packing and shipping department. To better distribute the goods manufactured by the firm (locks of all descriptions, door-knobs, etc.), a store was opened in New York city, Mr. Baldwin taking charge. After two years there he disposed of a part of his interest and came to Kansas as a member of the "Connecticut colony," organized by Mr. C. B. Lines, of New Haven. The colony started in the spring of 1856. The party outfitted at Kansas City, purchasing teams and supplies, and in due time arrived at Wabaunsee, near which place Mr. Baldwin thereafter resided. In the fall he returned to the East and was married to Miss Jane Augusta Barnes, of New Haven. In the spring of 1857 Mr. and Mrs. Baldwin came West, and lived in a tent until the completion of their house.

Besides filling the office of township treasurer for seven years, Mr. Baldwin was one of the trustees having in charge the building of the Wamego bridge across the Kansas river, served several years as deputy clerk of the district court, was twice elected register of deeds—1863 and 1865—was appointed county clerk on the death of Mr. H. M. Selden, in July, 1865, and served two terms as a representative in the state legislature. Faithful service in these several offices of trust secured for him an enviable place in the esteem of his constituents. He died March 31, 1903.

Mr. Baldwin's farm had previously been used as a camping-place by the Indians, and he early became interested in the flint weapons and implements which he from time to time picked up there. This led to making collections of similar objects from other localities. He was also interested in geological and mineralogical specimens. He consulted Prof. B. F. Mudge in respect to these, and was by him induced to become a member of the Academy. While not a scientist, he was a man of considerable breadth of reading, and always enjoyed the meetings of the Academy and attended them regularly for many years. He acquired a competence from his farm, but instead of using it to accumulate more, adopted the far saner practice of spending a reasonable amount of his income in travel. In this way he saw much of this country and added to his collections of various kinds.

He was of a modest and retiring disposition, but a cordial and generous friend and neighbor, and will live long in the memories of those who knew him.

MRS. MARY E. MUDGE.

By J. T. Willard.

MARY E. A. BECKFORD was born in Baltimore, Md., March 17, 1820. Her parents had moved there from Lynn, Mass., to which they returned a few months after their daughter's birth. Thus, though born in the South, her associations and education were those of New England. Her father died while she was yet an infant, but she was tenderly reared by her mother, who gave her the best possible education the town afforded in both public and private schools. While studying in Lynn Academy she gained her first real interest in botany and the other natural sciences. She was acquainted with Benjamin F. Mudge from girlhood, and, with their common tastes and interest in science, it was but natural that their friendship should culminate in marriage in 1846. They lived in Lynn until 1860, then removed to Kentucky, where a year was pleasantly passed, when they sought a new home at Quindaro, now a suburb of Kansas City, Kan. They made their final home at Manhattan, where, in 1865, her husband was elected professor of natural science and higher mathematics in the Kansas State Agricultural College. She lost his genial companionship by death November 21, 1879. She ever remained loyal to his work and memory. After Professor Mudge's death she and her daughter, Eusebia, made their home together, residing in Manhattan until November, 1900, when they removed to Kansas City, Mo. Some time previous her danghter had married Mr. Frank L. Irish, an attorney, whose business interests caused their removal mentioned. Mrs. Mudge died July 18, 1904. She was elected an associate member of the Academy of Science in 1897.

To those who knew Mrs. Mudge, she will always seem to be the embodiment of serene tranquillity; affectionate, cultivated, and charitable, she was deeply beloved by all who knew her. She was fond of reading, and maintained her interest in the progress of the world to the very last. At the age of eighty-three, with most painstaking care as to facts and researches, she wrote an account of the archeological researches of Prof. J. V. Brower, which was published in volume VII of his memoirs entitled "Kansas." She also wrote for volume I, entitled "Quivera," the researches of Prof. B. F. Mudge. She contributed many papers on scientific subjects for the domestic science club of Manhattan, of which she was a member. She also gave much aid in church work. Within the last six weeks of her life she made a collection of the wild flowers found on a farm where she was visiting, and a list of the birds observed. Her children, Melvin R. Mudge, Josiah B. Mudge, and Eusebia (Mudge) Irish, with their children, and friends without number, will ever hold her in dearest memory.

Mrs. MARY E. MUDGE.

Plate XXXIII.

VII.

APPENDIX.

Accessions to the Academy Library, 1903 and 1904.
Index to Volume XIX (1904).
Advertisement of Volumes Issued by the Academy.
Announcements by the Secretary.

APPENDIX.

ACCESSIONS TO THE LIBRARY.

JANUARY 1, 1903, TO DECEMBER 31, 1904.

CALIFORNIA.

BERKELEY.

University of California:

Bulletins of the Department of Geology, vol. III, Nos. 6 to 22, 1904.

Bulletins of the Department of Physiology, vol. I, Nos. 1 to 22; vol. II, Nos. 1, 2, 1904.

Bulletins of the Department of Pathology, vol. I, Nos. 1, 2, 1904.

SAN FRANCISCO.

California Academy of Sciences:

Proceedings, third series, 1903-'04.

Botany, vol. II, Nos. 9 to 11, and index vols. I and II.

Geology, vol. I, No. 10; vol. II, No. 1.

Math., Phys., vol. I, No. 8.

Zoology, vol. III, Nos. 5 to 13.

Memoirs, vol. IV.

STANFORD UNIVERSITY.

Contributions to Biology from the Hopkins Seaside Laboratory:

Articles 1 to 17, 29 to 32.

COLORADO.

BOULDER.

University of Colorado:

Studies, vol. I, Nos. 2 to 4; vol. II, Nos. 1 and 2, 1904.

COLORADO SPRINGS.

Colorado College:

Studies, vols. X, XI, XII.

DENVER.

Colorado Scientific Society:

Proceedings, vol. VII, pp. 41 to 340, 1904.

GOLDEN.

Bulletin of School of Mines:

Vol. I, Nos. 1, 2, 4; vol. II, No. 1.

DISTRICT OF COLUMBIA.

WASHINGTON.

Academy of Sciences:

Vol. V; vol. VI, pp. 1 to 332.

Biological Survey:

Proceedings, vol. 16, 1903; vol. 17, pp. 1 to 160, 1904.

United States Department of Agriculture:

Annual Report of Secretary for 1902-'03.

Year-books, 1902, 1903.

Bulletins, Circulars, Reports for 1903-'04, from the following divisions: Agrostology, Animal Industry, Biological Survey, Botany, Chemistry, Entomology, Experiment Stations, Foreign Markets, Forestry, Plant Industry, Publications, Soils, Weather Bureau.

United States Department of the Interior:

United States Geological Survey.

Twenty-second Annual Report, four parts, 1900-'01.

Twenty-third Annual Report, one part, 1901-'02.

WASHINGTON.
United States Department of the Interior:
United States Geological Survey.
Twenty-fourth Annual Report, one part, 1902-'03.
Bulletins 208-234, 1903-'04.
Monographs, vol. XLII, 212 pp.; vol. XLIII, 316 pp.; vol. XLIV, 351 pp.; vol. XLV, 465 pp.; vol. XLVI, 515 pp.
Professional Papers, Nos. 1 to 28, 1903-'04.
Water-supply Bulletins, Nos. 85 to 102.
Smithsonian Institution:
Annual Reports, 1902-'03.
Contributions to Knowledge, 33, 34 in part.
Miscellaneous Collections, parts of vols. 44, 45, 46, 47.
Special papers, American Hydroids; 1900 Solar Eclipse Expedition.
Bureau of Ethnology:
Annual Report, vol. 20, 1898-'99.
Bulletins, Nos. 25, 26, 27.
United States Navy Department:
Report of Superintendent of Naval Observatory, 1902.
United States Coast and Geodetic Survey:
Annual Reports, 1902, 1903.
Special Publications, Nos. 4, 7.
United States Census Department:
Report series, vols. 1 to 10.
Bulletins, Nos. 1 to 14.
Philippine Census Bulletins, Nos. 1 to 3.
Philosophical Society:
Bulletin, vols. 13, 14, 1904.

ILLINOIS.

CHICAGO.
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ANNOUNCEMENTS.

Since our last volume of the Transactions was issued, two years ago, 100 new annual members have been elected, a gain of 100 per cent. in the two years. The Academy has been enriched by the addition of the mineral exhibits from the St. Louis fair, giving us one of the finest museums of the mineral industries in the state. State support in form of a salary for the secretary has been given in this time. The Academy is in a flourishing condition, and membership in the Society should be looked upon as an honor. The work, however, should not stop with this progress ; each member should feel it a duty and privilege to work for the success of this Academy. This can be done by bringing in names for new members and preparing papers for the meetings. At the last meeting over sixty papers were presented, and the meeting was one of the most successful yet held.

In accordance with a resolution passed by the Academy, members will please send their photographs to the office. Seventy-five have been collected.

Papers presented at the Academy meetings, especially those intended for publication in the Transactions, should be typewritten carefully before being filed for publication.

With this volume my work as secretary of the Kansas Academy of Science ends, through a combination of interests which calls me to West Virginia. The work has been a pleasant one, and it is with some feeling of regret that I lay down this work. I wish in this public way to express my appreciation of the honors conferred on me by the Academy at the session just closed. If my work during the past three years has resulted in good to this society and has added to its progress, it has been due to the ready response of the members to suggestions sent out from this office and to their active cooperation.

The next meeting of the Academy will be held in Lawrence, near the close of 1905.

TOPEKA, KAN., January, 1905.

G. P. Grimsley

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