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TRANSACTIONS

OF THE

KANSAS ACADEMY OF SCIENCE.

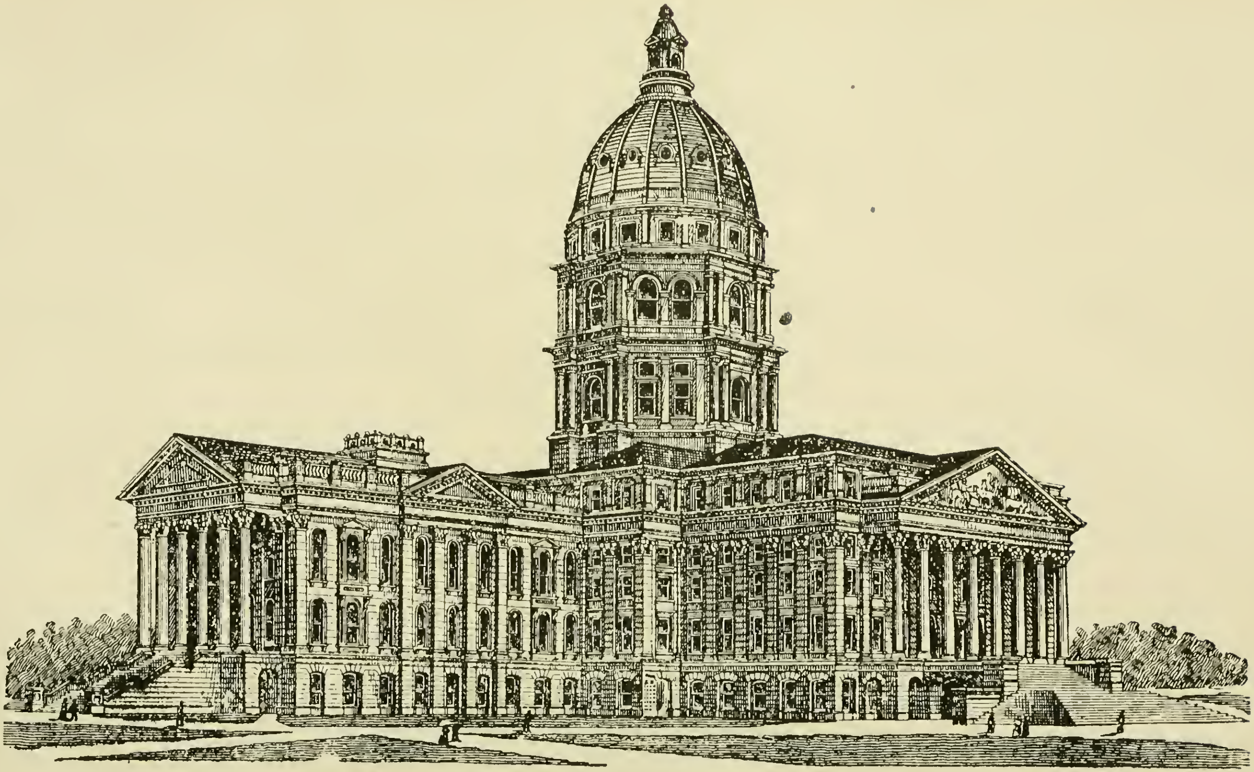
Volumes XXIII and XXIV.

CONTAINS

SECRETARY'S MINUTES OF FORTY-SECOND AND FORTY-THIRD ANNUAL MEETINGS; LIST OF OFFICERS; MEMBERSHIP LIST JANUARY 1, 1911; SOME PAPERS PRESENTED AT LAST MEETINGS; NECROLOGY; AND INDEX OF VOLS. XXIII AND XXIV.

January, 1911.

STATE PRINTING OFFICE,
TOPEKA, 1911.
3-5170



STATE CAPITOL, TOPEKA.

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OFFICERS OF THE ACADEMY, 1911.

President, J. M. McWharf	Ottawa.
Vice President, A. J. Smith	Emporia.
Vice President, J. E. Welin	Lindsborg.
Treasurer, F. W. Bushong	Lawrence.
Secretary, J. T. Lovewell	Topeka.

PAST PRESIDENTS OF THE ACADEMY.

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.
1899	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.
1905	L. C. Wooster.
1906	F. O. Marvin.
1907	J. A. Yates.
1908	E. Haworth.
1909,'10	F. B. Dains.

PAST VICE PRESIDENTS.

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

1901........	J. C. Cooper and L. C. Wooster.
1902........	Edward Bartow and J. A. Yates.
1903........	Edward Bartow and J. A. Yates.
1904........	L. C. Wooster and B. F. Eyer.
1905........	F. W. Bushong and W. A. Harshbarger.
1906........	B. F. Eyer and J. E. Welin.
1907........	E. Haworth and F. B. Dains.
1908........	F. B. Dains and J. M. McWharf.
1909........	J. M. McWharf and A. J. Smith.
1910........	J. M. McWharf and A. J. Smith.
1911........	A. J. Smith and J. E. Welin.

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.
1905-'11.....	J. T. Lovewell.

TREASURERS.

1869-'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-'08.....	Alva J. Smith.
1909-'11.....	F. W. Bushong.

MEMBERSHIP OF THE ACADEMY,

January 1, 1911.

Dates signify date of election to membership in the Academy.

HONORARY MEMBERS.

G. P. Grimsley, Ph. D., 1904, asst. state geologist, Morgantown, W. Va.
Edw. L. Nichols, Ph. D., 1897, Cornell Univ., Ithaca, N. Y.
W. S. Franklin, Sc. D., 1897, Lehigh Univ., South Bethlehem, Pa.
Geo. Wagner, Phar. D., 1904, Univ. of Wisconsin, Madison, Wis.
S. W. Williston, A. M., M. D., Ph. D., 1902, professor of paleontology, Univ. of Chicago, Chicago, Ill.

ASSOCIATE MEMBERS.

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

LIFE MEMBERS.

E. H. S. Bailey, Ph. D., 1883, Univ. of Kansas, Lawrence.
Edward Bartow, Ph. D., 1898, director of water survey, Urbana, Ill.
J. C. Cooper, 1877, mineralogist, Topeka.
F. W. Cragin, Ph. D., 1880, economic, geologic and historical research, Colorado Springs., Col.
Lewis Lindsay Dyche, M. S., 1881, professor of systematic zoölogy and curator of birds, mammals and fishes, state fish and game warden, Univ. of Kansas, Lawrence.
Geo. H. Failyer, M. Sc., 1879, chemist, Dept. of Agr., Washington, D. C.
E. C. Franklin, Ph. D., 1884, Stanford Univ., Stanford, Cal.
I. D. Graham, 1879, with *Kansas Farmer*, Topeka.
Wm. Ashbrook Harshbarger, B. S., 1900, professor of mathematics, Washburn Coll., Topeka.
Erasmus Haworth, Ph. D., 1882, state geologist, Univ. of Kansas, Lawrence.
Warren Knaus, M. Sc., 1884, entomologist, editor and publisher, McPherson.
D. E. Lantz, M. Sc., 1887, biological survey, Washington, D. C.
J. T. Lovewell, Ph. D., 1878, chemist, Topeka.
F. O. Marvin, A. M., 1884, Univ. of Kansas, Lawrence.
J. R. Mead,* 1879, Wichita.
Ephraim Miller, A. B., A. M., Ph. D., 1873, Pasadena, Cal.
E. A. Popenoe, A. M., 1872, entomologist, Topeka.
L. E. Sayre, Ph. M., 1885, Univ. of Kansas, Lawrence.
Alva J. Smith, 1903, city engineer, Emporia.
B. B. Smyth, 1880, curator Goss Ornith. Coll., Topeka.

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* Deceased.

C. H. Sternberg, 1896, explorer and collector, Lawrence.
A. H. Thompson, D. D. S., 1873, Topeka.
M. L. Ward, D. D., 1880, Ottawa Univ., Ottawa.
J. T. Willard, M. S., 1883, Kansas Agr. Coll., Manhattan.
S. W. Williston, Ph. D., 1880, Univ. of Chicago, Chicago, Ill.

ANNUAL MEMBERS.

Frank G. Agrelius, A. M., 1905, State Normal School, Emporia.
H. C. Allen, 1904, Univ. of Kansas, Lawrence.
John J. Arthur, 1904, Topeka.
Wm. R. Arthur, B. A., 1903, dean of law school, Washburn Coll., Topeka.
W. M. Bailey, 1906, teacher, Holton.
Harvey W. Baker, 1902, florist, Manhattan.
Benj. P. Baker, 1909, student, Agr. Coll., Manhattan.
Elam Bartholemew, M. S., 1905, mycologist, Stockton.
W. J. Baumgartner, 1904, professor zoölogy and histology, Univ. of Kansas, Lawrence.
Frank G. Bedell, 1904, Dodge City.
Joshua William Beede, Ph. D., 1894, asst. professor of geology, Bloomington, Ind.
F. H. Billings, Ph. D., 1909, Univ. of Kansas, Lawrence.
Julius Brandt, 1907, Bethany Coll., Lindsborg.
H. H. Braucher, 1907, teacher, K. S. N., Emporia.
E. W. Brown, B. S., 1909, science teacher, high school, Pendleton, Ore.
Edw. Bumgardner, M. D., Univ. of Kansas, Lawrence.
F. W. Bushong, Sc. D., 1896, asst. professor of chemistry, Univ. of Kansas, Lawrence.
H. P. Cady, Ph. D., 1904, professor chemistry, Univ. of Kansas, Lawrence.
M. E. Canty, 1903, Buffalo, Kan.
I. D. Cardiff, Ph. D., 1909, professor of botany, Washburn Coll., Topeka.
F. P. Clark, M. D., 1909, Univ. Hospital, Kansas City, Kan.
Eustis C. Clay, 1910, stamp collector, Topeka.
W. A. Cook, M. S., 1907, Baker Univ., Baldwin.
R. A. Cooley, 1910, Ag. Expt. Station, Bozeman, Mont.
Rev. John T. Copley, 1903, clergyman, Manhattan.
E. G. Corwine, 1905, Mulvane.
F. F. Crevecœur, 1899, entomologist, Onaga.
S. J. Crumbine, M. D., 1909, secretary State Board of Health, Topeka.
B. J. Dalton, C. E., 1909, Univ. of Kansas, Lawrence.
O. P. Dellinger, professor biology, M. T. S., Pittsburg.
Frank Burnett Dains, Ph. D., 1902, professor of chemistry, Univ. of Kansas, Lawrence.
Emil O. Deere, A. M., 1905, Bethany Coll., Lindsborg.
James Dickson, A. M., 1904, Univ. of Kansas, Lawrence.
Robt. K. Duncan, B. A., 1906, professor of industrial chemistry, Univ. of Pittsburg, Grant Boulevard, Pittsburg, Pa.
R. B. Dunlevy, M. A., 1896, S. W. Kansas Coll., Winfield.
E. H. Dunmire, B. S., 1895, Univ. of Kansas, Lawrence.
C. W. Edmondson, Ph. D., 1909, professor of zoölogy and histology, Washburn Coll., Topeka.

H. W. Emerson, B. S., 1904, Univ. of Kansas, Lawrence.
B. F. Eyer, B. S., E. E., 1904, professor of electrical engineering, Agr. Coll., Manhattan.
T. L. Eyerly, 1906, high school, department of physiography, Dallas, Tex.
Fred. Faragher, A. B., 1904, with Alden Spears' Sons Co., Chicago, Ill.
A. O. Garrett, 1901, teacher high school, Salt Lake City, Utah.
Roy W. Gragg, 1907, accountant, Bartlesville, Okla.
A. A. Graham, 1910, lawyer, Topeka.
O. S. Groner, Sc. M., 1907, professor of chemistry, Ottawa Univ., Ottawa.
H. J. Harnly, B. S., 1903, professor, McPherson Coll., McPherson.
L. D. Havenhill, Ph. D., 1904, professor of pharmaceutical chemistry, Univ. of Kansas, Lawrence.
Thomas J. Headlee, Ph. D., 1907, professor of zoölogy and entomology, Agr. Coll., Manhattan.
W. C. Hoad, B. S., 1904, Univ. of Kansas, Lawrence.
W. F. Hoyt, A. M., 1902, State Normal School, Neb.
Albert K. Hubbard, Ph. D., 1904, Univ. of Kansas, Lawrence.
Thomas M. Iden, 1897, State Normal School, Emporia.
H. Louis Jackson, B. S., 1909, state food analyst, Univ. of Kansas, Lawrence.
E. C. Jerman, 1911, edectrician, Topeka.
John J. Jewett, 1902, physicist, San Diego, Cal.
A. W. Jones, B. S., 1894, Wesleyan Univ., Salina.
F. E. Jones, 1909, manual training school, Lawrence.
W. H. Keller, 1898, high school, Emporia.
H. H. King, A. B., A. M., 1909, asst. professor of chemistry, Agr. Coll., Manhattan.
Leslie A. Kenoyer, 1906, Independence.
Harry L. Kent, 1904, nature study, Agr. Coll., Keene, N. H.
John H. Klopfer, 1904, collector and mining expert, Topeka.
Pierce Larkin, B. A., 1902, geology, Univ. Norman, Okla.
R. D. Landrum, B. S., 1909, Lisk Manufacturing Co., Canandaigua, N. Y.
Marcus A. Low, 1906, attorney C. R. I. & P. railway, Topeka.
L. A. Lowther, 1907, superintendent of schools, Emporia.
F. A. Marlatt, B. S., 1907, machinist, Agr. Coll., Manhattan.
R. Matthews, D. D. S., 1898, dental surgery, Wichita.
David F. McFarland, Ph. D., state water survey, Urbana, Ill.
W. P. McCartney, 1909, chemist, Manila, P. I.
J. M. McWharf, M. D., 1902, physician, Ottawa.
Grace R. Meeker, 1899, botanist, Ottawa.
C. F. Menninger, M. D., 1903, physician, Topeka.
S. T. Millard, M. D., 1909, physician and surgeon, Topeka.
W. L. Moodie, 1906, Univ. of Kansas, Lawrence.
Roy L. Moodie, Ph. D., 1909, instructor, Univ. of Kansas, Lawrence.
Merle M. Moore, 1909, student, Ottawa Univ., Ottawa.
R. K. Nabour, 1910, instructor in zoölogy, Agr. Coll., Manhattan.
C. A. Nash, 1907, instructor in chemistry, Univ. of Kansas, Lawrence.
J. H. Newby, 1899, photographer, Osage City.
N. P. Nielson, 1906, state architect, Topeka.
A. M. N[illegible]en, A. M., 1901, farmer, Wetmore.

H. N. Olson, 1895, Bethany Coll., Lindsborg.
J. B. Parker, 1909, Agr. Coll., Manhattan.
Frank Patrick, 1903, microscopist, Kansas City, Mo.
Leslie F. Paull, B. S., 1903, Agr. Coll., Fort Collins, Neb.
Rev. P. B. Peabody, 1909, clergyman, (ornithologist), Blue Rapids.
L. M. Peace, A. B., 1904, Univ. of Kansas. Lawrence.
Arthur D. Pitcher, A. M., 1906, Univ. of Kansas, Lawrence.
L. M. Plairs, asst. entomologist, Agr. Coll., Manhattan.
M. A. Pond, 1906, promoter, Topeka.
L. M. Powell, M. D., 1906, physician, Topeka.
Silas Eber Price, D. D., president Ottawa Univ., Ottawa.
Charles Smith Prosser, D. Sc., Ph. D., 1892, educator and geologist, Columbus, O.
Wm. S. Prout, 1904, medical student, hospital, Topeka.
Albert B. Reagan, 1904, director of Indian school, Orr, Minn.
L. J. Reiser, 1911, chemist, Topeka.
Geo. E. Rex, 1911, mgr. treating plants, A. T. & S. F. Rly., Topeka.
H. A. Rice, C. E., 1909, asst. professor of engineering, Univ. of Kansas, Lawrence.
B. R. Rogers, D. V., 1907, Agr. Coll., Manhattan.
Eulalia E. Roseberry, 1909, teacher of physiography, Pittsburg.
Frank K. Sanders, D. D., Ph. D., LL. D., 1909, president Washburn Coll., Topeka.
D. C. Schaffner, 1903, Coll. of Emporia, Emporia.
John H. Schaffner, A. M., M. S., 1902, professor of botany, Univ. of Ohio, Columbus, O.
Theo. S. Scheffer, 1903, instructor in zoölogy, Agr. Coll., Manhattan.
Miriam Sheldon, A. M., 1906, Univ. of Kansas, Lawrence.
Edwin Taylor Shelly, M. D., 1902, physician, Atchison.
Claude J. Shirk, A. M., M. S., 1905, instructor in physics and chemistry, McPherson.
J. A. G. Shirk, 1904, professor of physics, Ottawa Univ., Ottawa.
Eva Schley, A. B., 1903, natural history, high school, Topeka.
Ralph C. Shuey, 1905, Univ. of Idaho, Moscow, Idaho.
Eugene G. Smyth, 1901, entomology, Dept. Agr., Washington, D. C.
Mrs. L. C. R. Smyth, M. S., Ph. D., 1902, botany and entomology, Topeka.
S. G. Stewart, M. D., 1904, physician and surgeon, Topeka.
Chas. M. Sterling, A. B., 1904, Univ. of Kansas, Lawrence.
E. F. Stimpson, 1904, Univ. of Kansas, Lawrence.
Edgar H. Thomas, 1907, State Normal School, Emporia.
F. J. Titt, B. S., 1898, Kingfisher Coll., Kingfisher, Okla.
J. E. Todd, A. M., 1907, professor of geology, Univ. of Kansas, Lawrence.
David Train, 1907, student, Bethany Coll., Lindsborg.
J. F. True, 1909, stockman, Topeka.
E. S. Tucker, 1904, Bureau of Entomology, Dept. Agriculture, Washington, D. C., Dallas, Tex.
W. H. Twenhofel, 1910, professor of geology and paleontology, Univ. of Kansas, Lawrence.
Edith M. Twiss, Ph. D., 1910, dean of women, Washburn Coll., Topeka.
W. A. VanVoris, 1907, State Normal School, Emporia.

P. F. Walker, 1905, Univ. of Kansas, Lawrence.
J. D. Walters, M. S., 1894, Agr. Coll., Manhattan.
E. C. Warfel, A. M., 1909, lawyer, Wamego.
H. J. Waters, B. Sc., 1909, president Agr. Coll., Manhattan.
J. E. Welin, A. M., M. S., 1899, professor of chemistry, Bethany Coll., Lindsborg.
Archie J. Weith, 1906, Pfaudler Company, Rochester, N. Y.
J. B. Whelan, 1909, professor of chemistry, Agr. Coll., Manhattan.
E. A. White, 1909, chemist, Kansas City, Mo.
Stanley D. Wilson, B. A., 1910, instructor in chemistry, Washburn Coll., Topeka.
W. B. Wilson, B. S., M. S., 1903, professor of biology, Ottawa Univ., Ottawa.
John A. Wilson, 1909, science teacher, Ely, Minn.
C. H. Withington, B. S., 1903, high school, Topeka.
T. M. Wood, B. S., 1909, instructor, M. T. S., Pittsburg.
H. I. Woods, M. S., 1902, professor physics and astronomy, Washburn Coll., Topeka.
Lyman C. Wooster, Ph. D., 1897, State Normal School, Emporia.
J. A. Yates, M. S., 1897, geologist, M. T. S., Pittsburg.
C. C. Young, 1909, chemist State Water Survey, Lawrence.

HISTORICAL SKETCH.

THE organization of a Kansas association of scientific men at an early date was due to the efforts of the late 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 coördinate department of the State Board of Agriculture by the terms of the following act of the legislature:

> "The Academy of Science shall be a coördinate 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 forty-two annual meetings, of which twenty have been held in Topeka, six in Lawrence, four in Manhattan, two in Leavenworth, three in Emporia, two in Ottawa, and one each in Atchison, Baldwin, Iola, McPherson and Wichita.

Twenty-four 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 north wing of the Capitol building, at Topeka, in rooms on the fourth floor. It has two connecting rooms, used for the office and library, and the museum occupies the adjacent corridor.

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.

The Academy will have permanent quarters in the Memorial building whose erection is now begun, and with this advantage will enter upon a new career of expansiveness and usefulness.

CONSTITUTION.

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.

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.

SECRETARY'S REPORT.

Ottawa Meeting, 1909.

THE compilation, publication and distribution of the Transactions is an important part of your secretary's business. It is often the case that papers have been read only by title before the Academy, so that the publication committee cannot pass upon them until after reading and examination. Originality and value as contributions to science must be the chief conditions of acceptance, but it has frequently happened that limitation in the size of our volume has excluded papers which would otherwise have been printed.

Until the twentieth volume was reached our Transactions were only published biennially, with a few exceptions when the earlier numbers were appendices to the reports of the secretary of the State Board of Agriculture, of which body, by the Laws of 1873, the Academy was made a "coördinate department."

The nineteenth volume, compiled by Secretary Grimsley, was unusually large and expensive, and was the last of our Transactions published under the old *régime* of state printing. This large expense was fortunate for us, as it became the basis for scaling down appropriations, and when I was told to limit the expenses to about two-thirds of the previous year's it was understood that we could get quite as much printing done with the smaller appropriation.

The long delay in the publication of papers has always been a source of annoyance to members, who have had to wait in some cases nearly two years before seeing their contributions in print. To remedy in part this delay the Printing Board was asked to honor a requisition for an annual volume under the stipulation that our printing expenses would not exceed the appropriation granted. The state printer saw in this plan convenience to his department, since it would relieve somewhat the rush of legislative years. So the next year after the nineteenth volume was issued we were able to print volume XX, and, to carry out the old plan of a biennial volume, it was labeled "Vol. XX, Part I." The next year we had "Vol. XX, Part II," and two years ago "Vol. XXI, Part I."

On consultation with the publication committee it seemed best to abandon the biennial volume theory and to name the current number volume XXII. The precedent of an annual volume is pretty well established now and the State Printing Board has been very generous and liberal with the Academy.

Copy for the current volume was in the printer's hands about the 1st of March, but this being legislative year, there was such demand for printing that the plant was wholly unable to finish our job till November, when volume XXII was at once sent to all our members. The laws of the state and reports for the great departments must necessarily take precedence over our volume, and your secretary besieged the printing office, in endeavor to hurry up, quite as much as was consistent with good taste and prudence.

It should be remembered that we have no legal rights to demand in this matter, and our requisitions are wholly in the hands of the secretary of state, the attorney-general and the state printer, who are the Printing Board of the Executive Council. Fortunately our relations with these officers have been most pleasant, and they have done for the Academy quite as much as was to be expected.

Another want of our members is to secure "separates" of papers that are published, and as most scientific periodicals reward the writers of accepted articles with "separates," it is not generally known why we cannot have them from the state printer, even when we stand ready to pay the expense. The answer is found in a state law which forbids the printer to do custom work and requires a separate requisition for each job. Under the old law, when the state printer was best paid of all the state officers, we could and often did secure separates by payment of a small fee, but this is no longer possible, and if we want separates now we must get them at a job office. To partly meet the demand, we had this year 200 copies of the Transactions left unstitched. This enabled us to have 200 lists of members and secretary's minutes to bind in with the preliminary announcement of this meeting, which all members should have received. It also gave the same number of the memorial papers in honor of Doctor Snow, and of the retiring president's address. Besides these we could secure from 100 to 200 copies of most other papers, which would sometimes have part of a page of some other paper included. If these separates were taken to a job office and bound as pamphlets the cost would be from one to four dollars for each paper, and while some are thus disposed of, a good many papers remain in my office awaiting instructions from their authors.

It should be remembered that plates for cuts and maps in our Transactions are not furnished by the state printer and have to be paid for out of the contingent fund allowed to this department. Our bill this year from the Capper Engraving Company amounted to $105, which leaves less than $200 for telephone, postage, express and office expenses. The expense of postage or express on each volume this year is sixteen cents, and it requires careful administration to keep our expenses within the fund.

Our current volume is so large that it seemed necessary, in order to carry out our stipulation with the state printer, to omit some pages that have been repeated substantially from year to year till they have become monotonous. These are the "Historical Sketch," the "Constitution" and "By-laws," and the lists of domestic and foreign exchanges. While this matter is important, it seemed to the publication committee sufficient that it appear at intervals of two or three years, and then perhaps in a separate pamphlet. It is quite possible that this year, judging from the papers now submitted, there may be room for the above appendices. In the announcement all members can find the secretary's minutes of the Topeka meeting, and it is unnecessary to call further attention to them.

THE LIBRARY.

The growth of our library has been largely through government publications at Washington, and through exchanges with various scientific bodies of America and foreign countries.

Our exchange list remains about as it has been and could easily be enlarged. These exchanges, coming to us, for the most part, unbound, require binding before being usable and placing on our shelves, and we have now about 500 volumes thus awaiting binding, and many of them are of great value. We receive large numbers of memoirs and bulletins from the Imperial Academy at St. Petersburg, and the yearbooks and bulletins from Sweden and Norway are very numerous. We get regular reports of the geology and mineral resources of Australia and Tasmania, and from Chili and Argentina come reports of the minerals and natural history of those countries. Valuable reports come to us from Canada and Mexico, and especial attention is called to these rather than to those from other countries, because it is of course expected that from the various centers of Europe we should get our main supply, and such is the fact.

Our accessions during the past year have been not less than 600 unbound volumes and pamphlets and 60 bound volumes. We have also secured by purchase Le Dictionaire De Almeida, four volumes of Poggendorff Biograph. Literar. Handwörterbuch, ten parts of North American Flora, the Topeka City Directory, and American Men of Science.

There must come a time when the book collections of the statehouse will be consolidated under one general management, and then with wise and uniform cataloguing our libraries will have a usefulness hardly dreamed of as yet. There has been duplication and triplication of many of the publications from Washington, and if these are all bound separately for each department the state must spend money needlessly. When we consider what this money could do if used in enlarging and perfecting the library this waste of resources seems inexcusable.

We shall be in a condition a year or two hence to take a new departure, when transferred to the new building, and should have plans which look to the future. We should claim for the Academy the right of having charge of the scientific portion of the state library, of which our collection is a part. Under a law enacted for benefit of the State Historical Society, that body is entitled to demand for itself sixty bound copies of all our Transactions, as well as other books printed by the state, with exception of the statutes. These books the Historical Society exchanges often for the publications of foreign scientific societies which are on our list, and it creates another source of duplicate books. The Historical Society has cords of such publications, stored in closets and dark rooms, doing good to no one.

The greatest good to the state requires that each organization which is the custodian of books in the statehouse should be governed by no idea of self-aggrandizement, but should unite in a common effort to make our state library the most important institution of its class within our borders. The only way to do this is to agitate the question and bring it before the people and then before the legislature.

There is one direction in which we can enlarge our library, which is by purchase of books not likely to be found in any other collection in the state. A small beginning was made this year, as noted above, but the committee appointed last year hesitated to buy one set authorized till the Academy should have a chance to reflect and see if this is the best thing to do.

THE MUSEUM.

The founders of this Academy, men like Snow, Mudge, Parker and Savage, were collectors, and often brought contributions which formed the nucleus of a museum. This was especially true in the years when the Academy was quartered with the State Board of Agriculture. Quite a display of natural history as well as agricultural specimens was taken to Philadelphia for the Centennial, and when brought back crowded the narrow space west of the office of the secretary of agriculture with a heterogeneous mixture more or less in charge of the Academy. When the St. Louis Exposition came, our Secretary Grimsley was given charge of the Kansas mineral exhibits, and secured from the authorities of the Exposition the transfer to our Academy of the whole mineral collection from Kansas. This was a fine foundation for an economic museum, and it seems fitting that the Academy should go on enlarging and perfecting it until it represents in a proper way the mineral resources of Kansas. Such a museum would be a great attraction in the Memorial building, but its maintenance requires direct state aid, which can be secured only by act of the legislature.

Respectfully submitted.

J. T. Lovewell, *Secretary.*

On motion of Professor Sayre, the above report was received and its discussion postponed till to-morrow.

The treasurer's report was called for, and read, as follows:

Balance on hand from last year	$408 38
Interest on time deposits	8 30
Receipts from fees and dues	160 00
Receipts from sale of Transactions	13 90
Total	$590 78
Expenditures	104 80
Balance on hand	$455 98

Respectfully submitted.

F. W. Bushong, *Treasurer.*

On motion, the treasurer's report was received and referred to the auditing committee.

President Dains announced the following committees:

On program: Bushong, Groner, and Cardiff.

On press: Sayre, and Shirk.

On audit: Smith, and Havenhill.

On membership: Scheffer, McWharf, and Yates.

On time and place: Sternberg, Smith, and Wilson.

On nominations: Sayre, Yates, and Cardiff.

On resolutions: Wooster, Bailey, and Jones.

The committee on necrology, happily, does not seem to be needed, since no deaths of members have been reported this year.

The Academy next repaired to the University chapel, where a very interesting lecture was delivered by Prof. Frank E. Jones, of the University of Kansas. The lecture was entitled "A Tour of the Philippines." There were many lantern projections of photographs secured by the lecturer during a residence of several years in the islands.

Wednesday, December 29, 9 a. m.

The Academy convened pursuant to adjournment, and took up some suggestions from the secretary's report.

Professor Sayre advocated an increase in the executive committee, which would then act as a legislative committee. Professor Bushong advocated a small committee, and Professor Yates favored separate committees.

Professor Sayre moved that the committee be enlarged to seven members and that it be called the executive council. Prof. A. J. Smith thought the legislature is apt to be suspicious of lobbying committees.

Several others participated in the discussion, and finally a motion prevailed to refer the matter to a committee of five, to be appointed by the chair, who should consider the matter of nominating the executive council and report later.

The president appointed Wooster, Cardiff, Bushong, Smith, and Havenhill as this committee.

The Academy next listened to the reading of papers from the following list, in the order as announced by program committee:

1. A Suggested Revision of the Terminology of Agriculture, L. C. Wooster.
2. An Esker near Mason, Mich., L. C. Wooster.
3. A Rare Mexican Cycad, W. B. Wilson.
4. Recent Methods in Organic Analysis, E. R. Groner.
5. Successful Termination of the Loco Weed Investigation, L. E. Sayre.
6. Analysis of Food Accessories under the Food and Drugs Law, L. E. Sayre.
7. Physical Culture in Schools, J. H. Klopfer.
8. The Dance and Shamaic Performances of the Quileute Indians, A. B. Reagan.
9. Sketches of Indian Life and Character, A. B. Reagan.
10. Maxwell's Method of Comparing Electrostatic Capacity with Self-inductance, J. A. Shirk.
11. A New Geometrical Figure and its Possible Application, E. C. Warfel.
12. Preliminary Note on Measuring the Speed of Photographic Shutters, H. I. Woods.
13. Pollution of Domestic Ground Water Supply, S. J. Crumbine.
14. Tools and Toys, B. B. Smyth.
15. Milk Sickness in Kansas, L. C. R. Smyth.
16. The Flora of Minima Hill, L. C. R. Smyth.
17. An Embryonic Plesiosaur Propodial, R. L. Moodie.
18. Provisional List of the Flora of Kansas, B. B. Smyth, John H. Schaffner, and Lumina C. Riddle Smyth.
19. Is the Dakota Formation Upper or Lower Cretaceous? J. E. Todd.
20. Further Notes on Pleistocene Drainage, J. E. Todd.
21. An Unusual Walnut (?) I. D. Cardiff.
22. Fifty Years of Evolution, A. H. Thompson.
23. Additions to the List of Kansas Coleoptera for 1909, W. Knaus.
24. Note on the Food of Bothrotes Knausii Caley, W. Knaus.
25. Notes on Kansas Coleoptera, W. Knaus.
26. Kansas Coleoptera—the Families Throscidæ, Lampyridæ, Malachidæ, Clevidæ, Cupescidæ, Cioidæ, Melandoyidæ, Œdemeridæ, Anthicidæ, Pyrochroidæ and Rhipiphoride (five minutes), W. Knaus.

27. Changes in the Cottonwood Limestone South of Cottonwood Falls, J. A. Yates.
28. On the Coloring Matter in Fruits, E. H. S. Bailey, and E. L. Tague.
29. On the Occurrence of Manganese in Waters, C. C. Young.
30. A Comparison of Some Methods of Making Thymine, D. F. McFarland.
31. On Food Adulterations, H. L. Jackson.
32. The Prairie Dog Situation in Kansas, T. H. Scheffer.
33. Investigating the Mole, T. H. Scheffer.
34. Catalytic Tests and Treatment of Systematic Phtysis, W. P. McCartney.
35. Mid-continent Petroleum, F. W. Bushong.
36. Some Difficulties of Arsenic Tests, F. B. Dains.
37. In the Niobrara and Laramie Cretaceous, C. H. Sternberg.
38. Notes and Observations on Equisetum, I. D. Cardiff.

Doctor Wooster read paper No. 1, and it was discussed by Dains, Sayre, Cardiff and Wilson.

Prof. C. C. Young read paper No. 29. This was discussed by Dains, Sayre, Lovewell, Smith and Sternberg.

Prof. T. H. Scheffer read No. 33, and it was discussed by Sayre, Lovewell and Young. The latter said he had kept a mole in captivity for three months, feeding it on bread and milk.

Doctor Cardiff read No. 21. Discussed by Scheffer.

Doctor Dains read No. 36. Discussed by Bailey.

Session adjourned for lunch.

1:30 P. M.

The committee appointed to consider the matter of an executive council reported their conclusion that such a council is advisable, and recommended that it consist of the present executive committee and four others to be appointed by the Academy. Report adopted.

It was moved and carried that this committee bring in four additional names for the executive council and report them at the evening session.

Professor Sayre read No. 6. Discussed by Willard, Sternberg and Bailey.

Prof. H. L. Jackson next read paper No. 31. Discussed by Dains, Scheffer and Wooster. Professor Sayre said the chemist cannot always decide whether or not certain food preparations are injurious. There is much self-deception, as when a woman thought she made six pounds of butter out of three pounds by hydrating it with water. Willard, Sayre and Bailey spoke of the contamination of canned foods from zinc tops, porous porcelain and lacquers.

Doctor Crumbine read No. 13, and it was discussed by Dains, Wooster, Bushong, Cardiff and Jackson. In view of the importance of these papers it was voted that Doctor Crumbine be requested to secure the publication of papers Nos. 13 and 31 in the Board of Health Bulletin.

A. J. Smith told how to construct a well that would be free from bacteria. Doctor Wooster said that typhoid bacteria may come from cisterns, and Professor Bailey suggested that often these cisterns had cracks admitting ground water.

Professor Bailey read No. 28, which was discussed by Sayre.

Mrs. Smyth read papers Nos. 15 and 16, which were discussed by Willard, Cardiff, Bailey, Dains and Crumbine.

Professor Cardiff presented No. 38. Discussed by Mrs. Smyth.

Professor Scheffer read No. 32. Discussed by Miss Meeker.

T. H. Scheffer reported, for the membership committee, the following applications for membership, and recommended their acceptance:

Benj. P. Baker, landscape gardener, Topeka.
O. P. Dellingn, professor of biology, M. T. S., Pittsburg.
H. H. King, assistant professor of chemistry, Agr. Coll., Manhattan.
Dr. S. T. Millard, physician and surgeon, Topeka.
Merle M. Moore, student, Ottawa.
Rev. S. B. Peabody, clergyman (ornithologist), Blue Rapids.
S. Eber Price, president Ottawa University, Ottawa.
Eulalia E. Roseberry, teacher of physiography, M. T. S., Pittsburg.
H. J. Waters, president State Agriculture College, Manhattan.
J. B. Whelan, assistant professor of chemistry, K. S. A. C., Manhattan.
J. A. Wilson, B. S., teacher in high school, Ely, Minn.
T. M. Wood, instructor, M. T. S., Pittsburg.
C. C. Young, chemist State Water Survey, Lawrence.

By unanimous consent, the secretary was instructed to cast the ballot of the Academy for the names reported, and they were accordingly elected to membership in the Academy. Edward Bartow, Ph. D., director of Water Survey, Urbana, Ill., became a life member by completing the payment of twenty dollars for dues.

The auditing committee reported that they had examined the treasurer's report and found it correct. Voted that this report be adopted.

At six o'clock, by invitation of Ottawa members and friends, the members and guests repaired to Charlton cottage, where an elegant banquet had been prepared by Miss Stickler, who was helped in serving by an able corps of assistants. The rooms were tastefully decorated, and in all respects it was an occasion of great pleasure to the Academy. After partaking of the bountiful repast the Academy received an address of welcome from Doctor McWharf, and the toastmaster, Prof. W. B. Wilson, called on Professors Dains, Willard, Sayre, Bailey, Doctor Crumbine, Doctor Wooster, President Price and Mrs. Smyth, who pleasantly and wittily responded to the various toasts offered.

After the banquet the participants, returning to the chapel, listened to the retiring president's address.

The subject chosen was "Silliman, Hare and Cook, and their Influence on American Science." Pictures were thrown on the wall of these pioneer teachers, as well as of other great chemists of their time and earlier. Professor Lovewell gave personal reminiscences of the elder Silliman, whom he met at Yale more than fifty years ago, and gave some account of the science teaching of those days.

The committee on nominations reported the following recommendations for officers of the Academy for the ensuing year:

For president, F. B. Dains, Topeka.
For vice president, J. M. McWharf, Ottawa.
For vice president, A. J. Smith, Emporia.
For treasurer, F. W. Bushong, Lawrence.
For secretary, J. T. Lovewell, Topeka.

By unanimous vote of the Academy, the rules were suspended and Professor Bailey cast the ballot of the Academy for the officers as reported by the committee.

THURSDAY—9 A. M.

The Academy resumed their session and listened to an able paper, No. 10, by Prof. J. A. G. Shirk.

Prof. B. B. Smyth, as a substitute for No. 14, exhibited a white-backed fox squirrel, which brought out accounts of other freaks of similar character in the color of animals.

Professor Bushong (No. 35) gave a further account of his researches in the mid-continent petroleums.

Professor Yates read No. 27, and it was discussed by Wooster, B. B. Smyth and A. J. Smith, who did not agree with the writer in thinking the upper layer to be chalk.

Professor Sayre (No. 5) says he has killed animals by feeding them plants which contain barium. He thinks by sprinkling the hay from loco plants with Glauber's salt it would render the barium constituent insoluble and make a safe and valuable fodder. Discussed by Bushong, Wooster, Smith, Dains and Whelan.

Doctor Wooster read No. 2, which was discussed by Dains and Shirk.

Doctor McFarland read No. 36. Discussed by Bushong, Wooster, Sayre and Whelan.

Professor Groner (No. 4) spoke of recent methods of organic analysis. Discussed by Dains and Bushong.

On motion of Professor Sayre, it was voted that copy of all papers to be published in the Transactions should be in the hands of the secretary within two months from this date.

The committee on time and place reported Topeka as the place for next meeting of the Academy, and the time December 27, 1910, unless the executive council find good reason for changing this date.

Professor McFarland suggested an Academy medal to be awarded for valuable scientific work. This was discussed by Bushong, Whelan and Mrs. Smyth. It was voted that a committee be appointed by the president to take this matter into consideration and report at a future meeting.

The committee on resolutions reported as follows:

Resolved, That we commend the practice of sending to the secretary with its title the time that will be required in reading each paper.

Resolved, That the secretary be requested to compile a list of members of the Academy, appending to each name academic titles and the special line of subjects in which the member is working; also his latest post-office address.

Resolved, That we give hearty thanks to the faculty of Ottawa University and to the citizens of Ottawa for the convenient rooms and the excellent dinner furnished to members of the Academy, and for other social courtesies.

Resolved, That we offer to the local newspapers our thanks for their full reports of the meetings of the Academy.

By unanimous vote the report was adopted.

It was voted that papers Nos. 7, 8, 9, 11, 12, 17, 18, 19, 20, 22, 23, 24, 25 and 26 be read by title and referred to committee on publication.

The business being now finished the president declared the forty-second annual session of the Academy ended.

THE PRESIDENT'S ADDRESS.

SILLIMAN, HARE AND COOKE, AND THEIR RELATION TO AMERICAN SCIENCE.

By F. B. DAINS, Topeka.

THE first two hundred years of American history is strikingly bare in the annals of science. Such a condition of affairs is not strange, when we consider the conditions that obtained. The early emigrants to this country were not, as a rule, from the class that produced scholars, and their existence here was a struggle for things material and political.

Two men only had demonstrated that the New World could produce men of the keenest scientific mind; and they were the "many-sided" Franklin, whose discoveries in electricity had brought him unsought membership in the Royal Society, and whose advice, pregnant with results, had encouraged Priestley in his classic researches; and Benjamin Thompson, Count Rumford, who, casting his lot with the mother country in the war of independence, did his scientific work in England and on the continent, but whose influence in the Rumford Foundation extends its material aid to American science to the present day.

As was natural, the early scientific efforts of this country were directed along the descriptive lines of botany, natural history, geology and mineralogy, and the names of Cutlar, Wistar, Mitchell, Hosack, Bartram and Trooste all deserve grateful remembrance for their labors.

Chemistry, the science whose course I wish to follow more especially, was, at the beginning of the nineteenth century, little more than a name in the new republic. The latter decades of the eighteenth century in the Old World had witnessed an unparalleled advance in chemical knowledge. When we recall the names of Black, Bergman, Scheele, Lavoisier, Priestley, Cavendish and Klaproth we realize that "there were giants in those days." The era of quantitative measurements, of a true theory of combustion and of exact analytical methods was destined to change a descriptive science into an exact science.

But the New World was soon to catch an echo of these discoveries, when Priestley, theologian, scientist and last defender of the "phlogiston" theory, driven from his English home by a mob, landed in New York in 1794. Proceeding to Philadelphia, he was greeted with an address from the American Philosophical Society, and by an unanimous vote of the trustees was offered the professorship of chemistry in the University of Philadelphia. This he refused, retiring instead to the little town of Northumberland, where he was engaged in literary and scientific work until his death, in 1804. To Priestley, to Woodhouse, professor of chemistry in the University of Philadelphia and pupil of Humphrey Davy, and to John McLean, professor of chemistry at Princeton, who had received his training under Black and Lavoisier, we owe in great part the increased interest in chemistry in America at the beginning of the nineteenth century.

That such an interest was awakened is shown by the passage of the following resolution, at the suggestion of the shrewd president of Yale, Doctor Dwight, September 12, 1798: "Voted, that a professorship of chemistry and natural history be instituted in this college as soon as the funds shall be sufficiently productive to support it." Four years later it was "Voted, that a professorship of chemistry and natural history be, and hereby is, instituted in this college. Voted, that it is expedient to select for a professor of chemistry and natural history some person of competent talents, giving him such time to give his answer, whether he will accept such appointment or not, as he may desire and as may be agreed upon between him and the corporation." For this position Benjamin Silliman, esq., was declared chosen. Silliman at this time was twenty-three years of age. He had graduated at Yale at the age of seventeen and had later returned to his alma mater as tutor. He accepted the appointment, with the proviso that time and opportunity be given him to become acquainted with his new duties. He had this advantage: he came to these unfamiliar fields with mind wholly free from prejudice. He had nothing whatever to unlearn. As he remarks: "During my novitiate chemistry was scarcely ever named. I well remember when I received my earliest impressions in relation to chemistry. Prof. Josiah Meigs delivered lectures on natural philosophy from the pulpit of the college chapel. He was a gentleman of the greatest intelligence, and had read Chaptel, Lavoisier and other chemical writers of the French school. From these, and perhaps other sources, he occasionally introduced chemical facts and principles in common with those of natural philosophy. I heard from him that water contains a great amount of heat that does not make the water any hotter to the touch or to the thermometer; that this heat comes out of the water when it freezes, and still the freezing water is not warmed by the escaping heat. This appeared to me very surprising, and still more astonishing did it appear that water could not be made any hotter by urging the fire. My curiosity being aroused, I opened the encyclopedia, and there read that balloons were inflated by an inflammable gas obtained from water; and I looked with intense interest at the figures representing the apparatus by means of which steam, made to pass through an ignited gun barrel, came out inflammable gas at the other end of the tube. These and similar things created in my youthful mind a vivid curiosity to know more of the science to which they appertained."

Before he committed himself to the new science, Silliman passed his examination for admission to the bar, that he might have a respectable profession to fall back upon in case the chemical venture failed to succeed. The winter of 1802-'03 was spent in Philadelphia as a student with Dr. James Woodhouse. Woodhouse, who seems to have been a shrewd and observant man, had appeared as a defender of the French school in a paper opposing the phlogiston views of Priestley. He was also the first one to point out the superiority of anthracite over bituminous coal.

As a picture of the chemical instruction at this time, let me again quote Silliman: "The chemical lectures were important to me, who has as yet seen few chemical experiments. Those performed by Doctor Woodhouse were valuable, because every fact, with its proof, was an acquisition to me. The apparatus was humble, . . . and our instructor delighted, though he did not excel in the performance of experiments. He had no proper assistant, . . . and the work was imperfectly done. He had not the gift of a lucid mind, nor of high reasoning powers, nor of a fluent diction; still we could understand him. Doctor Woodhouse was wanting in personal dignity, and was, out of lecture hours, sometimes jocose with the students. . . . In his person he was short, with a florid face. He was always dressed with care; generally he wore a blue broadcloth coat with metal buttons. His hair was powdered and his appearance was gentlemanly. His lectures were quite free from any moral bearing. At the commencement of the course he treated with levity and ridicule the idea that the visitations of the yellow fever might be visitations of God for the sins of the people. He imputed them to material agencies and physical causes. I should add, respecting his lectures, that they were brief. He generally occupied a third or a fourth of the hour in recapitulating the subject of the preceding lecture, and thus advanced at the rate of about forty or forty-five minutes in a day."

One of the most valuable experiences for Silliman during the two winters he passed in Philadelphia was his acquaintance with Hare. They worked much together with the oxyhydrogen blowpipe, which had been recently invented by the young Philadelphia chemist.

It was also the good fortune of Silliman to meet, at the table of Doctor Wistar, Joseph Priestley, and he speaks of him as follows: "In person he was small and slender. His age was then about seventy. His dress was clerical and perfectly plain. His manners were mild, modest and conciliatory; so that, although in controversy a sturdy combatant, he always won kind regard and favor in his personal intercourse. Speaking of his chemical discoveries, which were very numerous, Priestley said: 'When I had made a discovery I did not wait to perfect it by a more elaborate research, but at once threw it out in the world, that I might establish my claim before it was anticipated.'" This method was certainly characteristic of the older scientist and at times led him into error.

The second period in the education of Silliman was the winter of 1805-'06, which was spent in England. Part of this time was passed in London in the laboratory of Frederick Accum, where the days were devoted to the analysis of ores, to the preparation of crystallized vegetable acids, to the investigation of arsenic compounds, etc.; in short, a course in analytical and preparative chemistry, facilities for which had been lacking in Philadelphia.

In 1806 he migrated to Edinburgh, to attend the lectures of

Professor Gregory and Dr. Thomas Hope, the discoverer of strontium. I cannot forbear from giving another quotation, because it illustrates so well the ideals of chemical instruction at this time. "Doctor Hope's lectures were not only learned, posting up the history of discovery, and giving the facts clearly and fully, but the experiments were prepared on a liberal scale. They were apposite and beautiful, and so neatly and skillfully performed that rarely was even a drop spilled on the table. No experiment failed, except that in two instances glass vessels were broken by the heat evolved in the experiment —in one case by burning phosphorus and in another by sulphur and iron filings combining with incandescence when gently heated, but in these cases there was no fault of the experimenter; the experiment was hazardous to the vessels, and in such cases, if the lecturer states the fact beforehand, he will save his credit, even if the glass be shattered. Doctor Hope lectured in full dress, without any protection for his clothes; he held a white handkerchief in his hand and performed all his experiments upon a high table, himself standing on an elevated platform, and surrounded on all sides and behind by his pupils. His lectures were all written out but very rarely read. He was cool and lucid, but sometimes, rising above his manuscript, he essayed a flight of eloquence. In these cases he was not very successful." Hope was a pupil of Lavoisier and Black, whom he took for his model. Black is known to us by his classic research, "Experiments on Magnesia Alba," in the course of which carbon dioxide was rediscovered, and by his discovery of latent heat.

Besides chemistry, Silliman listened to lectures in Edinburgh on geology, mineralogy and medicine. He also during this year made the acquaintance of Dalton, Davy and Wollaston.

If time allowed it would be interesting to speak of the early handicaps of Silliman at Yale, of his subterranean laboratory, of his difficulties in procuring apparatus. For instance, he sent to a glass factory in Connecticut, as a model, a retort, the neck of which was broken from the bulb. In due time he received a carefully packed shipment of retorts, the necks and bulbs being placed side by side: all having been neatly cracked in order to duplicate the original retort.

For the next half century, Silliman spent a busy life as teacher, investigator, public lecturer, and from 1819 editor of the American Journal of Science, which he founded. Those were years of enormous value to American science, not only for the men who were trained in the old laboratory at Yale—men like Dana (the great mineralogist) and Johnson (the pioneer in agricultural chemistry)—not only for the publication of the American Journal of Science, which "was for two-thirds of a century the most prominent register of the scientific work of the continent," but also for what these years meant in the education of part at least of the American people into an appreciation of the value of scientific work and investigation as it relates to the welfare of the state. Unless we consider the conditions in America seventy-five or one hundred years ago, we can hardly appreciate the services of Silliman, Hare, Griscom and others in their efforts toward popular scientific instruction. The educative value of it cannot be directly estimated, but its results were far-reaching, and to-day we are reaping its benefits.

Silliman was a man of broad interests and literary skill. His accounts of a journey to Canada, of his year in England in 1805-'06, and of his travels on the continent fifty years later, are still worth reading. One phase of his civic activity relates directly to our own state. He was instrumental in furnishing with rifles one of the New England colonies which made its way to Kansas, and later he signed a remonstrance which was forwarded to President Buchanan protesting against the use of the United States troops in enforcing the slave laws. For this stand he was bitterly assailed in the press and in the senate of the United States. In the latter body a defense and eulogy of Professor Silliman was pronounced by Senator Foster and Senator Dixon. In other fields also Silliman showed the wide range of his interests.

Robert Hare was born in Philadelphia in 1781, and in the same city spent the seventy-seven years of his long and fruitful life. His early training differed from that of Silliman and Cooke, in that it lacked the rigid classical drill they had both passed through. His predilection toward chemistry manifested itself at an early age and was fostered by his membership in the Philadelphia Chemical Society, where his associates and teachers were Priestley, Woodhouse and Seybert, the latter being a product of the School of Mines in Paris. From 1818 to 1847, Hare was professor in the University of Pennsylvania, where like Silliman he exercised a great influence as a teacher and exponent of scientific truth. He had, however. what Silliman largely lacked—originality; or, as we would now say, "research ability." While in the first fifty volumes of the American Journal of Science Silliman has only twenty-nine contributions of moderate importance, Hare's titles in the same volumes number some one hundred and fifty, in the fields of chemistry, physics and meteorology. The subjects range from descriptions of new apparatus, processes for making fulminating powder, analysis of gaseous mixtures, methods of detecting minute quantities of opium, to contributions on the theory of atoms, the nature of acids and bases, and the principles of chemical nomenclature. Space forbids any extended description of these papers, but two of them deserve at least a passing notice. Hare when a youth of twenty invented the oxyhydrogen blowpipe, a discovery which was later rewarded with the first Rumford medal. Lavoisier had obtained high temperatures by directing a stream of oxygen on glowing charcoal, but it was left for Hare to show that the maximum possible effects of heat could be obtained by surrounding the body to be heated with an atmosphere of burning gas, produced by burning hydrogen in an atmosphere of oxygen. In the hands of Hare and Silliman this apparatus, until the invention of the electric furnace, was the most powerful means for the development of high temperatures. By its aid metals like gold and platinum were not only fused but vaporized, while silicates, the precious stones, the oxides of barium, strontium and calcium were fused. Growing out of it are the later technical uses, the Drummond or calcium light and the purification of refractory metals like platinum.

Silliman, in an article in the Journal of Science, describes some experiments where plumbago or natural graphite was subjected to the heat of this flame. He speaks of obtaining crystals that would scratch glass, results which would indicate that he had obtained the silicide of carbon or carborundum, a product now manufactured in the electric furnace and one of great importance as an abrasive agent. A second interesting discovery of Hare was the "calorimeter," a description of which was published in 1819 in a memoir entitled "A New Theory of Galvanism." The apparatus consisted of large plates of copper and zinc which could be plunged into dilute acid. This was modified in 1820, in that sheets of copper and zinc containing several hundred square feet, separated by felt, saturated with acidulated water, were made into a roll. Enormous heat effects were obtained by this current, so much so that Silliman in 1823 was enabled to demonstrate the fusion and volatilization of carbon, a result of great interest. Using a battery of this type, Hare in 1831 made the first application of electricity to blasting under water.

We must not be too critical in our judgment of these papers of Silliman, Hare and their associates. From the standpoint of pure synthetic research they doubtless will be found wanting, but they had their place, and a most important one, in the development of scientific knowledge and spirit in America.

The third member of this illustrious trio, Josiah Parsons Cooke, began his work in the '50's, just at the close of the active labors of Silliman and Hare. As Philadelphia and New Haven had each made its contribution to science, so now it was the turn of Cambridge to carry on the torch of progress. Professor Cooke's interest in chemistry received its stimulus from the public lectures of Silliman, delivered on the Lowell Foundation. These were listened to with great eagerness, and the young lad supplemented these lectures by working through all the experiments in Turner's bulky volume in a small laboratory fitted up in his own home. His undergraduate days, which ended in 1848, offered him no opportunity to increase his store of chemical knowledge, because the only instructions given in that subject were a few desultory lectures of Professor Webster, of lamented fame.

In the fall of 1849 he was appointed tutor in mathematics, being transferred the same year to an instructorship in chemistry, thus giving him the eagerly desired opportunity. The next fall, at the age of twenty-three, he was made Eirving professor of chemistry and mineralogy. The other candidate for the position was David A. Wells, later the great political economist, the first graduate in chemistry of the Lawrence Scientific School. Why the untrained man was chosen in place of Wells we do not know, but for once the choice was a most fortunate one. The secret of the success of this young man was his ability, his store of common sense, and an insistent persistency which overcame in time all obstacles.

Cooke was essentially a self-taught man. He had, it is true, heard a few lectures from Regnault and Dumas in Paris, but only for a short time. He was, however, characterized by his ability to "keep abreast of the times" and to recognize the important fields of chemistry as they developed and to add them to the Harvard curriculum. To him came the necessity of shaping and developing the entire instruction in chemistry, and how well he succeeded the history of that department shows. A member of his first class, and later assistant in the department, was Doctor Eliot; and I have no doubt that the influence and efforts of Professor Cooke had much to do in molding the ideas and assisting the labors of President Eliot in the development of Harvard from college to a great American university.

Professor Cooke's contributions to Harvard and to American science are his services as a teacher, as an investigator, and as an exponent of scientific culture.

The first duty of a professor at that time, as it is now, in the American college is toward the actual instruction in his department, and from this standpoint Cooke accomplished much in bettering the methods and aims of scientific teaching. He developed in the college the laboratory method of teaching physical science. Silliman and Hare had followed a system of rather florid lectures, profusely illustrated with interesting experiments, but so far as actual manipulation was concerned the student remained a receptive, possibly, but passive, agent. Cooke sought to develop in the student by these laboratory methods the power of close and accurate observation and the ability to reason clearly from these observations, an aim which is the concrete essence of the value of all science training. Again, he sought to make chemistry not only a descriptive but an exact and disciplinary study. In this connection it is interesting to note that Professor Cooke published, in 1855, a little book on chemical equations and problems, as a drill for his class in the exact quantitative relations in chemistry. This is the first book of the kind with which I am acquainted, and it shows his desire to promote the rigid accuracy which forms the basis of any adequate science teaching.

To most of us only one gift is granted—that of adding by dint of much labor some new fact to the ever-increasing store of knowledge, but to some few there is given a clearer vision, which enables them to assort these scattered facts and derive from them a general law. To a certain degree this latter faculty was granted to Cooke. In 1854 he published a paper on "The Relation Between the Atomic Weights." Here he arranged the elements in a homologous series, which was to show the relation between them as does such a series in organic chemistry; and while he failed in anticipating the work of Newlands, of Mendelleef and of Lothar Meyer, he did catch a glimpse of the great truth "that we must not merely separate out here and there the so-called related elements, but must grasp the fact that there is a relationship even between the apparently dissimilar." This ability to grasp a subject is seen in his books, "The New Chemistry" and "Chemical Physics," which were remarkably clear and adequate presentations of the fundamental conceptions of chemistry. Of Professor Cooke's investigations, time permits us only to recall the determination in 1877 of the atomic weights of antimony, and ten years later, with T. W. Richards, the work on "The Relative Values of the Atomic Weights of Oxygen and Hydrogen."

These papers from the Harvard laboratory were the inspiration of that most brilliant series of researches by Richards and his pupils, which are marvels of careful and painstaking work, so that the efforts of these men, coupled with the classic memoir of Morley on "The Relation between Hydrogen and Oxygen," and the labors of W. A. Noyes, have given to American science the foremost place in this phase of scientific investigation.

Lastly, Professor Cooke stood as one of the best exponents of "scientific culture." His address on that subject, written in 1875 and published in the Popular Science Monthly, deserves to be read and reread by every follower of science. His breadth of view is well illustrated by the following sentence from the address, which was delivered at the opening of the summer school at Harvard: "Moreover, I hope, my friends, that you will come to value scientific studies, not simply because they cultivate the perceptive and reasoning faculties, but also because they fill the mind with lofty ideals, elevated conceptions and noble thoughts. Indeed, I claim that there is no better school in which to train the esthetic faculties of the mind, the tastes and the imagination than the study of natural science."

These men then are the three great names among the American chemists of the nineteenth century, and they are surpassed by none for their services in promoting scientific methods, ideas and ideals. The value of the past is largely in the light it gives to the present, and it seems to me that there are two lessons which can be drawn from even this brief account of their life activities.

The first is that they stood for rigid accuracy in observation and thinking. In an experience of almost two decades of teaching, my observation is—and I think that those of you who are teachers and those who have observed the results of secondary and college instruction will bear me out—that there is an almost universal lack of accuracy in thinking and working among our young people. The fault lies in no one place, but permeates the whole general scheme of education. Nor is it anything new. The malady was observed long ago, and the introduction of science teaching into our schools, which it was hoped would prove an antidote to the disease, has not alleviated the situation.

Some of the causes are not especially far to seek. Too much importance is placed on mere memory. As Professor Cooke remarks, "Many a student will solve an involved problem in algebra readily enough, so long as they can do it turning their mental crank, when they break down on the simplest practical problem of arithmetic, which requires of them only thought enough to decide whether they shall multiply or divide." To the average college student, "the acquisition of the elementary principles of a science is burdensome and distasteful," simply because, if the course is given rightly, he is forced to use methods of thought, in which he is wholly untrained; and it is difficult in the second place because he usually has no comprehension of the need of accuracy.

One of the causes of this latter failing is the introduction of the multiplicity of subjects into the secondary schools. The American plan has been to put every kind of a literary dish on the table, from nature study to psychology, and hand out a portion of each to the unfortunate pupil; and I fear, too, that much of the menu could not be guaranteed under any literary "food and drug act." The result is severe mental dyspepsia. The mental and moral make-up would have been much better nourished with a few subjects, chosen according to their needs, well "Fletcherized" and thoroughly digested. The fault goes back to the whole spirit of the American people—a spirit that likes to deal with large numbers and in glittering generalities—and in this regard a time has come when there must be a change. Our whole system of life, our agriculture, our economic processes, must be not alone extensive but intensive.

The second characteristic of these men that we should emulate is their broad interest in the various phases of human activities and knowledge. This is a point that I wish to emphasize especially. It seems to me that the ideal result of the study of science is to arouse an intense intellectual curiosity in the many sides of human activity. The lack of such an interest is, I find, another of the common faults of our young people. The printed page means nothing but a printed page; something to be gotten through with and out of the way. The wider aspects of the subjects are meaningless. This ought not so to be. Take, for instance, the fields of natural history, geology, chemistry and physics; when you consider them from the scientific, economic, historical and human side, there is little of life they do not touch and illustrate.

That a thorough sicentific training does develop men of the broadest sympathies is seen in the call to the headship of some of our leading universities of the chemists Eliot, Remsen, Venable and Avery, of the physicists Nichols and MacLaurin, the geologist Van Hise and the zoölogist Jordan. The ideal result of this training is to make men "who think that nothing of humanity is alien to themselves."

II.

CHEMICAL AND PHYSICAL PAPERS.

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1. "OCCURRENCE OF MANGANESE IN WATER."
   By C. C. YOUNG, University of Kansas, Lawrence.
2. "ON THE COLORING MATTER IN FRUIT JUICES."
   By E. H. S. BAILEY and E. L. TAGUE, University of Kansas, Lawrence.
3. "RECENT METHODS IN ELEMENTARY ORGANIC ANALYSIS."
   By O. S. GRONER, Ottawa University, Ottawa.
4. "LOCO WEED AND LOCO POISON."
   By L. E. SAYRE, University of Kansas, Lawrence.
5. "ANALYSIS OF FOOD ACCESSORIES UNDER THE FOOD-AND-DRUGS LAW."
   By L. E. SAYRE, University of Kansas, Lawrence.
6. "MAXWELL'S METHOD OF COMPARING AN ELECTROSTATIC CAPACITY WITH SELF-INDUCTANCE."
   By J. A. SHIRK, Ottawa.
7. "THE CIRCLE THAT IS NOT A CIRCLE."
   By E. C. WARFEL, Wamego.

OCCURRENCE OF MANGANESE IN WATER.

By C. C. Young, University of Kansas, Lawrence.

IN THE work of the Kansas Water Survey the presence of manganese was indicated in several waters that had been submitted for examination. Owing to the small amount of data relating to manganese-containing waters in this country it is thought well worth while to follow up the hint thus given. This article is in the main a statement of results obtained before making a complete survey of the ground-water supplies of the state in regard to manganese.

The presence of manganese in ground waters is due to the same causes that effect the solution of iron so commonly found in waters from river valleys. Manganese usually exists in these valley soils in the form of oxides or basic carbonate, and as surface water percolates through the soil containing unoxidized organic matter it is deprived of its free oxygen. When the free oxygen is used up from the water, the soluble organic matter attacks the oxides of iron and manganese and reduces them to a ferrous and manganous condition, when solution is then effected by the carbonic acid naturally present in the water.

Whenever the amount of iron and manganese so dissolved exceeds 0.5 to one part per million, the taste and value of the water for domestic purposes is impaired. At Hutchinson, Kan., in 1904, the service pipes of the water company were completely stopped up by an earthy brown deposit which, according to Dr. E. H. S. Bailey,[1] contained 45.2 per cent Mn_3O_4. The water causing this deposit contained only one part per million of manganese. Often deposits are caused by the presence of Crenothrix.

Waters containing these soluble salts are clear when drawn, but become very turbid on standing, due to the absorption of oxygen from the air and conversion of manganese into the hydroxides, which, on standing, will settle out as rusty precipitate. It has been shown[2] at Berlin, Brunswick, Hanover and several other places that the ferric hydroxide precipitates out faster than the manganic

1. Jr. Amer. Chem. Soc., vol. XXVI, No. 6.

2. Trans. Amer. Soc. Civil Eng., vol. LXIV, p. 173.

hydroxide. This is illustrated by some laboratory experiments made on the Lawrence (Kan.) waters:

TABLE I.

	Parts per million. $Fe_2O_3+Al_2O_3$	Manganese.
No. 25 (*a*) Taken from well	14.8	2.62
(*b*) After standing 48 hours	5.2	1.04
No. 26 (*a*) City water, after treatment before settling	14 4	2.51
(*b*) After standing 48 hours	3.2	.93

Sample No. 25 was taken directly from the large well from which a great portion of the city supply is drawn.

Sample No. 26 was taken from the outlet to the settling basin after the water had been treated with a small amount of lime and aerated. In both cases the waters were allowed to stand forty-eight hours and the clear solution above the precipitate pipeted off. The results above are the average of several analyses.

However, the ratio of the iron to the manganese removed from the water as delivered to the consumer is different, there being a larger per cent of manganese removed than iron. Results of analyses made on seven different days on the tap water showed an average of 1.16 parts per million of manganese and 10 parts per million of iron and aluminum oxides. The tap water thus contained about three times as much iron and aluminum oxides as the water which had settled in the laboratory. This discrepancy was due. no doubt, to a larger amount of the ferric hydroxide remaining in suspension, the first deposit carrying down the precipitated manganese, or the unoxidized organic matter still in the water has a tendency to keep the iron in solution while in contact with the iron pipes of the system, there being no solution of manganese going on while in the pipes.

The difficulty of determining manganese by long gravimetric methods, or by volumetric methods of doubtful accuracy in cases of small amounts of manganese, was obviated by making use of the bismuthate methods as adapted to waters by Mr. Robert Spurr Weston,[3] with a slight modification on account of the high chlorine in the Kansas waters. The method used in this work is as follows:

Evaporate with 5 cc. of concentrated sulphuric acid to strong fumes, 250 cc. of the water of unknown manganese content. Take up with 50 cc. of nitric acid (sp. gr. 1.135), and when the solution is cold add about 0.5 gram of sodium bismuthate. Heat until the pink color disappears, with or without the precipitation of manga-

3. Jr. Amer. Chem. Soc., vol. XXIX. p. 1073; Blair, Chem. Anal. Iron and Steel, p. 135; Chem. News. vol. LXXIV, pp. 247-302. vol. LXXXV, p. 59; Trans. Chem. Soc. 1895. p. 268; Ding. Poly. Jr., pp. 224-269; Brearley & Ibbotson. That Anal. of Street Wks. Materials.

nese dioxide. If the solution is colored brown, add enough ammonium ferrous sulphate to clear the solution, and boil off any oxides of nitrogen. Add a drop of silver nitrate to remove from the solution the last trace of chlorides. Cool to about 16° and add an excess of sodium bismuthate, shake for a few minutes, and filter through a washed asbestos mat free from organic matter. Wash the filter with three-per-cent nitric acid solution, then transfer to a large Nessler tube and make up to 100 cc. Run into another 100-cc. tube, containing sulphuric acid solution made very slightly pink with permanganate, enough standard potassium permanganate solution to match the color of the sample.

TABLE II.

Source of Supply.		Manganese, parts per million.	
		1.	2.
1. Chanute	Well No. 7	0	0
2. Chanute	Well No. 8	0.074	0.074
3. Chanute	Well No. 9	0.186	0.140
4. Barnes	Well	0	0
5. Barnes	City well	0	0
6. Lucas	Well	0	0
7. Lucas	Well	0	0
8. Lucas	Well	0	0
9. Lucas	Well	0	0
10. Lucas	Well	0	0
11. Excelsior Springs, Mo.	Ferro-Mn. water	3.86	4.00
12. Excelsior Springs, Mo.	Ferro-Mn. water	Trace.	Trace.
13. Excelsior Springs, Mo.	Ferro-Mn. water	0	0
14. Garden City	Well	0	0
15. Garden City	Well	0	0
16. Garden City	Well	0	0
17. Burlington	Well	0	0
18. Burlington	Well	0	0
19. Burlington	Well	0	0
20. Burlington	Well	0	0
21. Wakefield	Well	0.26	0.26
22. Wakefield	Well	0	0
23. Horton	Well	0.036	0.036
24. Lawrence:			
(a) Dec. 11, 1909	Tap water	1.34	....
(b) Dec. 13, 1909	Tap water	1.12	....
(c) Dec. 14, 1909	Tap water	1.30	....
(d) Dec. 16, 1909	Tap water	1.19	....
(e) Dec. 17, 1909	Tap water	0.74	....
(f) Dec. 20, 1909	Tap water	1.15	....
(g) Dec. 21, 1909	Tap water	1.30	....
25. Lawrence	Main well	2.60	2.64
26. Lawrence	City water after treatment before settling	2.51	2.51
27. Topeka	Tap water	0.74	0.74
28. Bonner Springs	Tap water	0.52	0.59
29. St. Marys	Tap water	Trace.	Trace.
30. Wamego	Tap water	Trace.	Trace.
31. Hays	Well	0 55	0.56

The results of the examination of twenty-nine different ground waters from Kansas and western Missouri show the presence of manganese in twelve cases, and a sufficient amount in a few cases to make the water undesirable for a city supply on account of the tendency for "*Crenothrix*[4] *ananganfera*" to grow, if for no other

4. Jr. Soc. Chem. Ind., 21-681; Trans. Amer. Nicro. Soc., 23-32; Bot. Zeit. 1888, bd. 46.

reason. However, at the time these analyses were made no *Crenothrix* could be found in the Lawrence supply, but at certain times of the year this supply is usually troubled with the growth.

From what has been said one might be led to think that all waters containing iron in considerable quantities contain manganese also, but the waters having no manganese in the table above were introduced to illustrate this point.

All of the twenty-nine supplies examined contained more than two parts per million of $Fe_2O_3+Al_2O_3$. The best illustration of waters with iron and no manganese are the Lucas waters.

TABLE III.

	Parts per million $Fe_2O_3+Al_2O_3$.
No. 6	14.4
No. 7	4 4
No. 8	5.2
No. 9	5.8
No. 10	Not determined.

The waters showing the greatest amount of manganese are the ones whose sources are the water-bearing sands and gravel of the Kaw river valley.

It has been observed in the city water supplies along the Kaw river that the rusty iron precipitate does not show up until the supply has been in use for some time.

At the present time the village of Bonner Springs is considering the abandonment of the present source on account of the large amount of iron and manganese present, as the cost of maintaining a filter plant or any other method of purification would be too great.

The plants longest in operation along the Kaw show the most manganese. The Lawrence and Topeka works were put in operation about the same time. Wamego was next, with Bonner Springs and St. Marys last, in the order given. The time is not far distant when the larger towns will be compelled to put in operation some form of purification other than settling the water, for at times when the organic matter is high in the water scarcely any of the iron is removed by the slight aeration and settling now given it. The private wells in Topeka and Lawrence are so badly polluted that a good supply will be demanded for domestic uses before many years.

N. B.—In the last volume of the Transactions of the American Society of Civil Engineers (September 19, 1909), there is a complete discussion of iron and manganese removal, as practiced in this country and abroad, by Mr. Robert Spurr Weston.

December 21, 1909. Water Survey Laboratory, University of Kansas.

ON THE COLORING MATTER IN FRUIT JUICES.

(ABSTRACT.)

By E. H. S. BAILEY and E. L. TAGUE, University of Kansas, Lawrence.

THIS work was undertaken in order to find out, if possible, some scheme for detecting the different natural colors of fruit juices, and also the different artificial colors used in the preparation of food products. Experiments were made upon the juice of Red raspberries, Black raspberries, huckleberries, strawberries, blackberries, Red currants and Black cherries.

This work was carried out along three lines: (1) To find new solvents for natural colors; (2) to apply known tests to these extracts; and (3) to find new characteristic tests to be applied to coloring matters extracted by known methods.

The solvent power of carbon tetrachloride, several hydrocarbons and sulphonic acids were tried with negative results. It was found that ethyl alcohol, propyl alcohol and isobutyl alcohol were good solvents, if the fruit juice was first saturated with sodium chloride. Cymene, quinoline and pyridine were found to be good solvents. Cymene would extract the coloring matter from other extracts, *e. g.*, acetone, and leave the original clear and colorless. Pyridine gave characteristic reactions with the fruit juices themselves.

An effort was made to diazotize the different coloring matters, with some encouraging results. The effects of oxidizing and reducing agents were tried and the resulting colors were tested with (1) acids, (2) bases, and (3) salts, and results tabulated. Several oxidizing and reducing agents were tried, among which bromine was found to be the best oxidizing agent and sodium hydrosulphite the best reducing agent. The above scheme of oxidation and reduction, with subsequent treatment with acids, bases and salts, gave splendid results.

The work was extended so as to include some of the coal-tar colors and also some of the harmless vegetable colors permitted to be used in food products. The tables of the results show that natural fruit juice colors can be readily distinguished from each other and from the coal-tar dyes, as well as from the vegetable dyes, in this manner. If coal-tar dyes are mixed with natural colors, as would be the case in food products, they can be separated by the double-dyeing method given in U. S. Bulletin No. 25. Since natural colors do not dye in the second bath, the above scheme can be applied subsequently to both the natural color and the added artificial color.

If natural colors and artificial colors are mixed, the added color will completely mask the natural color reactions. Since the artificial colors give an entirely different set of reactions upon oxidation and reduction, the presence of the added color can be readily detected.

RECENT METHODS IN ELEMENTARY ORGANIC ANALYSIS.

(ABSTRACT.)

O. S. GRONER. Ottawa University, Ottawa.

IN THE paper a careful study was made of the Dennstedt, Morse and Walker methods of determining carbon, hydrogen and nitrogen in organic compounds. In the Dennstedt method (compare Ber. d. Deut. Chem. Ges., vol. 30, p. 1590; vol. 38, p. 3729; vol. 39, p. 1623; Dennstedt's Anleitung zur Vereinfachten Elementaranalyse) three applications of chlorplatinic acid were found necessary in order to prepare the quartz properly for the combustions. The results on nitrogen, which is determined simultaneously with the carbon and hydrogen by absorbing the nitrogen tetroxide with lead dioxide and weighing as lead nitrate, were low, and there is evidently greater difficulty in obtaining concordant results than by the other two methods.

The Morse method was carried out as described by the author (Am. Chem. J., vol. 33, p 457; Exercises in Quan. Chemistry, p. 457, H. N. Morse). The objectionable feature is that it does not permit of the determination of nitrogen.

In the history of chemical science no portion is of greater interest than the one which concerns itself with the development of our present system of elementary organic analysis.

Lavoisier was the first chemist to reduce the subject to a quantitative basis. By his experiments he established the true principles of combustion, which furnished a basis for the determination of the composition of organic compounds. Working on the principle that oxygen united with carbon and hydrogen to form permanent compounds, Lavoisier succeeded in determining the quantitative composition of some organic compounds. His first work was done with crude apparatus, but his results were quite accurate, when the process which he employed is taken into consideration. Lavoisier improved his methods very rapidly and devised methods which are very similar to those in use at the present time. He succeeded in analyzing substances which were difficult to burn, and obtained good results.

It would be difficult to estimate too highly the significance of his work. He established the fundamental principles of elementary organic analysis and devised methods by which these principles could be used in quantitative determinations.

But little was done after the death of Lavoisier until 1806, when Saussure, Thénard and Berthollet made an attempt at organic analysis. Their method was essentially one of mixing the substances to be analyzed, in the form of a vapor, with oxygen and exploding the mixture or decomposing the substance at a high temperature. By this means they succeeded in converting the carbon and hydrogen into permanent gaseous compounds. With many substances they obtained good results.

The next modification of the process was made by Gay-Lussac and Thénard. They continued the process of Lavoisier, but used potassium chlorate as an oxidizing agent. A definite quantity of the substance to be analyzed was mixed with potassium chlorate, and the mixture heated. They obtained some good results for carbon and hydrogen. In the nitrogen determination they used copper oxide. The results obtained were good with a small number of substances.

Berzelius continued the work, using Lavoisier's plan. He used potassium chlorate as an oxidizing agent. The activity of the action was modified by the addition of sodium chloride.

The work of Liebig (1823–1830) is considered to be the most important contribution from the time of Lavoisier to the present. Liebig succeeded in perfecting the first process that would produce satisfactory results. Liebig used a hard glass tube about 18 inches long and 0.5 inch in diameter. The tube was closed at one end, the closed end being drawn out to a sharp tip. The tube was charged for a few inches with granular copper oxide. The weighed substance was added, mixed with fine copper oxide. The tube was then filled with copper oxide. Calcium chloride was used to absorb the water, and potassium hydroxide to absorb the carbon dioxide. The tube was heated in a charcoal furnace. To remove all the gas from the tube an aspirator was attached to the potassium hydroxide bulbs, the tip of the closed end of the combustion tube was broken off and dry air allowed to enter. Liebig succeeded in making satisfactory nitrogen determinations.

Liebig's process, with a few modifications, is the one in general use at the present time. The substance can be completely burned, and if sufficient care is exercised satisfactory results are obtained.

The furnace used at present is provided with a tube open at both ends. Through the rear end dry oxygen is admitted. At the opposite end the absorption apparatus is attached. A tile furnace is used, and heat is supplied by means of gas burners.

The following references were used in this historical sketch: Quantitative Chemical Analysis, Julian, p. 295; Organischen Chemie, Meyer and Jacobson, p. 19; Treatise on Chemistry, Roscoe and Schorlemmer, vol. 3, p. 40.

For a long time there have been objections to the old form of combustion furnace which is used in elementary organic analysis. The furnace is expensive, it is heavy and requires a large amount of table space. Much time is required in heating and cooling it. If a small room is used the temperature soon becomes too high for comfort. The quantity of gas used in heating the furnace and the amount of oxygen consumed are both so large that methods which will be less expensive than this one are very desirable. The old form of furnace does not allow the flame to come near the tube. The more recent methods aim to secure as near as possible direct effects of the heat. Because of these facts simple and less expensive apparatus have been designed.

Three of the more recent and most inviting methods proposed were tested by the writer and the results were compared with those obtained by the older method.

I. DENNSTEDT'S METHOD.

The first of the new methods employed was the one generally known as Dennstedt's method, the apparatus having been designed and carefully tested by Prof. Max Dennstedt, of Hamburg. Professor Dennstedt's papers on the subject are to be found in Berichte der deutschen Chemischen Gesellschaft, as follows: Vol. 30, page 1590; vol. 38, page 3729; vol. 39, page 1623.

A very carefully prepared paper has been published by Professor Dennstedt under the title of "Anleitung zur Verinfachten Elementaranalyse."

The characteristic features of this method are that platinized quartz is used in the combustion tube without copper oxide, and that the nitrogen is determined by means of lead peroxide at the same time that carbon and hydrogen are determined.

This furnace has many desirable features. It costs but little, it is easy to handle, is easily heated and cooled, and requires less gas than the old form. Good results are said by some to be obtained by experienced operators; by others the method is considered unsatisfactory. I succeeded in getting a few good results for carbon and hydrogen, but in spite of prolonged attempts and variation of methods I did not succeed in getting a satisfactory result for nitrogen, as will be seen in examining the table.

References on the above method are as follows: Anleitung zur

Vereinfachten Elementare Analyse, by Max Dennstedt. Der deutschen Chemischen Gesellschaft, Berichte, vol. 30, page 1590; vol. 38, page 3729; vol. 39, page 1623. Organische Verbindungen, by Carl Meyer, page 117.

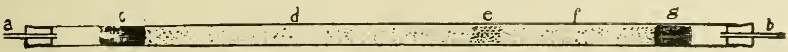
II. MORSE'S METHOD.

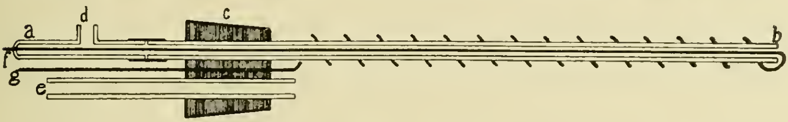
The second method used in the test was what is known as Morse's method. This method was first used by Prof. H. N. Morse of Johns Hopkins University. The original paper on the subject is to be found in the American Chemical Journal, vol. 33, page 457. The principal feature of the method is that the forward part of the tube is heated entirely by means of a hot platinum wire spiral on the inside of the tube.

A tube of hard glass 15 mm. in diameter and 70 cm. long is used. Into one end of the tube is fitted a two-hole rubber stopper. Through one hole in the stopper is put a porcelain or quartz tube 250 mm. long and 6 mm. in diameter. The bore of the tube should be just large enough to admit a No. 14 wire loosely. The other hole of the rubber stopper is used for the calcium chloride tube of the absorption apparatus. The quartz tube is allowed to project about 25 mm. outside of the rubber stopper. A piece of No. 14 platinum wire about 10–12 cm. long is united to a piece of No. 28 or 29 platinum wire about 175 cm. long. The piece of coarse wire is placed inside the tube so that the union of the two wires is 3–4 cm. on the inside. Removed from the rubber stopper the fine wire extends through the tube to the inner end, and is then wrapped about the quartz tube in small even loops back to within 3–4 cm. of the rubber stopper. Here union is made with another piece of No. 14 platinum wire which leads through the stopper. A small glass T tube 6 mm. in diameter is joined to the quartz tube by means of a piece of rubber tubing. Through one opening the platinum wire leads, and through the other the stream of oxygen enters. The opening through which the platinum wire leads must be sealed. It is very necessary that the platinum wire does not come into contact with the walls of the combustion tube. In case it does make direct contact it will adhere to the sides of the tube as soon as it is heated.

Just behind the quartz tube and platinum spiral there is placed a 10-cm. spiral of reduced copper-wire gauze. Back of this reduced copper-wire gauze is a 7-cm. spiral of well oxidized copper-wire gauze, and behind this spiral of oxidized copper is the porcelain boat containing the substance to be analyzed. Behind the boat is a small spiral of copper-oxide gauze. The distance between the boat and the spirals of oxidized copper is determined by the nature of the substance in the boat.

The tube can be supported by clamps, or, what is still better, a sheet-iron trough lined with asbestos paper, as described in part I of this paper. The whole apparatus can be mounted on sheet-iron supports. The following diagrams represent the relationship of the parts:





III. WALKER'S METHOD.

The third method employed in conducting this comparative test was what is known as Walker's method, the apparatus having been designed and used under the directions of Prof. James Walker, of the University College of Dundee.[1]

The most significant feature of this method is that the size of the furnace is greatly reduced and simplified. The apparatus is a modification of the apparatus used in the Dennstedt process, the only essential difference being that the combustion tube is much smaller and copper oxide is used instead of platinized quartz. The apparatus as used in the experiment herein described consisted of a combustion tube 70 cm. long and 9 mm. inside diameter.

The furnace is heated quickly and cools quickly; this means a great saving of time. The heat applied is not great enough to bend the tube. About the only disadvantage found was that it was deemed necessary by the authors to remove all the copper oxide every time a combustion was made. But even this is not necessary; one need remove only sufficient copper oxide to mix with the substance, and to rinse the tube. The introduction of the sample by means of a porcelain boat is, however, much simpler still. This simple furnace is perfectly satisfactory for all purposes of ordinary combustion.

The substances used in conducting the experiments were acetanilide and aniline.

1. Compare Proceed. Royal Soc. of Edinburg, vol. 28, p. 708.

The following are the theoretical values for carbon, hydrogen and nitrogen:

Substance.	Per cent C.	Per cent H.	Per cent N.
Acetanilide	71.05	6.73	10.32
Aniline	77.35	7.58	15.05

About one-third of the results obtained in becoming familiar with the methods were outside the limit of accepted values, and no record was made of these, with the exception of Dennstedt's method, where all the results are recorded:

The following are results obtained by the usual method:

Substance.	Weight.	Per cent C.	Per cent H.	Per cent N.
Acetanilide	0.1799	71.18	6.83	... .
Acetanilide	0.2204	71.20	6.96	....
Acetanilide	0.1360	....	....	10.38
Acetanilide	0.1476	....	....	10.26
Aniline	0.1411	77.28	7.62	....
Aniline	0.2156	77.29	7.67	....
Aniline	0.1271	....	....	14.93
Aniline	0.1296	....	....	14.94

These results are taken from determinations made at an earlier time, and no record was kept of the time of each combustion.

Results obtained are as follows for each of the processes tested:

Method.	Substance.	Weight.	Per cent C.	Per cent H.	Per cent N.	Time.
Dennstedt	Acetanilide	.1206g	70.04	7.76	6.07	2:45
Dennstedt	Acetanilide	.1143g	70.07	6.98	6.22	1:50
Dennstedt	Acetanilide	.0703g	70.71	7.04	6.22	2:10
Dennstedt	Acetanilide	.0702g	71.03	7.05	6.17	2:05
Dennstedt	Acetanilide	.1428g	70.54	6.93	6.33	2:25
Dennstedt	Acetanilide	.0948g	68.14	7.94	5.59	3:20
Morse	Acetanilide	.0968g	71.03	6.70	....	0:50
Morse	Acetanilide	.1108g	71.17	6.85	....	0:45
Morse	Acetanilide	.1049g	70.91	6.94	....	0:45
Morse	Aniline	.0891g	77.22	7.67	....	0:50
Morse	Aniline	.1292g	77.37	7.63	....	1:10
Morse	Aniline	.1232g	77.21	7.69	....	1:05
Walker	Acetanilide	.1608g	70.98	6.78	....	1:05
Walker	Acetanilide	.1884g	70.93	6.89	....	1:10
Walker	Acetanilide	.1158g	70.84	6.73	....	0:50
Walker	Acetanilide	.2319g	70.94	6.66	....	1:15
Walker	Acetanilide	.1597g	70.85	6.71	....	1:10
Walker	Acetanilide	.1591g	....	....	10.33	1:05
Walker	Acetanilide	.1029g	....	....	10.21	0:50
Walker	Acetanilide	.1594g	....	....	10.27	0:55
Walker	Aniline	.1551g	77.27	7.68	....	0:50
Walker	Aniline	.1383g	77.29	7.58	....	0:45
Walker	Aniline	.1021g	77.33	7.64	....	0:40
Walker	Aniline	.1494g	....	....	15 09	0:55
Walker	Aniline	.1471g	....	....	15.01	0:45

LOCO WEED AND LOCO POISON.

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

BY REFERRING to the Sixth Biennial Report of the Kansas Board of Agriculture, page 147, and other publications by this department, it will be noted that the investigation of the poisonous qualities of the loco weeds was inaugurated in 1886 by the above board, under direction of the writer. The geographical distribution of the plant in the state and bordering states, the description of the various species of loco plants, and a chemical examination of these, were made and reported upon.

As all of the various physiological symptoms produced by the loco were reported as caused by opium or some such vegetable poison, everyone felt pretty sure that the so-called loco poison must be that of a *vegetable toxic principle*, somewhat akin to that of morphine or to that of any of the numerous narcotic alkaloidal poisons. A thorough analysis of the loco plants, however, proved conclusively that such a vegetable poison did not exist. However, it was shown that minute quantities of an alkaloid existed in the plant, but not in sufficient quantity to account for the reputed action of the loco upon stock. The cause of the poisonous action of the drug was therefore an enigma. A medical writer, speaking of the mystery of the problem, says: "The disease called loco is as murky as was milk sickness, so prevalent in Indiana and Kentucky in early days."[1] Loco plants, it was finally conceded, were poisonous to animals, but were without action upon human beings. "So far as I can learn," the above writer adds, "it neither impresses the human being therapeutically nor is possessed of any remarkable physiological power, and as an active physiological agent it has passed silently into oblivion."

The writer never ceased to regard the subject of loco poisoning as one of the greatest importance to the farmer and ranchman, and made continuous effort to keep the subject before scientists, in the hope that others would join in the investigation. Quoting from the Sixth Biennial Report, page 147, it was observed: "It might seem a very easy matter to reach a conclusion upon this subject, which is of such vital interest to the farmer and ranchman of the West, but to do this and satisfy the demands of science it re-

1. Eclectic Med. Journal, Oct., 1893, page 482.

quires not only careful physiological and chemical investigations of a peculiar and delicate kind, but the closest and long-continued observation. We have had hearsay evidence enough on this subject, and now we need to go at it in earnest, in a way that will be recognized by scientific men, and investigations should be pushed to the farthest limits without any short-sighted regard for the cost." It was further urged that experimental work upon the field was necessary for the final settlement of the question of loco poisoning.

In the year of 1905 the United States government took up the investigation of loco in a very elaborate manner. A feeding station was located at Hugo, Colo., under the general direction of Dr. Rodney H. True, of the Bureau of Plant Industry, placing the station under the immediate supervision of C. Dwight Marsh. At the same time that this field work was in progress, pharmaceutical experiments upon animals, using the concentrated extract of the plant upon them, were conducted in the laboratories of the Bureau of Animal Industry by Dr. A. C. Crawford. As the works of these two scientists are now completed, it is well to refer to their classic reports, published by the Bureau of Plant Industry (Bulletins Nos. 112 and 129 of the Bureau of Animal Industry). It would be impossible to give a résumé of these two bulletins, but a sufficient number of extracts from these publications may suffice.

Crawford found by his experiments upon rabbits that "concentrated aqueous extracts of the drug induced death." A series of records are made showing that rabbits were killed after administering the extracts in various ways, by subcutaneous injections, etc. In summing up his experiments upon rabbits, he says: "The experiments indicate that an acute form of poisoning may be induced by feeding concentrated extracts of *Astragalus mollissimus* and *Aragallus lamberti*, from Hugo, Colo., and Imperial, Neb., to rabbits, and that if the extract be given in smaller and repeated doses a more prolonged and chronic condition will follow. The rabbits showing the chronic effects of these plants exhibit symptoms which have a marked parallelism with those reported as occurring in larger herbivora (horses and cattle) on the range when locoed; that is, the loss of appetite, the emaciation and loss of weight, the dullness and stupor, with more or less anesthesia, the disturbance in the visual function, and the mental symptoms. The occasional abortion compares with what has been observed in larger animals. The dried *Astragalus mollissimus* and *Aragallus lamberti* still retained their poisonous properties. Aqueous extracts of the dried plants, made in the laboratory under the proper conditions, produced fatal effects. But what was the nature of the poison? It had been proven a nonvegetable substance. What other poison could a vegetable secrete?"

Chemical experiments conducted along with the pharmacological experiments of Marsh and Crawford resulted in a very important discovery, namely, that if the ashed plant was extracted with sulphuric acid the *solution proved inactive to rabbits.* In other words, the substance removed by the use of sulphuric acid seemed to be the active material. Such a reaction would point to one of a group of important substances which a plant would be liable to assimilate Accidentally, Crawford found that Spengel had reported the presence of barium in one of the species of *Astragalus*, a closely allied plant to the loco, and also found recorded in chemical literature that barium had been found in a number of other plants by other chemists. Guided by this indication pointing to a solution of the problem, and having well-grounded suspicions that the cause of the poison might be after all an inorganic poison, and having suspicioned barium as the inorganic element, feeding experiments with barium were conducted upon animals in the laboratories. These were accompanied with positive results. It was found, for example, that one gram of barium carbonate would kill a dog in eight hours. It may well be stated in passing that it is well known that barium carbonate has been employed as a rat poison, and its toxic qualities upon lower animals have been well established. Recently the high toxicity of barium has been recognized by a writer on pharmacology. The peculiar effect of its salts upon the circulation, upon the heart, upon the nervous system and upon the blood pressure are symptoms giving evidence of this; and if barium is contained in the soil and is absorbed by the plants, the plants ingested and the barium content assimilated in the circulatory system, it would produce, very gradually, the symptoms recognized as the loco disease. But the physiological action of this inorganic element was thoroughly worked out (for the first time) by Crawford in the pharmacological laboratory, and the connection with it and loco well established—and thus the mystery of the loco poisoning seems to be finally solved. The work of Marsh aud Crawford is by far one of the most important issuing from the laboratories of plant and animal industry, located in Washington.

One of the mysteries connected with the problem was that loco in certain pastures was nontoxic. This phenomenon has also been accounted for by the above investigation. It has been shown by experiment that if loco plants are grown upon certain soils—soils that contain no barium—these plants are not poisonous or are pharmacologically inactive. This solves that mystery which confronted ranchmen and farmers. In the present writer's early reports it was stated that very contradictory testimony was obtained from ranchmen of different localities, some stating positively that loco weed was not poisonous, while others stated, on the contrary, that it was deadly poisonous. Many observers in the western part of Kansas stated that where the loco plant grows abundantly it had no deleterious effect upon animals. This can now, in the light of the Crawford and Marsh investigations, be accounted for by the fact that the soil of that particular region contains no barium.

It will be seen at once that this investigation has been of value, and opens up a field considerably wider than first anticipated. In our laboratory at the University of Kansas, since Crawford's report, we have collected numerous plants upon which cattle are likely to feed, and have subjected these to artificial digestion in an artificial gastric fluid. This fluid is prepared by employing an active pepsin and acidulated water. These experiments have been conducted, under our supervision, by Mr. James T. B. Bowles. We shall at present confine ourselves to laboratory experiments upon loco weed.

ANALYSIS OF FOOD ACCESSORIES UNDER THE FOOD-AND-DRUGS LAW.

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

AMONG the most important of the food accessories that we have to deal with in the drug laboratory are the aromatics, or spices, which furnish not an unimportant part of our daily food. The definitions and analytical data fixed for the various spices were referred to in a former paper given to this Academy. Circular No. 19 of the U. S. Department of Agriculture contains the standard for these important substances: but it is clear from our observations that certain revisions will be necessary from time to time. We have noticed in our own laboratory work, for example, that there is a great variation existing between the minimum and the maximum quantities of important constituents of these spices, and the spices under consideration were in every case genuine. This experience has been duplicated by others who are working in the same line.

Federal standards are very fair and liberal, and it would seem that these standards should be observed. Yet there are occasionally those who will transgress the limits fixed in the federal standards, and yet are genuine. We may cite, for example, the percentage content of quercitannic acid and the ash content. These not infrequently fall below the minimum requirements of the federal standard, but it is fair to assume that the analyst, when he finds by microscopical analysis that the sample is a pure spice, will not of course refuse to pass it if it should analyze below the minimum requirements in these particulars.

The essential constituent, of course, of a spice is the volatile oil. In the majority of cases this is determined by the volatile extract and the nonvolatile extract. It is rather surprising how variable this constituent is, as, for example, will be seen from a report of allspice, or pimento. We shall quote from the analyses of a number of samples which are published by R. O. Brooks, formerly state chemist of Pennsylvania and New Jersey. The approximate analysis, showing the variations in composition as reported in twenty-five analyses of pure allspice, are as follows:

	Minimum.	Maximum.
Moisture	5 51%	10.14%
Ash (mineral matter)	4 01	7 51
Ash insoluble in acid	0 00	0 95
Volatile ether extract (oil)	1 29	5 21

	Minimum.	Maximum.
Nonvolatile ether extract	1.60%	7.72%
Starch by diastase method	1 82	3.76
"Starch" by acid inversion	16.56	20 65
Crude fiber	13 45	23 98
Protein (nitrogen × 6.25)	4.03	6.37
Quercitannic acid	4.32	12.48

What is said of allspice is also true of cloves, pepper and other spices. As regards cinnamon bark, we have found a considerable amount of adulteration of cinnamon in carton packages. A number of cinnamon-like barks of unknown species and of little value are coming into the market in quills and in more or less flat pieces. They contain little or no oil, and commercial powdered cinnamon of all kinds has rarely if ever been strictly pure. In 1894 the Department of Chemistry, U. S. Department of Agriculture, bulletin 13, page 2, published the statement that "not a particle of ground cinnamon (referring to Ceylon cinnamon) can be found upon the market." It is well known, however, that powdered cinnamon is made from cassia cinnamon and cassia chips. And it is interesting to state here that Mr. Brooks's analyses of twenty-six samples of cassia were of the following percentage in composition:

	Minimum.	Maximum.
Moisture	6 53%	17.45%
Volatile ether extract	0.55	5.15
Nonvolatile ether extract	0.74	4.13
Crude fiber	14.33	28.80
Starch (by acid method)	16 65	32.04
"Protein" (N. × 6.25)	2.63	5.44
Total ash (mineral matter)	2.35	6.20
Ash insoluble in acid ("sand")	0.02	2.42

In regard to black pepper, it has been the common practice of former days to grind with the pepper grains, and mix with the pepper, an undue amount of hulls. We examined recently a package of pepper labeled "Compound Pepper." Why the term "compound" was applied to this spice is difficult to imagine. But on examining the sample microscopically it was found that at least 25 per cent more of the hulls of the pepper were present than ordinary pepper pulverized would furnish. It has been necessary, therefore, for the board to make a ruling that a spice, or compound spice, shall include the whole spice, representing the various constituents in the proportions in which they exist in the fruit itself in the dried condition. This will in the future eliminate such methods of adulteration. Pepper itself should contain no less than 6 per cent of nonvolatile extract, not more than 7 per cent of total ash, and not more than 15 per cent of crude fiber. It is evident that such a spice as I have indicated above would not come within the limits of such a standard. Pepper hulls will contain only about from 0.68 to 1.11 per cent of volatile ether extract, while the minimum for a good sample of pepper should be at least 0.9 per cent. As to crude fiber, there is an immense difference between pepper hulls and true pepper. Pepper hulls yield from 21 to 32 per cent of crude fiber, while a Singapore pepper will yield but from 3.5 to 6.2 per cent. The ash constituent of pepper hulls will be from about 8 per cent to 18 per cent, and in exceptional cases much more, while pure pepper will yield from about 1 per cent (or in exceptional cases less) to 1.8 per cent.

For a rapid determination of the quality of a spice, I would report what was said in a former paper: "That a standard alcoholic solution, diluted to a definite volume in water, sweetened or otherwise, serves very well for the purpose of comparison, and for quickly eliminating worthless material."

Laboratory No. 3483. GROUND CLOVES.—"Jupiter Brand."

Ash	13.20%
Total ether extract	8.31
Nonvolatile ether extract	7.58
Volatile extract	.73
Soluble ash	11.89
Insoluble ash	1.31
Color of ash	Red.

Soluble ash composed partly of iron and alumina, showing flagrant adulteration.

Laboratory No. 3484. GROUND ALLSPICE.

Ash	5.59%
Total ether extract	5.53
Nonvolatile ether extract	4.87
Volatile ether extract	.65

Laboratory No. 3482. GROUND PEPPER.

Ash	5.98%
Total ether extract	8.26
Nonvolatile ether extract	7.80
Volatile ether extract	.46

Laboratory No. 3531. PURE POWDERED CINNAMON.

Ash	4.17%
Total ether extract	4.45
Nonvolatile ether extract	2.97
Volatile ether extract	1.48

Laboratory No. 3533. PURE POWDERED MUSTARD.

Ash	5.10%
Total ether extract	19.55
Nonvolatile ether extract	19.47
Volatile ether extract	.08

Laboratory No. 3599. PURE POWDERED BLACK PEPPER.

Ash	6.38%
Total ether extract	8.84
Nonvolatile ether extract	8.34
Volatile ether extract	.50

MAXWELL'S METHOD OF COMPARING AN ELECTROSTATIC CAPACITY WITH A SELF-INDUCTANCE.

By J. A. G. SHIRK, Ottawa, Kan.

WHEN direct currents are used in a Wheatstone bridge, there is a balance when the resistances of the four arms of the bridge are proportional, *i. e.*, $R_1 : R_2 = R_3 : R_4$. (Figure 1.)

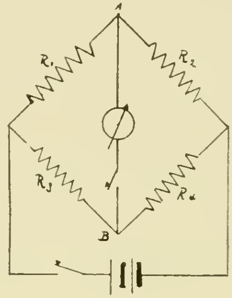


Fig 1

If three of these resistances are known, the fourth may be determined by adjusting the three known ones until there is a balance, and hence no deflection of the galvanometer, as the points A and B will be at the same potential.

This is the ordinary application of the Wheatstone bridge in measuring the resistance of an unknown conductor. If alternating currents are used there is a balance if the impedances of the four arms are proportional. The impedances consist of the resistances and reactances of the different branches. Let R_1, R_2, R_3, and R_4 represent the resistances of the four arms, as before, and let X_1, X_2, X_3, and X_4 represent the reactances of the corresponding arms. Then the impedances of the four arms become: $R_1 - jX_1$, $R_2 - jX_2$, $R_3 - jX_3$, and $R_4 - jX_4$, where $j = \sqrt{-1}$. (This method of representing the impedances of a circuit may be found in chapter V, vol. II, of the "Elements of Electrical Engineering," by Franklin and Esty.)

If three of the impedances are known, the fourth can be determined by adjusting the three known ones until there is a balance in the bridge. In order to accomplish this result arrange the bridge as in figure 2. For the direct current use a storage coil or a primary battery, the current being reduced to the desired value by increasing the total resistance of the entire circuit. A low-voltage-pressure transformer, giving one or two volts, is best adapted for supplying the alternating current. In this case only one resistance and one reactance may be known, and therefore this method can be employed to compare two capacities, two self-inductances, or a self-inductance and a capacity. Figure 2 illustrates the method of comparing a capacity with a self-inductance.

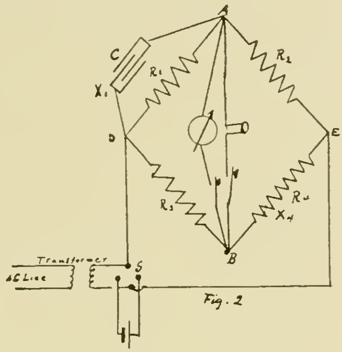


Fig. 2

R_1, R_2, and R_3 are known adjustable resistances, wound noninductively. R_4 is the resistance of the self-inductance, and is generally unknown. To find R_4, use direct currents and balance the bridge. Then disconnect the source of direct current and balance the bridge with the alternating current, using the telephone receiver instead of the galvanometer. A balance is obtained when the sound in the receiver is a minimum. If the capacity of the condenser is given and the self-inductance is unknown, it will be easier to balance the bridge if two of the known resistances, such as R_1 and R_3, constitute a slide-wire bridge, as their ratio can then be changed quickly and continuously and the minimum of sound can easily be determined.

If the capacity of the condenser is unknown it will be better to use a variable self-inductance at K whose resistance is constant, but if the self-inductance is constant use a slide-wire bridge for two of the resistances. If R_1 and R_3 constitute the two segments of a slide-wire bridge the condenser C should be connected in parallel with R_2.

The following is an illustration of the use of the method in finding the capacity of a condenser C (figure 2):

Let Z_1, Z_2, Z_3, and Z_4 represent the impedances of the four arms of the bridge. Since AD is a divided circuit, its impedance must be found by a method similar to that used in finding the resistance of a divided circuit:

$$\therefore \frac{1}{Z_1} = \frac{1}{R_1} + \frac{1}{jX_1} = \frac{X_1 - jR_1}{R_1 X_1}$$

$X_1 = \frac{1}{CW}$, C being the unknown capacity of the condenser and W the angular velocity of a single rotating coil making the same number of alternations per second as the alternating currents used, and therefore equals 2π times the frequency of the current used.

From the above equation $Z_1 = \frac{R_1 X_1}{X_1 - jR_1}$. Also $Z_2 = R_2$, $Z_3 = R_3$, and $Z_4 = R_4 - jX_4$.

When the bridge is balanced for alternating currents these impedances are proportional:

$$\therefore Z_1 : Z_2 = Z_3 : Z_4 \text{ or } Z_1 Z_4 = Z_2 Z_3$$

$$\therefore \frac{R_1 X_1}{X_1 - jR_1} (R_4 - jX_4) = R_2 R_3$$

$$\because X_1 R_1 R_4 - jR_1 X_1 X_4 = R_2 R_3 X_1 - jR_1 R_2 R_3$$

This equation contains both real and imaginary quantities, and therefore the real quantities must be equal to each other, and the same for the imaginaries:

$$\therefore X_1 R_1 R_4 = X_1 R_2 R_3 \text{ and } R_1 X_1 X_4 = R_1 R_2 R_3$$

$$\therefore R_1 R_4 = R_2 R_3 \text{ and } X_1 X_4 = R_2 R_3$$

The first was obtained before on balancing the bridge for direct currents. From the second equation, $X_1 = \frac{R_2 R_3}{X_4}$

Since K is a self-inductance, $X_4 = L_w$

$$\therefore \frac{1}{C_w} = \frac{R_2 . R_3}{L_w} \text{ and } C = \frac{L}{R_2 R_3}$$

In this experiment a variable known self-inductance was used at K, and it balanced the bridge at 20.5 mil-henrys. The values of the resistances used were $R_1 = R_3 = 400$ ohms, $R_2 = R_4 = 52.66$ ohms. The results are better when the values of the resistances are so chosen that the resistances of the two branches between D and E are nearly the same.

For these values $C = \frac{.0205}{(52.66)\ 400} = .973$ microfarads.

The capacity of the same condenser was measured by the first method given in Carhart's "Electrical Measurements," article 107, and was found to be .979 microfarads. The results show a substantial agreement of the two methods, and considering the greater amount of time consumed and the liability of errors in this latter method, it would seem that the method of using alternating currents is to be preferred even in the measurement of capacity.

THE CIRCLE THAT IS NOT A CIRCLE.

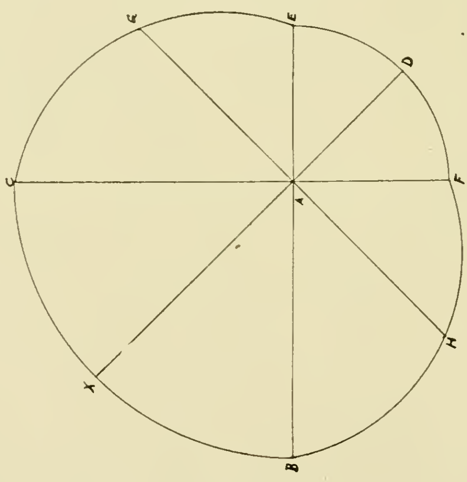
By C. E. WARFEL, Wamego, Kan.

A GOOD many years ago, while teaching in a college in Illinois, a proposition one day suggested itself to me, and after several futile efforts the figure herein presented was evolved and some experiments made in its practical application to machinery and to determine whether or not it was mechanically correct.

Little attention was further given it for several years, until one evening about a year ago, in a casual conversation with the learned secretary of this Society, it was presented to him, and his curiosity was thereby aroused and he requested that it be submitted to the Academy.

THE PROPOSITION.

Construct a plane figure which is not a circle such that passing in a straight line through a certain point within from perimeter to perimeter it will be same distance across in every direction.



CONSTRUCTION.

First.—With any point A as a center, and with any radius X, construct a quadrant of any circle BC.

Second.—With the same point A as a center, and with any greater (or less) radius D, construct a quadrant of another circle EF directly opposite the quadrant BC.

Third.—Construct a line GH perpendicular to the bisector of the two arcs BC and EF.

Fourth.—Locate a point on the line GH in both directions from the point A at a distance equal to one-half the sum of the two radii X and D from the point A.

Fifth.—With an arc of a circle determined by the three points B, H and F connect such three points.

Sixth.—Also, with an arc of a circle determined by the three points C, G and E, connect the three said points C, G and E.

An engine builded with the outline of the casing constructed on this curve allows no escape of power and allows the application of the power on the ends of levers far from the fulcrum, and so little speed is needed, and consequently little wear on the machinery results.

With the same mechanism water power can be utilized to the very limit of its potential efficiency, as no water can escape until the machine turns, so a small flow with a high head can be readily controlled.

In fact, any kind of a power engine may be so constructed which will allow high or low speed with safety, and without the wrench and strain on the machinery found in the slide-valve engine.

A model of such an engine constructed for the use of steam is now in the possession of the secretary of this Society, and by actual test verifies the principles above stated.

III.

GEOLOGICAL PAPERS.

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1. "Is the Dakota Formation Upper or Lower Cretaceous?"
By J. C. Todd, University of Kansas, Lawrence.

2. "In the Niobrara and Laramie Cretaceous."
By Charles H. Sternberg, Lawrence.

3. "A Description of the Changes in the Cottonwood Limestone South of Cottonwood Falls, Kan."
By J. A. Yates, Manual Training Normal School, Pittsburg.

4. "An Esker at Mason, Mich."
By L. C. Wooster, State Normal School, Emporia.

5. "An Embryonic Plesiosaurian Propodial."
By Roy L. Moodie, University of Lawrence, Kansas.

IS THE DAKOTA FORMATION UPPER OR LOWER CRETACEOUS?

By J. E. Todd, University of Kansas, Lawrence.

BECAUSE of the quite diverse classification of this formation by prominent geologists, the writer has desired to find for himself a satisfactory answer to the above question. Thinking that it may be of interest to others also, he offers this paper.

The formation was first limited and named by Meek and Hayden in 1856. The name was derived from Dakota City, opposite Sioux City, Iowa, and was applied to a thick stratum of rusty sandstone there exposed for 50 or 60 feet, and in other localities found to attain 400 or 500 feet. They recognized its Cretaceous character, but as that system was not very well known, and because the Dakota rests upon the Carboniferous there, it was judged by them to be at or near the base of the Cretaceous.

In 1859 Beer and Lesquereaux decided that the leaves found abundantly in the formation indicated Tertiary age, but Meek and Hayden showed by the invertebrate life that it was at least Cretaceous.

In 1870 Credner pointed out similarities between the New Jersey Cretaceous and the Senonian, or Upper Cretaceous, of Europe, forty species being common to both.

Dr. C. A. White, in his "Correlation" paper on the Cretaceous (1891), concludes that "the Dakota is as clearly distinguishable as a separate formation in the northern and central portions of the south interior region as it is at the typical localities in the northern interior region, in all of which districts the strata are plainly of non-marine origin. In the southern part of the southern interior region, however, as well as in central Kansas and in eastern Texas, the strata which are confidently regarded as representing the Dakota formation are found to bear true marine fossils, and in some cases both paleontologically and stratigraphically to blend so intimately with the next overlying strata, which are regarded as equivalent to the lower part of the Colorado formation, as to render their inter-delimitation indistinct." [1]

Prof. Lester F. Ward, in 1894, found cycads of the Lower Cretaceous in the lower part of the Dakota in the southern Black Hills,

1. U. S. G. S. Bull., 82, p. 158.

though the upper strata contained forms very different from them and closely similar to, though not identical with, well-known forms from the true Dakota elsewhere.[2]

In 1895 Cragin showed that some of the invertebrates in the Dakota beds at Mentor, southwest of Salina, Kan , were identical with some in the Kiowa shales in the Comanche, in the southern part of that state. These were partly the same as those which Meek had described from that locality and referred to the Dakota in his final report on the invertebrates of the Cretaceous.

In 1896 T. W. Stanton stated that he had no doubt that the Mentor beds are the equivalent of the Comanche, for not only invertebrate fossils but plants harmonize with that view.[3]

Prosser expressed a similar conclusion, and claimed as additional evidence that Cope had provisionally referred teeth found in the Kansas Dakota to Lepidotid fishes, and stated that he had never found Lepidotid fish remains in the Upper Cretaceous of North America, while they were characteristically Lower Cretaceous and Jurassic in Europe. He also stated that the Mentor invertebrates are from either the same or higher beds as some which have furnished plants characteristic of the Dakota.[4]

In 1901 Darton, in his report on the Black Hills, following the decisions of Ward, proposed to separate the original Dakota of Hayden into three formations—the Lakota, the Fuson and the Dakota, the last being the upper third of the original. This he placed in the Upper Cretaceous, while the others were considered Lower Cretaceous. As he states it, "the sandstone formerly designated 'the Dakota sandstone,' or 'Cretaceous No. 1,' has in the last few years been found to comprise not only a formation carrying an Upper Cretaceous flora, but an extensive series of Lower Cretaceous deposits as well. Accordingly, the term Dakota has been restricted to the upper sandstone, containing the Upper Cretaceous flora, while the much thicker, lower series has been separated as Lower Cretaceous; and as it consists of several stratigraphic units, these will be differentiated here as separate formations."[5]

In 1905 Grabau brought out the principle of overlap, transgressive and regressive, and applied it to the Dakota formation, among others. After a lengthy and lucid discussion, he sums up as follows:

"The interpretation of these sections, in the light of the princi-

2. Journal of Geology, vol. II, p. 263.

3. Letter to Prosser quoted, K. U. Geol. Survey, vol. II, p. 190.

4. Ibid, p. 192.

5. U. S. G. S., 21st Ann., part IV, p. 526.

ples discussed, shows us that the Dakota sandstone represents the deposits between the retreat and readvance of the sea. The retreat, as we have seen, began in Washita time, almost at the beginning of that period. The Washita division itself is the depositional equivalent of the retreatal Dakota sandstone, and hence the Dakota is actually of Washita age—of lowest Washita in the northern and of highest Washita in the southern area. The retreat of the sea was considerable, as shown by the unconformity between the Buda and the Eagle Ford and by the thinness of the latter. With the readvance of the sea a new fauna, an immigrant from Europe, came in; and as the sea continued to advance the continental sands of the Dakota-Woodbine-Graneros were reworked and incorporated as basal deposits of later Cretacic age. The Upper Dakota sandstone is thus of Eagle Ford-Benton age, the return of the sea being finally accomplished in mid-Benton time.

"From this it appears that the Dakota sandstone cannot be included as a time element of the standard scale, since it represents different time in different localities. This consideration also suggests that the Washita be made the base of the Middle Cretacic, the classification being approximately the following:

		Marine.	Nonmarine.
Upper Cretacic-Montanan		Navarro.	Laramie.
		Taylor	
Mid-Cretacic	Coloradoan	Austin.	
		Eagle Ford.	
	Unrepresented interval		Dakota.
	Washitan		
Lower Cretacic-Comanchean		Fredericksburg.	
		Trinity.	

"If two systems are to be made of the present Cretacic, the Comanchic system would end with the Washitan, and the Cretacic begin with the Coloradoan, the unknown base of which must be looked for in southern Texas or in Mexico.[6]"

Dr. W. B. Scott, in his "Introduction to Geology" (2d edition, 1907), in his tabular presentation of Cretaceous formations, follows Grabau, and represents the Dakota as belonging to the Lower Cretaceous. In the discussion in the text he says:

"Whenever the marine Upper Cretaceous is in contact with the Comanche limestones north of Mexico, the two are unconformable, and no species of animal is known to pass from one to the other. In Mexico the Lower Cretaceous passes into the Upper without a break, the disturbances there taking place at a later date.

"The Upper Cretaceous rocks have a far wider distribution over North America than have those of the lower division, which is due

6. Bull. Geol. Soc. Am. (1905), vol. 17, p. 627.

to an enormous transgression of the sea over the land, one of the greatest in all recorded geological history. Over the region of the Great Plains the Upper Cretaceous was inaugurated by the formation of a nonmarine stage, the Dakota."[7]

This seems at first discordant with the table, but, in the light of it, he may mean that the terrestrial Dakota — formed over the Great Plains contemporaneously with the upper portion of the marine Comanche further south — seems in that region to begin the Upper Cretaceous, but in no other way could a nonmarine formation be said to inaugurate a marine formation. Hence, logically, the division between the Lower and Upper Cretaceous should be above the Dakota rather than below it.

In view of these facts. it is with surprise that we find that Chamberlin and Salisbury's "College Geology," recently published, distinctly places the division between the Lower and Upper Cretaceous below the Dakota, and, moreover, makes it a break between periods instead of epochs as heretofore, though the authors are constrained to add that "north of Texas the formation (Dakota) is in apparent conformity with the Comanche in some places; though in others, as in the Wasatch and Uinta mountains, it rests on older formations."[8] They are, as a result, betrayed into figuring a cycad from the Dakota as illustrating Comanche life.

The results of our research may be briefly summed up as follows:

All the students of the Dakota formation seem now to be agreed that it is mainly Lower Cretaceous in age, and most recent writers on the subject express themselves to that effect, while some have referred the whole of it to that epoch.

That the latter position is right seems clear for the following reasons:

1. From the standpoint of stratigraphy, it is questionable whether much, if any, of the present Dakota sandstone was laid down contemporaneously with any of the marine Upper Cretaceous. No doubt there were terrestrial deposits laid down over the Great Plains, while marine beds, now recognized as Upper Cretaceous, were forming in southern Texas or Mexico; but in the later transgression of the sea northward several feet in thickness of such beds must have been cut away by the wave action and rearranged in the Benton of the Upper Cretaceous, as Grabau argues. This may have removed all which was formed on the land during such transgression, and should it ever be found to be otherwise, still the

7. Int. to Geol., pp. 702, 705.

8. Coll. Geol., p. 747.

rational and most convenient place of division would be above the Dakota.

2. The invertebrate remains of the Dakota are closely akin to those counted Lower Cretaceous, and are quite distinct from those of the Upper Cretaceous. The plant life, also, though less decisive, is in part at least coördinate with that of the beds below rather than with that of those above. The paleontological evidence, therefore, favors the same division as the stratigraphical.

3. Lithologically, also, the most natural classification will be to put the whole of the Dakota, as originally limited, in the Lower Cretaceous. To divide it in most cases brings greater confusion. The division between the Dakota and Benton is not very sharply defined, for it takes a few scores of feet to change from a decidedly sandy formation to one decidedly clayey, several variable thin strata of sand and shale being intermingled between. As it marks the advent of the sea, however, the occurrence of marine fossils assists in the demarkation.

Though such a division cannot be looked upon as marking a point of time, but as progressively constructed from north to south over the Great Plains, yet it is better marked and probably records a shorter time than most similar divisions in geologic history.

IN THE NIOBRARA AND LARAMIE CRETACEOUS.

By Charles H. Sternberg, Lawrence.

THE early part of the season was spent in the Kansas chalk. As has been the case during many of the last thirty-five years, since I first began collecting in this formation, I have been quite successful. My three sons, George, Charles and Levi, were with me, while the monotony of camp life was broken by the presence of my son George's wife and baby son. We made our first camp at Mrs. Livingston's ranch, on Hackberry creek, south of Quinter, Kan., in Gove county, near the eastern line. And we are under many obligations to Mrs. Livingston and her two sons for shelter for our team, as well as hay; otherwise our horses might have suffered from the inclemency of the weather.

While here I experienced for the first time a very peculiar electric storm. About the 10th of May a violent wind and dust storm came up from the northeast about sundown, and gravel, sand and earth were hurled through the air with great force. I faced it for a hundred yards to get my son Levi, who was at the barn. My face was beaten with sand and gravel, and I could hardly walk, owing to the fury of the gale. However, I got to the barn, and, taking my son's hand, we started to return. It was so dark that we could not see an inch ahead. What was my surprise to see the telephone line that was suspended over my tent dotted with points from which light radiated in all directions, and as far as I could see the line it was swinging, with myriad little lamps, back and forth with the wind. Looking around, I saw posts that supported a barbed-wire fence sending out light in the same way, except, of course, they were stationary. I found after the storm that these centers of light were nails driven in the posts. So for the first time in the history of western Kansas, as far as I have observed, we had a display of St. Elmo's fire.

At our camp on Hackberry we discovered, among other fine material, the largest example of a species of *Inoceramus* I have ever seen preserved. It measured four feet in height and five feet in length. At certain horizons in the Niobrara of Kansas acres of chalk are strewn with fragments of these shells in endless profusion, owing to the fact that the chalk is disintegrated and washed away by water or blown to the four points of the compass by Kansas winds. No wonder the late Prof. E. D. Cope saw in imagination these shells as the remains of a feast of Titans.

This great Cretaceous shell will be mounted in the American Museum, New York. We found in the same vicinity enough material of the mosasaur *Platecarpus coryphæus* to enable us, with the assistance of some exchanges we made with the University of Kansas, to make a complete slab mount of this swimming lizard, once so abundant along the shores of the old Cretaceous ocean in western Kansas. The specimen is seventeen feet long, and is being mounted by my two sons, George and Charles, and myself, and is now nearly completed.

Our second camp proved very rich. Here we camped southwest of Banner post office, in Trego county. Some photographs I exhibit show some sculptured towers near Castle Rock, a few miles west of our camp. George discovered a fine skeleton of a great flying reptile *Pteranodon.* This also has gone to the American Museum. One wing was complete, including the claw-armed fingers used in clinging to rocks while at rest. Our bats hang head downward, while the *Pteranodons* hung with head up.

The crowning discovery of our work here was the discovery by George Sternberg of a nearly complete skeleton of a great shark, *Lamna.* In 1891, while employed by the Munich Museum, I discovered the first and most complete skeleton known of the shark *Oxyrhina mantelli* in the same vicinity. This was made the subject of Dr C. R. Eastman's inaugural address delivered before the Ludwig-Maximillian University of Munich for his Ph. D. degree.

The specimen we collected on the south side of Hackberry creek, south of Banner post office, in Trego county, includes the plates of the mouth holding the teeth, of which some 150 are in sight, and the entire column of flattened disk-like vertebræ to within five feet of the end of the tail. The total length is about twenty feet of the preserved head and column. I think this will prove one of the greatest scientific discoveries of the year, because the sharks are cartilagenous, and consequently their skeletons are not preserved. But in the two cases mentioned enough bone was deposited to preserve the greater part of the skeleton. I further believe that such discoveries will prove that the ancient sharks do not reach the enormous proportions that science has believed, owing to the size of the teeth. For instance, the great shark of the Tertiary, *Charcharodon megalodon*, found along on the coast of South Carolina, has enormous teeth, measuring six inches in length. By comparing them with the living man-eating shark of the same region to-day, Doctor Dean has restored a set of jaws measuring nine feet across and having a gape of six feet.

In my specimen the largest tooth is an inch and a half long, while the smallest is but three-eighths of an inch. According to these measurements, the ancient shark with teeth six inches long must have been 100 feet in length. That such measurements cannot be relied on is proved by my discovery of a large part of the shark *Corax*, from the Kansas chalk. The vertebræ proved to be as large as in *Lamna*, and yet none of the teeth were over half an inch in length. Further, I have in my laboratory to-day a new species of shark, found this season on Hackberry creek, whose vertebræ are half as large as the *Lamna* we secured. The teeth are so small that some of them can only be seen with a magnifying glass. It is pretty safe to restore one of these extinct sharks, because their skeletons are so rare that they will in all likelihood never be discovered. But I believe if these great teeth of the Carolinas are ever, as in my specimen, found in place, the beautiful restoration in the American Museum will go to the junk pile.

On the 23d of June my sons Charlie and Levi started with their team, wagon and outfit to drive across northern Kansas and Nebraska to Cheyenne river, in Converse county, Wyoming, to take up the work we left off last year. I sent George in the meantime to the rich fossil field at Florissant, Colo. Here he made a fine collection of leaves, fruit, flowers and insects from the rich Tertiary shales. Then Charlie proceeded to Wyoming, joining George there, and I soon followed. What was my delight, on my arrival at Newcastle, Wyo., to learn that Charlie had been so fortunate as to discover a magnificent skull of the great *Triceratops*, with horn-cores thirty-three inches long. This was sent to the American Museum directly from the field. Professor Osborn writes, under date of December 19, 1907: "We have at last opened and examined the *Triceratops* skull, and I am happy to write you that we are all delighted with it. It promises to be a very splendid specimen, worthy of the other great things which you have found. The men are hopeful of restoring the frill." You will not wonder that my delight knew no bounds when we made this discovery in a so-called barren country. This country has been deserted for years because the collectors who have spent many years there for Yale and Carnegie and the American Museum had declared it exhausted; and my party of three sons have found, since we entered it last year, the best specimen of the great duck-billed *Trachodon* ever known. This discovery proves that all the existing mounts made up from disassociated bones by Marsh and Hatcher, and the other authorities who copied after them, were wrong; and instead of its being a land animal with thick skin, and leaping around like a kangaroo or frog, it is a water animal, and was web-footed, with a skin as thin as ours, covered with minute scales no larger than a snake's. So, as I have said so often before, the most carefully prepared restorations made by our highest scientific authorities fall to pieces when the complete skeleton is found of the animal in its normal position. A man cannot mount a skeleton right when he has every bone lying slightly disassociated before him unless he has seen the animal with bones in position first. The quicker scientists learn this truth the sooner will science teach the truth instead of so much error.

As I have already, in my paper of last year, described the physical characters of the region, I will finish with a few words in regard to my illustrations. The one marked "Cannon Ball hill" shows lying in the grass a great many round concretions that have weathered out of the grey sandstone above. These are from four to eight inches in diameter. This hill is across the Cheyenne river from our camp, above the mouth of Greasewood creek. I also show you the skull of *Triceratops* as it lies, hewn out of the grey cross-bedded sandstone, ready to wrap with burlap, soaked in plaster, so we can take it up ready for shipment. The horn-cores are in sight, as well as the roof of the mouth, the eye socket under the horn, and the nasal opening, the beak that was covered with horn, etc. The frill had weathered out and lay in fragments, mingled with the debris at the foot of the cliff.

I might, in closing, mention the very fine tail we found of *Trachodon*, the duck-billed dinosaur, as well as a second, containing the entire trunk region. This, with the loose bones we collected, will enable the British Museum to make a very fine mount of this great dinosaur, some thirty feet in length. I believe it is the first specimen of a large American dinosaur to be mounted in Europe, though a cast of the great *Diplodocus carnegie* was sent to England, Germany and France, and the great specimen mounted by the late Mr. Hatcher, its discoverer, in Carnegie Museum, at Pittsburg. If we live, you will hear more of this barren region, as we hope to enter that field as soon as the frost is out of the ground.

A DESCRIPTION OF THE CHANGES IN THE COTTONWOOD LIMESTONE SOUTH OF COTTONWOOD FALLS, KAN.

By J. A. YATES, Manual Training Normal School, Pittsburg.

IN THIS paper I shall describe the changes that I observed in the Cottonwood limestone and some of the changes that were noticed in the formations above and below it. The Cottonwood limestone forms a rather prominent escarpment along the Flint Hills, being about 150 feet below the Wreford limestone, which forms the upper escarpment of what is known as the Flint Hills. Towards the southern part of the state, beginning some fifteen or twenty miles north of Grenola, the Neva[1] limestone thickens up and produces a heavy escarpment from three to four miles to the east, giving the appearance in the topography of two ranges of flint hills. This appearance continues to the south line of the state, the Florena shales and Cottonwood limestone having been entirely eroded from this eastern range of hills, the Eskridge shale covering a large part of the rather broad plateau which connects the two ranges of hills. In a broad way it might be said that the Neva limestone appears at the top of the east range of hills, or the first escarpment, and the Cottonwood limestone at the base of the next escarpment. Throughout the entire course from Cottonwood Falls to the south line of the state the limestone at the top of the Florena shales, and often two other layers of limestone, which occur in the Garrison formation below the Wreford limestone, may be seen. Also, the upper, middle and lower Neva limestones appear in the formation below and seem to be continuous.

Some of these formations change greatly in their lithological characters as one follows them south. Also, rather strong anticlines are noticed at the divides between the river systems, and synclines at the heads of these streams. This is especially noticeable along the divide between the Verdigris and Fall rivers, where the dip is about 1°. Also, near Derry, now called Blodgett, the dip is 2°; as the streams run east, in the main, the dip on one side is to the north and on the other to the south.

While the lithological characters of the Cottonwood limestone change many times in the territory mentioned, the Florena shales remain more constant in character than any other formation near

1. For description and nomenclature of the formation in this paper as they appear at other points in the state, see Cottonwood Falls Folio, No. 109, U. S. Geological Survey.

it. The limestone at the top of the Florena shales forms a conspicuous escarpment at Grand Summit, forming the massive limestone through which the Santa Fe railroad passes about a half mile east of the station. This rather marked escarpment continues on to the south, and at Hooser it is seen at the base of the escarpment, east of the depot. The railroad crosses this layer about one and one-quarter miles south of the Hooser station, and it forms a prominent escarpment around the schoolhouse, in section 11, township 34, range 7, the top of which is seventy feet above the limestone appearing in the branch near this schoolhouse. I believe this layer in the branch to be what I have called middle Neva. This limestone at top of Florena shales continues to the state line. During the last six miles it seems to be disappearing and layers of sandstone to be taking its place, making it somewhat difficult to map.

The Cottonwood limestone, as it appears in the large quarries east of the town of Cottonwood Falls, is a massive layer of limestone about six feet in thickness. About two and one-half feet from the top surface of this limestone appears a layer which is full of holes. The quarrymen split this massive limestone horizontally at this place The upper part is very full of *Fusulina*, while the lower part contains very few. The general appearance of the two layers, were it not for the *Fusulina*, is the same. This limestone is quite soft when first quarried and weathers very slowly and evenly, thus making it one of the best limestones for economic purposes in the state, it being quarried and sawed near the town of Cottonwood Falls and shipped in large quantities to various parts of the state. where it is used for building purposes.

The Cottonwood limestone is found near the top of the hills around Bloody creek. The eastern escarpment appears just west of Jacobs creek, passing on to the east line of Chase county; then running almost due south, near the western line of Butler and Elk counties, into the eastern part of Cowley county, where the formation entirely disappears about seven miles north and a mile east of Hooser.

This formation north of Cottonwood Falls, according to the U. S. Geological Survey and the statements of the state geologist, has as distinct and clearly defined lithological characteristics as any limestone in the state. These distinct characteristics continue in this layer until, following the outcrop along to the east side of Jacob's creek, for the first time changes were noticed in it, and which continued throughout the course of the escarpment until the stratum entirely disappears at the point noted above.

For some fifteen or twenty miles north of the point of the complete disappearance of the Cottonwood limestone it becomes so changed as to make very little escarpment, and had it not been for the limestone at the top of the Florena shales forming a prominent escarpment it would not be possible to map the Cottonwood as far south as mentioned.

A section of the formation as it appears on the east-and-west road, three miles east of Cottonwood Falls, on the east side of the south fork of the Cottonwood river:

About 100 yards to the south of the road, on top of the hill, the Cottonwood limestone is nicely exposed in a small quarry.

7. The shale is well seen in the road; has first three to five feet of yellow shale, four to five feet of greenish-blue shale.

6. A very red fossiliferous lime, one foot thick, probably not a continuous formation.

5. One foot in clay.

4. About nineteen feet of blue shale to the Neva limestone. The latter is composed of layers of limestone with shale between. The thickest layer is about two feet thick.

3. A foot of shale.

2. Two feet of limestone. Only two massive layers are seen in the Neva lime. The appearance of the fracture of this limestone is bluish in color and quite hard; fossils are scarce.

1. Forty-eight feet of a yellow shale down to the flood plane of the river.

On the east side of the south fork of the Cottonwood, in the northwest quarter of section 23, township 20, range 8, a very high cliff is found. The Cottonwood limestone makes a very characteristic layer here, and sixteen feet above it is a stratum of limestone twelve to fifteen inches thick, which breaks up into massive blocks, weathering in appearance very much like the Cottonwood. When broken it contains reddish crystalline particles. This layer seems to have thickened up somewhat here, it being the limestone at the top of the Florena shales. On the east of Sharp's creek, in section 34, township 20, range 8, we find the lime above the Cottonwood at least three feet thick, massive in appearance and forming a prominent escarpment. It still has its characteristic blue and red particles and weathers in holes. The Cottonwood limestone is very near the bank of the creek.

In the southeast quarter of section 25, township 20, range 9, at the head of Jacobs creek, near the Chase county line, the Cottonwood for three miles north makes comparatively little escarpment, the ironweeds marking its course; the *Fusulina* layer becomes much softer; the other layer has the characteristic color, but appears as flagging. The lower layer has the appearance of the top layer of the Neva. The rather porous layer in the Cottonwood limestone seems to be displaced and a rather hard sort of violet-striped layer has taken its place. In the southeast quarter of section 30, township 20, range 10, in Lyon county, the *Fusulina* layer has disintegrated and only the shells are left. In this same section some flint is noticed in the Cottonwood formation. To the north and east of Mrs. Saunders' home, in section 30, township 20, range 10, some flint is noticed in the Cottonwood limestone, and here the *Fusulina* are again scarce. The flint is found imbedded in the limestone, which appears to be "shelly," weathering into very small pieces, usually breaking into flat "rubble." In the southeast quarter of section 20, township 20, range 10, the Cottonwood limestone has almost disappeared, except in ravines. In a ravine near the half-mile line it is about four feet thick, very "shelly," very few *Fusulina*, the chert increasing quite rapidly. As seen at a stock pond to the west, the outcrop of it would give the appearance that one-half of the formation is chert. In sections 20 and 29 the limestone is largely covered with soil, but its presence is evident from its occurrence in ditches, the calcareous flint increasing. Between sections 29 and 30, in the north-and-south road, it may be readily seen that much chert is just above this lime. Following the escarpment around through sections 30, 19, 20, 29 and 31, township 20, range 10, section 36, township 20, range 9, and section 1, township 21, range 9, the outcrop of the Cottonwood limestone in all of these sections is very inconspicuous. At places at the head of ravines and ditches the formation is seen, but very little escarpment is made by the limestone formation; and this being the large divide between the Cottonwood river and the Verdigris river, the outcrop of the formation here is quite different from the outcrop of the same formation to the north and west. The region is a high plateau, and were it not for the Nevas below it would be almost impossible to trace the formation across this plane.

There are three somewhat conspicuous limestone strata that are noticed below the Cottonwood. The one just below the Cottonwood limestone has been described above. The middle one, some fifteen to twenty feet below the upper Neva, is usually made up of three layers of limestone, separated from each other by one to three feet of shale. The middle layer in appearance is very much like the Cottonwood, the lower and upper layers being harder and of a bluish color. Below this middle Neva some fifteen feet is a layer of limestone that I have called the lower Neva. It is a very impure limestone, containing large quantities of impurities. Some parts of it are very soft and others quite hard, thus giving the weathered exposure a very rugged, honeycombed appearance. The outcrop of these Nevas is very conspicuous around Bloody, Spring and Jacobs creeks. On the west side of Jacobs creek, in section 14, the lower Neva is exceedingly rough and honeycombed in appearance. As we go south this continues throughout a number of sections, and then it appears much more homogeneous in character, to again become rugged and change its lithological characteristics. The changes in the various limestone formations from the head of Jacobs creek to the south line of the state, both above and below the Cottonwood, are very noticeable and exceedingly interesting. However, they maintain a constant vertical relation. Across a very level plane extending east through section 2, township 21, range 9, it is impossible to follow the outcrop of the Cottonwood limestone, but by its relation to the limestones above and below it may be mapped, since south of this point the formations are identical with those north of it. The Cottonwood limestone is normal in appearance where exposed, except the upper part seems to have become much softer and to have disintegrated more readily, consequently giving very little escarpment. Where the limestone could be seen in the ditches the *Fusulina* were found in large quantities in their proper place, and serve as an excellent means of locating the formation. Where the Verdigris river has cut back to the west, and the formations above the Cottonwood are exposed, its outcrop becomes normal. The dip to the south from section 31, township 20, range 10, is quite noticeable, being between 1° and 2°. In section 11, township 21, range 9, near a windmill, the Cottonwood lime has been quarried, and appears normal, save near the bottom of it, where it is noticed to be somewhat molluscan (containing shells of Mollusca). For some distance here the Cottonwood appears normal. In the northeast quarter of section 27, township 21, range 9, it has lost many of its normal characteristics. The molluscan layer has increased greatly in size until about one-half of it is of this character. The *Fusulina* seem to be few; the lime is blue in appearance, though the texture is the same; the hardness normal. The *Fusulina* layer seems to have become very soft on account of the addition of mud in its formation. Where seen it is very rotten, and blue in color. Some layers are seen in the formation that when broken have a crystalline appearance, and are much harder than the normal Cottonwood. At the head of a deep ravine in section 22, township 21, range 9, where the talus has recently tumbled down in massive boulders on the underlying shale, there are about two feet of massive stone, very much like the lower layer of the Cottonwood, except bluish in color. The texture is normal. Then comes eight or ten inches of this violet-colored lime. The violet color is in lines, as though it were made of a conglomeration of shells. These violet lines are harder, as shown by the way it weathers. Above this is a four-inch layer of knotty ironstone; then what corresponds to the porous layer in the normal Cottonwood; then a *Fusulina* layer, which is very soft.

In section 3, township 21, range 9, the limestone at the top of the Florena shales has become much thicker, with a rather bluish tinge, very hard, containing iron, nonhomogeneous, and hence erodes with very jagged appearance. The *Fusulina* layer of the Cottonwood limestone at this place is little more than calcareous shale. Near the head of the Verdigris, where the stream cuts through it at a high bluff, the Cottonwood limestone appeared three feet above low-water mark. Here the lower layer is massive, about four feet thick. The top part of this four-foot layer for about one foot is filled with *Fusulina*. The calcareous *Fusulina* shale above graduates into a blue shale filled with *Fusulina*, so that it is very difficult to find the dividing line between the Cottonwood limestone and the Florena shales. The Florena shales are nicely seen at this place, with their characteristic fossils. The hard violet layer is not seen in the Cottonwood limestone here; neither is the portion which is filled with holes, that separates the two massive layers. The stratum seems to be of a very bluish appearance, and probably of economic value. None of it would be of value unless it be the lower three feet. The upper part disintegrates like shale. The fossils in the blue slaty shale above appear in layers for a thickness of eight or ten feet. A small ravine through the cliff enables one to see clearly the layers above as well as the Cottonwood.

The lithological characteristics of the formation are entirely different from the Cottonwood limestone at Cottonwood Falls. In the northeast quarter of section 2, township 22, range 9, in a ravine where a good showing of an outcrop is found, we find the hard violet layer becoming harder and larger; the massive blue layer beneath this being blue, and the *Fusulina* layer still shaly. The formation runs regularly in composition for several miles on the east and south side of the Verdigris river, making a well-defined escarpment, the *Fusulina* layer only appearing in ravines. Usually the shells may be seen in the dirt just above the exposure. The hard *Fusulina* layer is in evidence for several miles north, the flint having disappeared. Running out northeast from section 7 into section 5, township 22, range 10, is a plane a mile and a half to two miles long. In the northeast quarter of section 5 a small patch of Cottonwood limestone is found. To follow the limestone across this plane is again quite difficult. Only the harder part of the stratum is left, on account of the erosion having been very slow.

Here again one must rely largely upon the formation above and below in order to follow the Cottonwood. Near the section line of section 8, township 22, range 10, is a long, very gently sloping ridge. On the highest part near the east line, say one-fourth of a mile from the east line, occurs the Cottonwood limestone; but only a few acres, at most, and in a very narrow line. The ridge is covered by chert, the limestone being mostly gone. More chert seems to be here in the upper half of the limestone. No solid limestone that contains *Fusulina* is seen for many miles to the north. The upper and middle Neva limestones have changed in their outcrop from what they were to the north.

About the center of section 18, township 22, range 10, a large cliff gives a good exposure of Cottonwood limestone, and here the formation is only about two and one-half feet thick, blue in color instead of yellow, but with the texture of the Cottonwood line. Chert is seen in all parts of the formation. The *Fusulina* part seems to be nothing but shale. The fauna of the Florena shales is nicely seen here. The line at the top of the Florena shales is quite hard, while in appearance it resembles the lower Neva, except some very large molluscan shells are found in it. This stratum is thick enough to make a good escarpment for some six or eight miles north of this point. The escarpment around the two branches of the Verdigris may be easily followed, but it is quite difficult to cross the divides, because here the land lies in the form of a plane, and when the formation is seen, on account of the very slow weathering and erosion only the hardest and most irregular parts of it are left. The appearance of the land is such as to deceive one greatly. The Cottonwood limestone runs far up on the main escarpment of the Flint Hills, the creeks all having a very great fall; and often just where the limestone crosses a ravine is the only place where you can drive across. The velocity of the water is so great that great quantities of rock are brought down that weigh from a few to 50 or 100 pounds. Often holes are cut out in the bed of the stream where the water pours over the harden limestone, and this affords most excellent places to study the recently eroded formations. Often the head of the creek is from one-half mile to a mile above the Cottonwood limestone, and the made land covers it near the heads of the creeks in such a way that it is hid-

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den on one side of the creek, with usually a bluff on the other, which will enable one to see exactly where the creek has cut through, and affords excellent exposures. The Cottonwood limestone through this section of the country is blue instead of yellow in appearance. The upper Neva is quite in evidence around the main Verdigris, and on Camp creek appears as good flagging. On the South Fork it is not noticeable. The middle and lower Nevas are very heavy and still have their characteristic appearance.

In the southeast quarter of section 29, township 22, range 10, there is an outcrop, probably of a quarter of an acre, covered with Cottonwood lime. In the southwest quarter of section 29, township 22, range 10, at the head of a ravine, the *Fusulina* are very noticeable, lying in the blue shale that is in the place of the *Fusulina* layer of the Cottonwood limestone. Here may be noticed crystals of calcite. Fossils, such as crinoid stems, appear all through the formation. These fossils may be noticed for some miles towards the north, but are more pronounced at this place.

In the southeast quarter of section 29, at a high embankment, six feet below the Cottonwood limestone a calcareous shale two feet and four inches thick appears. It is quite hard and makes a prominent feature in the cliff. A similar shale in the same position is found in section 11, township 22, range 9. The Cottonwood seems to be homogeneous and about two and one-half feet thick; yet at the head of the creek on the north side of section 5, township 23, range 10, the Cottonwood appears very massive, but it weathers like shale. In two places it is well exposed in the creek bank. It breaks up into flagging from one to two inches thick, with an area of two or three square feet. In sections 9 and 8, township 23, range 10, the dip is very great to the west. In a little less distance than three-fourths of a mile it is forty-eight feet; measured in degrees, about one. In section 28, township 23, range 9, the layer above the Cottonwood seems to be mixed with Cottonwood lime. The Cottonwood lime is well exposed in a number of ravines here. Little white shells are seen laminated through the limestone. In a rather large layer, four inches above the bottom, a three-inch layer of shells occurs. This laminated layer has thickened up in the Cottonwood lime until it has become a large part of it.

A good exposure is seen in a ravine northwest of a house which is in the southwest quarter of section 28, township 23, range 9. Here some four inches of the bottom layer of the Cottonwood seems normal blue Cottonwood lime. Above this is a hard layer of fossiliferous stone, which weathers into a very rough flagging lime hard, flinty and useless, with no appearance of the Cottonwood lime. The stratum through this section of the country is quite irregular in its outcrop and appearance but it makes a good escarpment, very easily followed.

Much of the weathered rock has a yellow appearance and contains holes in it like the middle Neva. Then it appears again as red hard lime, resembling the lime at the top of the Florena shales. The "shelly," violet-colored layer seems to have changed into the impure part of the stratum and has become a large part of the formation. The hard calcareous shale described above, occurring just below the Cottonwood line, in some places contains enough grit to be used for whetstones, though no analysis was made of it. By its constant appearance, always in the same vertical position, it serves as a guide in following the Cottonwood limestone.

The *Fusulina* part of the Cottonwood limestone still appears, but seems to be a little harder here than farther north; yet it weathers as shale. In section 8, township 24, range 9, at the head of a ravine, the impure layer, which is near the bottom, has holes in it and weathers so that the outcrop appears like the lower Neva. This part of the stone is ten to twelve inches in thickness. There is still a small amount of the molluscan layer, and *Fusulina* in the dirt above.

In section 16, township 21, range 9, the Cottonwood lime weathers into a very checked honeycombed structure, and when broken part of it contains small cavities filled with a red material. This layer is the same near the lower part of the stratum. The formation here, however, is at the very top of the divide, on Colonel Bailey's ranch, between the east and west branches of Fall river.

In section 20, township 24, range 9, the honeycombed layer measured at one place eighteen inches in thickness. Below this layer are about six inches of the blue Cottonwood lime. As we go west into the synclinal valley of the west branch of Fall river it is quite noticeable that the topography of the country changes. The formations above the Cottonwood limestone have been cut away and the hills appear to be not so high, and from the topography one would judge that it would be easy to drive across the escarpment. In the southeast quarter of section 12, township 24, range 8, great massive boulders are seen, three feet thick and very nearly homogeneous, honeycombed in structure, and forming a most pronounced escarpment. The rocks are filled with red granules, which are quite soft, and these wash out, thus causing it to weather in holes. No special part of this layer is more honeycombed than the other, to judge from what can be seen from the boulders.

Above this three-foot layer is one of about six inches, softer and with hard streaks running through it, looking as though half the volume of it was made of some sort of large shells, but so worn as to be incapable of classification. It seems to be a layer of coquina. Above this layer we find another layer about one foot to eighteen inches of typical blue Cottonwood limestone containing crinoid stems, and an abundance of *Fusulina* is seen in the dirt above. The hardness and general lithological character of the layer of Cottonwood seems perfectly normal at this point. The *Fusulina* are in the dirt just over this layer, but do not occur in the rock for many miles to the north.

In the southeast quarter of section 3, township 24, range 8, the honeycombed layer seems to have grown much less, while the normal Cottonwood appears to be a much larger part of the formation, which is well seen here in a large cliff, and there is from one to one and one-half feet of normal limestone, like the lower layer at Cottonwood Falls. Abundance of *Fusulina* is in the dirt above. The remainder of the limestone is still the impure variety, but erodes more readily, thus allowing the Cottonwood part to appear on the outcrop. In section 16, township 24, range 8, on the west side of Cat creek, the line at the top of the Florena shales has thickened up and forms a very prominent escarpment.

Fall river seems to be in a synclinal valley running northwest and southeast. On the south side of Ivanpagh creek the dip is northwest about 40′. At a stock pond in the southwest quarter of section 18, township 25, range 9, a little north and east of Sugarloaf, the Cottonwood lime is nicely seen in a ravine. The shelly kind is at the top; the bottom part is very hard, yellow, and somewhat different from the massive. In the southwest quarter of section 16, township 26, range 8, at a big spring and ravine, the Cottonwood lime has changed at the top to a very yellow color, with the normal texture. The *Fusulina* is seen in the dirt, but none could be found in the stone. The Florena shale fauna is nicely seen here. The formation makes a prominent escarpment for many miles to the north, the outcrop being massive boulders, honeycombed, rough, jagged in appearance. The top part of the limestone seems to be not perfectly homogeneous, but softer spots appear in it and some black dots. The honeycombed layer is three and one-half feet thick, and when broken probably half of it is so soft that it may be cut with a knife, like chalk. The other part is quite hard. The impure nodular layer is about one foot in thickness, and the Cottonwood part about six inches, the shale above containing *Fusulina*. On the south side of section 3, township

27, range 8, near the head of Spring creek, the coquina layer has become a calcareous shale, very yellow, with about six inches of Cottonwood limestone above it. Very few *Fusulina* are seen in it.

Coming around the divide between Spring and Otter creeks, the outcrop becomes more like the normal Cottonwood lime It erodes smoothly and has the texture of the Cottonwood lime; when the honeycombed layer is examined the fracture reveals the fact that the molluscan layer has become crystalline. The appearance of the stratum here is that it is repeatedly changing to normal Cottonwood lime. A large part of the stratum here would serve for building purposes. The fauna of the Florena shales is well seen at this point; also the calcareous shale below the Cottonwood lime. The layer at the top of the Florena shale has changed decidedly in appearance. It now has the fracture and texture of the Cottonwood lime in hardness and general lithological characters, and forms as prominent an escarpment as the Cottonwood, its vertical position being unchanged. Also, the Nevas at this place make prominent escarpments.

In the northwest quarter of section 2, township 28, range 8, the Cottonwood lime is well shown in a cut on the Frisco railroad. The limestone measures five feet eight inches in thickness:

5. The upper part, two feet 4 inches in thickness, has the usual appearance of the Cottonwood lime. Some *Fusulina* are seen in it and some crinoid stems. The color is tinged with red instead of yellow, but has the texture of the Cottonwood lime.

4. Below this is a soft, shaly layer of from one to two inches in thickness.

3. The layer of stone that I have described above as the violet molluscan shows clearly the shells of which it is composed, at the weathered surface. It also has red specks of iron in it. Thickness, eight inches.

2. A very thin lamina, less than one-fourth of an inch in thickness.

1. The basal layer, two and one-half feet in thickness, is a more conglomerate-looking stone, as though it was made up of much larger shells. This is the part that causes the rough, rugged boulders to the north. The limestone at the top of the Florena shales is still somewhat prominent and has a good deal of the appearance of Cottonwood lime, except that the *Fusulina* are at the bottom.

In the northeast quarter of section 11, township 28, range 8, the Cottonwood limestone appears on two very small mounds — probably an acre in the west one, and still less in the one to the east — the limestone being the top layer of each mound. The dip to the southeast is a little less than 2°.

Quite a narrow syncline is noticed between the two ponds by the railroad, a litle west of Derry, or Blodgett. This synclinal fold may be seen distinctly by beginning at the railroad cut, already described, and following the outcrop, which is mainly south to the head of the ravine on the west side of section 11, to where the road crosses the ravine and a big spring comes out of the shale below the Cottonwood limestone. At this place the layer on the east side of the ravine is much lower than on the west side, and if followed its outcrop passes near by the railroad pond, reaching nearly to the surface of the water of the west one, the fall here being some fifty feet in a half mile, about 2° dip. Following it around a sort of mound, we find it on the north side of the railroad track, fifty yards west of the water tanks. The limestone over the Florena shale appears at the railroad crossing. The Cottonwood appears just west of the cut at the pond, and may be seen in the outcrop to the west and northeast. The outcrop may be seen on the hill just east of the pond, forty feet above the water level. Here the dip is to the west, the opposite of the way it is at the east pond. The railroad runs northeast and southwest near the center of section 11, township 28, range 8. This appears to be a synclinal valley about a mile wide, running northeast and southwest. It is nearly two miles from outcrop to outcrop of Cottonwood.

After crossing the divide to Elk river *Fusulina* appear in the limestone at the top of the Florena shales, especially the lower part; the stone is soft and yellow in appearance, quite like the Cottonwood limestone. At the head of Elk river this formation is seen nicely in a quarry, and here the lower part of it is quite impure. Near where the Elk river cuts through the Cottonwood limestone an excellent bluff for studying the layers is found. Here the stratum of Cottonwood limestone is found to be five and one-half feet thick, the dirt above being filled with *Fusulina*. This stratum breaks up here into boulders resembling the normal Cottonwood limestone at Cottonwood Falls. Further north the bottom part of the stratum shows on the outcrop rugged and rough, the top part maintaining more of the appearance of normal Cottonwood. The underlying calcareous shale, which is conspicuously noticeable to the north just beneath the Cottonwood limestone, seems to have become an impure limestone, very hard, containing iron, and sometimes described as "knotty."

Between sections 30 and 31, township 29, range 9, an examination of the limestone being made at the head of a small creek running into Elk river, two layers of limestone appear above the Cottonwood to the top of the hill, the rugged and the flagging layers both making some escarpment, but not very marked, the flagging layer being the less noticeable of the two. From the railroad cut described to the north the limestone above the Florena shale has become more and more pronounced, until from six miles or more north it makes a much more prominent escarpment than the Cottonwood limestone. The appearance of the Cottonwood limestone on the escarpment, where it may be seen, is nodular, shelly and shaly-looking (not distinctly shaly, but weathering somewhat that way). An examination at the point above mentioned shows the Cottonwood limestone, which can be seen only in places, to be about two feet thick, bluish in color, breaking up into flagging nodules without seams, *Fusulina* occurring. The Florena shales can be well observed here, containing the characteristic fossils, this being an excellent place for collecting. The limestone overlying the Florena shales measured fourteen feet in thickness and consists of a fossiliferous layer containing *Fusulina*, crinoid stems and many molluscan shells, weathering into the appearance of flagging, the thickness of which is two feet, the lower ten or twelve inches being fossiliferous. Above this part the limestone appears in layers of yellow lime, easily eroded, containing soft layers, causing the weathered appearance to be that of massive blocks. This massive layer is fully nine feet thick at this place. Some of the layers weather into jagged, knotty, irony lime, which appear on the outcrop. No fossils were found in any but the lower layers.

A layer of clay occurs just above this limestone for several miles and causes many springs, giving it the appearance of springs almost on top of the hill, and the ravines are very rugged. In the main there are two massive layers of this limestone, with a more or less easily eroded layer between them, the lower layer weathering into jagged, honeycombed rock, which appears on the outcrop. A few feet below the Cottonwood limestone a bluish-looking lime of one and a half feet in thickness continues, this being the limestone that has taken the place of the calcareous shale further north.

On the Santa Fe railroad, west of Grenola and for many miles to the north, the lime above the Florena shale makes a very prominent mesa. The Cottonwood limestone makes a very inconspicuous one, which is continuous, but is usually the same as a small step just below the prominent one. The outcrop of the Cottonwood limestone appears nodular; the shale above it is more conspicuous than the limestone. Many small ravines in it afford excellent opportunity for observing its characteristic fauna, which occur in great abundance. The railroad cut about a half mile east of Grand Summit, at the top of the hill, is mostly in the shale above the lime which is above the Florena shale. The cut and quarry in this limestone afford an excellent opportunity for studying it. This limestone appears columnar on the outcrop. On examination it is found that the layer next to the top one is about two feet thick, weathering in such a way as to give it this appearance. Just below the columnar layer is one two feet thick which weathers very white, and in the quarry on the north side of the railroad near the cut is seen to be a white crystalline lime.

The columnar layer breaks up on the outcrop, looking as if it had been blasted away. The railroad runs over the Cottonwood stratum of limestone without making any cut in it. The layer of blue, hard calcareous shale seems somewhat thicker at this point and makes a layer which could apparently be mapped. The Cottonwood limestone at this point is two or three feet thick, very nodular, with seams of shale running through it, the thicker layer less than two feet. The Cottonwood limestone runs into Cowley county a mile and a half north of the north line of Chautauqua county, in the Otter creek basin. In this basin the hills have flattened down, the escarpment being much more difficult to follow.

In the southwest quarter of section 19, township 30, range 8, just south of the place where a house formerly stood, the remnant of the Cottonwood limestone is seen to be a knotty, hard layer, having the appearance of a temporary limestone. No outcrop of the Cottonwood limestone can be seen for at least two miles north. The limestone above the Florena shales makes a less notable escarpment, but this limestone thickens up to the south.

In the southwest quarter of section 30, township 32, range 7, toward the head of a long branch running into Otter creek, a rather high bluff is seen on the east side of the stream with several sycamore trees around it, and in this bluff the only trace that could be found of the Cottonwood limestone is little knotty streaks of limestone through the shale, a clay shale being between every streak, and fossils found in it, and chunks of hard, blue, rotten, shaly limestone. The fossils common to this horizon found in the shale are sometimes in the limestone. The tops of these layers (if such they may be called) are horizontal and in regular lamina, which are separated from each other by thin layers of clay shale. The lamina of limestone are not continuous, but are separated vertically every few feet by patches of shale. The shale above this streak is pure Florena shale seven or eight feet thick. The limestone above the Florena shales begins with layers of shelly streaks of lime. From the top of the upper streak of Cottonwood limestone to the first solid continuous layer of limestone above the Florena shales is nine to ten feet. From the appearance of the streak of fossils and nodules of limestone where the Cottonwood limestone would normally appear, I should say that when this material was being deposited that it was near a coast line, and the different layers of shells, followed by shales, would clearly show that the animals had been killed by the overflows of mud. Then the water becoming normal again and teeming with life, again overflowed. Finally the sea became deeper and the Florena shale was deposited; then the shelly layers of impure limestone, and finally the deeper waters for the formation of the heavy limestone at the top of the Florena shales. The Cottonwood limestone makes no outcrop for several miles to the north; the limestone at the top of the Florena shales making an outcrop which is fairly easily followed, and its nearness to the Cottonwood limestone, makes the mapping of the one practically the mapping of the other. On the west side of the creek above described, in many deep ravines coming into the creek for a mile or so, frequently the same formation as described above is found.

CONCLUSIONS.

It would appear from the facts observed in the changes in the lithographical structure of the Cottonwood limestone that the outcrop of this formation was near the margin of the sea at the time the material was laid down. The first change noted being in the top part of the layer, and it gradually becoming more and more shaly, would indicate that the land was rising here to the east of the most eastern outcrop near the head of Jacobs creek, and that before the stratum was completed the water was filled with mud, thus in this way producing the shaly limestone at the top. It was generally observed that where the creeks cut far back to the west the limestone was more normal in its characteristics. The chert in the limestone would indicate that it was formed near the margin of the sea. From the manner in which the chert is found in the formation it is evident that it was deposited in the layer while it was in the process of being formed. The highly fossiliferous shale immediately above the Cottonwood limestone certainly shows the land to have been rising and to have come above the depth for the formation of the limestone, and the life to have been exterminated by the muddy deposit now forming the Florena shales. The lithological characteristics of the layer after passing into the Verdigris and farther south, where the molluscan part of the layer disappears, strongly reminds one of coquina as formed on the Florida coast to-day. It is this molluscan layer that changes into the layer containing much iron and made up of materials which in some places are very hard and in others very soft, and when exposed by erosion causes the stones on the outcrop to appear very rugged and rough.

and finally, where the limestone displaces it, gradually becoming thinner and thinner; streaks of shale divide it into different layers, and finally the shale replaces it entirely, the streaks of limestone becoming merely little, thin layers of shells, the shells being perfectly preserved in the shale.

If the Neva limestones and the one at the top of the Florena shales be considered as part of the Cottonwood limestone formation, then this limestone continues, south of Hooser into Oklahoma, in the limestone described as Neva in this paper.

AN ESKER AT MASON, MICHIGAN.

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

DURING the summer of 1881, while making a rapid survey of the drift deposits of southern Michigan for the United States Geological Survey, I stopped for a day at Mason, about fourteen miles south of Lansing. The surface was then heavily timbered and sloped approximately three feet to the mile towards Lansing, with no elevations of any consequence apart from the esker. This plane topography makes the long, sinuous esker a very conspicuous feature of the topography—one to be reckoned with by the road-maker as well as by the geologist. Plate 1 gives a typical view of a portion of the esker as it exists in 1908, and plate 2 shows its internal structure. Limitations of time forbade my tracing the esker throughout its course, and the nature of the esker at its beginning near Lansing and its southern terminus southeast of Mason are unknown. One tributary was noted from the car window near Mason. The people at Mason say that the length of "the ridge" is about twenty miles, height thirty to fifty feet, and its width, at base, 150 to 400 feet.

Geologists tell us that eskers mark the course of subglacial rivers, rivers which carried southward the waters of the glacier in its old age. This esker marks the channel of a south-flowing river of the drainage system of the Saginaw glacier, whose terminal moraine (or one of whose terminal moraines) lies a little southeast of Jackson. The present slope of the surface to the northward is due to the thicker deposit of drift near the moraine, and not to the slope of the subjacent rock surface. The esker probably loses its identity in the front moraine of the Saginaw glacier, or it may even extend beyond and terminate as a kame or delta on its southern slope.

The component material of the esker is all water-worn, and was evidently deposited through the agency of water. The boulders are of all sizes up to twelve inches. The material of the esker is shown in plate 2, but the boulderets shown in the front of the plate have been through a process of concentration by the removal of the sand for local use. Perhaps forty per cent are sandstone, similar in lithological character to the subjacent rock strata. The remainder are species of metamorphic or igneous rocks similar to those of the neighboring till, with the exception of a red, white

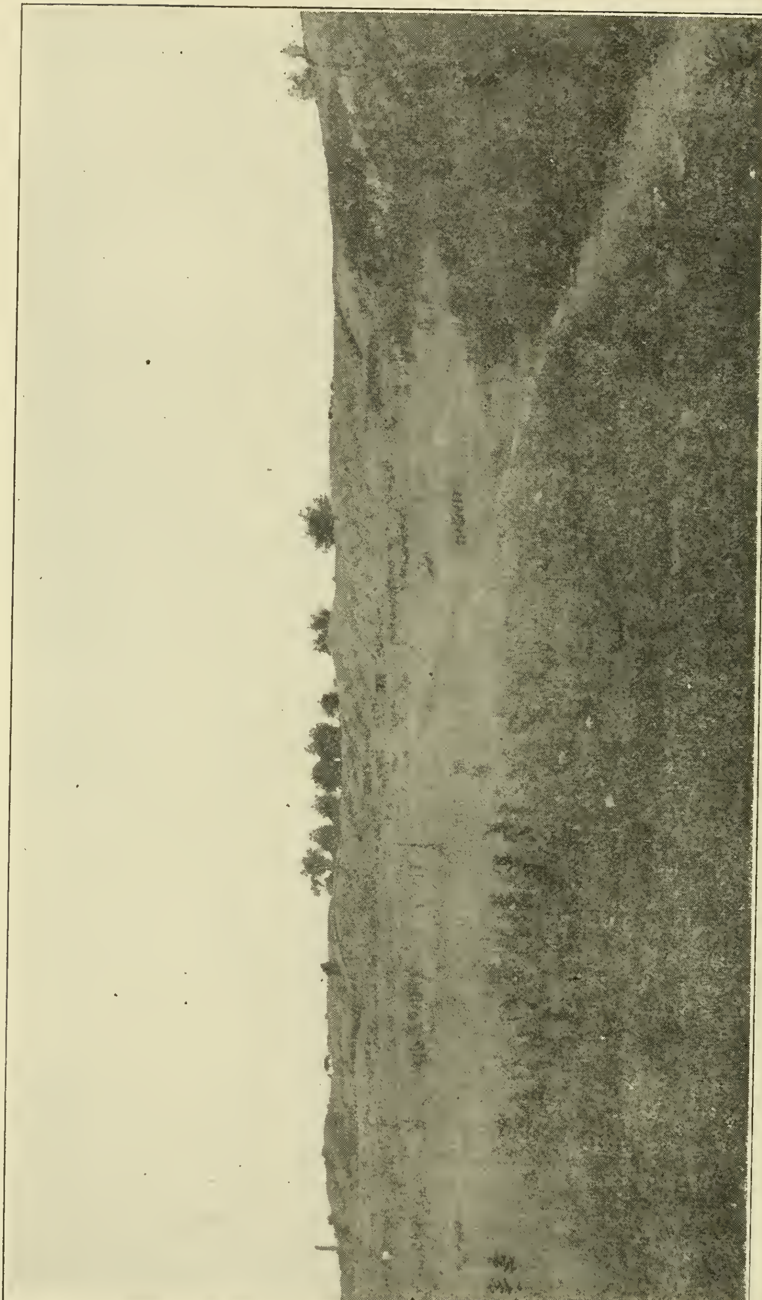


PLATE 1. The Mason, Michigan, Esker, extending from near Jackson to near Lansing, about twenty miles.

PLATE 2. The Mason, Michigan, Esker, height 30 to 50 feet, width at base 150 to 400 feet.

and blue jasper and crystalline quartz conglomerate so common in the Michigan drift. None of these were seen. There were seen a few limestone pebbles.

I prepared a brief notice of this esker which was printed in *Science* early in 1884, but at that time the term "kame" was deemed the appropriate name for this form of drift, and that title was used.

AN EMBRYONIC PLESIOSAURIAN PROPODIAL.

By Roy L. Moodie, University of Kansas.

OUR conception of the morphology of vertebrate limb bones is much complicated by the conditions found in the propodials of embryonic and young plesiosaurs. Examples of these bones are not at all rare in the Cretaceous deposits of the West, and there are several references to them in the literature, including a few discussions of the characters which they present. Doctor Williston has especially dwelt upon the characters of a very immature plesiosaurian limb bone which he discovered in the chalk of western Kansas. He also figured examples of other, more mature, propodials (Field Museum, Publication 73, plates 22 and 23, 1903). The writer later referred to the immature element and described others in an attempt to arrive at some conclusions in regard to the morphology of the so-called epiphyses of the plesiosaurs (Amer. Journ. Anat., vol. VII, No. 4, p. 443, 1908). The conclusions reached pointed definitely to the fact that the so-called epiphyses of plesiosaurs, turtles and dinosaurs are in reality the endochondral ossifications of the limb bones, and differ in all structural respects from true epiphyses.

The conditions which complicate our conceptions of the morphology of the vertebrate limb bones are the presence of numerous grooves and foramina in many places on certain types of plesiosaurian propodials. These grooves and canals are especially well marked in the specimen which is described herewith.

There has been in the museum of the University of Kansas for some time a small embryonic plesiosaurian propodial which I suppose to represent a humerus. It is as immature as any propodial known to me, with the exception of the small one described by Doctor Williston. Judging from the matrix still adhering to the specimen, it is from the Niobrara Cretaceous, but just what locality is not known, though probably somewhere in western Kansas. The element presents most peculiar and unusual characters, which are believed to be new to our knowledge of plesiosaurian anatomy. The character which is especially striking is the deep, well-marked groove on the radial (?) side. It forms, save for a small pathological interruption, a shallow, smooth-bottomed trough which extends fully half around the periphery. On the opposite edge there is a very shallow groove which is not nearly so well marked as the one described above. Its bottom is rough and has the openings of at least three distinct foramina, with many smaller vascular openings.

It has been observed that the structure of the immature plesiosaurian propodial is more dense than is the case in fully matured bones. This holds true for the present specimen. The density of the embryonic propodial is undoubtedly due to the fact that the bone cells have not yet become vascularized. This dense condition of the perichondrium is not confined to the bones of plesiosaurs, since the same characters are found in the limb bones of young alligators and lizards.

The presence of the grooves and foramina appears to be peculiar to the plesiosaurian propodial. The writer has examined, during the past few months, the embryonic skeletal systems of numerous specimens of several species of turtles, lizards and the American alligator. In none of these has he been able to distinguish any structure which could be correlated with the grooves and foramina found in the plesiosaurian propodial, but it has been observed that the structure of the perichondrium is more dense in the embryonic limb bones than in the bones of the adults of the same species. The exterior surfaces are smooth. Possibly the degrees of density of the limb bones of vertebrates is to be correlated with the rate of growth of the animal. It is a matter of easy observation that different immature plesiosaurian propodials offer different degrees of density of structure even among the embryonic bones. The above-mentioned foramina and grooves have not been described, so far as I am aware, in the limb bones of any adult vertebrate, recent or extinct.

The present example of plesiosaurian propodial measures 83 mm. in length by 31 mm. in width. It tapers somewhat at each end, with the greater width at the distal end. There is a distinct roughening of the surface in several places, near the edges, which do not have the same characters as the muscular roughenings of the adults, but seem to be due to blood vessels in the caps of cartilage which undoubtedly covered the ends and sides of the bone.

The deep groove, present on one edge of the bone, is peculiar both in its extent and width. It has hitherto not been observed on immature plesiosaurian limb bones. It fills nearly the entire radial (?) edge. Its edges are sharply defined and its bottom is marked by numerous small and a few large vascular pits, giving the surface a punctate appearance. Somewhat more than half beyond the length of the bone distally there is a large, rough tuberosity, probably due to some disease or accident, as it is very vascular, like most exostosial growths. It recalls, for instance, the pathological growth known as the "lump-jaw" of cattle, which is familiar to travelers on the western plains. This pathological interruption occupies 15 mm. of the bottom of the groove. It lies just over the opening of a rather large canal, which gives passage to a calcite-filled cavity in the center of the bone. This cavity is paralleled by the condition found in the more mature propodial shown in figures 8 and 9.

Grooves of a similar nature have been observed on more mature material. There are examples of several adult and immature propodials in the collection which show these grooves, and a few of them show the foramina as well, as is shown in figures 4, 5, 6, and 7. Three foramina are shown in figure 4 and one in figure 9. In the adult and less mature propodials the grooves never extend the entire length of the bone, but are restricted to the distal one-third, or, at most, to the distal half. In five specimens there are grooves present on both edges of the bone, as shown in one instance in figures 4 and 5.

The pits and foramina opening into the canals which pass to the internal cavities usually occur on the edge opposite the groove, but occasionally they occur on the same edge, and in case the groove is present on both edges the foramina are present at times on both edges also. The specimen outlined in figure 4 has the grooves on both edges. On the edge represented in figure 5 there is a single foramen, while on the edge shown in figure 4 there occur three foramina. The specimen outlined in figure 6 shows no pits at all, and the groove occurs only on the edge where it is figured. The adult bone of figure 7 has no pits and the groove is confined to one edge.

The meaning of these various grooves, foramina, pits, etc., is rather difficult to perceive. Judging from the condition found in the embryonic bone described above, one might be correct in saying that there were two ossific centers for the perichondral bone. But there are immature propodials and mature ones which show not the slightest signs of the pits, grooves or foramina, nor, on sectioning, does any evidence of the internal cavity appear. So far as I am aware, all propodials which exhibit these structures belong in the genus *Polycotylus*. I do not recall that they have ever been detected in bones assigned to *Elasmosaurus*, *Trinacromerum* or *Plesiosaurus*. Certainly there are no evidences of them in the propodials of these genera which are accessible. And, oddly enough, they do not occur in all examples of *Polycotylus*, for they are not found in the propodial associated with a nearly complete paddle of *Polycotylus latipinnis* Cope, which is, I believe, regarded by Doctor Williston as a hind paddle. This seems to mean that the above-mentioned characters are confined to the humerus, which only serves to complicate our bewilderment. It has been suggested that the pits, canals and cavities corresponded to similar structures in other vertebrate limb bones where the pits and canals give passage to blood vessels, and the internal cavity corresponded with the medullary cavity. This may well be true, but we still have to explain the presence of this peculiar groove which is so highly developed on the present embryonic plesiosaurian propodial.

EXPLANATION OF FIGURES.

FIG. 1. Dorsal view of the embryonic plesiosaurian propodial. The groove will be seen on the right side of the figure. X 1.

FIG. 2. Edge of the embryonic propodial, to show the shallow groove. X $\frac{2}{5}$.

FIG. 3. Edge of the embryonic propodial, to show the deep groove. X $\frac{2}{5}$.

FIG. 4. Edge of more mature propodial, showing an elongate groove and three foramina. X $\frac{2}{5}$.

FIG. 5. Opposite edge of distal end of propodial figured in 4.

FIG. 6. Edge of a worn, nearly mature propodial of *Polycotylus*. X $\frac{2}{5}$.

FIG. 7. Edge of a mature propodial of *Polycotylus*, showing the elongate fissure at the distal end on one edge. X $\frac{2}{5}$.

FIG. 8. Section through a mature propodial of an undescribed plesiosaur. X $\frac{1}{2}$.

FIG. 9. Lateral view of same propodial shown in figure 8. A = foramen shown at A in figure 8. X $\frac{1}{2}$.

PLATE I. A series of plesiosaurian propodials, showing the evolution of the shape of the bone. Two genera, *Polycotylus* and *Elasmosaurus*, are possibly represented. Not all the bones figured show the pits, grooves and canals. The small white nodule above the row at the right is a so-called "epiphysis" belonging to an immature plesiosaurian propodial. The embryonic bone described above is the last of the series to the right. X $\frac{1}{4}$.

Fig. 1

Fig. 8

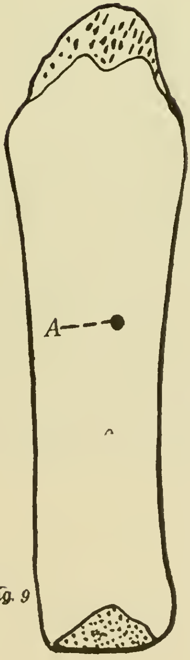


Fig. 9

Fig. 2

Fig. 3

Fig. 4

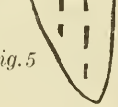


Fig. 5

Fig. 6

Fig 7

PLATE I.

IV.

BIOLOGICAL PAPERS.

1. "DESCRIPTION OF A NEW FLY OF THE FAMILY DOLICHOPODIDÆ, WITH REMARKS AND CORRECTIONS OF PRECEDING PAPERS."

   By E. S. TUCKER, Bureau of Entomology, U. S. Department of Agriculture.

2. "ADDITIONS TO THE LIST OF KANSAS COLEOPTERA FOR 1909."

   By W. KNAUS, McPherson.

3. "DISTRIBUTION, NATURAL ENEMIES, AND BREEDING HABITS OF THE KANSAS POCKET GOPHERS."

   By THEO. H. SCHEFFER, Kansas State Agricultural College.

4. "THE PRAIRIE-DOG SITUATION IN KANSAS."

   By THEO. H. SCHEFFER, Kansas State Agricultural College.

5. "INVESTIGATING THE MOLE."

   By THEO. H. SCHEFFER, Kansas State Agricultural College.

6. "A RARE MEXICAN CYCAD."

   By W. B. WILSON, Ottawa University.

7. "AN ABERRANT WALNUT."

   By IRA D. CARAIFF, Washburn College, Topeka.

DESCRIPTION OF A NEW FLY OF THE FAMILY DOLICHOPODIDAE, WITH REMARKS AND CORRECTIONS OF PRECEDING PAPERS.

By E. S. TUCKER, Bureau of Entomology, U. S. Department of Agriculture.

THE fly to be described herein was collected on one of my vacation trips, which altogether have resulted in the collection of numerous species of insects, including several new to science. The names and records, which in great part are additions to the faunal lists of both Kansas and Colorado, wherein the insects were taken, have been published so far as the systematic determinations have permitted. My recent contributions to the lists appeared in volume XXII of the Transactions of the Kansas Academy of Science, under three titles: "Additional Results of Collecting Insects in Kansas and Colorado," pp. 276–304; "Supplementary Additions to the List of Kansas Diptera," pp. 306–307; and "Supplementary Additions to the List of Kansas Hymenoptera," pp. 308–310. Owing to the fact that printer's proof was not submitted to me, a number of errors occur, which require the following corrections:

Page 278.—Families "Sarcophagidæ to Agromyzidæ," inclusive, are misplaced; they belong to end of list of Diptera, on page 307.

Page 279.—In heading of first specific division, read "*agilis*" for "*agillis*"; in sections (1) and (6), read "cinereous" for "cinerous"; also, in (2) and (5), read "ferrugineous," as spelled in original descriptions, for "ferruginous."

Page 280.—In part 1 of table, third line, read "cinereous" for "cinerous."

Page 282.—In family Panurgidæ, read "*Perdita*" for "*Purdita.*"

Page 286.—Forty-first line, substitute "its" for "other."

Page 287.—Fourteenth line, read "ornamentations" for "ornamentation."

Page 291.—Thirty-fifth line, read "Vr." as authority for "Br."

Page 295.—Tenth line, read "*mellitor*" for "*millitor.*"

Page 300.—In family Syrphidæ, after record for *Melanostoma mellinum*, add "New to the Kansas list."

Page 302.—Thirteenth line, read "laterally" for "latterally."

Page 303.—Sixteenth line, read "*Pelina*" for "*Pilina.*"

Page 307.—Note continuation of list misplaced on page 278.

Page 309.—In second column, with *Pristomerus*, add *appalachianus* Vr., to indicate typical form.

With reference to the validity of three closely allied species of bees, as discussed on pages 278–281, Prof. T. D. A. Cockerell has written me as follows: "*Melissodes agilis* and *M. aurigenia* I have regarded as forms (races) of one species. They may be distinct.

I cannot at this moment go into the matter again. A male *M. snowii* (Cresson cotype before me) looks distinct by the white pubescence and very long antennæ. In favor of the validity of *snowii* is the fact that it does not seem to occur in southern New Mexico, where *agilis* is so very common."

Before proceeding to describe another fly as a new species, I have to acknowledge the synonymy of *Leria caccabata*, as described by me in the preceding papers, as mentioned on pages 301–302, with *Leria latens* Ald. My name must, therefore, fall, according to the authority of Mr. D. W. Coquillett, of the U. S. National Museum, Washington, D. C., who compared my specimen with determined examples of *Leria latens* of Aldrich, and found it to be identically the same species. My description is in fault regarding the statement of single vibrissa, when in fact an additional one on each side had been broken off. The basal pits showed where these missing bristles had been attached. The record, however, of the insect being new to the Kansas list still holds good, even with a change of name.

Dolichopus jugalis, n. sp. Colorado, Tabernash, 8310 feet, western side of the continental divide of the Rocky Mountains, 89 miles west of Denver; August, 1906. Type: one male specimen.

General color shining green. Femora and other joints of legs, except as specified, yellow; cilia of inferior orbit pale; tegulæ with black cilia, fourth longitudinal vein deflected, running somewhat forward at the tip.

Closely allied to *coloradensis* Aldrich, from which it differs in the following particulars: The first antennal joint is yellow only on the under side; face golden yellow, decidedly concave for the greater part above; eyes subopaque black, with comparatively coarse facets; front with a bronze reflection; thorax with a distinct median stripe of shining bronze. Fore coxæ yellow, touched with black at base, and transversely marked on the front side with a preapical black line bordered by a row of fine black bristles. The two outer bristles are equally long, but inwardly the bristles are much reduced in size, and all are set behind the line. Fore tarsi are two-thirds longer than their tibiæ; first three joints extremely slender; the second scarcely longer than the first; the third hardly less than two-thirds the length of the second; fourth and fifth together equal in length to the third, black and enlarged to all appearances the same as with *coloradensis*, unless more symmetrically equal on each side of the axial line. Lamellæ of hypopygium more than twice as long as wide, the tips touching posterior coxæ. Costa of wing slightly thickened at junction of first vein. The posterior margin of scutellum is slightly tinged with yellow. In other respects, the tarsi of middle legs are strongly black from the tip of the first joint; posterior tibiæ are infuscated at apex, their tarsi black; the middle and posterior tibiæ bear two rows of long, stout black bristles behind, and a few similar bristles are attached in front.

On each of the middle and posterior femora a single bristle is situated at some distance before the apex. Fore coxæ clothed with fine black hairs on front surface in addition to the row of bristles. Palpi and halteres yellow.

Length, 5.5 mm.; wing, 5 mm.

ADDITIONS TO THE LIST OF KANSAS COLEOPTERA FOR 1909.

By W. KNAUS, McPherson.

THE following twenty-nine species have been added to the list of Kansas Coleoptera by collecting and from the monographic papers of Horn, Casey, Bowditch, Schaeffer, Knab, and Hopkins:

1— 804 Platynus basalis Lec. (Horn.)
2— 809 Var. Platynus maculicollis Dej. (Horn.)
3— 826 Platynus crenistriatus Lec. (Horn.)
4— 834 Platynus picipennis Kirby. (Horn.)
5—3527 Hister cylindricus Payk. Onaga, June.
6—3907 Ptilodactyla angustata Horn. Onaga, June.
7——— Spinthopterus woodhousei Lec. (Casey.)
8——— Dicerca porcatula Casey. (Casey.)
9——— Buprestis violesceus Casey. (Casey.)
10——— Buprestis morosa Casey. (Casey.)
11——— Agrilus knausii Schaeffer. Belvidere, Kiowa county, June and July, on Hackberry.
12——— Dyscinetus puncticauda Casey. Ford and Hamilton counties.
13——— Pachybrachys rotundicollis Bowditch. Morton and Hamilton counties.
14——— Pachybrachys atomus Bow. Douglas and McPherson counties.
15——— Pachybrachys (?) xialtico Suff. One specimen, Rago, Kan.
16——— Pachybrachys arizonensis Bow. Douglas county.
17——— Calligrapha rhoda Knab. Onaga, June, on Hazel.
18——— Eusattus turgidus Casey. (Casey.)
19——— Eusattus peropacus Casey. Ford county.
20——— Eusattus acutus Casey. Logan county.
21——— Palorus depressus Hrbst. Working in mill stuff; received from F. B. Milliken, Manhattan, Kan.
22——— Pseudo-cistela penguis Lec. Cat. Coleoptorum, Schemkling.
23—7774 Tomoxia lineella Lec. Onaga, June.
24—7785 Mordella serval Say. Onaga, June.
25—7790 Mordella undulata Melsh. Onaga.
26—8910 Stethobaris tubulatus Say. Onaga, June.
27—8933 Centrinus lineicolle Lec. Onaga, July.
28——— Sphenophorus zeae Walsh. One specimen, Cheyenne county.
29——— Dendroctonus valens Lec. (Hopkins.) Extreme southwest Kansas.

DISTRIBUTION, NATURAL ENEMIES AND BREEDING HABITS OF THE KANSAS POCKET GOPHER.

By THEO. H. SCHEFFER, Kansas State Agricultural College.

THE following notes embody some of the results of investigations of the pocket gopher, conducted principally at Manhattan. Data were also collected in a number of trips made to various parts of the state, including the banner alfalfa counties, the irrigated lands of the Southwest, the potato-growing districts of the Kansas valley, and nurseries and orchards in several quarters.

DISTRIBUTION.

The prairie pocket gopher, *Geomys bursarius*, is distributed over that part of the upper Mississippi valley which includes the central and eastern parts of the Dakotas, Nebraska, and Kansas, the whole of Iowa, and portions of Missouri, Illinois, Wisconsin, and Minnesota. On the west, excepting in the Dakotas, its range meets and partly overlaps that of the plains pocket gopher, *G. lutescens*, and on the south that of the Louisiana gopher, *G. breviceps*. In the western part of the Dakotas *Geomys* is replaced by a distinct genus, *Thomomys*, inhabiting nearly the whole of the Rocky Mountains and Pacific regions.

KANSAS SPECIES.

In Kansas the dominant species of gopher is *G. bursarius*. It is most abundant in the central and northeastern parts of the state, and ranges at least as far west as the ninety-ninth meridian. Here it is partly, and a little further west fully, replaced by the paler, sand-colored species, *G. lutescens*. Whether the two species intergrade on the common border of their respective ranges I have not been able to determine. In no part of western Kansas have I found the plains pocket gopher very plentiful. It is more scattering in its distribution than *G. bursarius*, being locally abundant only in the gravel flats along the streams or among the sand hills. The harder soil of the buffalo-grass tracts has little attraction for this burrowing animal. In the lower Arkansas valley of south-central Kansas the species becomes as abundant, however, as does *G. bursarius* in any quarter of the state.

If reports of depredations by pocket gophers and demand for measures of repression and extermination can be taken as an index to distribution, it may be seen from the accompanying map that

Geomys bursarius is most abundant in the region drained by the Kansas river and the lower courses of its main tributaries. The area of greatest infestation is also shown to include that portion of the Arkansas Valley east of Great Bend, but here the plains species is the more abundant. A personal survey of the valleys of the Kansas, the Blue, the Republican, the Solomon, the Smoky Hill and the lower Arkansas confirms the evidence of the map to which I have referred. Southeastern Kansas seems to be comparatively free from the pest, at least in numbers sufficient to make it troublesome. In this region and along the south-central border of the state the range of *G. bursarius* probably meets that of the Louisiana pocket gopher, *Geomys breviceps.* The evidence of this is shown by specimens from the valley of the Ninnescah—now in the zoölogical collection at Washington—having some characteristics of both species.

NATURAL ENEMIES.

Since the pocket gopher so seldom shows itself outside of its subterranean galleries, it has little to fear from the natural enemies of the rodent race. It is not entirely safe from attack, however, for a few sharp-eyed and vigilant foes habitually capture numbers of gophers when they come to the mouths of their burrows to push out a load of earth. Hawks and owls take toll at these favorable moments, and many a house cat has learned the trick of capturing a meal then with little difficulty.

The gopher's habit of confining active operations in mining mainly to the hours of twilight particularly favors the owl and the cat. The Great Horned owl, the Long-eared owl, and the Barn owl, particularly the last named, render valuable service in keeping down the numbers of these destructive rodents. A single pair of owls, nesting on the farm, have been known to destroy scores of gophers in a brief season. Sometimes they live on nothing else for a time, as evidenced by the pellets of bones and fur which they, like most birds of prey, invariably disgorge after a meal.

Instances of a house cat becoming addicted to the gopher habit are not uncommon. In a number of cases that were reported directly to me, mother cats brought in several gophers a day, regularly as clockwork, to their families of kittens. In many instances of reported gopher-catching, however, the informant has had in mind the little striped "gopher," or ground squirrel.

Two enemies that in some localities are said to hold the pocket gopher in check more than all others are the weasel and the bull snake. The former is too scarce in most parts of Kansas to be worth considering in this relation; but the bull snake is common enough on farms whose owners or tenants have had the wisdom and forethought to protect the natural enemies of the destructive rodent tribe. The snake is able to gain entrance to the gopher's runway not only when the latter is temporarily left open, but also by vigorously burrowing into the loose earth about a fresh mound. In a case that came to my notice a large bull snake was surprised in the act of trying to force his way into a burrow. The observer quietly approached and for some minutes watched the reptile at work. The *modus operandi* was to force the snout into the soil by moving the head and neck from side to side, accompanied by a slight rotary motion as the strong, rigid muscles of the body folds came into play. At intervals, as the folds were crowded back upon one another by this exertion, the front part of the body would come out of the deepening excavation, scooping along a quantity of earth in the curve between the head and neck. Only a short distance from this snake another was crawling about over a gopher hill, evidently seeking for an entrance or a favorable spot for forcing one. Catching sight of the intruder, he became alarmed and made off in some haste. When the observer quit the field the first snake had burrowed to a depth of five or six inches and was still at work. Once inside, the snake probably remains there for some time and makes things interesting for the occupants. When one is trapping gophers he will occasionally surprise a bull snake in the act of trying to swallow the captured animal, trap and all. I have also found this snake in the burrow of the striped spermophile, helping himself to a nestful of the young of the latter, and have seen him capture and kill the adult spermophile at the mouth of its burrow.

The little striped skunk (*Spilogale interrupta*) should not be left out of account in discussing the natural enemies of the pocket gopher. I had not supposed that these animals could make their way through the burrows of the gopher, and had laid to the charge of weasels a number of cases of killing and feeding on gophers imprisoned in steel traps. Finally I resorted to setting traps a second time in the mouths of the burrows where a gopher had been partly eaten, and in two instances succeeded in capturing a little striped skunk. There was no question in either case but that the skunk had entered the burrow at some point remote from the location of the trap, for the opening through which the trap had been introduced had been carefully covered with a board and loose earth; this covering was undisturbed. In comparing this slender little skunk's body with the diameter of many of the gopher burrows in alfalfa fields, it will be seen at once that it is not a difficult matter for the skunk to make his way through the underground passages. The additional fact that by digging he can enter the burrow at any point and corner the occupant in some lateral or pocket tunnel renders the little striped skunk especially valuable as a gopher-catcher.

In summary, it may be said that we cannot, except in a few favored localities, depend upon natural forces to keep in check the increase of the pocket gopher. On one hand, by increasing the acreage of alfalfa we are producing the very conditions that are favorable to the most rapid multiplication of the species; and, on the other hand, by thoughtlessly or wantonly destroying harmless owls, hawks, bull snakes, and certain mammals, we still further interfere with nature's efforts to preserve the balance of power in the animal world. The worst that can be said of the enemies of the pocket gopher is that the Great Horned owl, the weasel and the skunk sometimes destroy domestic fowls. But a little wise precaution in shutting up coops at night would prevent these inroads on the poultry industry.

BREEDING HABITS.

But little information along this line was obtainable in the literature accessible to the writer, and some of the statements therein made are, in the light of our own investigations, found to be more or less erroneous. The pocket gopher lives such a secluded life in its underground burrows that direct observations of its breeding habits require considerable painstaking effort. I have never been able to find a litter of the young myself, although I have explored a great many burrows in studying the animal. Occasionally, though, I have run across a nest of soft, dry grass that had probably been constructed for the purpose of rearing the young.

As might be expected of animals living in such comparative security, the pocket gopher is not a very prolific breeder. It certainly rears but one litter a year in this locality, for I have examined scores of specimens in all months of the year and have found the embryos only in late winter and early spring. The number of young in a litter varies from three to six, and averages a little more than four. Very rarely only two embryos are found in the uteri.

Quite early in the spring, before the snows are fairly gone, the male gophers are said to roam about in search of mates. As I have never encountered one on such amorous errands intent, I have not been able to verify the statement. It is entirely probable, however, that for reasons of personal safety such excursions are undertaken mainly after nightfall. If the statements concerning the wanderings of the males are correct, the period of gestation is short, for the young are nearly all born, in this locality, in March and April. It seems more probable, however, that mating takes place in late fall as well as in early spring; perhaps also during milder periods of the winter, as fairly well-developed embryos are found in the uteri from January to May. The following table gives the results of some investigations conducted in the spring of 1907 and spring of 1908:

Number of females examined, and date.	Number of embryos.	Stage of development of embryos, etc.
1907.		
4....... Feb. 27	0	No signs of pregnancy.
2....... Mar. 15	4, 5	1 lot nearly fully developed, the other a little less so.
4....... Mar. 18	5, 5, 0, 0	1 lot only slightly developed; 1 lot about an inch long, thick as one's finger; 1 female evidently pregnant, but fœti not distinguishable; 1 female, no signs of pregnancy.
1....... Mar. 19	0	Uteri congested, but fœti not distinguishable.
2....... Mar 25	3, 4	1 lot size of thumb; 1 lot size of peanut kernel.
2....... Mar. 26	1, 0	1 lot size of peanut kernel; 1 female gave evidence of having been suckled.
2....... Apr. 1	3, 4	1 lot size of pea; 1 lot size of peanut kernel.
3....... Apr. 4	4, 4, 5	2 lots size of end of thumb; 1 lot size of peanut kernel.
3....... Apr. 5	4, 4, 5	2 lots size of end of one's finger; 1 lot size of peanut kernel.
1....... Apr. 8	0	Evidence that young had been born.
3....... Apr. 9	4, 4, 4	2 lots fœti in early stages of development; 1 lot size of end of thumb.
3....... Apr. 15	5, 5, 0	2 lots fœti size of hulled peanut; no fœti distinguishable in other female.
2....... Apr. 22	4, 4	1 lot size of pea; 1 lot size of hulled peanut.
2....... Apr. 24	4, 3	1 lot in early stage of development; 1 lot size of end of little finger.
2....... May 3	0, 0	Young evidently born; milk in glands of females.
5....... May 7	3, 0, 0, 0, 0	1 lot of fœti size of pea; 2 females showed no signs of pregnancy nor of having had young; 2 females had milk in glands.
10....... May 13	2, 4, 0, 0, 0, 0, 0, 0, 0, 0	7 females contained no fœti and gave no evidence of suckling young; 1 female had milk in glands; 1 lot of fœti size of pea; 1 lot size of lima bean.
7....... May 14	0, 0, 0, 0, 0, 0, 0	No trace of fœti or evidence of suckling young.
10....... May 20	0, 0, 0, 0, 0, 0, 0, 0, 0, 0	Of the 10 females none carried fœti and only 3 gave evidence of being suckled.
1908.		
2....... Jan. 31	0, 4	1 female showed no signs of pregnancy; 1 lot of fœti size of peanut kernel.
4....... Feb. 5	5, 0, 0, 0	1 lot of fœti size of pea; 1 female no traces; 2 females had congested uteri.
5....... Feb. 7	5, 0, 0, 0, 0	1 lot fœti size of peanut kernel; 2 females no traces; 2 females with congested uteri.
3....... Feb. 8	0, 0, 0	2 females no traces; 1 female with congested uteri.
9....... Feb. 10	6, 6, 5, 0, 0, 0, 0, 0, 0	1 lot size of pea; 1 lot size of peanut kernel; 1 lot size of end of little finger; 2 females no traces; 4 females with congested uteri.
4....... Feb. 12	4, 0, 0, 0	1 lot size of pea; 1 female no traces; 2 females with congested uteri.

It will be seen that of the ninety-five females examined, some showed signs of pregnancy in the latter part of January, and all but two or three had given birth to their young before the first week in May. The record for some parts of the season is not so complete, however, as it should be. It should include data for the remainder of January and for the first half of March.

The young are described as being entirely hairless, with transparent skin of a delicate pinky-white. They are blind, their ears are sealed, and in most respects, therefore, they are perfectly helpless. In the fall one may still distinguish the younger specimens by their smaller size, but most of them seem to be fully grown by the advent of cold weather. Long before this time they have excavated burrows of their own and laid up some stores for the winter.

THE PRAIRIE-DOG SITUATION IN KANSAS.

By THEO. H. SCHEFFER, Kansas State Agricultural College.

TIME was when the prairie-dog had things pretty much his own way on the plains, at least so far as interference by man was concerned. His kind was then known from the Rio Grande almost to the South Fork of the Saskatchewan and from the sunrise slope of the Rockies to the grassy prairies of eastern Kansas, Oklahoma, and the Dakotas. The prairie-dog has always been a denizen of the short-grass country, loving sunshine and dry atmosphere. Not even the luxuriant grasses of the better-watered prairies have been able to lure him farther east than about to the ninety-eighth meridian.

Over much of this range the villages of the prairie-dog have been common enough in the pioneer days of the history of the West. Lieutenant Pike first describes these towns and their inhabitants as he found them on the Arkansas, near the present site of Larned, in 1806. The journals of the Lewis and Clark expedition of about the same date contain notes and descriptions relating to the "*petit chien*" living in villages on the flats along the then unnamed streams of the region now included in South Dakota. Captain Marcy, in his report on the "Exploration of the Red River of Louisiana," speaks of traveling for an entire day through one prairie-dog town somewhere near the Wichita mountains in Texas or Oklahoma. He estimated the population of this village as being greater than that of any city on the globe inhabited by human beings.

It remained for C. H. Merriam, of the U. S. Biological Survey, to present some careful estimates and figures relating to the prairie-dog in the Year Book of 1901. According to this report, villages twenty to thirty miles in length were not rare, and one in Texas was known to be spread over an area of 25,000 square miles. From a very conservative estimate, based on actual count on limited areas, the population of this community must have been at least 400,000,000. The largest prairie-dog community in Kansas extended almost continuously for about 125 miles along the Smoky Hill river and its tributaries in southern Trego, Gove, Logan and Wallace counties, and in the northern parts of the counties adjoining these on the south.

As long as free range for cattle existed in western Kansas little attention was paid to the prairie-dog, except to note that the numbers of the little animal were steadily increasing with the advent of the settler. This increase was due to man's interference in nature's balance of power by destroying the natural enemies of the prairie-dog, and to the cultivation of crops, which furnished additional food supplies for the herbivorous wild animals. When, however, the lands began to be taken up by sections and quarters for grazing, dry farming and irrigation purposes, it soon became evident that the prairie-dog was in the way—that his village disfigured the fair face of the plains, and that his kind cropped the grass so closely as to leave nothing for the cattle. The first occupation of western Kansas by settlers in the middle eighties lasted such a brief time that before the prairie-dogs had become accustomed to the proximity of sod shanties and to the neatly turned furrows made by the breaking plow, these same shanties began to crumble from neglect, and dwarf sunflowers were bending before the wind where the erstwhile claim-holder had pictured fields of waving grain.

When, in the beginning of the present decade, the West began to fill up again with settlers, the latter were not long in taking stock of the country's resources, and the prairie-dog was reckoned — well, not among the assets. By careful investigation and computations it was found that 250 of these little animals will eat about as much as one steer, and that on their extensive village sites they were drawing upon the land for from fifty to seventy-five per cent of its producing capacity. Moreover, in the interim between the first and the second influx of immigration the prairie-dog had steadily increased in numbers to such an extent that some of the few remaining settlers along the infested territory on the Smoky were literally forced to leave the country with their cattle. It is said that the post office at Elkader was abandoned for this reason —no patrons. From general apathy regarding the prairie-dog, the settlers awoke to the knowledge that he was a terrible nuisance— a menace to the industries of the country. Something must be done. The legislature was importuned for aid at the session of 1901. One Steve Cave, of Haskell county, introduced a bill aimed at the destruction of the pest, and the war was on.

It may be said that the campaign, though not brief, was decisive. After the passage of the bill the conduct of matters experimental and aggressive was given in charge of a special field agent appointed by the regents of the State Agricultural College. Circular letters of inquiry were at once sent out to the officers of the various townships in the state, and the facts and figures given in their replies were tabulated. In this way it was learned that the total area of lands in Kansas infested by prairie dogs amounted to about 2,500,000 acres. A few months of experimentation now followed, as a result of which the field agent, Mr. D. E. Lantz, at present with the Department of Agriculture at Washington, D. C., adopted poisoning as the cheapest and most easily applied method of ridding our western lands of their greatest pest. He at once proceeded to carry the war in the prairie-dog territory in a series of vigorous campaigns, which have since been followed by attacks all along the line. Bulletin succeeded bulletin in organizing and furthering the work, and the wholesale drug houses of the country were taxed to their utmost to supply the poison. The legislative act of 1901 was followed by a more stringent one in 1903.

After four years of this campaigning, there being no further special appropriations of money available, the service of a field agent was dispensed with and the charge of affairs turned over to the department of zoölogy and entomology of the Agricultural College. This department is still carrying on the work, in pursuance of the policy of the institution to extend its usefulness along as many lines as possible to the classes of people who helped to create it.

In the eight years' war on the prairie-dog in Kansas operations in the field have been largely conducted by township and county officers acting under the provisions of the law. To their efforts have been added those of many private individuals whose interests enlisted their coöperation. In all a little more than 16,000 quarts of a specially prepared poison mixture have been sent out from the laboratory at the College. In the manufacture of this poison preparation a ton of potassium cyanide and strychnine has been used.

The results of all this effort may be briefly summed up. During the past summer the writer made an extended and careful survey of the prairie-dog territory of western Kansas lying between the Union Pacific railroad on the north and the Santa Fe line on the south. Over most of this extensive scope of country the prairie-dog is no longer a factor to be reckoned with by the farmer and the stockman. In many townships and some counties practical extermination of the pest has been secured. To such an extent has the little animal become a thing of the past in many localities that the occasional isolated "dog town" is now looked upon by the residents as a matter of interest and old-time association rather than as a nuisance. On the other hand, in several quarters of the

West, particularly along the flats and breaks adjacent to the Smoky Hill river, the prairie-dog has yielded ground more slowly, and still causes the farmer considerable trouble. The edict of the settler has gone forth against the "*petit chien*," however, and this means that the day of the dog is in its closing hours.

INVESTIGATION OF THE MOLE.

By THEO. H. SCHEFFER, Kansas State Agricultural College.

DESCRIPTION AND DISTRIBUTION.

THE mole which forms the subject of this discussion is usually referred to as the "common garden mole." It belongs to a genus (*Scalops*) which is distributed very generally over the eastern part of the United States, and the Mississippi valley as far west as the plains. There is not enough variation in type over this range to establish more than a single species (*aquaticus*), but four or five subspecies are recognized. The Kansas mole has usually been assigned to the subspecies *machrinus*, but from the large number of specimens I have examined I should feel more inclined to place it in the subspecies *intermedius* of Elliott. We may, therefore, designate our mole as *Scalops aquaticus intermedius.*

The variation in size among individuals taken in the same locality is not especially marked, but it is more noticeable when comparing specimens taken in arid and in moist regions, respectively. The following data apply to 100 moles taken at Manhattan:

Males (45 specimens):
- Average total length, 176 mm. (about 7 inches).
- Average length of tail, 30 mm. (about 1$\frac{3}{16}$ inches).
- Average weight, 4 ounces.

Females (55 specimens):
- Average total length, 168 mm. (about 6$\frac{5}{8}$ inches).
- Average length of tail, 30 mm. (about 1$\frac{3}{16}$ inches).
- Average weight, 3 ounces.

In contrast to the slight variation in size among moles taken in the same locality is the marked variation in color. The dominant shade is a mingling of lead color and brown, but some specimens are darker than this and, on the other hand, some are a beautiful silver gray, or, perhaps, are tinged with purplish. I have taken at least two that were suffused all over with rich golden brown. On the average, about one-half of the moles taken here have certain regions of the body—particularly the nose, chin and breast—washed with a tinge of orange, or have distinct patches of this color on the head or belly. Some of these patches are yellowish or golden brown instead of orange, and occasionally one is nearly white. A common marking is a band on the nose. The patches vary in size from a mere streak to a blotch covering almost the entire area of the belly or head. The following data on color markings are from the same 100 moles discussed under the head of variation in size:

Males (45 specimens):

Number having orange or rusty-brown markings	27
Number marked on nose only	5
Number suffused or washed in part	18
Number having well-defined patches	6

Females (55 specimens):

Number having orange or rusty-brown markings	23
Number marked on nose only	12
Number suffused or washed in part	2
Number having well-defined patches	9

The distribution of moles seems to depend very largely upon the humidity of the climate and consequent conditions of the soil in any particular region. As will be shown later, the mole thrives best in a loose, moist soil abounding in grubs and earthworms. The hard, compact surface earth of arid and semiarid regions is not at all inviting to an animal that must make its living by plowing along beneath the feet of the more favored creatures that crop the grass. Though able, perhaps, to burrow wherever an earthworm can burrow, the mole could not thrive and maintain its numbers in regions where these worms were few and small in size.

The map exhibited gives the distribution of the genus *Scalops*. Two other genera, *Condylura* and *Parascalops*, occupy portions of this same territory. Between the shaded area on the map and a narrow strip bordering the Pacific coast there are said to be no moles. This statement must be taken with some reservation, however, for moles are to be found in decreasing numbers on the lowlands along the watercourses as far west, at least, as the 101st meridian. On a recent trip through the western part of Kansas I made careful search for evidences of moles in favorable spots along the Saline, the Smoky Hill and the Arkansas rivers and their tributaries. At Wilson, on the Saline, moles were fairly common in cultivated fields and gardens. They were also reported from the Experiment Station grounds at Hays. At Oakley I could find no traces of the animal, nor could I learn by inquiry of any resident who had ever seen one there. On the Smoky Hill I learned of a mole having been taken occasionally as far west as Logan county, but could find no traces of their work myself. Residents on the river at Wallace assert that there are no moles in the country. At Garden City, on the Arkansas, moles were sufficiently numerous to be troublesome in lawns. A specimen taken at Great Bend did not seem to differ in any respect from those collected at Manhattan.

THE MOLE'S GUESTS.

Whether willing or not, the mole finds himself compelled to act as host to a large number of guests that throng his hallways. The maze of passages that thread the soil everywhere furnishes concealment and lines of traffic to several species of small mammals not favored by nature with the means for digging runways of their own. What the mole's attitude towards each species of these intruders may be I have not been able to discover. In the case of the shrew, I would infer it to be one of hostility, for the shrew and the mole are on the lookout for the same kinds of food. The shrew is generally supposed to do some burrowing on his own account, but I have trapped any number of the little animals in runways that from their size and general appearance were undoubtedly constructed by moles. In fact, I have more than once found a trap holding a dead shrew pushed up by fresh mole work almost out of the small excavation I had made. Whether tolerated or not, the shrew by no act contributes to blackening the reputation of his host as do the other guests — mainly voles (meadow mice), white-footed field mice and the common house mouse. These latter are directly responsible for most of the thefts of grain, seeds and tubers commonly laid to the charge of the mole.

BREEDING HABITS.

Though one of the most abundant of our small mammals, the mole is a slow breeder. This we would expect of an animal withdrawn from the strife and competition that reddens tooth and claw in the world above his secluded burrows. As will be seen from the accompanying table, the number of young at a birth is normally four, and but one litter is produced annually. These facts were ascertained from the examination of a large number of females — 101 — taken in all months of the year. Thirty-three of these were either pregnant or gave indisputable evidence of having recently born their young. The first specimen of this latter number was trapped February 27; the last April 20.

It would appear, then, that in this vicinity (Manhattan) the young are produced within a period of three to five weeks, mainly in March and early in April. The period of gestation must be comparatively short, for signs of pregnancy did not appear until about five weeks before the first females gave evidence of having born their young. I must admit, however, that my data on this point are not full enough to warrant a positive conclusion; for, of the twenty-five moles trapped during the months of December and January, and up to February 27, only five were females. This fact itself may be significant of a period of seclusion or less activity among the females during the period of pregnancy.

While, as above stated, the normal number of young is four, there were two cases in which there was but a single fœtus in one horn of the uterus; the other horn contained two, as usual. In one instance, also, there were five fœti.

That development after birth is quite rapid is shown by the litter of young moles referred to in the last item in the accompanying table. These were discovered in a nest of dry grass, under some sod, April 22. The sod had been turned over by the plow only about ten days previously. Although still perfectly hairless, these young moles weighed one ounce each—from one-fourth to one-third the weight of the adult. In all my trapping I have taken but three or four moles that seemed to be undergrown.

Results of the Examination of 38 Female Moles for Breeding Conditions.

Date. CONDITIONS FOR BREEDING, NUMBER OF EMBRYOS, ETC.

Dec. 11...No signs of pregnancy.
Dec. 17...No signs of pregnancy.
Feb. 6...No signs of pregnancy.
Feb. 20...No signs of pregnancy.
Feb. 22...No signs of pregnancy.
Feb. 27...Uterus congested; very evidently pregnant.
Feb. 27.. Uterus very much congested, but fœti not distinguishable.
Feb. 27...Uterus very much congested, but fœti not distinguishable.
Mar. 6...Uterus very much congested, but fœti not distinguishable.
Mar. 7...Three fœti in one horn of uterus, two in the other; scarcely distinguishable.
Mar. 8...Pregnant. Number of fœti probably four; scarcely distinguishable.
Mar. 8...Two fœti in each horn of the uterus; very small.
Mar. 8...Pregnant, but number of fœti not distinguishable.
Mar. 18...Pregnant, but number of fœti not distinguishable.
Mar. 22...Pregnant, but number of fœti not distinguishable.
Mar. 26.. Pregnant, but number of fœti not distinguishable.
Mar. 29...Pregnant, but number of fœti not distinguishable.
Mar. 30...Two fœti in each horn of the uterus; about as large as navy beans.
Mar. 30...Two fœti in each horn of the uterus; about as large as navy beans.
Apr. 1...Two fœti in each horn of the uterus; a little smaller than the above.
Apr. 2 ..One fœtus in right horn of the uterus, two in the left; size of hulled peanut.
Apr. 8.. Indications that the young had been recently born.
Apr. 9...Two fœti in each horn of uterus; size of navy bean.
Apr. 10 ..Indications that the young had been recently born; milk in glands.
Apr. 11...Three fœti; size of small navy bean.
Apr. 13...Four fœti; quite small, but easily distinguishable.

Apr. 13...Young evidently recently born; uterus flabby and veins congested.
Apr. 14...Young evidently recently born; the number of fœti had been four.
Apr. 14...Young evidently recently born; the number of fœti had been four.
Apr. 14...Young evidently recently born; the number of fœti had been four.
Apr. 15 ..Young born; evidences of being suckled.
Apr. 16...Young evidently born.
Apr. 17...Young born; number of fœti had been four.
Apr. 17...Young evidently born.
Apr. 19...Young evidently born.
Apr. 20...Young evidently born.
Apr. 20...Young evidently born.
Apr. 22...Four young moles taken in nest; weighed one ounce each.

SUMMARY.

Number of females pregnant or having recently born young	33
Normal number of young, apparently	4
Largest number of young in any case	5
Smallest number of young in any case	3
Number of cases in which fœti were distinguishable	10
Cases in which condition of uterus indicated number of young recently born	4
Nests of young moles	1
Cases of four fœti	12
Cases of three foeti	2
Cases of five fœeti	1

FOOD HABITS.

The moles and the shrews constitute the sole representatives in North America of the mammalian order Insectivora (insect-eaters). A study of their dentition, the character of their food and their general behavior in several respects shows that they are much more closely related to the carnivorous, or flesh-eating mammals, than to the rodents, a group which includes the rats, mice, rabbits, squirrels, and the like. This is especially true of the shrews, which are quite weasel-like in character. They fight savagely, kill and eat other small mammals larger than themselves, and when angry or excited emit a musky odor like the weasel and the mink.

It has long been known to scientists, through careful study and investigation, that the diet of moles consists mainly of the insects, grubs and worms to be found in the soil. This fact, however, has been slower in gaining popular credence than most scientific pronunciamentos. In other parts of this paper we have called the mole's guests to account for the general prejudice which has arisen against him, and again, in this connection, we wish to reiterate that the mole is directly responsible for only a very small portion of any damage to seeds, grains and tubers in the ground. Field mice, voles and the common house mice are the guilty parties. If anyone is skeptical on this point he has only to set a few small mouse traps, properly baited, in the mole's runway and await results. In setting the trap a small excavation should be made with a knife or trowel. Place the trap on a level with the bottom of the runway. See that the latter is open both ways, and cover the excavation with a board or piece of sod to exclude the light and prevent the entrance of any small animal except by way of the burrow. Try various baits, such as soaked corn or peas, bits of meat, insects and pieces of potato.

With respect to damage to roots and tubers by eating into them, it will usually be found on careful examination that the tooth marks are those of rodents.

EXAMINATION OF STOMACH CONTENTS.

Direct evidence of what an animal eats may usually be obtained in one or all of three ways: by examination of stomach contents, by observations in the field, and by experiments with captives. In the case of the mole, field observations are of course impracticable. By the other two methods, therefore, we have endeavored to satisfy ourselves, and we hope others, as to the character of a mole's diet. The accompanying table gives the results of the careful examination of the stomach contents of one hundred moles:

Results of Examination of 100 Moles' Stomachs.

Serial number.	Stomach Contents.
1	7 white grubs, 20 ants, 2 centipedes, 1 wasp.
2	2 white grubs, 1 earthworm, 1 beetle.
3	3 white grubs, 2 earthworms, 5 Diptera, beetle fragments.
4	8 white grubs, 3 larvæ (cutworms?), 1 beetle, plant rootlets.
5	2 white grubs, beetle fragments, 1 insect larva, plant fibers.
6	2 earthworms, 1 May beetle, 1 plant rootlet.
7	2 white grubs, 1 beetle larva, plant fibers.
8	5 white grubs, 5 beetle larvæ, 1 earthworm, 3 larvæ, 1 cricket, fragments of vegetable tissue.
9	2 earthworms, 2 white grubs, 2 larvæ, 1 beetle, plant fibers.
10	15 white grubs (small), insect fragments.
11	5 earthworms, 1 white grub, 1 centipede, 1 fly, 1 cricket, 1 puparium, insect fragments.
12	2 earthworms, 18 ants, 1 beetle larva.
13	3 earthworms, 17 ants, 2 puparia, insect fragments, plant fibers.
14	2 white grubs, 2 beetles.
15	2 white grubs, 1 beetle larva, 2 beetles, 1 cricket, 1 ant, 3 centipedes.
16	2 earthworms, 3 insect cocoons, insect fragments.
17	8 earthworms, 19 white grubs, plant fibers.
18	1 earthworm, 1 puparium, 1 spider, 1 larva, plant fibers.

Serial number.	Stomach Contents.
19	1 white grub, 1 earthworm, 1 centipede, 328 ants, 3 beetles, 1 tree cricket, plant fibers.
20	4 earthworms, 1 May beetle, 1 tiger beetle, 10 puparia, 2 beetle larvæ, 2 larvæ.
21	1 beetle, 20 ants, 1 earthworm, insect fragments.
22	1 white grub, 5 cocoons, 6 larvæ, 1 beetle (Carabid), 1 beetle (Scarabeidæ), plant fibers.
23	3 earthworms, 2 white grubs, 2 centipedes, 5 ants, 1 May beetle, 1 beetle, 1 beetle larva.
24	1 earthworm, 1 centipede, 30 ants, 2 beetles, 1 beetle larva.
25	19 puparia, 1 earthworm, 16 ants, 1 beetle.
26	5 earthworms, 6 puparia, 2 beetles.
27	4 centipedes, 2 white grubs, 4 beetles, 5 beetle larvæ.
28	1 centipede, 2 beetle larvæ, insect fragments.
29	1 white grub, 2 ants, 1 beetle, insect fragments.
30	2 white grubs, 1 spider, 1 beetle, 1 May beetle, plant fibers.
31	1 beetle (Chrysomelid), 1 cocoon, 1 puparium, fragments of plant tissue.
32	1 white grub, 1 spider, 1 centipede, insect fragments, fragments of plant tissue.
33	1 May beetle, 1 ant, 1 beetle.
34	1 white grub, 82 ant puparia, 3 ants, 1 beetle, 1 beetle larva.
35	2 white grubs, 1 spider, 1 beetle larva, insect fragments.
36	1 white grub, 7 puparia, 1 centipede, 1 ant, 1 bug, 1 grasshopper, 1 May beetle, 1 tiger beetle.
37	1 earthworm, 1 white grub.
38	1 beetle (Carabid), 2 white grubs, 2 larvæ, 1 beetle larva.
39	4 earthworms, 1 white grub, 10 cocoons, 1 centipede, 1 beetle (Carabid), 21 larvæ.
40	6 white grubs, 1 beetle, fragments of plant rootlets.
41	1 white grub, 1 cocoon.
42	2 beetle larvæ, 2 earthworms, several plant fibers and rootlets.
43	6 beetles, 3 beetle larvæ, 1 white grub, 1 spider.
44	1 beetle larva, 1 pupa, 1 white grub, 1 beetle, 1 earthworm.
45	4 earthworms.
46	3 earthworms, 15 small beetle larvæ, 1 white grub, 1 beetle, fragments of plant tissue.
47	1 white grub, insect fragments, 1 seed husk.
48	12 earthworms, 1 beetle larva, 2 white grubs.
49	4 white grubs, 2 earthworms, 1 ant, 1 bug, 1 cocoon, a few plant fibers.
50	3 white grubs, beetle fragments, a few bits of plant fiber.
51	4 earthworms, 1 white grub, 6 beetle larvæ, 1 wasp, fragments of plant tissue.
52	2 white grubs, 1 spider, 1 larva, insect fragments.
53	4 earthworms, 3 white grubs, 2 beetle larvæ, 1 cricket, 1 centipede, a few plant fibers.
54	5 white grubs, 1 earthworm, 15 beetle larvæ, 1 beetle, 1 cocoon of eggs, plant fibers.

Serial number.	Stomach Contents.
55	6 earthworms, 7 white grubs, 2 beetle larvæ, 1 beetle.
56	6 white grubs, 1 earthworm, 1 beetle larva, insect fragments, fragments of plant tissue.
57	14 white grubs, 2 beetle larvæ, 2 beetles, 20 small larvæ.
58	2 white grubs, 2 wasps, 1 beetle, 1 beetle larva, insect fragments, 1 seed pod.
59	5 white grubs, 2 wire worms, 1 cricket, 1 wasp, 1 beetle, 3 beetle larvæ, 7 puparia.
60	4 white grubs, 2 earthworms, 1 beetle, 1 centipede, 1 spider.
61	12 white grubs, 2 earthworms, 2 beetle larvæ, 1 beetle, a few bits of plant tissue.
62	26 white grubs, 4 wireworms, 2 beetles, 1 centipede, 1 beetle larva.
63	2 puparia, 2 white grubs, 2 beetles, 3 centipedes, 2 beetle larvæ.
64	4 white grubs, 1 beetle, 1 beetle larva.
65	2 earthworms, 2 beetle larvæ, 1 beetle.
66	3 earthworms, 3 centipedes, 1 beetle, 1 puparium, 2 seed husks.
67	3 centipedes, 4 beetle larvæ, 2 beetles, 1 spider, 1 bit of plant tissue.
68	7 white grubs, 1 earthworm, 1 spider, 1 wasp, 1 beetle larva, 1 beetle, bits of plant tissue.
69	3 spiders, 1 beetle, 1 beetle larva, 1 plant rootlet.
70	171 small white grubs, 3 large white grubs, 1 May beetle, 1 beetle larva, 2 plant rootlets.
71	55 small white grubs, 1 grasshopper.
72	8 beetle larvæ, several spiders, 1 earthworm, 1 wasp, fragments of several beetles.
73	3 beetles, 1 earthworm, 1 cocoon, 1 wasp, 3 beetle larvæ, skin of seed or root.
74	1 cocoon, 1 spider, 1 cricket, 1 earthworm, 1 beetle larva, 1 beetle, a few plant fibers.
75	4 earthworms, 8 puparia, 1 beetle, 1 cricket, 1 beetle larva, skin of seed or root.
76	1 earthworm, 1 spider, 1 May beetle, a few plant fibers.
77	1 earthworm, 7 beetle larvæ, 1 beetle, miscellaneous insect fragments.
78	3 beetles, 1 bug, 1 beetle larva, 1 white grub, insect fragments.
79	4 white grubs, 1 spider, 1 beetle, 2 beetle larvæ, a few plant fibers.
80	12 white grubs, 1 seed husk, a few plant rootlets.
81	44 insect larvæ, 1 beetle.
82	73 white grubs, 4 cutworms, 1 beetle, 1 larva, 1 seed husk, a few plant fibers.
83	1 earthworm, 2 spiders, 3 beetles, 1 cricket.
84	250 ant puparia, 2 beetle larvæ, 2 spiders, 2 beetles, a few plant rootlets.
85	3 earthworms, 1 spider, 8 puparia, 2 beetle larvæ, 1 beetle.
86	205 ants, 4 white grubs, 38 cutworms, 2 beetles, 1 spider, plant fibers.
87	2 earthworms, 1 puparium, 5 white grubs, 1 spider.
88	12 insect larvæ, 58 ants, 4 spiders, 1 hairworm (*Gordius*), 3 beetles.
89	3 cutworms, 60 ants, 1 beetle, 2 earthworms, skin of seed or root.
90	1 earthworm, 1 centipede, 18 puparia, 1 beetle.
91	10 cutworms, 1 spider, 1 beetle, insect fragments.

Serial number.	Stomach Contents.
92	5 white grubs, 3 centipedes, 1 puparium, 1 cricket, 4 cutworms, a few plant fibers.
93	1 earthworm, 1 white grub, 3 larvæ, skin of seed or root, a few plant fibers.
94	2 centipedes, 5 cutworms, 1 spider, 2 larvæ, skin of seed or root.
95	2 centipedes, 1 puparium, comminuted mass of insect and centipede fragments.
96	3 white grubs, 1 larva, 1 centipede, 1 beetle, skin of grain or root.
97	4 white grubs, 1 cutworm, 1 ant, insect fragments, a few plant rootlets.
98	3 earthworms, 2 centipedes, 3 larvæ, 1 spider, 1 beetle, 1 puparium.
99	2 earthworms, 1 white grub, 2 centipedes, insect fragments.
100	1 white grub, 2 centipedes, 8 ants, mass of beetle fragments.

SUMMARY OF TABLE.

White grubs	64	stomachs.
Earthworms	49	"
Beetles	67	"
Beetle larvæ	44	"
Larvæ	25	"
Centipedes	25	"
Ants	19	"
Wasps	7	"
Flies	2	"
Plant fibers and rootlets	43	"
Seed pods or husks	8	"
Crickets	10	"
Insect fragments	31	"
Puparia	21	"
Cocoons	10	"
Spiders	23	"
Grasshoppers	2	"
Bugs	3	"
Skin of grain or roots	6	"
Hairworm	1	stomach.
Number of stomachs infested by parasitic threadworms		28

In the course of the two years in which I have been investigating the ways of the mole, about 200 specimens have been checked up on my notes. From this number the 100 individuals given above were selected so as to include some from each month in the year, and to exclude any whose stomachs were empty or nearly so. The selections had no reference to stomach content, however, for they were made before examination of the latter.

The proportions of the various articles of food do not vary with the season as they do in the case of birds, for in some form the insects, worms and grubs listed in the above table are about as abundant in the soil at one time of the year as at another. It is scarcely necessary to add, however, that these supplies are not always equally accessible. In summer, when the soil is wet with recent rains the mole plows along very near the surface, extending his runways rapidly and gathering in a harvest of insects and worms, some of which have also come nearer the surface under these conditions. In dry periods or during portions of the winter season the mole must range deeper, for his prey has likewise found retreat farther down in the soil.

I have not attempted to compute the actual percentages of each article of food in the list of twenty or more kinds given in the table. Such figures would be mere approximations at best. The end in view in the examination of each stomach was to discover what kinds of creatures or substances it contained and, by noting repetition of similar parts of these organisms, how many of each kind.

While plant fibers or rootlets show up in forty-three cases, *in no case was the amount of identifiable plant tissue more than might have been taken in incidental to the ingestion of other food.* In many of the stomachs there was a considerable residue after repeated washings, filterings and eliminations of the identifiable substances. This residue undoubtedly consisted largely of soil from the intestines of earthworms and finely comminuted animal and, perhaps, plant tissues. Even though starch, sugar or cellulose might be detected by chemical analysis, there would be no means of telling how much of this might have come from the digestive tracts of the insects taken as food.

Six stomachs contained fragments of plant tissue which may have been parts of the seed coat of corn, but resembled very closely thin bark taken from plant roots.

EXPERIMENTS WITH CAPTIVE MOLES.

It is a difficult matter to keep a mole any considerable length of time in captivity. Altogether I have had more than a score under observation for a short time, but seldom managed to keep any of them alive for more than a day or two. Either fright and worry or lack of proper food in sufficient quantity soon terminated the life of each captive. I have always kept them in tubs or boxes with a layer of earth several inches deep on the bottom. They were supplied with water and with food of several kinds, some of which they would eat readily. One individual survived for nearly two weeks and seemed to grow fat and sleek under the care we gave him. I think he finally died of too much kindness.

These imprisoned moles had insatiable appetites, eating ravenously bits of beefsteak and large numbers of earthworms. When freshly killed English sparrows were put in the cages in the evening very little but bones and feathers would be left by morning. All refused to touch corn, potatoes or sweet potatoes, except the individual we kept so long. He would eat these articles with some apparent relish, although he went about it very awkwardly. Instead of nibbling at a grain of corn as a rodent does, he would crowd it against the ground with his cheek, and, gaining possession of it, chew it in the side of his mouth much as a steer chews a nubbin. The act of drinking water from a shallow dish was accomplished hog fashion, owing to the considerable projection of his snout beyond the aperture of the mouth.

When he was feeding on earthworms I could not see that he made any attempt to first strip out the contents of the worm's alimentary canal, as has been reported by one investigator.

ECONOMIC STATUS.

Considered from the standpoint of food habits alone, it has never been shown that the mole affects detrimentally the interests of the farmer or gardener. Indeed, it can be proven that quite the reverse is true. When, however, the mole is charged with disfiguring lawns and parks, destroying flower beds, tearing up the roots of grasses, and making himself a general nuisance in small garden plots, he will have to plead guilty. The evidence against him is abundant and direct. In this connection he furnishes but another illustration of the general principle that there is no such thing as unqualified good.

In dealing with a mole it seems to me that it is all a question of whether or not that particular individual is out of place. The mole has his place among the forces of nature, and no unimportant role does he play. One of the most abundant of small mammals, his kind has for ages been working over the soil and subsoil in the interests of plant life. Within the limits of his normal range it is almost safe to say that every square yard of arable land is traversed one or more times each season by portions of his extensive runways. A part of this work is visible at the surface, but much of it is not. The hoe, the plow, the cultivator strike into unsuspected burrows everywhere. After a flood has subsided on lowlands the unequal settling at the surface of the ground discloses the fact that the soil is simply honeycombed with the runways of the mole and one or two other burrowing mammals. This tunneling and this shifting of earth particles permits better aeration of the soil and favors the entrance of water from the surface. It also mixes the soil and subsoil, carrying humus farther down and bringing the subsoil nearer the surface where its elements of plant food may be made available by the agencies at work there. As an offset to this good work of the mole, it may be argued that the earthworms, which form a large part of his diet, play a similar part in the economy of nature. This is true, but who knows but that the earthworm, which lives partly upon green vegetation, might become a terrible scourge if the mole were not placed as a check upon its increase. Nature preserves the balance of power very nicely in the animal world if left to herself. It is only when blundering man interferes that trouble looms up. This has proven true only too often in our dealings with mammals and birds.

In support of the statement above, that moles are beneficial animals from the standpoint of their food habits also, one need only to weigh the results of stomach examinations for evidence. One of the larger items of food—earthworms—has already been disposed of. An equally large, or often larger, item is made up of white grubs, those scourges of grass and other valuable plant roots. The table of stomach analyses shows that nearly two-thirds of the moles had eaten white grubs. One had performed the astonishing feat of eating 175, another 73 and another 55. For his good work in destroying grubs alone, therefore, the mole deserves much credit. Among the beetles, also, and the insect larvæ in general which form a considerable part of the mole's food, are many forms that are injurious to agriculture. On the other hand, perhaps the bulk of the beetles were of those ground types that are predaceous in habit, and therefore may be considered either neutral or beneficial. It would be a tedious if not impossible undertaking to attempt to so classify these beetles as to determine the economic status of each individual or lot. In the vast majority of cases the fragmental character of the remains no more than served to distinguish the order. The spiders, centipedes and ants listed in the table may, so far as our present knowledge goes, be reckoned as neutral or beneficial in their relation to agricultural interests.

The proportionately large amount of food consumed by a mole in a given time serves also to raise him in the rank of importance as a destroyer of noxious insects and their larvæ. A mole's appetite seems to be insatiable. Experiments with captives show that they will usually eat voraciously as long as they are supplied with food to their liking, consuming often more than their own weight in a day. This is not gluttony, as it is sometimes characterized. The tremendous amount of energy expended in plowing through the resistant soil requires a correspondingly large amount of food to supply that energy. That they must have this food at frequent intervals also is shown by the fact that a mole in captivity usually starves in a few hours unless supplied with nourishment.

I have tried to make it apparent that the mole is one of nature's forces to be reckoned with by the agriculturist as he would reckon with nitrogen-forming bacteria, the birds that visit his fields and the bees that pollinate his fruit blossoms. If the individual mole is not out of place, mark him down as an asset and proceed accordingly. If he is where we do not want him, we are privileged to set swift death on his track in the form of trap, poison or club.

A RARE MEXICAN CYCAD.

By W. B. WILSON, Ottawa University.

THROUGH the courtesy of Dr. C. J. Chamberlain, of the University of Chicago, the writer is enabled to present to the Academy for inspection an ovulate cone of the rare cycad *Dioon edule.*

The *Dioon* tree, which is a near relative of the so-called Sago palm of our greenhouses, is found only in tropical Mexico, and there in limited numbers. Little of a scientific nature has been written concerning it, recent publications in the *Botanical Gazette* containing practically all that is authoritative on its morphology.

In 1843, Lindley, of the Smithsonian Institution, found specimens of this tree in the state of Vera Cruz, and listed them as *Dioon edule.* All the *Dioons* were roughly classified under this species until 1883, when Eichler described *Dioon spinulosum*, a few leaves and a few trunks without leaves constituting his material. *Dioon purpusii* was described by Purpus, in 1908, from a few specimens which he collected in the state of Puebla, near Tomellin.

Dioon edule is a small tree, reaching a height of only six or eight feet, with trunk about four to six inches in diameter, bearing a crown of leaves suggesting strongly in habit our Sago palm, or *Cycas revoluta.* A new crop of leaves is produced every alternate year, except those years when the tree goes into a resting state. About twenty leaves, on an average, are put forth in a season, and since the old leaf bases persist they furnish a valuable index to the age of the tree. Conservative estimates fix the life period of a specimen five feet high, under normal conditions, at 1000 years.

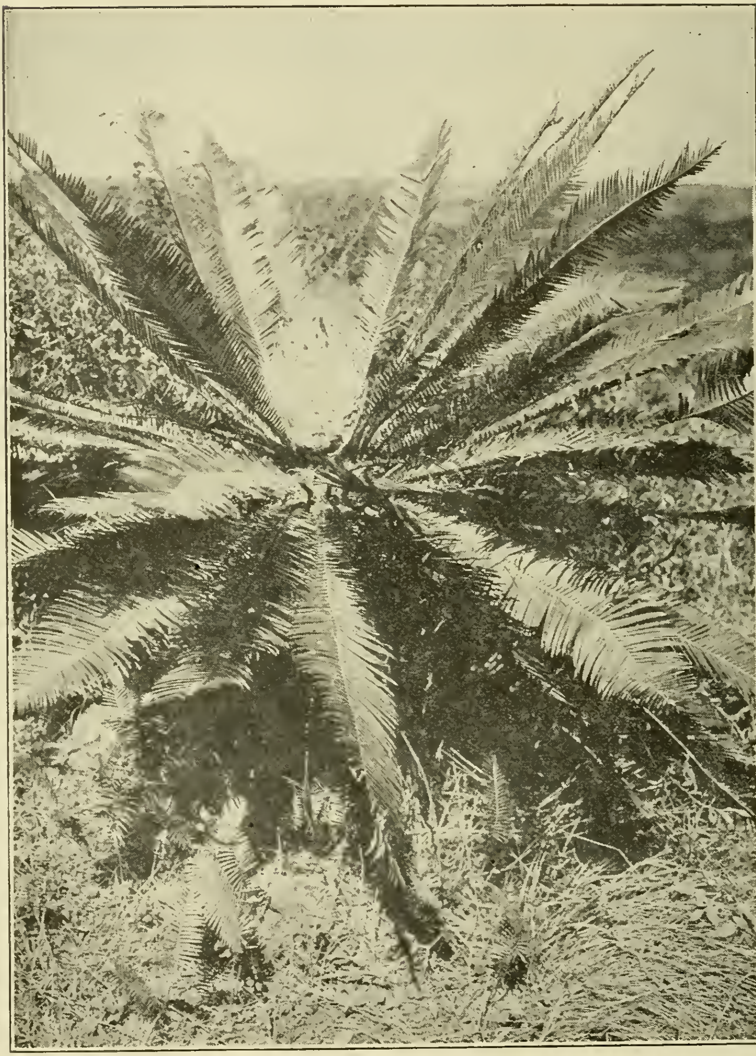
The natural habitat of *Dioon edule* is the open rocky stretches and slopes of the southern Mexican mountains, where it is exposed to the blazing tropical sunlight, though fine specimens are found sometimes growing in sheltered cañons, shaded by bushes and small trees. The Mexican Southern and International railways pass through the *Dioon edule* country. The best specimens have been found on the International line near Chavarrillo, about fifteen miles southeast of Jalapa. *Dioon spinulosum* is fairly abundant near Tierra Blanca, sixty miles south of Vera Cruz. Doctor Chamberlain reports having seen magnificent specimens there, as well as in the vicinity of Tuxtepec, forty miles southeast of Tierra Blanca.

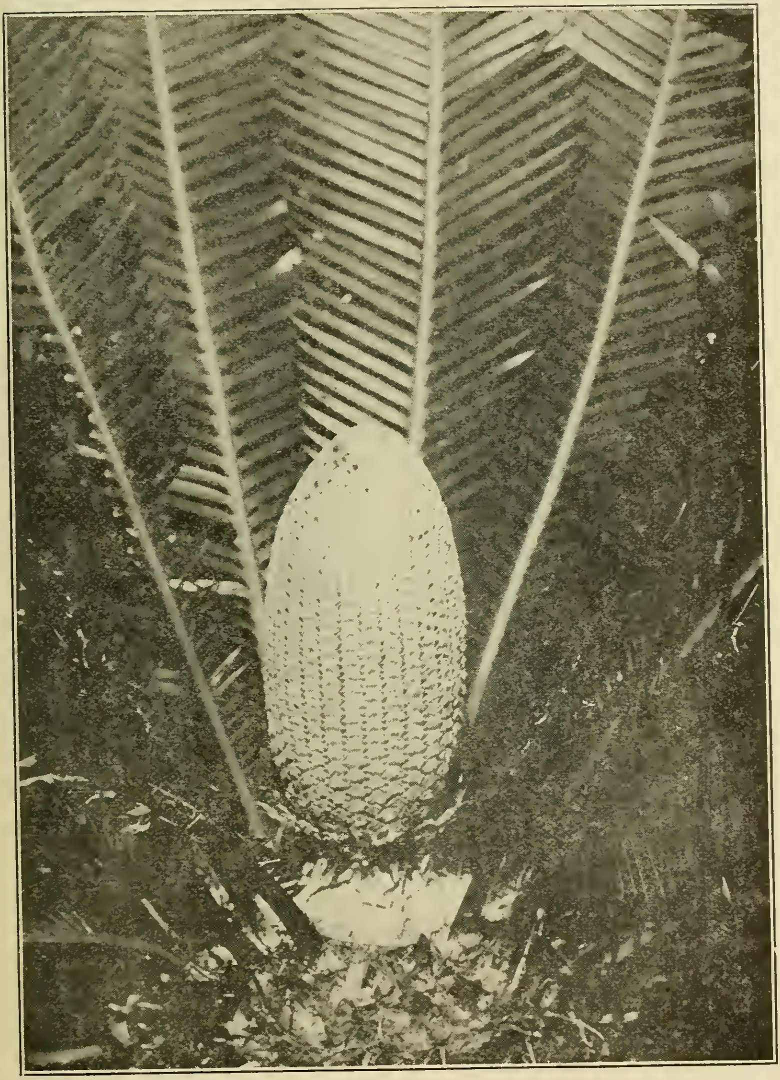
The recently discovered species, *Diocn purpusii*, is found near Tomellin, 300 miles south of the city of Puebla.

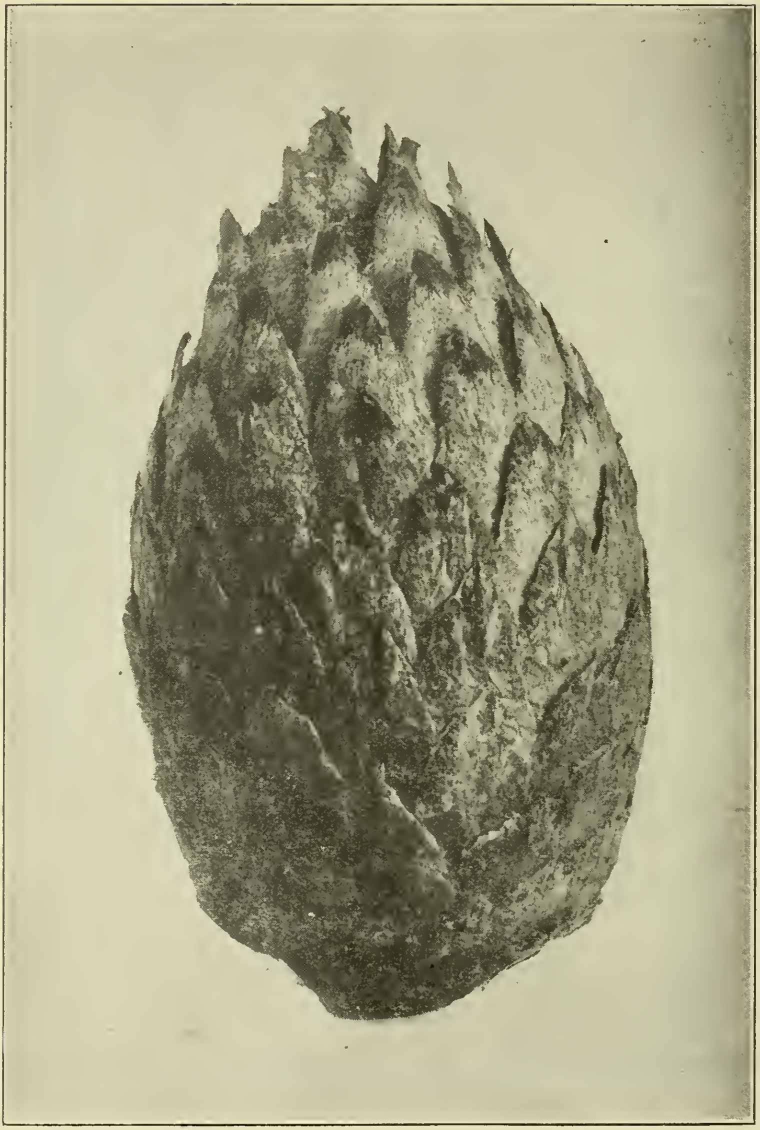
Dioon is diœcious, each individual bearing a single cone at the apex of the stem. The ovulate cone is much larger than the staminate, and constitutes one of the most interesting features of this interesting tree. The average cone is about nine inches in length, six inches in diameter, and weighs about ten pounds. The megasporophylls are large and relatively long and are covered with rementum, a coarse, hairy growth which serves as a splendid protective coat. The cone is somewhat looser in make-up than the ovulate cone of the pine. Two megaspores are borne at the base of each sporophyll, thus giving to the tree the name *Dioon*, which means two eggs. The cone displayed herewith is smaller than the average, being somewhat dwarfed in the upper sporophylls. It was picked in July, near Chavarrillo, sent by parcels post to Chicago, and carried in a grip to Ottawa in August. Since that time it has been kept by the writer in the cellar. It shows no sign of mold or decay. In fact, it is green; so it is safe to say that the gametophytes are still alive and would make interesting histological material.

The staminate cones are much smaller, as has been indicated, and are less conical in shape than the ovulate ones. The collector would scarcely notice them among the leaves in their natural position, as they have very short bases, which do not elevate them above the leaves enough to be seen well from the ground. In July they appear full grown and present a very solid, definite form, with sporophylls regularly arranged in spirals. In the accompanying photograph a few of the topmost leaves have been cut away in order to display the cone. Later the cone lengthens and falls over to one side, while the pollen is shed abundantly. The pollen is produced in microsporangia situated on the upper side of the sporophylls. Several hundreds of these microsporangia are borne on a single microsporophyll, so that the pollen grains are produced in great profusion.

We are indebted to Doctor Chamberlain, of the Hull Botanical Laboratory, Chicago, for definite knowledge of the morphology of *Dioon edule*. With the aid of a grant from the Botanical Society of America he visited Mexico several times to collect material for research. Governor Theodoro A. Dehesa, of Vera Cruz, and Alexander M. Gaw, of the State Bureau of Information, at Jalapa, have coöperated heartily in the work of securing suitable specimens for







study. A detailed account of this morphological research would not fall within the province of this paper.

Dioon edule is confined to an area not one-fourth as large as the state of Kansas, and nowhere do sufficient numbers appear to constitute a forest. *Dioon spinulosum* is very much more abundant, and, being many times larger in habit, presents a far more impressive appearance to the traveler. The uneducated classes in Mexico call *Dioon edule* "Tio Tamal," which is interpreted "Uncle Tamale," for from the seeds they procure a meal from which tamales are made. Many beautiful trees are cut down by the natives to get the cones, because it is the easy way. This thoughtless method threatens the species with extinction, unless steps are taken immediately to protect it. Among the educated Mexicans there is a growing interest in the *Palma de Dolores*, as they call the tree. It is to be hoped that they will preserve this rare cycad and show their appreciation of an exclusive inheritance.

AN ABERRANT WALNUT.

A Preliminary Report.

By Ira D. Cardiff, Washburn College, Topeka.

ABERRANT nuts which were borne upon trees that are apparently walnut (*Juglaus niger*) were reported from two localities (northern Indiana and southern Tennessee). These nuts, externally, at least, are very different in appearance from a walnut (see figure). They are divided transversely into two almost equal halves. The basal half, or that portion which is attached to the stem, resembles a walnut, having a glabrous, roughly dotted, somewhat spongy hull. Upon drying it becomes irregularly wrinkled and roughened with small pits and elevations. The opposite half, on the other hand, possesses a smooth exocarp of firm texture, without dots, and remains smooth upon drying. Furthermore, this outer half is marked by four deep furrows running longitudinally and converging at the apex, like the four valves of a hickory (*Hicora*) nut exocarp. In fact, this half of the nut has, externally, all the appearance of a hickory nut, though the furrows above mentioned do not extend entirely through to the exocarp.

There is a transverse groove at the meeting of these two halves and extending back for a millimeter or more under the basal exocarp. So closely did this basal and apical half resemble a walnut and a hickory nut, respectively, that the parties who found one of them was certain that the nut was the result of a cross between these two genera, though they had no further evidence than the appearance of the nut for this supposition.

The Indiana tree has borne these peculiar nuts for seven or eight years at least, while the Tennessee tree is said to have borne such fruit for forty years. Both trees have been visited by the writer, and growing experiments are being conducted with material from the same.

Information in regard to any unusual behavior in the fruiting of walnuts is earnestly solicited.

V.

MISCELLANEOUS PAPERS.

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1. "Sketches of Indian Life and Character."
   By Albert B. Reagan, Nett Lake Indian School.
2. "An Improved Water Supply for the City of Emporia."
   By A. J. Smith, City Engineer, Emporia.
3. "Fifty Years of Evolution."
   By Alton Howard Thompson, Topeka.
4. "Pollution of Underground Waters."
   By S. J. Crumbine, M. D., Topeka.

SKETCHES OF INDIAN LIFE AND CHARACTER.

By ALBERT B. REAGAN, Nett Lake Indian School.

WHEN a boy I read in some book that an Indian is always truthful, and once a friend always a friend, but my experience has often been quite contrary to this maxim. A majority of the Indians over whom I have been placed by the government have been willing to tell an untruth even when the truth would have been more plausible, and friendship with them often goes no farther than securing a living from it. If it is to the red man's advantage to appear friendly he will do so, but if not he will not know you. This has always been one of his traits, but he is improving in this respect year by year.

In the accounts of the massacre of the whites in Iowa in the '60's we learn that the Indians entered a trader's store at one place, pretending to be friends till an opportune moment, and then mercilessly killed him and all his family.

During the Indian trouble at Fort Apache, in 1886, the Indians shut in the fort for a time before word could be got to outlying camps, and the government live-stock camp on the mesa was sacked. The Indians came to the camp as friendlies. A lone scout had charge of the provision house, while several other men were herding the horses and cattle some distance away. The scout cooked dinner for his Apache friends, who sat down and partook of the meal and then killed their host as he was drinking from his coffee cup. He fell over on the table, where he was found several days afterward. The savages then went out, killed the herders, and slaughtered all the stock for a great feast. Illustrating their untruthfulness an experience of my own may be cited.

While at Jemez I had a chore man, and asked him if he would not take me to his estufa to see the dance, then in session, on a certain night in the winter of 1899. He said he would take me and come to my house at nine P. M. that evening. But after waiting till ten o'clock he did not come, and I went to the estufa alone. I climbed the ladder to the flat roof of the rectangular building, and there stood my chore man. I spoke to him, but he feigned not to see me, even when I asked him to take me to the secret room, and passed by me down the ladder to the plaza and disappeared in the darkness. I then went boldly into the secret room alone, and at once was made welcome, as I was many times afterwards.

So far I have found the Zias and Apaches the most truthful Indians I have met, while the Jemez are less truthful and more thieving. The Hoh and Quileute Indians are the most untruthful of the lot, and also the most jealous and quarrelsome. Among the Jemez it is not considered a sin to lie or steal, but the sin is in getting caught. Among the Quileutes it seems to be no sin either to lie or to be caught in it. The Indians often do not wish their children to attend the government schools, and tell them horrid stories to make them afraid of the white people. Sometimes they tell them the whites are cannibals and are especially fond of the flesh of Indian children.

DANCES.

The dances of the Quileute Indians are many in number; in fact each and every event in life is celebrated with its own peculiar dance. By a dance ceremony the Quileutes invited strangers to visit their village; a welcome dance is given the visitors when they arrive, and a responsive dance is given by the visitors. A series of dances proclaim the opening of the salmon-fishing season; another series the opening of the hunting season or the whaling season, and so on. Then come the dances of a secret nature. Principal among these are the Ka-kla-kwal, the Tsi-yuk, and the Klu-kwal-le. These were great ceremonies in the old times, and not to belong to at least one of them meant simply that one was an outcast. We will give a short description of these three dances.

The Ka-kla-kwal ("Tomaneous"—Trance, Sick) Dance.

The purpose of this dance is to aid one in going through medicine trances; to aid one in sending the spirits from one who has been caused to go into a trance by them. The Indians used to believe, and the old people do still, that unless the dance is given the "tomaneous" sick one will die, to use the common expression among the Quileutes. The sick one imagines that many spirits have entered her, and the dance is given to drive them out.

The dance is a secret organization, presided over by the shamans of the tribe. To join it one must give a general "potlatch" to the members of the organization—a give-away feast—to the value of $200 or more. Should one try to get in the performance without giving the potlatch he is roughly handled and put out of the hall in which it is held.

The dancer in this dance has his face lightly painted in black. He also wears a cedar-bark head band, from which at the sides of the head, both in front and behind, there project upward tassels of the same material. In addition he carries a short stick in each hand, and, when dancing, he leans forward on the sticks and moves about on all fours like a prancing elk, though he sometimes dances in an upright position.

In the daytime the medicine men go into trances to aid the "tomaneous" sick person. At night they chant and shake sphere-shaped rattles, fashioned from wood and partly filled with pebbles from the beach.

The dance lasts five days and five nights. As the fifth night draws toward a close all the actors dance around the sick one twice in a great circle. Then the master of the ceremonies makes her get up, and her "spell" is over. No one else can do this with her. The evil spirits obey this one. Mrs. Sheshecoop and Mrs. David Hudson used to be "tomaneous" sick every winter; but now since the government is stopping the old things they don't get sick that way any more.

The dance is always followed by a feast. (Carl Black.)

The Tsi-yuk (Striped Cheek, Red-painted Face) Dance.

This dance is given both for pleasure and to cure the sick. The masters of the ceremony are the medicine men. These perform over the presented sick with their "tomaneous" medicine sticks. They also go into trances to cure the sick. When the dance is given to benefit the sick it lasts five days.

This dance, like the Ka-kla-kwal dance above, is a secret organization, and, like in that organization, one must give a potlatch to the members of the order before he can be admitted into it. Should one try to enter the Tsi-yuk hall when the ceremony is in session his clothes are torn from him and he is roughly expelled.

The actors in the dance wear cedar-bark head bands, with tassels of the same material extending upward on each side of the head both before and behind. Some also have shredded cedar-bark rolls suspended over the shoulders at the back, shaped somewhat like the floating ends of a comforter or scarf; others have a cape of the same material suspended from the shoulders at the back, somewhat like the panya worn at the back by the Pueblo women. Thus attired, they dance in an upright position to a monotonous chant and tom-tom music, keeping time by shrugging their bodies and by shifting their palm-up, extended hands first to one side and then to the other.

The dance is followed by a feast. At this there is only one waiter, called "father" of the occasion. He, and no other man, is allowed to wait on the table. Joel Pullen was the last "father."

The Klu-kwal-le (Black-face) Dance.

This is the great dance among the Quileutes; and before the government commenced stopping the old customs the Indians kept it in session most all the time, day and night, throughout the winter months. It is now only occasionally allowed, and then with the objectionable features removed. It is a secret organization, and to gain admittance to it with all its privileges one must give a potlatch to its members and their families—one dollar in money or goods to each base person and five dollars to each person of chieftain stock. In the days when the sealing industry was at its height a give-away feast of the value of $1000 was a common potlatch. Should any one try to get into the dance without first giving the required potlatch, five Klu-kwal-le seize him by the hair, drag him around the central fire in the great hall, and then roughly put him from the building. Also, should anyone but those appointed for any special work or ceremony attempt to perform it, he is severely handled. For instance, Ka-la-dook and Kates-buc-ud are the firemen, and should anyone else attempt to attend to the fire his clothes are torn from him. Should anyone attempt to pass water from the water barrel in the building except the one appointed for that purpose, the water in the barrel is thrown out and the offender is compelled to fill it again.

The purpose of the dance is to restore departed spirits, whether they have departed on account of sickness or on account of the death of some relative. The Indians believe that sickness is caused by the spirit temporarily leaving the body; also that the spirits of a dead one's relatives remain on his grave with him till they are restored by the Klu-kwal-le.

The costumes of the actors are many and varied, but the most common costume is that of men dressed and acting to represent wolves, accompanied by other men screened from view with salal bushes. The faces of the actors are always smeared with black.

"In the Klu-kwal-le dance in the old times the Indians had their faces blackened with charcoal by an old woman appointed to do that work. Should an Indian paint himself he was fined three yards of calico, or some other article of barter, for each member of the Klu-kwal-le organization. Moreover, the men, and sometimes the women, slashed themselves with knives, and some also thrust themselves through on the upper flesh of the arms with arrows and bones. One old man here, used to thrust pointed bones through his lips in a cross shape, the bones penetrating both lips. I myself went through this ordeal when a young man, and I am marked all over where the bones and arrows were thrust through my flesh. These things were done that the doctors might have greater power in bringing back the spirits of the sick from the 'Land of Shades.' Thus cut and thrust through with bones and arrows, they stripped off their shirts and danced.

"In this dance the boys and young men repaired to the woods and prepared every kind of bark whistle they could. Then decorating themselves profusely with salal branches they came into the dance hall whistling, while within the hall wolf-acting men were crawling and leaping over the floor on all fours. As they thus came, the people beat the drum, yelled, and with short clubs pounded long boards suspended horizontally, and did everything they could to make the greatest possible noise.

"This dance lasted five days. Then came the potlatch scenes, alternating with masked-dance scenes."

HOW THE QUILEUTE INDIANS TATTOOED THEMSELVES.

In tattooing, the Quileute Indians, of LaPush, Wash., took charcoal and, having powdered it, mixed it with water so as to make an ink of it. Then they threaded a needle with thread or very fine sinew. This thread they saturated with the ink thus made. Then they drew the needle and thread through the skin in the positions they wished the tattoo markings to show. They "stitched" themselves, pulling the thread out after each stitch was taken. This left the charcoal particles in the ink beneath the skin, to be the black marking desired—a permanent marking ever after. The stitched places are usually quite sore for a long time.

SOME MYTHS OF THE QUILEUTE INDIANS.

In the old times all people walked on their hands, with heads down. This was so that they could see and catch fish in the water. All peoples were fish eaters then. But one day the god Kwatte came along, and, seeing that man's walking position was not good for him, he caused him to reverse his walking position and walk on his feet as he does now. Since then man has lived on the land, instead of in the water like a fish. Kwatte was always doing good.

The Quileute River Monster.

There is a monster of the deep living in the vicinity of the mouth of the Quileute river. It eats up the fish. It seizes fishnets and destroys them. It draws boats into its gigantic mouth and swallows boat and occupants. It destroyed eighty fathoms of Billy Hudson's fish net in 1907. It drowned Conrad Williams's little eight-year-old boy the same fall. Many years ago it swallowed down two white men and their boats. This monster of the deep is a terrible beast. You never can see anything of this monster but his tail, sometimes; it is always just going out of sight as you see it. The beast is one big, big thing, but we Indians have never seen what it looks like. We old people of Quileute are afraid of it.

Finishing this legend, the aged chief who was reciting it turned to me and asked: "Did you ever see this monstrous beast, Mr. White Man?"

The Fossil Legend.

The giantess Duskia, sister of the god Kwatte, and known to the coast Indians as the Evil One, had her home at the mouth of Maxfield creek (a tributary of the Bogachiel river from the south, forming a confluence with that river about eight miles above the Indian village of LaPush, Wash.). She gathered clams and seashells from the beach and took them to her home and there ate them. The middens from her "table" are there yet. They have turned to stone. (There are large fossil beds at the mouth of the above creek.) You can see them there to-day.

Duskia, you know, had stolen many children. These she fed on the clams. These clams she carried from the beach to where the shells are now stone. This woman had three different places of abode—one at a place just this side of Quillayute prairie, one just over Quillayute Needle's Point, south of LaPush, and this one at the mouth of Maxfield creek. At each of these places you can find the clam shells and other kitchen middens turned to stone.

This woman Duskia took away—stole—all the Indian children who would cry. When walking around, if she heard a child cry she would go and eat it. That is why one never hears an Indian baby cry.

This woman lived not so long ago, the old people say. The first white men who came to this country lost many things from camp. They could not imagine what became of them. At last they set a beaver trap; and lo! they caught Duskia in it. She was a very large woman, with long hair that reached to her heels. She was good looking. She did not dress like an Indian then; she wore a short dress that came only to her knees. This dress was made of snake skin. When they caught her she hallooed and screamed and talked a language no one could understand. She tried to get away as ordinary mortals might, but failed. Quickly then she changed herself to a meteor and passed out into space as a vanishing streak of blaze.

THE MEDICINE FRATERNITY OF THE APACHES.

Among the Apaches the medicine fraternity is composed of both men and women. These doctors claim to be endowed with supernatural powers—special powers from the gods. Some even claim to be gods themselves. They often not only claim to have power over "sick," but to be able to raise the dead. These shamans preside at all medicine performances, and lead the singing in all such performances. They command the people to move near the river or away from it, as their fancy decides. Before the coming of the white man, it is said, they put to death all who disobeyed their orders or doubted their being endowed with superhuman powers. Below are some of the sayings and doings of medicine men that are out of the ordinary.

Chief Brigham Young used to tell the Indians, and also the white people of the agency, that he was God, and he created all things, and that he was all powerful. Also, if he wished to kill a man or an animal all he needed to do was to just put his hand out and touch it and it would drop dead.

An old chief, whose name I do not now recall, also used to tell the Indians the same kind of a story, and they all believed it. This Indian lived at what is now known as Canyon, south of Fort Apache. Once he got into trouble and was fined several days' work. He declared to the officers that he was God and would not work. He was locked up till he was willing to work and did work. He worked as a prisoner some two or three weeks, and at no time did he try to kill the officers by his supernatural power. But the Indians said: "White man different; doctor can no kill white man."

It is evident to a close student of Indian performances that fakery, hypnotism and superstition are the instruments used by medicine men to keep their people under their control.

VISIT OF CHIEFS OF BOIS FORT INDIANS TO WASHINGTON.

As has been indicated in other articles published in the Transactions by the present author, Indians are always of the opinion that some part of some old treaty has not been fulfilled. The Bois Fort Chippewas are no exception to the rule. Throughout all last winter the Indians here councilled day after day about what they said the government owed them. Finally, February 12, they agreed on their wants and their demands and had them put in written form as here given in the next succeeding sheets. With copies of the council proceedings in their pockets, Interpreter Frank H. Pequette and four chiefs started to Washington on March 1, 1910. It had been intended to have Chiefs Day-bway-wain-dung, Bay-baum-we-che-waish-kung, Mah-jish-kung and May-zhuc-ke-aune-quaib accompany Mr. Pequette; but the Indians quarrelled at Orr railway station, and Ain-ay-way-way-aush forced himself in in place of May-zhuc-ke-aune-quaib and went to Washington in his stead. The Indians had collected money to pay the expenses of the respective chiefs, and the forced withdrawal of May-zhuc-ke-aune-quaib caused that chief to withdraw the money appropriated to pay his expenses; but Ain-ay-way-way-aush went anyway, trusting to luck to get back home.

Arriving at Washington, Ain-ay-way-way-aush and Bay-baum-we-che-waish-kung got drunk and blew out the gas in the jet over their bed in their sleeping apartments, on the night of March 3, and were consequently found dead in their rooms on the morning of the 4th. The honorable commissioner furnished coffins for the deceased Indians, and also paid the expenses of the survivors and the interpreter back to Orr, our railroad station; and, on arriving at the agency, the bodies of the deceased chiefs were interred, after a funeral held over them in the government schoolhouse by Reverend Pequette, the interpreter mentioned above. At the close of the funeral the coffins were opened, notwithstanding the objections of many of the old timers, and the remains were viewed. It was a scene to be remembered. Not a tear was shed; not a word was uttered by a single person, as one after another passed around the coffins, till the wife of the aged Bay-baum-we-che-waish-kung (he who had signed the treaty of the Chippewa Indians at Washington in 1866) came to view the dead. She put some pouches of medicine and some eatables and some tobacco in the coffin of her husband. Then, without shedding a tear, she exclaimed, addressing the dead: "I told you when you went to Washington that you should not drink whisky. Now see—see; you bring back your poor dead soul to me." Her remarks closed the viewing the dead. At the graveyard there was also no outward signs of feeling over the death of the chiefs. After the burial was completed the usual "medicines," eatables, a cup of water and some tobacco were placed on the graves of each.

The two other things that might be mentioned with this burying of the chiefs is that a special bill was passed by Congress to pay the transportation and funeral expenses of these chiefs and the return expenses of the survivors of the party. Also, with the burying of these two chiefs the Bois Fort Indians started a graveyard in which to bury their dead. Previously they had buried their dead near their houses, where they could go and visit them and take food to them at morning, noon and night.

Before returning from Washington the survivors presented their petition to the honorable commissioner and received an answer thereto, setting forth very positively that most of the Indians' claims were undoubtedly erroneously founded.

AN IMPROVED WATER SUPPLY FOR THE CITY OF EMPORIA.

By A. J. SMITH, City Engineer, Emporia.

THE need of a purer water supply for the cities and towns of eastern Kansas is becoming more important each year, as the population continues to grow, increasing the contamination of our rivers—the present water supply of many towns. There are two reasons for this bad condition of our rivers. The first is the increased number of floods in late years, which, sweeping over the lowlands, wash the filth from the fever-breeding barnyards into the rivers, from which it is pumped into the towns for drinking purposes. Of course, a certain part of these impurities are oxidized by the action of the air, but it is certainly impossible for it all to be removed in this way.

The second reason is the manner of disposal of the city sewage. As a town increases in size there must be some way to get rid of the increased sewage. In most towns this is done in the easiest and cheapest way, by dumping it into the nearest stream. This is true of Emporia and the Neosho river, as well as most other towns in eastern Kansas.

In the fall of 1907 the Emporia authorities began to realize the dangers of river water for drinking purposes. After some discussion, the city council appropriated $300 for the purpose of prospecting for and testing the underflow in the gravel beds underlying the valleys of both the Neosho and Cottonwood rivers, which flow near the city. The engineering department was instructed to carry on these tests, and as head of that department I had full charge of the work.

In order to determine the quantity of water that could be secured it was necessary to know the width and thickness of the gravel deposits and the percentage of voids contained therein; also the direction and velocity of the flow of the water through it. In determining the quality of the water a chemical analysis was made; also, for comparison, a parallel chemical analysis of water from both the Cottonwood and Neosho rivers and from the hydrants in the city.

The methods used in the prospecting were modifications of those devised by Prof. Charles S. Sclichter of the United States Geological Survey, the manner of sinking the wells, however, being entirely different. In sinking these wells a common seven-inch post auger was used for boring down to the gravel, which was found at a depth of from twenty-five to thirty feet. On striking the gravel a casing of five-inch gas pipe was put in the well. This casing was then sunk to solid rock by bailing the gravel from under or within it, in the following manner: Through a pulley at the top of a tripod derrick a rope is strung, with one end attached to a bailer. This bailer is similar to the sand buckets used by well drillers, having a valve at the bottom. In addition to this it has a plunger that works up and down inside the bucket, creating a suction through the valve in the bottom, so that by pulling a few times on the rope a quantity of gravel is drawn into the bailer. It is then pulled to the surface and dumped. The casing settles down as the gravel is taken from under it, until it rests on solid rock or shale. When all the gravel was removed from inside of the casing a four-inch sheet-iron casing, with a four-foot expanded metal screen on the bottom, was let down in the well, and the outside casing was pulled by means of a block and tackle.

For determining the velocity and direction of the flow, four wells were drilled in the following manner: One in the center of a circle having a radius of six feet; then three other wells were put down three feet apart on the circumference of this circle, in the direction from the center well in which the current was supposed to pass. Salt was then placed in the center well. Samples of water were taken every hour, or oftener, from the other wells and tested for chlorine. When an increase of chlorine was observed in the water from one of the wells, it was known to have passed a distance of six feet, and the location of the well in which the chlorine first appeared gave the direction of the flow.

It was learned through these test wells that the water-bearing gravel bed of the Neosho river valley were about two and one-half miles wide and averaged about six feet in thickness; also that the flow was toward the southeast at an average rate of twelve feet per day. In general, the gravel at the top of the bed was filled with mud or clay; a few feet lower the interstices were more open and filled with water. In many places sand having the properties of quicksand was encountered for several feet, but coarse gravel was invariably found overlying the rock or shale at the bottom.

After determining that the quantity and quality of the water was satisfactory for supply for the city, there remained the necessary problem of collecting the water from a wide area and delivering it to an accessible point near the pumping station. After the consideration of several different plans, it was decided to adopt a siphon system, which comprehended the connecting a large number of small wells with an extensive siphon line that would deliver the water into a big well near the pumps at a rate of 2,500,000 gallons per day, that being about the capacity of the present pumping plant.

The main siphon line is 3000 feet long, made of twelve-, fourteen- and sixteen-inch cast-iron bell-and-spigot pipe laid from six to fourteen feet deep in the ground, the joints being leaded with unusual care, and to prevent settlement each joint is supported by a block of concrete about three feet square and eighteen inches deep, placed around the pipe after it was in place.

The wells, which are about fifty feet apart, are connected to the siphon line by a four-inch cast-iron pipe six feet long, which is provided with a gate valve at one end, so that any well or group of wells can be shut off from the line for any purpose without interfering with the working of the remainder of the system. The wells are six inches in diameter, cased with wrought-iron screw-jointed pipe, having a screen of the same size at the bottom made of perforated sheet brass. The length of the screen was determined for each well by the thickness of the gravel stratum, which varied from three to thirteen feet. The wells are so arranged that they are easily accessible for cleaning out, though they are entirely covered with earth to a depth of a foot or two, so that the soil above the wells may be farmed without interfering in any way with the working of the system.

The big well into which the water is carried by the siphon is twenty feet in diameter and about forty feet deep, walled with brick and covered with a roof that is packed with sawdust to prevent the freezing of the water in the pipes in the well. The suction pipe from the pump takes the water from this well.

The most important new feature of the entire system is an automatic device for priming the siphon line and keeping it constantly filled with water, so that air cannot accumulate at the high point on the line and obstruct the flow. This machine extracts the air from the line of pipe and wells, causing a vacuum that allows the water from the wells to fill the pipe as fast as the air is removed. It takes about two hours for the machine to remove all the air from the line.

The twelve-, fourteen- and sixteen-inch pipe of the siphon line is laid to a grade of one-half inch to the hundred feet from the well, so that the highest point on the line is where the short leg of the siphon turns down into the big well. Any air, therefore, that may leak into the siphon line or be separated from solution in the water is carried to this high point, where it is removed by the machine as fast as accumulation occurs. A vacuum of twenty-one inches has been maintained in the line without any difficulty. A vacuum gauge placed on the farthermost well shows an average of one and one-half inches less vacuum than there is at the big well when the wells are being pumped.

Tests were made, with a specially designed water meter, of the amount of water furnished by each individual well when all were in operation, which gave results varying from nothing to 130 gallons per minute, the farthermost well being, except one, the best producer in the system.

The great difference in the amount of water produced by wells in the same locality is accounted for by the fact that the gravel is quite variable, being much more open and less silted up in some wells than in others. The water takes the course of least resistance out, and if it requires more head to force it through silted gravel to one well than it does through more open gravel to another well farther away, it will go to the farther well.

The installation of this new well system has been accomplished under many difficulties, ranging from the blathering of pin-head politicians and the continued opposition of the men in charge of the pumps, to the breaking of flanges and the blowing out of gaskets twenty-four feet under ground after the work was completed. But a demonstration has been made of the fact that water can be successfully pumped from wells located more than one-half mile from the pumping station.

FIFTY YEARS OF EVOLUTION.

By Alton Howard Thompson, Topeka.

DURING the past year, 1909, many memorial exercises and celebrations were held commemorative of the centenary of Charles Darwin's birth and of the fiftieth anniversary of the publication of "The Origin of Species." Meetings were held by colleges, universities and scientific societies throughout the world, at which many symposiums and addresses were given bearing upon Darwin and his wonderful work and its effect upon science and the world. From some of these addresses I have endeavored to glean material for a brief review of what evolution has accomplished in the last half century, without pretending to any completeness in any direction. It will be an informal talk upon an exhaustless theme. I hope that it may contribute to our better appreciation of the fact that the value of Darwin's work to the world cannot be overestimated. It can only be compared to that of Copernicus and Sir Isaac Newton in its epoch-making influence. His promulgation of evolution as a scientific principle certainly ranks with the copernican theory of the universe and with gravitation in the revolution it produced in the scientific world. All three of these great discoveries mark the birth of new working principles and the inauguration of new methods of thought. Old beliefs and methods were swept aside by master hands and new and wonderful principles were established and new sciences were created. New ways of looking at life and the universe were formulated and the horizon of the human mind was extended. This is especially true of evolution as a new principle of science. How it has extended and enlarged our knowledge of life and of the world within the memory of men now living! Most of us remember the fierce conflict of forty years ago between the teleologists and the evolutionists — popularly known as the special creationists and the Darwinians — and those battles were worth all that they cost in the enlargement and liberty they gave to the human mind. We are freer to-day to say and write what we think because of those battles. More than that, the idea of evolution itself gives a grasp of the universe in all of its beauty and grandeur that the old, rigid conceptions did not confer. We are greater and wiser to-day because of what evolution has done for us. Mankind is on a higher plane and the world is better because of the light that has come to us through a better understanding of Nature and her revelations of the wonderful methods of the Creator.

The year 1909 was remarkable as being the centennial anniversary of so many great men, not the least of whom was Charles Darwin. Evolution was not a new idea with him, for it had been first suggested by Aristotle and the Greeks. But it had been smothered by the scolastics of the dark ages and only began to blaze forth again in feeble sparks during the first part of the nineteenth century. Several writers had touched upon it, but none studied and systematically accumulated facts bearing upon it until Darwin began his tireless investigations. While he owed much to previous writers for the inception of the idea, what he owed to no one was the application of the inductive method of research, and he stands out as the first who worked upon true Baconian principles. He sought a hundred facts and deductions where his predecessors had been satisfied with but one. His was the matchless genius that crystallized all that had gone before, and added thereto his own stupendous observations, and deduced the great principles for which the world was waiting.

The great storehouse of facts was fairly bursting for want of generalization. The accumulated data of the centuries were all ready to blaze forth into the flame of a great philosophy, and the spark that lit the conflagration was Darwin's great book upon "The Origin of Species." It has been said that the true greatness of a writer consists in the greatness of his theme, and this is especially true of Darwin. His was the genius to give expression to a great thought that was in the air and for which the world was waiting. As the promulgator of the theme of evolution he was the right man in the right place at the right time. He produced immortal work, and the world rightly estimates him as one of the intellectual giants of the English race.

It is now generally conceded that Darwin's "Origin of Species' was the greatest book of the nineteenth century, and this preëminence is accorded to it, not on account of its literary merit—although it is a model of dignity and simplicity and may well be reckoned as an English classic—but because of its far-reaching influence; because the principle of evolution that it established on a firm basis has permeated and revolutionized every domain of human thought. It was a great book because it contained the complete elaboration of a great idea for which the world was waiting, and it was immediately recognized as being great. As you know, Alfred Russel Wallace had the idea of natural selection come to him in the wilds of the Malay archipelago, independently of Darwin, and wrote to him about it. To be perfectly fair, both had papers read at the same meeting of the Linnæan Society, in July, 1858, so that unseemly controversy about priority was averted—a spectacle which sometimes belittles science as well as scientific men. They were both too great and generous to wish to deprive each other of the honors due to each, and the world has honored them both the more. For twenty years Darwin had been accumulating a mass of data. It was in the air, so that Wallace felt it in far-off Asia. It was a world thought, not the invention of any one man; but the man who gave it complete expression opened up a new era for humanity and made himself immortal. The nineteenth century will be known as the century of unprecedented progress, but not the least of its glories will be the fact that it added to the establishment of the principle of evolution as a great working idea.

In the volume on "Darwin and Modern Science," containing the addresses given at the anniversary exercises at Cambridge last June (Sci., Oct. 15, 1909, p. 527), in tone, all recognized the intellectual supremacy of Darwin, although most of the speakers had made some additions of fact or theory to the verification of evolution. Darwin, they said, was the great explorer who charted the way, and while much of detail has been added to the map, the original chart remains much the same. The scheme of the evolution of species, through variation and heredity, on the one hand, and the selective influence of environment, on the other, has not greatly changed since the date of the "Origin of Species." The method, degree, and to some extent the causes, of variation have been critically and successfully studied. The meaning and the machinery of heredity have been the subject of most fruitful investigation and experiment. Natural selection has been subjected to the most searching analysis, but it still remains the only general cause of the universal phenomenon of adaptation of life to environment. The work of fifty years has but intensified the main features of the sketch, and has constantly added to the work of the master without the obliteration of any essential details.

Darwin's great doctrine was what he called "natural selection and the survival of the fittest," which accounted for the persistence of animals and plants in the struggle for existence. By the workings of these laws the strongest survived and the weaker went to the wall in the battle for life. This crude statement must be greatly modified, however, for there are many qualifying factors entering into its manifestations before it can be considered in its entirety. Let us listen briefly to what Darwin himself says in "Origin of Species" (I, p. 150):

"If, under changing conditions of life organic beings present individual differences in almost every part of their structure—and this cannot be disputed—and if, owing to the rate of increase, there would be a severe struggle for life—and this cannot be disputed—then, considering the infinite complexity of the relations of all organic beings to each other and their conditions of life, causing an infinite variety in structure, constitution and habits, to be advantageous to them, it would be most extraordinary if no variations had ever occurred useful to each being's own welfare, in the same manner as so many variations have occurred useful to man. But if variations useful to any organic being ever *do* occur, assuredly individuals thus characterized will have the best chance of being preserved in the struggle for life, and, from the strong principle of inheritance, these will tend to produce offspring similarly characterized. This principle of preservation, or the survival of the fittest, I have called 'natural selection.'"

Again (p. 151):

"Natural selection acts exclusively by the preservation and accumulation of variations which are beneficial under the organic and inorganic conditions to which each creature is exposed at all periods of life. The ultimate result is that each creature tends to become more and more improved in relation to its conditions. This improvement inevitably leads to the gradual advancement of the greater number of living beings throughout the world."

Again (p. 153):

"But it may be objected that if all organic beings thus tend to rise in the scale, how is it that throughout the world a multitude of the lowest forms still exist? . . . On our theory, the continued existence of the lowest forms offers no difficulty, for natural selection or the survival of the fittest does not necessarily include progressive development; it only takes advantage of such variations as arise and are beneficial to each creature under its own complex relations of life."

Again (pp. 75–76):

"How have all those exquisite adaptations of one part of the organism to another part, of one being to another being and to the conditions of life been perfected? We see beautiful coadaptations plainly, as in the woodpecker and the mistletoe; in the humblest parasite that clings to the hairs of a quadruped or the feathers of a bird; in the structure of a beetle that dives through the water; in the plumed seed that is wafted by the gentlest breeze—in short, we see beautiful adaptations everywhere and in every part of the organic world."

Again (p. 118):

"Natural selection acts only by the preservation and accumulation of small inherited modifications, each profitable to the preserved being. . . . Natural selection will banish belief in the continued creation of organic beings or of any great and sudden modification of structure."

Again (p. 132):

"Slow though the process of selection may be, if feeble man can do much by artificial selection, I can see no limit to the amount of change, to the beauty and complexity of the coadaptations between all organic beings and their conditions of life which may have been effected in the long course of time through nature's power of selection, that is, by the survival of the fittest. . . . Natural selection acts solely through the preservation of variations in some way advantageous, and which consequently endured."

Again (p. 164):

"Variability is generally related to the conditions of life to which each species has been exposed during several successive generations."

While the fundamental principle thus brought out and elaborated in "The Origin of Species" revolutionized science and still remains unassailable as a principle, much criticism has arisen of the sweeping application that Darwin made of it during the half century since its promulgation. The application of the idea of natural selection to all kinds of variations is undoubtedly a weakness of the great discoverer. Darwin cites and discusses many objections that were raised in his day, and did not overthrow them all by any means. Other objections have arisen since, so that to-day natural selection and slow modification stands only as one of several methods by which species may have arisen.

One of the most important of these opposing ideas is that of the sudden and spontaneous arising of species, proposed by Prof. Hugo De Vries, of Amsterdam. It is undoubtedly true that the discovery and demonstration of the principle of mutations in the formation of species and varieties of plants by Hugo De Vries, is one of the most brilliant achievements in the history of evolution since the publication of Darwin's "Origin of Species." Its recent promulgation has thrown a flood of light upon many puzzling and obscure questions, and has aided materially in the solution of some intricate problems in the science of biology. Of course there is danger of carrying it too far in its application, like all revolutionary discoveries, for after all it only supplements natural selection and assists in solving problems that that great principle could not account for. It is a source of wonder to later scientists that Darwin, with all his observations and great insight into the workings of nature, should have failed to perceive the idea of sudden mutations, and held it as an inviolable principle that all changes of structure were due to very gradual alterations, the result of natural selection.

So it remained for the astute mind of De Vries to perceive that sudden changes of structure were possible, and under certain conditions could be made permanent. The general acceptance and the revolutionary effect of the idea of the origin of species by mutations has been marvelous, and second only to the revolutionary wave that swept over the world of thought following the publication of the "Origin of Species."

He says of the previous condition of the science of origins (in speaking of Burbank's work) that—

"Of great scientific importance is the question whether repeated selections are sufficient to bring about new forms, and, further, if by this means more variations are produced. We have no facts to indicate this, but it has great importance in the study of conditions. It is closely connected with the question whether species slowly merge into one another or whether they originate by mutations. In the former case small deviations would increase in the course of generations, and thus a long series of intermediate forms would connect man and all other species. In the latter case of mutations a jump is made without any intermediate stages."

The doctrine of mutations is founded upon seven laws, which De Vries thus states:

"(1) New elementary species appear suddenly, without intermediate steps; (2) they spring latterly from the main stem, not affecting it; (3) they attain their full constancy at once; (4) some of the new strains are elementary species, others are to be regarded as varieties; (5) the same new species are produced in a large number of individuals; (6) mutations undergo fluctuating variation, but the latter is not evolution; and (7) mutations take place in nearly all directions."

Like Darwin, his great discovery was founded on experimentation, elaborate and long continued, and he worked upon well-known and familiar facts. Stock-breeders and horticulturists have long employed the method of making permanent the sudden changes that produce variations, but no one before ever attempted to formulate the facts of mutation into a law and to conduct investigations upon such a basis.

Prof. Chas. A. White thus well summarizes the subject in *Science:*

"Species originate from other species through the ordinary function of reproduction, but they each originate suddenly and completely by one mutative act, and not by the slow accumulative variations of individuals. The beginning of the mutative process which is due to some unknown natural determinative cause, some molecular change in the germ-cell of the fertilized ovum, whereby the new individual acquires changed structural characters. The new species thus produced by mutation is in immediate possession of clearly distinguishing and hereditary transmissible characters, and it has no more tendency to hybridize with any other member of the mother species than have other species. Strains thus produced are called elementary species, and differ distinctly but not widely from the mother species."

The claims of the mutation theory are thus as extravagant in that direction as that of natural selection in the other. The truth lies in the medium ground, as usual. Darwin anticipated this idea, to a degree, when he said (Or. Sp., I, p. 313):

"Every one who believes in slow and gradual evolution will, of course, admit that specific changes may have been as abrupt and as great as any single variation which we meet under nature, or even under domestication. But as species are more variable when domesticated or cultivated than under their natural conditions, it is not probable that such great variations have often occurred under nature as are known occasionally to arise under domestication. . . . My reasons for doubting if this can occur, and for entirely disbelieving that species can change in the wonderful manner that is claimed by some, are as follows: According to our observations, abrupt and strongly marked variations occur in our domestic productions, singly and at long intervals of time. If such occurred in nature they would be liable to be lost by accidental causes of destruction and by subsequent intercrossing, as is the case under domestication unless special efforts are made for its preservation. Hence it is necessary to believe that several similarly changed individuals appeared simultaneously in the same district."

Again (p. 316):

"It is claimed that the sudden appearance of new species in geological formations supports the theory, but the admittedly imperfect record of the rocks prevents that evidence from being of any value. . . . He who believes that some ancient form was transformed suddenly, through internal force or tendence, will be almost compelled to assume, in opposition to all analogy, that many individuals varied simultaneously. . . . Against such abrupt changes, embryology enters a strong protest. It is notorious that the wings of birds, the legs of horses and other quadrupeds, are indistinguishable at an early embryonic period, and that they become differentiated later by insensibly fine steps. . . . Hence it is that it is incredible that an animal should have undergone momentous and adrupt transformation and yet should not bear even a trace in its embryonic condition of any sudden modification, every detail in its structure being developed by insensibly fine steps."

A striking book of the past year was that on "Evolution and Pathology," by D. von Hanseman (Sci., Dec. 3, 1909, p. 826), who takes the very original view that, as a ball upon an inclined plane is prevented from rolling by some external hindrance, so species having an inherent and continual tendency to vary are prevented from changing by reason of external conditions. Adaptation means the establishing of an equilibrium between the internal forces and external conditions. The phenomena usually credited with bringing about variations are here regarded as effective agents in checking the inherent tendency to vary. This results, in the long run, in the power for variation being weakened or lost, so that in the highest animals we find great fixity of types. The conditions throughout nature, as regards the struggle for existence, indicate a compromise of individuals bound by a fundamental law of altruism, which is operative everywhere. These views are striking and impressive, and illustrate the idea that the evolution discussion has been stimulating to originality of thought.

Darwin has been much criticized for his theories of heredity, and yet, as in other branches of biology, his ideas revolutionized this branch and gave thought upon the subject a new trend. For instance, his theory of pangenesis has been condemned as exploded, and yet Weisman's theory of germ plasm is along the same lines and furnishes explanations that nothing else can give. Darwin's theory of pangenesis he explains as meaning (Var. Domes., II, p. 350), "that every separate part of the whole organization reproduces itself. So that ovules, spermatazoa and pollen grains—the fertilized seed, as well as buds—include and consist of a multitude of germs thrown off from each separate part or unit. . . . (P. 378:) According to our hypothesis all forms of reproduction depend upon the aggregation of gemmules derived from the whole body." The power of growth and development, as well as the repair and reproduction of injured and lost parts, especially in lower animals, is fully explained, he contends, by assuming the presence of the gemmules in all parts of the body with particular affinities and tendencies. (P. 397:) "The chief assumption is," he says, "that all the units of the body, besides having the universally admitted power of self-division, throw off minute gemmules that are dispersed through the system. . . . In a highly organized animal the gemmules thrown off from each unit of the body must be inconceivably numerous and minute. Each unit of each part, as it changes during development, must throw off its gemmules. (P. 398:) The units of the body are generally admitted by physiologists to be autonomous. I go one step further and assume that they throw off reproductive gemmules. Thus an organism does not generate its kind as a whole, but each separate unit generates its kind. . . . Inheritance must be looked at as merely a form of growth, like the self-division of lowly organized unicellular organisms." From this lucid statement of his theory, and the logic of it, we cannot wonder that the theories of heredity were completely revolutionized by the promulgation of what he calls his provisional hypothesis.

Following De Vries's principle, and next in importance, was Mendelism — the idea of mathematical proportions in the inherited and transmissible qualities of plants and animals. It was the discovery of Gregor Mendel, a monk of the monastery of Brunn. Born in 1822, he studied natural history in 1851–'53 and became interested in the problems of hybridism, and conducted his classical experiments upon the common edible pea up to 1865. Although the contemporary of Darwin, it is curious that neither knew of the other's work. But as Mendel published but little, his work did not become generally known till 1900, years after his death, when it was discovered in obscure journals, and has been repeated and verified by many experimenters since. According to Mr. R. C. Punnet's book on Mendelism, the classic experiments were first conducted on varieties of the common pea. He bred tall and dwarf varieties of the pea together, and the first offsprings were all tall. These were then crossed, and both tall and dwarfs appeared in the second generation, in the proportion of three talls to one dwarf. Hence he called the talls the "dominants" and the dwarfs "recessives." From these seeds he got dwarfs that bred true in the third generation, but the talls gave some that bred true and others gave seeds that produced both talls and shorts, in the proportion of three to one as before. Subsequent experiments with gray and white mice gave the same results, the gray being dominant and the white recessive. These proportions, with varying details, have been borne out by thousands of experiments with all kinds of plants and animals since that time, by investigators and breeders. As Mr. Punnet says (p. 60):

"The phenomena are of great scientific interest, and the facts elicited by Mendel and others cannot but affect our conceptions of the nature and origin of living beings. Of the fact of evolution we are certain; of the workings of natural selection we have no doubt. But as to the nature of the variations upon which selection works there is much diversity of opinion. The discoveries of Mendel must greatly influence our conception of the part played by the different forms of variations in the evolutionary process. . . . (Pp. 72-74:) We now recognize discontinuity in inheritance as well as in variation. Once a new character has arisen as a mutation, only selection can eliminate it. Mendel's discovery has led us to alter materially our ideas of the evolutionary process. . . . Evolution takes place through the action of selection upon the common mutations. Where there are no mutations there can be no evolution. How and why these mutations arise is the great outstanding problem of biology."

A remarkable recent work was Dr. Frederick A. Woods's, on "Heredity in Royalty," a sociological study of history, in which the privileged class of royal families was taken, as the records are so complete for several generations. (Am. Anthrop., 1909, 529.) They were a high class with a favorable environment. Doctor Woods assumes that the mental, moral and physical make-up of individuals are the resultant of three causes, *i. e.*, heredity, environment, and free will. But he sums up his investigations in the statement, "The most interesting, and even startling thing has been the ease with which heredity alone has been made to bear the brunt of explaining the general make-up of character." His facts all point to the importance of inheritance as a factor in character, and if so, society must bear the blame, in some measure, for the propagation of the criminal and vicious classes. Biologists, in considering the development of moral qualities by natural selection, have found difficulty in perceiving how altruistic tendencies could be favored by natural selection, but there were correlations observed which would throw light on the subject. He says (p. 513): "The probability is that there are at work forces of natural selection of which we know little of the value as yet, but which are such that, setting aside the influences of environment, whether we will or not, the natural quality of humanity must progress." He says again (p. 515): "The upshot of it all is, as regards intellectual life, that environment is a totally inadequate explanation. We are forced to the conclusion that all the main differences in intellectual activity are due to predetermined differences in the germ cells." Taken all together, Doctor Woods has made us feel that heredity has a much more important part in the determination of character than it has credit for, and the sociologist finds suggestions for the improvement of the race, which, if not feasible now, may be so sometime.

Darwin's influence upon biology in general was most profound and far-reaching. As Prof. Wm. R. Wheeler, of Harvard, in his anniversary address, says (Pop. Sci. Mon., Apr. 19, '09, p. 381):

"Charles Darwin undoubtedly exerted a great and threefold influence upon zoölogy, botany and kindred sciences, first, by his rehabilitation of Lamarck's theory of transformism or evolution; second, by his wonderful studies on variation; and, third, by his brilliant theory of natural selection and the survival of the fittest. . . . (P. 383:) The first effect of the 'Origin of Species' was destructive, as it tended to dissolve the rigid conceptual scheme that dominated not only in zoölogy and botany but the whole cosmogony of the time. The conception of an evolution that melted all living beings into a vital stream that surged on into the future as it has surged through the æons of the past, continually creating new and destroying old forms, could not but clash with a conception of a world created once for all and since engaged in marking time. . . . Evolution, as conceived by Darwin, admitted of a mechanical explanation and so allied itself with the physical sciences rather than with psychology and philosophy. It compelled zoölogists and botanists to attend to every aspect of an organism, every phase of its development, from an egg to its dissolution; nothing in its structure was too insignificant to decide whether a species could survive in the struggle for existence. Hence the incentive to record the minutest variations and to search for their causes. . . . Paleontology was born anew and the distribution of life in the past and present became the subject of ardent study. . . . The constantly increasing tendency during the last half century to substitute a careful genetic study—that is, a study of all the life processes—for the ancient cut-and-dried methods—has spread far beyond the confines of biology properly so called. . . . (P. 385:) These tendencies have reached not only psychology and philosophy, but even sociology, anthropology, archeology, philology, economics and education. Of course great progress would necessarily have been made in fifty years if Darwin had not revived the doctrine of evolution, but that it dominated and quickened the development theory there can be no doubt. But for the doctrine of evolution we would still be contemplating living organisms from afar, in the scholastic and theologizing spirit of the first half of the nineteenth century, and not, as now, at close range, with a deeper and freer insight into the significance of the minutest details of development, structure and function."

As to Darwin's influence on zoölogy, the one science in which he was preëminent—although he was well accomplished in botany and geology also—Prof. T. H. Morgan, of Columbia University, wrote (Pop. Sci., Apr , 1909, p. 367):

"It is the general belief of zoölogists that Darwin's influence in bringing about the acceptance of the theory of evolution marked a turning point in the history of their science. . . . In the mind of the general public Darwinism stands to-day for evolution, which is generally accepted as Darwin's chief contribution to human thought. To the zoölogist Darwinism means evolution especially as accounted for by natural selection. . . . The example of Darwin's precision in observing, his truthfulness in recording, and wisdom in interpreting has transformed zoölogy from prosaic description to acute speculation — from an interesting study to an aggressive science. This change has taken place in an incredibly short space of time. . . . The loyalty that every man of science feels toward Darwin is something greater than any special theory; it is the spirit of Darwinism, the point of view, the method, the procedure of Darwin. . . . (P. 372:) After Darwin, and largely as the result of the outgrowth of the wide interest his views aroused, there was increased activity in all fields of zoölogy. The systematists, in their intensive study of species and varieties, the geographical and geological distribution of animals, and the influence of environment in modifying species, have supplied the most extensive contributions, perhaps, that have been made to the theory of species formation and transmutation. . . . The morphologists, or philosophical anatomists, form the second group of students whose activity is the result of Darwinism. They have determined the relationship of the great classes of animals on the principle of descent; they have pursued the history of the species in embryology, and have studied heredity in relation to the germ cells that are the links in the chain of organic life. Few other studies have advanced in recent years at so rapid a pace and few have added facts of greater significance. . . . These students have advanced the principles of their science, and the aspect of modern zoölogy is largely the outcome of their varied and far-reaching labors. . . .

(P. 374:) The last twenty years is the brightest chapter in the history, for the spirit of Darwin is once more abroad. . . . Before his time evolution was a general idea, but one of profound significance. After Darwin evolution rested its claims upon a definite body of information relating to variations and their inheritance. It is these data that first convinced his greatest contemporaries of the truth of evolution and finally convinced the rank and file of thinking men. Darwin also opened the doors into unexplored territory, and the rewards in these new fields have been and continue very great."

The bearings of Darwin's discovery upon man and human institutions were most important and revolutionary. Concerning this Mr. Benjamin Kid, in his "Social Evolution" says:

"One of the most remarkable epochs in the history of human thought is that through which we have passed in the last half of the nineteenth century. The revolution beginning with the publication of the "Origin of Species" has gradually extended until it has affected the entire intellectual life of our Western civilization. The sciences dealing with man in society have naturally been the last to be affected, but the changes therein promise to be more startling in character. The whole plan of life is being revealed to us in a new light, and we are beginning to perceive that it presents a single majestic unity, throughout every part of which prevail the conditions of law and orderly progress. We have lived through a period when the very foundations of human thought have been rebuilt. . . . The great triumph of science in the nineteenth century has been the tracing of steps in the evolution of life up to human society."

Prof. F. H. Giddings, in an address upon "Darwinism and Social Evolution," said: "Revolutionizing as the life work of Darwin was in the fields of biology, it is doubtful if his writings were felt anywhere more profoundly than in pre-Darwinian social philosophy." (Pop. Sci., July, 1909, p. 72.) "It was not until the publication of the 'Descent of Man' in 1871, twelve years after the 'Origin of Species,' with its intellectual tempest, that the full significance of natural selection for the doctrine of human progress was apprehended by the scientific world. Mr. Spencer saw it when the 'Origin of Species' was published, and Darwin perceived that he must offer a credible explanation of the paradox that a ruthless struggle for existence could yield the fruits of righteousness. But it was neither of these great thinkers, but a gifted man, Mr. Walter Bageot, who made the brilliant discovery of the final solution, in his 'Physics and Politics.' Mr. Spencer had worked out the idea of savage conflict and the survival of the fittest as applied to individuals in the struggle for existence; but it remained for Mr. Bageot to conceive the idea of group solidarity and collective conflict in distinction from a mere individual struggle for existence. He said: 'The progress of *man* requires the coöperation of *men* for its development; that man can only make progress in coöperative groups. Tribes and nations are coöperative groups, and it is their being so that makes their value,' etc." Prof. Giddings comments on this view:

"Social evolution thus proceeds through the conflict of antagonistic tendencies, on the one hand, towards uniformity and solidarity, on the other—toward variation and individuality. Mr. Bageot thus arrived at conclusions that we recognize to-day as being at the core of scientific sociology. Society was a factor in the evolution of man before man became a factor in the evolution of society, and the difference is important. . . . In the 'Descent of Man' Mr. Darwin recognizes the utility of group solidarity, and of the struggle of associated individuals to adjust their interest and activities to each other, that the group life may be maintained. To observe the successive stages and the complications of man's collective struggle for existence is to follow the evolution of tribal society and thence the history of civilization. . . . In one favored place, the Athenian city state, society became for a brief period idealistic; that is to say, its bonds were those of a common purpose, or ideal. After 2000 years of arrest and slow recovery, the cosmopolitan society of the Western world is, possibly, once more approaching the Athenian model. And the goal is what? What has evolution done for man? If it be true, indeed, that 'Thro' the ages an increasing purpose runs,' is it made manifest in something that we may legitimately call progress? For progress, rightly defined, is more than evolution. It is either race survival with individuation, or it is increasing individual power, capacity and happiness not entailing race extermination Have we made sure of this? We hate to think ill of ourselves, yet the question will recur, Has the survival of the fit become, at length, the survival of the best."

Of "Darwin's Influence on Philosophy," Prof. John Dewey, of Columbia University, says (Pop. Sci., July, 1909, p. 90):

"The conception that had reigned supreme for 2000 years in the philosophy of nature and knowledge, the conceptions that had become the familiar furniture of the mind, rested on the assumption of the superiority of the fixed and final. In laying hands upon the sacred ark of absolute permanency, in treating forms of life as originating and then passing away, the 'Origin of Species' introduced a mode of thinking that in the end was bound to transform knowledge, and hence the treatment of morals, politics and religion. . . . (P. 93:) The exact bearings on philosophy of the new logical outlook are, of course, as yet uncertain and inchoate. We live in the twilight of an intellectual transition. One must add the rashness of the prophet to the stubbornness of the partisan to venture a systematic exposition of the influence upon philosophy of the Darwinian method. . . . (P. 96:) When Henry Sidgwick casually remarked in a letter that, as one grew older his interest in what or who made the world was altered into interest in what kind of a world it was, anyway, his voicing of a common experience of our own day illustrates also the nature of that intellectual transformation effected by the Darwinian logic. Interest shifts from an intelligence that shaped things once for all to the particular intelligence that things are even now shaping. . . . (P. 97:) The new logic introduces responsibility into the intellectual life. To idealize and rationalize the universe at large is, after all, a confession of inability to master the courses of things that specifically concern us—a shifting of the burden over to the shoulder of the Transcendent Cause. Philosophy must in time thus become a method of locating and interpreting the more serious of the conflicts that occur in life and a method of projecting ways of dealing with them. . . . (P. 98:) No one can fairly deny that at present there are evident two effects of the Darwinian mode of thinking. On the one hand, there are efforts to revise our traditional philosophic conceptions in accordance with its demands. On the other hand, there is a type of philosophic knowing, distinct from that of the sciences to which they give access, something that radically transcends experiences. . . . Old ideas give way slowly, for they are habits, predispositions, deeply ingrained attitudes of aversion and preference. Intellectual progress usually occurs from the mere abandonment of hotly disputed questions. We do not solve them—we get over them. Old questions are solved by disappearing, evaporating, and new questions take their place. So, doubtless, the greatest dissolvent of old questions, the greatest precipitant of new methods and problems, is the one effected by the scientific revolution begun by 'Origin of Species.'"

Some one has said, wisely, that the scrap basket of civilization is full of forgotten and abandoned problems, their day passed,

As Dr. E. F. Nichols said, in his recent inaugural address as president of Dartmouth College (Sci., Oct. 15, 1909, p. 507):

"To understand the recent history of our colleges from any point of view, the intellectual development of the world must be taken into account. . . . The middle of the last century saw the beginning of several intellectual movements. Natural science got under way earliest by establishing the doctrines of evolution and energy. The bearing of these broad principles soon became necessary to our modes of thought, as they were immediately recognized to be for our material development. To-day there is no branch of knowledge which has not in some wise been extended and enriched by the philosophical bearing of these wide-sweeping laws which at first were the individual property of natural science. So intimately have they become the guiding principles of all modern constructive thinking that, steer how we will, the man in college cannot escape their teachings. Although these principles are still most significantly presented in the laboratories in which they arose, the student will find their progeny in history, in theology and in law."

And so, to sum up, perhaps the greatest thing that can be said about evolution is that it gave to the world a new method of thought. It marked an intellectual awakening and made men think broader, deeper and more vigorously. Men have escaped from the trammels of authority and finality, and have learned to investigate for themselves and to go to the primal sources for knowledge. The dominant note in intellectual life to-day is earnestness to know the truht. There is a disposition to investigate and analyze, and the weight of mere authority is fast disappearing. But more than that, there is that in the fundamental principles of evolution that makes men look upon life and the world differently. As we well know, evolution is but a new name for transformation, growth, development, change, such as is going on everywhere about us. That seems such a truism that it is not now worth while to be reminded of it, but the time was when it was scientific as well as religious heresy to mention such a thing. In a former stage, the pre-Darwinian era, men believed in the fixity of species and of all life, and that change was impossible. This permanency of things as a method or thought is now a thing of the past. We do not think that way now. We think in terms of evolution, of progressive and constantly improving development. Things are constantly becoming, and change, growth, evolution, is everywhere. We do not apply sixteenth century methods of thought to twentieth century life and things. The greatest gift, therefore, that evolution has bestowed upon us is liberty of thought and the idea of thinking in terms of progressive development as applied to life and things about us. We do not now care so much for the controversy about the origin of life and of the universe as we do for an insight into what it all means. What are we here for? What are we becoming in the process of our evolution? Are we worthy of the life that has been given us? Are we guiding it to its best outcome? These are thoughts that are being forced upon us as we contemplate the wonderful workings of evolution and impress us with a sense of our own appalling responsibility.

THE POLLUTION OF UNDERGROUND WATERS.

By S. J. Crumbine, M. D., Topeka.

THE source of water for domestic purposes might be divided into three classes: First, waters secured from streams or lakes; second, impounded surface waters, as ponds, cisterns, etc.; third, the ground waters, such as wells and springs. The latter is by far the greatest source of supply to the people of this country, and it is to the discussion of the pollution of this class of water that I desire to direct your attention.

The amount of ground water in the earth's crust is enormous. An estimate made by DeLesse—based on the assumption that the water in rocks diminished from 5 per cent of their weight, or $12\frac{1}{2}$ per cent of their volume at the surface, to nothing at a depth of six miles, and that water may exist in liquid form at a temperature of 600° C.—gave a sheet of water over 7500 feet thick surrounding the earth.

Slichter made an estimate of less than half that of DeLesse, which estimate was equivalent to a uniform sheet of water 3000 feet in thickness.

Van Hise's guess was 226 feet of water over the continental areas, no computation being made regarding the oceanic areas.

Chamberlain and Salisbury, assuming a porosity of 5 per cent for the soil, estimated a layer of water 1600 feet in depth covering the entire surface.

Myron L. Fuller, of the United States Geological Survey, after making an extensive investigation and experiments as to the porosity of soil and rock in this country, together with the thickness of sediments, and the evidence of circulation of free water in the earth's crust, came to the conclusion that the total free water held in the earth's crust would be equivalent to a uniform sheet over the entire surface of a depth of ninety-six feet. The underground water would, therefore, be estimated to be only one one-hundredth of the volume of the ocean, instead of nearly one-half, as figured by DeLesse. Fuller finally concludes that the average amount of water in the earth is probably under, rather than over, the amount estimated.

Comparatively little of this ground water is available for the purpose of a domestic water supply, for reasons which are self-evident. First, probably a larger share of it carries such quantities of chlorine or minerals as to make it unsuitable; and second, the greater portion of it is at such depths as to be beyond the reach of economic production. It is only that portion of the ground water coming from springs, or that is available by comparatively shallow wells, which has any sanitary significance, and to which we will confine our discussion.

Ordinarily the amount of ground water available in a community depends upon the annual precipitation. The mean annual average rainfall for the different portions of the United States, as tabulated by the weather bureau, is thirty inches.

Church estimates that one inch of rain would amount to nearly 101 gross tons per acre; or, on a house roof of say 20x30, one inch of rain would amount to about 374 gallons.

Some one has estimated that one-half of the precipitation finds its way into the streams, finally joining the great ocean. This would give the remaining half of this tremendous annual precipitation to be absorbed by the soil or given off by evaporation.

It is commonly believed by the majority of laymen that rain water is an absolutely pure water, but this belief is erroneous; for the raindrops in passing through the atmosphere wash out and collect enormous quantities of dust, smoke and gases, so that, bacteriologically speaking, it is exceedingly doubtful whether any rain water is absolutely pure. It is probably true that there would be very little, if any, pollution of rain water to the extent of making it a dangerous pollution.

As soon as the rain falls upon the earth it of necessity comes in contact with the gross pollution of the top layers of the soil, which some one has denominated "the living earth," and which, as every-one knows, is teeming with myriads of all sorts of germ life. In the inhabited areas this pollution is of a dangerous sort, as would naturally be expected.

With the descent of the rain drops into the soil there is carried with it more or less organic and inorganic matter, soluble and insoluble, and myriads of living and lifeless organisms. As the water sinks deeper and deeper into the porous soil the insoluble matters, as well as the bacterial contents, are gradually filtered out; the rapidity and degree of filtration depending, of course, on the nature and porosity of the soil. As the filtration process goes on, the water, being robbed of its organic matter, becomes the less able to support abundant bacterial life.

The average soil under ordinary and uncontaminated conditions is supposed to be practically sterile at a depth of twelve feet; at least sufficiently so for all sanitary purposes. Thus the great mass of rainfall, although grossly polluted when first finding its way through the top layer of soil, under ordinary conditions is of a high sanitary quality after having passed through ten or twelve feet of soil. These waters, while of a high organic purity, become in many places rich in inorganic matters and belong to the class known as hard, or mineral waters; in many cases being so highly loaded with sulphates, chlorides or carbonates as to be unfitted for domestic use.

On the other hand, ground waters may be basely polluted, instead of purified, when they are on their passage through the earth. If the earth is saturated with impurities, as may occur from leaching cesspools, privy vaults, sink drains, barnyards, burying grounds, or other sources of pollution, nature's purifying operations may give way to one of intense pollution.

Wells whose source of supply is from the so-called first stratum of water, in the densely populated communities along the Arkansas river and the Kaw river and its tributaries, are peculiarly susceptible to this form of ground-water pollution. The first stratum of water is usually from eight to fifteen feet from the surface, with an exceedingly porous and sandy soil intervening, and thus any unusual or great amount of pollution overtaxes the purifying and filtration properties of this soil, and there is a resulting contamination of the underground water.

The prosperity of the people in the smaller communities and towns of the state is perhaps no better reflected than in the movement to improve and modernize their homes. This calls for some method of sewage disposal, and, in the absence of a sewerage system, the disposal usually resorted to is the construction of the cesspool, and, in some instances, the use of an abandoned well. Thus in the river valleys above referred to the ground water may be and often is very badly polluted.

Recently it was suspected that a cesspool situated about 150 feet to the west of a well, in a certain city on the Smoky Hill river, was polluting the underground water. In order to determine whether or not the liquid contents of the cesspool was finding its way into the well, a solution of iron sulphate was put into the cesspool, and in about forty-eight hours the people who were using the waters of the well were able to identify the astringent and bitter taste of the iron. Chemical and sanitary analyses of the waters of this well proved, what the solution of iron sulphate had already proven, that the users of the water from the well were drinking the diluted sewage of their neighbor's cesspool.

It is true that this sewage would for a considerable period of time be to a greater or less extent purified, that is to say, would not contain any pathogenic organism; yet as time goes on the degree of pollution, as well as the area of pollution, gradually increases, until it would seem to be entirely possible for disease to be transmitted in this manner. At all events there are few of us who have the desire to drink the sewage of our neighbors, notwithstanding we may have the scientific assurance that it is perfectly harmless.

Another illustration of this sort of pollution occurred at the sugar refinery at Garden City. Tons and tons of beet pulp were heaped upon the ground, for the want of a better place of storage, and was allowed to remain for a number of months, much of it undergoing fermentation and decomposition. In the spring this beet pulp was disposed of and the ground thoroughly cleansed of all of the pulp. Yet for a number of months afterwards a series of wells, which had been constructed by the sugar company at a point several hundred feet east of the place used as a storage for the beet pulp, and which were being pumped at the rate of several million gallons of water per day, continued to throw off the vilest odors of sulphureted hydrogen gas, and deposited in the troughs which conveyed the water to the factory a thick, heavy layer of organic matter.

Another method of pollution of wells and springs is through faults or fissures of an impervious strata carrying the ground-water supply, or through which a head of water draining a polluted basin or area finds its way to the surface in the form of a spring through a fissure.

There is at least one example of this kind in Kansas. A certain city has for a number of years boasted upon the purity of its public supply, because, forsooth, it was spring water. Bacteriological tests of this water on a number of occasions showed it contaminated with colon bacillus. Careful investigation by the engineer and secretary of the State Board of Health revealed the fact that this spring was, in the main, the outlet from extensive basins and swamps located near by, and which came to the surface through a large fissure of the overlying rock.

Literature records a number of extensive epidemics of typhoid fever due to these underground breaks or fissures. In one instance, in Switzerland, an epidemic of typhoid fever broke out in a certain village, and over 17 per cent of the inhabitants were stricken. The entire village was supplied from waters of a spring. A painstaking investigation revealed the following facts: On the other side of the ridge was a little valley which when irrigated always increased the flow of the spring on the village side of the mountain. It was found that a peasant living in the valley had returned from a distant city sick with the fever, and that the water in a brook in which his clothes had been washed and into which the slops of the house had been cast had been used to irrigate the meadow. Of course the polluted water filtered through the surface of the soil and joined the underground water to go to no one knew where. In order to determine if it could be possible that this spring was fed by the underground waters of a valley a mile away, a large quantity of salt was thrown into a hole dug into the valley to a water-bearing vein of sand, and in a few hours the waters of the spring became very salty, and thus was established the connection between the irrigated valley and the spring.

To conclude that because water is bright, clear and sparkling, that therefore it is wholesome, is highly erroneous. The very gases of decomposition may make a sparkling water, and but little filtration is necessary under ordinary conditions to remove turbidity. Therefore, shallow wells or springs located in densely populated areas, or in loose, porous soil, or near to known and evident sources of pollution, must be always under suspicion as to its purity and wholesomeness, regardless of its physical appearance.

Another source of pollution of wells and springs, and which, after all, is probably the most common, and certainly the most dangerous, is that of direct surface contamination, in which the polluted surface water finds its way into the well or spring without the purifying filtration of intervening layers of soil.

In this connection I desire to quote a paragraph which recently appeared in the pamphlet issued by the Merchants' Association Committee of New York which had undertaken the investigation of the cause of typhoid fever in that state:

"Great cities are developing some sort of a sanitary conscience. Farmers and country districts have as yet little or none. Bad as our city water often is, and defective as our system of sewage, they cannot for a moment compare in deadliness with the most unheavenly pair of twins—the shallow well and the vault privy. A more ingenious combination for the dissemination of typhoid than this precious couple could hardly have been devised. The innocent householder sallies forth, and at an appropriate distance from his cot digs two holes, one about thirty feet deep, the other about four. Into the shallower he throws his excreta, while upon the surface of the ground he flings abroad his household waste from the back stoop. The gentle rain from heaven washes these various products down into the soil and percolates gradually into the deeper hole. When the interesting solution has accumulated to a sufficient depth, it is drawn up by the old oaken bucket or modern pump, and drank. Is it any wonder that in this progressive and highly civilized country 350,000 cases of typhoid occur every year, with a death penalty of ten per cent?"

It must be admitted that in locating the outbuildings and the well on the average farm or in the average small town, the bearing of such location on sanitation and hygiene is entirely disregarded, the convenience of the family only being taken into consideration; and thus the well is as often located below as above the surrounding sources of pollution, and the surface water from rains carrying house slops, barnyard drainage, and filth from the near-by privy, near to, or often actually into, the well, unless it has been constructed in such a way as to exclude surface contamination.

Not only may typhoid-fever bacteria be carried into wells and springs in this manner, but those organisms which cause digestive disturbances and serious troubles, such as diarrhea, dysentery, cholera and tuberculosis may be carried into the water used for domestic purposes. Then, again, eggs of animal parasites may be washed in from the surface, and it seems to be quite certain that many of our intestinal parasites are thus disseminated.

At the recent International Congress on Tuberculosis Dr. Samuel Dixon, health officer of Pennsylvania, called attention to the possibility of the dissemination of tuberculosis through drinking tubercular-infected water.

Rosenau has recently compiled the observations made by other investigators, and concludes that the tubercular bacillus may live and remain virulent in water for several months.

Since the danger of ingesting the tubercle bacillus is now so well established, its presence in drinking water assumes a special significance. Drinking water may, therefore, harbor a disease equally dangerous to that of typhoid fever and cholera.

Hazen some time ago formulated and enunciated the following theorem: "For every death from typhoid fever avoided by the purification of public water supplies, two or three deaths are avoided from other causes."

The habit of promiscuous spitting of a consumptive upon the ground surrounding his dwelling, on the theory that the air and sun will soon make proper disposition of the sputum, is fraught with quite as much danger to the users of an unprotected ground-water supply as would be the habit of throwing the unsterilized discharges of a typhoid-fever patient upon the ground surface about the house.

We are beginning to appreciate more and more the absolute necessity of safeguarding our water and food supply from the contamination of the tubercle bacillus, if we may hope for a control of this widespread disease. We have found out that the second and third cases of tuberculosis occurring in the same family is a case of the inoculation of the well from the sick, and not that of hereditary transmission; and it is not improbable that this inoculation is very often conveyed through the medium of the domestic water supply.

In the report of President Roosevelt's Country Life Commission I find the suggestive comment: "Theoretically, the farm should be the most healthful place in which to live, but it is a fact that there are numberless farmhouses and rural schoolhouses that do not have the rudiments of sanitary arrangement. . . . The extensive spread of hookworm disease in the Gulf Atlantic states and the presence of typhoid fever and malaria in many localities is more than a regional question; it is nation-wide in importance."

Dr. Worden Stiles, in a recent pamphlet issued by the Public Health and Marine Hospital Service, made a tabulation of 366 farmhouses scattered over four southern states, and which was presumed to be representative of the conditions in those states. He found that only 115, or 31.4 per cent, were provided with privies, while 251 houses, or 68.5 per cent, had no privy. Thus a condition of theoretical maximum soil pollution was occurring in 68.5 per cent of the houses in question.

When it is considered that not only hookworm disease but typhoid fever are spread through night soil, the importance of this soil pollution becomes evident. Of course, it is understood that even when a privy is present soil pollution may occur in case the outhouse is not properly built or not properly cleaned.

Stiles goes on to say that among several thousand privies examined on farms and in various villages, the prevailing style was found to be the surface privy, open in the back. This is the poorest compromise that can be made, for not only is the danger present of contaminating the water supply in near-by wells, but soil pollution naturally occurs around the outhouse, and this is increased by the fact that chickens, dogs and hogs have access to the night soil and scatter the infectious material around.

Of the 121 public water supplies of Kansas, 89 are ground-water supplies, 4 of which are from springs and 85 from wells. In view of this large per cent of the city population, together with the greater number of our entire rural population, who are dependent for their domestic water-supply upon the underground waters, it is at once apparent that the conservation of the ground waters of the state from dangerous pollution is of state-wide importance.

Water pollution involves economic as well as public-health problems. According to the census of 1900 there were 35,379 deaths from typhoid fever throughout the United States. On an estimated mortality of 10 per cent, it is within reason to assume a yearly prevalence of 353,790 cases of this disease. If we calculated the average cost for care, treatment and loss of work to be $300, and the average value of a human life at $5000, we have a total loss in the United States of $283,320,000 from one of the so-called preventable diseases.

Applying these same figures to Kansas, we find that last year there were reported 355 deaths from typhoid fever, which, with a mortality rate of 10 per cent, would make 3550 cases, making an economic loss to the state of $2,730,000.

Add to this enormous sum the economic loss through the dissemination of other diseases which might properly be charged to the pollution of water supply, and it swells the total to amounts which are almost beyond credulity.

Surely the time has come, now that science has demonstrated these facts beyond successful contradiction, that our government, both state and national, assume such control over the natural waters of this country, both surface and underground, as will preserve the lives and health of its citizens and will stay this enormous economic waste.

TRANSACTIONS

OF THE FORTY-THIRD ANNUAL MEETING.

CONTAINS

MINUTES OF THE FORTY-THIRD ANNUAL MEETING; SOME PAPERS READ; OBITUARY NOTICES; AND INDEX TO TWENTY-THIRD AND TWENTY-FOURTH VOLUMES.

MINUTES.

Forty-third Annual Meeting, Academy of Science,

December 27, 28, 29, 1910, at Topeka, Kan.

PURSUANT to published announcement, the Academy convened in the supreme court room at the state house at seven P. M. December 27, and was called to order by President Dains, and the secretary read his report of the last meeting, which was adopted by the Academy. The treasurer's report was next given, as follows:

Balance on hand December 28, 1909	$485.98	
Receipts from membership dues	106.00	
Receipts from sale of Transactions	12.35	
Receipts from interest on deposits	16.70	
Total		$621.03
Expenditures—for Library		16.40
Balance on hand		$604.63

F. W. BUSHONG, *Treasurer.*

This report was referred to the Auditing Committee.

A lecture illustrated by stereopticon projections was next given by Dr. C. F. Menninger; subject, "Some Aspects of the Etiology of Pellagra." This was ably treated and listened to with much interest.

The president announced the following committees:

Nominations: Knaus, Yates, and Emerson.

Resolutions: McWharf and Welin.

Membership: Harshbarger, Smith, and Withington.

Program: Bushong and Mrs. Smyth.

Necrology: Lovewell and Matthews.

Press: Cardiff and Menninger.

Time and Place: Yates, Welin, and Bushong.

Auditing: Smith and Cooper.

The meeting adjourned till to-morrow, Wednesday, at 9 A. M.

WEDNESDAY, DECEMBER 28—9 A. M.

Supreme Court Room.

Academy met pursuant to adjournment.

Secretary's minutes read and approved.

It was moved, and by vote adopted, that a Legislative Council be constituted to take into consideration the interests of the Academy, and especially to look after the legislative measures which may affect its welfare. Said Executive Council shall consist of the present Executive Committee, to which four members are added, to be proposed by a nominating committee. The committee named were E. H. S. Bailey, F. B. Dains, S. J. Crumbine, and J. T. Willard, who, on ballot, were declared elected.

The Academy next listened to the reading and discussion of papers, in order as posted by program committee who selected them from the following list. This list is given in the order of the papers as received by the secretary. The order of reading is determined by the Program Committee.

1. Lightning. A. A. Graham, Topeka.
2. Origin and Distribution of the Human Race. A. A. Graham, Topeka.
3. The Cause of Earthquakes and Volcanic Action. A. A. Graham, Topeka.
4. The Relation Between the Activity of Ground Bacteria and the Climate. A. A. Graham, Topeka.
5. Letters to the Director of the Weather Bureau, Topeka, Kan. A. A. Graham, Topeka.
6. History of Catalysis and its Utility in Systematic Phthisis. Wm. P. McCartney, Manilla, P. I.
7. Song of the Stars. Part I. Rev. B. T. Stauber, Lincoln, Kan.
8. Thoughts on Tuberculosis. J. M. McWharf, Ottawa.
9. Short Weights and Measures. S. J. Crumbine, Topeka.
10. McMurry Indian contracts and the Gore Investigation. A. B. Reagan, Nett Lake, Minn.
11. Birds of the Olympic Peninsula, Washington. A. B. Reagan, Nett Lake, Minn.
12. Sketches of Indian Life and Character. A. B. Reagan, Nett Lake, Minn.
13. The Great Rock Wall of Texas. T. L. Eyerly, Dallas, Tex.
14. Notes on the Preglacial Channel of the Kansas River. (10 minutes.) J. E. Todd, Lawrence.
15. History of Wakarusa Creek. (20 minutes.) J. E. Todd, Lawrence.
16. Some Aspects of the Etiology of Pellagra. (Illustrated by lantern projections.) Dr. C. F. Menninger, Topeka.
17. Additions to the List of Uredineæ of Bourbon County. A. O. Garrett, Salt Lake City, Utah.
18. Notes on the Caves of Cuba. J. W. Beede, Bloomington, Ind.

19. Additions to the List of Kansas Coleoptera for 1910. (3 minutes.) W. Knaus, McPherson.
20. Notes on Six Species of Kansas Beetles. W. Knaus, McPherson.
21. Kansas Coleoptera: the Families Rhynchitidæ, Attelabidæ, Byrsophidæ, Otiorhynclidæ, Curculionidæ, Brenthidæ, and Calandridæ. (Read by title, ½ minute.) W. Knaus, McPherson.
22. Ephemerides of Glacial Epochs. Bernard B. Smyth, Topeka.
23. America During the Bronze Age. Bernard B. Smyth, Topeka.
24. Harmonic Forms, III—Paladin Squares. Bernard B. Smyth, Topeka.
25. An Adobe Architect. Mrs. Lumina C. R. Smyth, Topeka.
26. "Still in the Laramie Country, Converse County, Wyoming." C. H. Sternberg, Lawrence.
27. The Examination of a Sample of Millet for Alleged Poisonous Qualities. L. E. Sayre, Lawrence.
28. The Present Status of Ornithological Science in Kansas. Rev. P. B. Peabody.
29. Determining from the Excise Records the Amount of Alcohol Consumed in Beverages. E. C. Warfel, Wamego.
30. Erosion in Cool Moss-covered Regions. W. G. Twenhofel, Lawrence.
31. Recent Fractures and Faults in Meade County. E. Haworth, Lawrence.
32. Accuracy of the Safety-lamp Test for Methane. C. M. Young, Lawrence.
33. Book Collections in the State House. J. T. Lovewell, Topeka.
34. The Trend of the Pure Food Legislation. E. H. S. Bailey, Lawrence.
35. Analyses of Soft Waters from the Sandstone in the Lawrence Shales. C. C. Young, Lawrence.
36. Some Problems in the Drug End of the Food-and-drugs Law Administration. L. E. Sayre, Lawrence.
37. The Influence of Germination of Wheat upon the Baking Qualities of Flour made from such Wheat. C. O. Swanson and J. T. Willard, Manhattan.
38. The Influence of Milling By-products upon the Baking Quality of Flour. J. T. Willard and C. O. Swanson, Manhattan.
39. The Influence of Chemical Substances, Especially Amido Compounds, upon the Baking Quality of Flour. J. T. Willard and C. O. Swanson, Manhattan.
40. A Visit to the Ruins of Puyé. A. H. Thompson, Topeka.
41. The Place of Science in the Development of Kansas. (Presidential Address.) F. B. Dains, Topeka.
42. Eclipse Photographs, Washburn College Observatory. H. I. Woods, Topeka.
43. Double-star Observation, Washburn College Observatory. H. I. Woods, Topeka.
44. Geographical Distribution of Plants. W. C. Stevens, Lawrence.

45. Some Notes on the Prairie Dog. Theo. H. Sheffer, Manhattan.
46. Marine Animals of Puget Sound. W. J. Baumgartner, Lawrence.
47. Occurrence of Barium in Certain Common Weeds. E. H. S. Bailey and L. E. Sayre, Lawrence.
48. A Study of Petroleum. B. C. Frichet, Lawrence.
49. Origin and Development of Plant and Animal Instincts. L. C. Wooster.
50. Mineral Specimens. J. C. Cooper, Topeka.
51. Difficulties in Detecting Poisons. A. P. Cady, Lawrence.

Paper No. 2 was read by its author, A. A. Graham, and discussed.

Paper No. 32 followed, entitled "Accuracy of the Safety-lamp Test for Methane," read by author, C. M. Young, and discussed.

Prof. C. H. Sternberg read an interesting paper, No. 26, which was an account of his field work in Laramie county, Wyoming.

No. 25 followed, which was a charming account of the mud-wasp, illustrated with specimens of its work, and was read by the author, Mrs. L. C. R. Smyth, of Topeka.

No. 20 was a list of Kansas Beetles, by W. Knaus, who also gave, in No. 19, "Additions to the List of Kansas Coleoptera for 1910."

In No. 21 the same author spoke of various families of Coleoptera.

No. 30, "Erosion in Cool Moss-covered Regions," was an account by Mr. Twenhofel of his observations in Newfoundland and other places.

Professors Bailey and Sayre reported their investigations in finding barium in certain common weeds, in paper No. 47.

The Committee on Membership reported the following applications for membership in the Academy, and recommended their acceptance:

Prof. R. A. Cooley, Agricultural Experiment Station, Bozeman, Mont.
B. C. Trichot, Leavenworth.
A. A. Graham, lawyer, Topeka.
C. E. Hall, horticulturist, Hutchinson.
Roy Jones, student, Topeka.
C. F. Lee, Ph. D., M. T. S., Pittsburg.
R. K. Nabour, Manhattan.
L. M. Plairs, Manhattan.
David L. Randall, Ph. D., Baldwin.
M. C. Slagle, Salina.
Orestes H. St. John, Topeka.
W. H. Twenhofel, Lawrence.
Edith M. Twiss, Ph. D., Topeka.
Geo. N. Watson, Lawrence.
Stanley D. Wilson, Topeka.
W. B. Wood, Manhattan.

By unanimous consent, the rules were suspended, and by vote of the secretary the candidates above named were elected members of the Academy.

W. H. Harshbarger, having completed the payment of dues to the amount of $20, was elected a life member.

WEDNESDAY, DECEMBER 28—2:30 P. M.

Supreme Court Room.

The Nominating Committee for candidates for officers of the Academy in ensuing year reported as follows:

For president: J. M. McWharf, Ottawa.
For first vice president: A. J. Smith, Emporia.
For second vice president: J. E. Welin, Lindsborg.
For treasurer: F. W. Bushong, Lawrence.
For secretary: J. T. Lovewell, Topeka.

W. KNAUS,
J. A. YATES,
H. W. EMERSON,
Committee.

By unanimous consent rules were suspended and the ballot was cast by the president, and candidates above named were declared elected.

WEDNESDAY, DECEMBER 28—7:30 P. M.

Carnegie Library, Washburn College.

The Academy, in papers 42 and 43, was treated with lantern projections of lunar eclipse observations taken at the Washburn Observatory at time of late eclipse. Professor Woods also exhibited projections of some of his double-star observations, and gave a brief lecture on this work at the observatory.

The Academy was next invited to partake of refreshments, served by the Washburn faculty and young lady students, who provided a happy interlude to the papers and lectures.

President Dains then introduced Doctor Sanders, who, in his usual happy manner, spoke of the Academy and its work, and was followed by Professor Yates and others, in remarks equally felicitous.

THURSDAY, DECEMBER 29.

Supreme Court Room.

The Committee on Resolutions reported as follows:

Resolved, That we commend the practice of sending to the secretary the title of the paper and the time required for reading the same.

Resolved, That the secretary be requested to continue the compilation of the list of members of the Academy, appending to each name its academic title and the special line of work in which each member is engaged, and also the latest post-office address.

Resolved, That the thanks of this Academy are extended to its local members for their general good-fellowship and their royal entertainment at Washburn College.

Resolved, That the thanks of the Academy are extended to the local papers for their liberal reports of the meetings of the Academy.

J. M. McWharf,
J. E. Welin, *Committee.*

It was moved and carried that a committee of five be appointed to seek the assistance of the Board of Health in trying to procure legislation to prevent the use of mineral poisons in embalming fluids. Voted that retiring and incoming presidents be members of this committee. The other members, named by the chair, were Dr. C. F. Menninger and Dr. S. J. Crumbine.

At the suggestion of Mr. Withington, the secretary was directed to subscribe for the *Entomological News* for the Academy.

Moved and carried that the Executive Committee be authorized to buy, with the Academy's funds, such books and journals as they deem important for the library, when the same cannot be obtained by exchanges.

The Auditing Committee reported that they had found the treasurer's report correct. Adopted.

The Necrology Committee reported the death of a life member, Hon. J. R. Mead, of Wichita. Obituary notice to be prepared by secretary.

The reading of papers was then resumed.

In No. 36 Doctor Sayre discussed "Some Problems in the Drug End of Food-and-Drugs Law Administration."

Prof. J. E. Todd read "Notes on the Preglacial Channel of the Kansas River," No. 14.

No. 23 was a paper by Bernard B. Smyth, "America During the Bronze Age." Professor Smyth also read No. 24, "Harmonic Forms III—Paladin Squares."

No. 34, "The Trend of Pure-food Legislation," was given in abstract by Professor Bailey.

J. T. Lovewell read No. 33, "The Future Library of the Kansas Academy Book Collections in the State House."

In No. 7 Rev. B. F. Stauber gave in Miltonic verse a rhapsody entitled "Song of the Stars—Part I," which implied a promise that in some future session we shall have the pleasure of listening, in this pleasant way, to the author's speculations on cosmogony.

A. A. Graham, in Nos. 2, 3 and 4, discussed "The Origin and Distribution of the Human Race," "The Cause of Earthquakes and Volcanic Action," and "The Relation Between the Activity of Ground Bacteria and Climate."

Paper No. 48 was a "Study of Petroleum," by B. C. Frichet.

Prof. L. C. Wooster read a thoughtful paper on "The Origin and Development of Plant and Animal Instincts." This paper presented some new views and elicited considerable discussion.

Mr. J. C. Cooper exhibited a collection of interesting minerals, as No. 50.

Prof. H. P. Cady discussed "Some of the Difficulties in Toxicology Owing to the Use of Mineral Poisons in Embalming Fluids." It seems to need legislation to prohibit the use of such fluids.

The following numbers, mainly from absence of writers, were not read: Nos. 1, 5, 6, 9, 10, 11, 12, 13, 17, 27, 28, 29, 31, 37, 38, 39, 40, 44, 45, 46. All these were referred to the Committee on Publication.

I.

CHEMICAL AND PHYSICAL PAPERS.

1. "An Investigation of Millet."
   By L. E. Sayre, University of Kansas, Lawrence.
2. "Some Problems Connected with the Administration of the Drug End of the Food-and-drugs Law."
   By L. E. Sayre, University of Kansas, Lawrence.
3. "On the Presence of Barium in the Ash and Extract of Certain Kansas Weeds."
   By E. H. S. Bailey and L. E. Sayre, University of Kansas, Lawrence.
4. "Note on the Waters from the Sandstone in the Lawrence Shales."
   By C. C. Young, Chemist, State Water Survey.
5. "The Baking Qualities of Flour as Influenced by Certain Chemical Substances, Milling By-products, and Germination of the Wheat."
   By J. T. Willard and C. O. Swanson.

AN INVESTIGATION OF MILLET.

(Abstract.)

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

ON MARCH 8, 1910, I received a letter from O. O. Wolf, secretary of the State Board of Veterinary Examiners, Ottawa, Kan., enclosing a letter, which read as follows:

Dear Sir—Last week I wrote a party at Wakefield to send you a sample of millet, which I would be glad to have you examine.

The millet was grown on ground that had been in alfalfa for eleven years, and used as a hog pasture for nine years prior to the time of sowing the millet. It was thought, from the great amount of nitrogen that would naturally be stored up in the soil as a result of this treatment, possibly some cyanide had developed in the millet. Ten head of horses have died on the farm where this was grown, in a short time—since December 13, 1909. On the evening previous to that date the horses were fed millet, and one was dead in the morning. One died the next morning and one on the day following. Two of them were found dead in their stalls, while the remaining eight lasted from one to ten days. A young mare is still alive that has been ailing for over three weeks. They received no millet since the 15th of December.

They go down and are unable to get up. The one still alive can stand and get around when helped up. They lose control of the tail, have difficulty in swallowing, and seem nervous. Aside from that they are apparently normal; appetite good, temperature nearly normal, occasionally subnormal; pulse usually somewhat increased in frequency.

Will greatly appreciate any suggestion you may make.

Yours very truly, O. O. Wolf.

Two hundred and fifty grams of the above millet, consisting of leaves, stems and a few tops, were ground to a very fine powder by aid of the drug mill. The resulting powder was extracted by process of percolation, using as the menstruum an alcoholic solution—alcohol three parts and water one part. The tincture thus obtained had a decided green color, with a light brownish tint.

The tincture was evaporated to a small volume, 25 cc., at a temperature not exceeding 55° C., a fan, blowing hot, dry air over the tincture, being used to hasten vaporization.

To this concentrated solution 50 cc. of $N_{10}HCl$ were added, immediately causing a heavy resinous precipitate to be deposited. The acidulated solution was filtered into a separatory funnel and shaken out with immiscible solvents, using 15 cc. of ether twice and 10 cc. of ether twice, and again shaken with the same amount of chloroform. The residues left on evaporating spontaneously the etheral and chloroformic solutions were identical. Both residues were examined carefully through a microscope for crystalline forms, but none could be found. Both were of a yellowish-green amorphous substance, having a drug-like odor and a slight bitter taste. The yield was small, 0.0979 grams being extracted from the 250 gm. of millet. This residue or glucoside (?) was dissolved in 10 cc. of alcohol, 5 cc. being set aside for future examination and the other evaporated to 3.3 cc. at a temperature not above 55° C., and 3.3 cc. each of water and pure glycerine were added to the 3.3 cc. alcoholic solution of the glucoside, making 10 cc. of a 0.5 per cent solution of the glucoside.

This solution, on injecting it into the lymph sack of lively frogs proved to have a decided toxic effect, even in very small quantities. At present we are not prepared to state definitely the quantity of glucoside necessary to produce a fatal effect on frogs.

Control experiments, using the solvent of the glucoside only, demonstrated that the toxic effect was due to the glucoside present in the above solution.[1]

CHEMICAL ANALYSIS OF HUNGARIAN MILLET.

Air-dried Material.

Crude protein.	Fiber.	Ash.
6.7 %	31.6 %	0.23 %

Oven-dried Material.

Constant weight, 100° C.	Seeds.	Stems.	Leaves.
SiO_2	18.73%	24.32%	22 62%
$F_2O_3Al_2O_3$	4.15	4.62	3.85
CaO	14.55	11.48	13 44
MgO	2.78	1.82	2.85
KNaS	58.84	55.89	56.12
Totals	99.05%	98.13%	98.88%

ANALYSIS OF SOIL ON WHICH MILLET WAS GROWN.

Loss on ignition	11.04%
Alkalies (calculated as potassium oxide)	0.45
Acid insoluble	77.10
Ferric oxide	2.56
Alumina	6.34
Phosphorus pentoxide	.70
Calcium oxide	.83
Manganese oxide	Trace.
Sulphur trioxide	Trace.
Magnesia	.56
Undetermined	.42
Total	100.00%

From this examination it would appear that there was a toxic principle of glucosidal character residing in this specimen of millet;

1. For the study of physiological action I am indebted to Dr. Ida Hyde.

that the millet also contained an excess of alkali. It is probable that the soil had something to do with the large percentage of toxic principle, as it is well known that variation in soil constituents has a marked effect upon the increase in toxic principles where they are liable to exist. Millet under normal conditions has a diuretic effect and throws a vast amount of work upon the kidneys, which, when overworked, produce muscular disorders.

SOME PROBLEMS CONNECTED WITH THE ADMINISTRATION OF THE DRUG END OF THE FOOD-AND-DRUGS LAW.

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

SOME of the problems of administering the drug law relate to the question of meeting certain legal constructions of the law, which seem to evade the application of the spirit of the law, if not the letter. One of the cases in point is where a "cancer cure" was sold in Kansas City, Mo. The manufacturer was prosecuted under the food-and-drugs law, under the charge of shipping misbranded drugs, the government contending that the proprietor of the remedy implied on the label of his illegal remedy that *it would cure cancer*, and such an implication was an unwarranted falsehood; therefore the material was to be considered misbranded. When the United States grand jury indicted this "cancer cure," the manufacturer's attorneys filed a motion to quash the indictment on the ground that the food-and-drugs act applies merely to the composition or ingredients of the medicaments, and not to their therapeutic effects. In other words, the defense was that so long as an exploiter does not falsify on the label regarding the composition of his nostrum he may misrepresent with impunity concerning its effects. Strange to say, the position of the manufacturer was sustained by a federal district judge. Judge Philips said, in closing the case: "At no time in the debate in Congress was it proposed to hold the manufacturers of proprietary medicines to criminal liability for misstatements as to the curative value of their products. It is a strained construction to read it into the statutes. Statements on label of a bottle of medicine as to the curative powers, if regarded as 'misbranded,' is an entire misconception of the act. Statements as to curative powers would depend on the opinions of contending experts and upon the uses thereof."

Another case of where the apparent evasion of the law, or the spirit of the law, is made in connection with the question of the application of the letter instead of the spirit, may be illustrated by the following case: A pharmacist orders a well-known drug, and is supplied with an article labeled by that name, which, on examination, is found to be adulterated; but the proof that it is adulterated is not to be found in the official tests laid down in the United States Pharmacopœia. Since this particular adulterant is not considered under this article in the Pharmacopœia, the offender now claims that, inasmuch as the law contains the phrase "as determined by tests laid down therein" ("therein" meaning in the Pharmacopœia), no other tests can be legally applied to prove that it is adulterated. Now such a defense has not as yet been submitted to a higher court, but we are told that the best legal opinion is to the effect that this defense is good and sufficient. Should this prove to be correct, then the spirit of the law is certainly evaded; for, although the Pharmacopœia does not give a special test for the adulterant, it is nevertheless found to be adulterated, and as the Pharmacopœia cannot practically provide for every possible adulteration, then the failure to do this makes the practice of adulteration possible, and that particular form of adulteration which is not mentioned in the Pharmacopœia may be practiced *ad libitum*. It may be said that a defendant is entitled to the strict interpretation of the act itself, but if such interpretation is going to defeat the very object of the law, namely, to prevent adulteration, then certainly the law should be changed.

The United States Pharmacopœial Committee of Revision is now taking into consideration all such problems, and it has a great task before it to make the food-and-drugs law of real service to the people. But it stands to reason that the law itself, if, by its strict interpretation as it now reads, can protect any form of adulteration, should be changed in such a way that the law should read, in connection with the phrase above alluded to, namely, "as determined by the tests laid down therein," somewhat as follows: "A proof of adulteration may be established if the drug does not respond to the tests for the genuine, authentic material as described in the U. S. P., and if any test of the Pharmacopœia or other chemical tests show the presence of any adulterant." In such a case we have here what we may consider as a positive test, namely, a test which identifies the genuine material, and what we may call a negative test—one which shows the presence of material that is not the genuine article. Either or both of these may be applied to detect the adulterants.

ON THE PRESENCE OF BARIUM IN THE ASH AND EXTRACT OF CERTAIN KANSAS WEEDS.

By E. H. S. Bailey and L. E. Sayre, University of Kansas, Lawrence.

SOME time during the last year, at the suggestion of Dr. S. J. Crumbine, we made an analysis of ash of certain weeds growing in this state. It was thought that there might be some relation between the composition of the ash of these weeds and the acute disease, anterio poliomyelitis (infantile paralysis), which has been prevalent in Kansas as well as throughout other states within the last two or three years. As there was one case reported in Douglas county, one of us (Bailey), in company with F. Agrelius, on October 13, visited the locality, which is about twelve miles southwest of Lawrence, and collected samples of the weeds growing in the pastures where the cows were feeding. The milk of these cows had been used by the family. This was, however, not a typical case of infantile paralysis, as the family had not lived in this locality very long, having come from Osage county. The weeds growing in the pasture were of the ordinary variety found in upland pastures. As there was a swale with a small stream running through the pasture, some of the plants were more or less aquatic. The genera and species of the plants were identified by Mr. Agrelius.

For the chemical analysis, a convenient amount was ashed and special tests were made, after a few preliminaries, for the amount of ash, insoluble residue (iron, alumina, phosphoric acid, calcium oxide, magnesium oxide, and especially barium oxide).

The following weeds were found growing in the Moss pasture:

Goldenrod—Solidago altissima L.
Horsemint—Monarda fistulosa L.
False indigo—Amorpha fruticosa L.
Ditch stonecrop—Penthorum sedoides L.
Spanish needles—Bidens involucrata (Nutt.) Britton.
Goldenrod—Solidago rigida L.
Cottonwood leaves—Populus deltoides Marsh.
Three-seeded mercury—Acalypha virginica L.
Aster—Aster Lævis L.
        Aster dumosus L.
Sour dock—Rumex altissimus Wood.
False indigo—Baptisia leucantha T. & G.
        Aplopappus ciliatus (Nutt.) D. C.
False gromwell—Onosmodium occidentale Mack.

Sedge—Cyperus esculentus L. (?)
Willow leaves—Salix longifolia Muhl. (?)
Osage orange—Maclura pomifera (Raf.) Schneider.
Annual ragweed—Ambrosia trifida L.
Green foxtail—Setaria viridis (L.) Beauv.
Fetid marigold—Dysodia papposa (Vent.) Hitch.
Dandelion—Taraxacum officinale Weber.
Coral berry—Symphoricarpos orbiculatus Moench.
Thistle—Circium discolor (Muhl.) Spreng.
Ironweed—Vernonia baldwinii Torr.
*Mare's tail—Erigeron canadensis L.
Vervain—Verbena stricta Vent.
*Agrimony—Agrimonia parviflora Ait. (?)
Triple-awned grass—Aristida oligantha Mx.
Nimble Will grass—Muhlenborgia schreberi J. F. Gmel.
Horse nettle—Solanum carolinense L.
*Croton weed—Croton capitatus Mx.
Mullein—Verbascum thapsus L.
Lobelia—Lobelia syphilitica L.
Mallow—Sida spinosa L.
*Goldenrod—Solidago tenuifolia Pursh.
Dogwood—Cornus asperifolia Ms.
Mountain mint—Pyenanthemum flexuosum (Walt.) B. S. P.
Frog fruit—Lippia lancelolata Mx.
White clover—Trifolium repens L.
Blue grass—Poa pratensis L.
Crab grass—Digitaria sanguinalis L. Scop.
*Elder—Sambucus canadensis L.

Some of these were abundant, others were found only in small quantities. Those marked * were collected in sufficient quantities so that the ash could be examined. Others, which were found afterwards to contain barium salts, were collected in the vicinity of Lawrence in sufficient quantity for analysis. The plants collected locally were as follows:

Indigo—Baptisia leucantha T. & G.
Hedge—Maclura pomifera (Raf.) Schneider.
Ragweed—Ambrosia artemisiae folia L.
Horseweed—Ambrosia trifida L.
Ironweed—Vernonia baldwinii Torr.
Erigeron—Canadensis L.
Yellow dock—Rumex crispus L.
Wild lettuce—Sonchus asper (L.) Hill.
Corn—(white field).

* Large samples taken.

In table I is given an analysis for the ash, and the amount of barium and manganese found.

TABLE I.

No.	Common name.	Per cent ash. Ave. 2/2.	Per cent Ba., as $BaSO_4$, in ash.	Per cent Mn. in ash.
3790	Goldenrod	2 97	None.	.34
3791	Agrimony	2.55	.25–.27	.1137
3792	Mare's tail	4.05	None.	.122
3793	Croton weed	4.70	Trace.	.122
3794	Aplopappus ciliatus	14.84	.44	.044
3795	Sambucus (Moss)	1.69	.45	.128
3799	Ragweed	4.36	.18	.16
3800	Horseweed	7 55	None.	.079
3850	Ironweed	4 08	None.	.083
3851	Baptisia	2 31	None.	.096
3852	Osage orange	9.96	None.	.032
3853	Yellow dock	2 76	None.	.019
3854	Wild lettuce	2.77	None.	.075
3730	Oxytropis lamberti (Pursh)	15.89	.27	.091
3878	Sambucus (local)	1.36	.23	Undetermined.
3880	Equisetum hyemal (horse tail)	6.01	None.	.058

The soil of the Moss pasture was also examined, using the hydrochloric acid extract. In one sample no barium was obtained, and in another a trace. A little manganese was found to be present. The water of the small stream running through the pasture was also examined and found to contain no barium, but 0.0042 gms. per liter of manganese.

An examination was also made (table II) to determine the amount of insoluble residue (iron, alumina and phosphoric acid, calcium oxide and magnesium oxide) in the ash.

TABLE II.

No.	Per cent insoluble residue.	Per cent $Fe_2O_3+Al_2O_3+P_2O_5$.	Per cent CaO.	Per cent MgO.
3790	7.13	15.32	9 70	2 78
3791	23 65	22.77	17 15	2.11
3792	4 67	18.88	20 29	4.92
3793	26 34	4.30	45 95	6.26
3794	10.64	23.33	18.46	5.22
3795	3 36	14.37	21 99	6 20
3799	4 56	18 94	20 27	6.49
3800	3.41	22.20	17 65	3.48
3850	8 08	18 91	30 34	4.69
3851	1.96	19.65	41.00	5.53
3852	9 73	8 37	46.79	6 07
3853	15 71	9 14	6.75	6.67
3854	14.31	9 77	14.70	6 76
3730	65.22	13 11	13 02	1 85
3878	3.11	27.72	24 02	5 66
3880	65.97	6.25	12 37	1 5
3865	63.08	6.51	8 63	3.66
3855 (soil)	73.31	13.21	.44	.70
3798 (water)*	.0299	*.0183	*.1392	*.0456

* Grams per liter.

It will be noticed that the common plants containing barium are *Sambucus* (the elder), ragweed, *Aplopappus ciliatus*, *Oxytropis lamberti* (Pursh), and agrimony.

In regard to the occurrence of barium and its effect, attention is called to the article by Albert C. Crawford on "Barium and Cause of the Loco-weed Disease," Bureau of Plant Industry, Bulletin No. 129, and more recent articles on the same subject. Here are many quotations as to the effect of barium on the system, and also feeding experiments of barium salts on animals in the laboratory. Among the other symptoms mentioned, paralysis is noted. In the Bulletin of the Agricultural Experiment Station, University of Nebraska, part I, 1905, is a report on poisoning of cattle by certain weeds, some of which produce some of the symptoms of paralysis.

It is a well-known fact that cattle, during August and September, when there is often lack of rain and the forage is scarce, will eat such plants as ragweed and the green sprouts of *Sambucus*. There was no opportunity to feed cows on such fodder exclusively, to determine whether the milk secreted would contain barium and manganese. Such experiments would be of interest.

From the pharmaceutical laboratory the results in connection with this report are as follows:

So far as the relation of barium constituent in connection with the disease called "locoism" is concerned, the experiments in the pharmaceutical laboratory, under the immediate supervision of Mr. James T. B. Bowles, indicate that while barium may be a very large factor in producing the disease, there is an indication that there is another principle which the *Astragalus* contains that acts as a poison to guinea pigs. For example, 400 grammes of the finely divided *Astragalus* was macerated with Prollius fluid and perfectly exhausted by the fluid. This was evaporated to dryness and the residue purified with 90-per-cent alcohol. The alcoholic residue was disolved in water, made slightly alkaline, and shaken out with chloroform, and afterward with ether. The ethereal solutions were evaporated to dryness, purified with 95-per-cent alcohol, and again evaporated to dryness. This residue was dissolved in diluted hydrochloric acid. Two cc. of this solution was injected intraperitoneally into a 375-gram guinea pig. The pig first had the nervous twitching of its head, followed with rapid respiration; dullness came on, and then spasms at intervals, which threw the pig into convulsions. The pig finally died in convulsions forty minutes after having been injected with the solution. *Post-mortem* showed that the stomach was quite inflated; the intestines, liver, heart and spleen were normal. The effect seemed to be upon the nervous system.

In experimental work upon the subjoined list of weeds, the idea in the pharmaceutical laboratory was to ascertain whether the barium, if present, would be imparted to a digestive fluid or would be rendered soluble in an artificial gastric fluid. The weeds were ground very finely; 250-gram samples were used. One portion was macerated with water in the cold, while another was boiled for eight or nine hours after macerating. The samples were then digested with artificial gastric fluid. In making the gastric fluid double the amount of pepsin was used as prescribed by the United States Pharmacopœia in the pepsin test. Each sample was digested for two and one-half hours at body temperature. Barium was found only in four samples of the weeds, which will be indicated in the table below. The method used for determining the barium was that used by Crawford, of the Bureau of Animal Industry. The solutions were concentrated and acidified with hydrochloric acid and then precipitated by means of sulphuric acid. The precipitate was collected and weighed as barium sulphate.

In testing the manganese content the persulphate method was used, and manganese was found in the digestive fluid, as indicated.

		Barium, per cent per gm.	Manganese, per cent.
3790	Solidago tenuifolia	....	0.21
3791	Agrimony parviflora	0.21	....
3792	Erigeron canadensis	....	....
3793	Croton capitatus	....	0.06
3794	Aplopappus ciliatus	0.36	....
3795	Sambucus canadensis	0.37	....
3799	Ambrosia artemisiæfolia	....	0.10
3800	Ambrosia trifida	....	....
3850	Vernonia baldwinii Tarr	....	0.06
3851	Baptisia	....	0.07
3852	Osage orange	....	0.25
3853	Rumex crispus	....	....
3854	Sonchus asper	....	....
3865	White field corn	....	....
....	Equisetum hyemale	....	....
....	*Oxythropis lamberti (Pursh)	0.26	....

* Meade county, near Meade, Kan.

NOTE ON THE WATERS FROM THE SANDSTONE IN THE LAWRENCE SHALES.

By C. C. YOUNG, Chemist, State Water Survey.

THE water-bearing formations of Kansas usually yield what is termed hard waters. However, there are at least two distinct formations from which soft waters may be obtained. These are the Dakota sandstones of western Kansas and the sandstones in the Lawrence shales. The latter are sometimes termed, at the southern outcropping, the "Chautauqua sandstones."

The Chautauqua sandstones give us the best examples of soft waters that we have in the state. In fact, they resemble very closely the waters which come from the massive granite in the Appalachian system. These water-bearing sandstones extend almost entirely across the state from Leavenworth to Sedan. Mr. Adams has given a good description of them in volume III of the Kansas Geological Survey.

The author has recently had occasion to examine three springs near Fall river, in Elk county, the analyses of which appear below, the determinations being calculated to their probable combination to better show the character of the water.

ANALYSES.

	Grams per liter. *1*	Grams per liter. *2*	Grams per liter. *3*
$NaCl$	.0132	.0099	.0066
Na_2CO_3	.0060	.0080	.0052
Na_2SO_4	None.	Trace.	.0011
$CaCO_3$	.0073	.0097	.0068
$MgCO_3$	.0052	.0061	.0052
Fe_2O_3, Al_2O_3	Trace.	Trace.	.0003
SiO_2	.0127	.0152	0134
Total grams	.0444	.0489	0386
Total grams per gal	2.359	2.856	2.237

In volume VII of the Kansas Geological Survey Doctor Bailey has given, under "Soft Water Group," analyses of several other springs in these localities, and a glance at their location will show in a measure their extent.

	Grains per gallon.
Linwood spring, Leavenworth county	9.90
California spring, Franklin county	6.13
Kansas Clarus spring, Woodson county	20.83
Delaware spring, Wilson county	8.27

The analyses which appear above show these waters to be as soft as some of the most noted springs in the world. The author intends, as time goes on, to make a complete survey of all the springs in the Lawrence shales yielding soft water.

THE BAKING QUALITIES OF FLOUR

As Influenced by Certain Chemical Substances, Milling By-products, and Germination of the Wheat.

(ABSTRACT).

By J. T. WILLARD and C. O. SWANSON.

THE milling tests of wheat and baking tests of flour conducted by the department of chemistry began in 1905, when an experimental reduction mill was purchased. During that year Mr. W. E. Mathewson, in a research conducted as a part of his work for the master's degree, made very careful analyses of several flours, including determinations of the percentages of each of the distinct proteids present, and compared their chemical composition with their baking qualities as shown by baking tests made for us in the department of domestic science. At that time the statement was frequently made, and perhaps is, even to-day, that the ratio of the gliadin to the glutenin of the flour determines its baking qualities. Mr. Mathewson's results threw grave doubt on this supposition, and all subsequent investigations in the department have confirmed the view suggested at that time, namely, that the chemical factors entering into the baking quality of flour are more complex than that. Flours may be very good in their content of gliadin and in the gliadin-glutenin ratio, and yet be inferior in baking qualities to others with supposedly less favorable composition. Of two flours essentially the same in respect to these data, one may be very good and the other very poor.

As a result of such observations the department has been conducting numerous experiments designed to throw light on the subject of baking quality in flour. Many of these do not come within the scope of the present paper, which is concerned with the effects of the addition of certain substances to the flour. These tests were suggested by the thought that, inasmuch as considerable differences in respect to the gliadin and the gliadin-glutenin ratio did not in themselves appear to influence the results much, it might easily be true that the difference in baking qualities exhibited might be caused by substances present in very small amounts. It will be recalled that capacity to produce a good loaf depends on the quality of the gluten that a given flour can yield, other conditions being favorable. Gluten does not exist as such in the flour, but is produced, in a manner not altogether understood, from constituents existing in the flour, chiefly the gliadin and the glutenin, when the flour is stirred with water.

Gliadin is a gluey, adhesive substance which binds the glutenin and other constituents of the flour together in the dough and produces the well-known condition so essential to the production of good bread, in which the carbon dioxide produced by yeast is held in small bubbles that give the loaf its lightness. If the gluten is too weak the partitions between the globules are broken, and globules coalesce, with the production of coarse-grained bread. A weak gluten will yield under the weight of the loaf, and, instead of rising in a well-rounded form, will flatten out and run over the edge of the pan, if possible. The production of a good loaf depends on the physical properties of the gluten. It is well known that small percentages of substances may cause very great differences in the physical properties of mixtures. It is, therefore, quite reasonable to expect that the physical properties of gluten may be profoundly affected by small quantities of associated substances. This would be a purely physical phenomenon. It is, however, also possible that small quantities of substances may influence the character of the loaf in an entirely different manner, by favoring or inhibiting, as the case may be, the growth of the yeast.

It is well known that graham flour lacks the power to yield as round and light a loaf as does white flour produced from the same wheat. This fact suggested experiments to ascertain the effect of substances in the bran and shorts the action of which is excluded from white flour. These effects were tested in different ways, which will be detailed later, using bran, extracted bran, extract from bran, extract from wheat scourings, etc.

Recent research has shown that the protein substances consist in large part of nuclei derived from a considerable number of amino acids. It is highly probable that, in the growth of the yeast in the flour, hydrolysis of the proteins takes place with the liberation of some of these amino acids, and it is possible that they play an important part in the development of the yeast, or affect the physical properties of the gluten. A part of our study in this connection then, has been to ascertain what effect, if any, the addition of small amounts of amino acids has on the character of the loaf produced. As but few of the amino acids represented in proteins are to be purchased in the market, our experiments in this line are not completed as yet. It is planned to import as complete a list of these substances as can be obtained for continuation of this investigation.

A considerable number of observations are made in connection with each baking test, and a detailed study of any set of these would involve considerable time and the inspection of many figures —a proceeding that would be wearisome to all not especially interested in this line of work. In most cases, therefore, only the figures for loaf volume are presented.

In addition to the experiments using amino acids, others have been made with salts such as might be present in the flour or that are related to them.

The accompanying table exhibits the results obtained with bran, etc. If bran were merely a diluent, and without active effect on the gluten, we should expect that the quality of the loaf would be affected by incorporating a considerable percentage of it with the flour. To offset this effect of dilution a loaf was made in which an equal weight of starch was used instead of bran, starch being presumed to be without specific influence, or, at least, without much influence except as a diluent. In all of our baking tests a check loaf is baked from the untreated standard flour, and with this, as a rule, all others are to be compared. The difficulty of conducting exactly comparable baking tests is such that, without such a test loaf produced by a parallel treatment in each baking, it would be impossible to draw any conclusions. Of the results obtained with the bran, in addition to loaf volume, there is presented the scoring as to texture, and total time in minutes required for the rising.

The bran used in these tests was free from scourings or screenings of any kind. In preparing the extracts, 500 grams were treated with 2000 cc. of water. The bran was allowed to soak over night, and then placed on linen and the extract squeezed out. The residue was treated several times with additional portions of water in preparing the washed bran. In extracting hot, the bran was boiled about ten minutes with water, then washed several times on linen with hot water, the water being squeezed out.

The table shows that the unextracted bran had a notable deteriorating effect on the loaf, in respect to both volume and texture, as compared with the check loaf or with the loaf to which an equal weight of starch was added. The extracted bran was less marked in its effect on loaf texture, and the loaf volume exceeded that of the loaf in which starch was used. The loaf in which the extract from 40 grams of bran was used was the best of all. The fact that extracted bran and bran extract each produces better results than when the two coexist in the enextracted bran is something that would not have been expected, but which was confirmed by the repetition of the test.

EFFECT OF BRAN, BRAN EXTRACT, AND STARCH.

	Time for total rise, minutes.		Loaf volume.		Loaf texture. 100=Perfection.	
	I	*II*	*I*	*II*	*I*	*II*
Check	173	162	1430	1410	95	95
Starch, 40g	168	159	1290	1290	95	95
Bran, 40g	154	143	1260	1250	91	91
Bran, extracted by cold water, 40g	148	137	1380	1370	92	92
Bran, extracted by hot water, 40g	142	137	1300	1310	92	92
Extract from 40g. bran, cold water	136	127	1520	1540	96	96

LOAF VOLUME AS AFFECTED BY DIFFERENT SUBSTANCES.

SUBSTANCE ADDED.	Minimum amount.	Times minimum amount—					
		0	1	2	4	8	16
Bran extract, cold extraction	2.5g.*	1480	1490	1410	1510	1520	1520
Bran extract, cold extraction, filtered	2.5g.*	1470	1500	1520	1550	1550	1550
Bran extract, hot extraction	2.5g.*	1400	1420	1440	1520	1550	1560
Wheat-scourings, extract I	2.5g.*	1450	1480	1500	1520	1540	1490
Wheat-scourings, extract II	2.5g.*	1360	1460	1280	1360	1260	1190
Peptones	0.4g.	1380	1390	1370	1280	1300	1320
Glycocoll, $CH_2(NH_2)$, COOH	0.1g.	1380	1330	1270	1240	1180	1180
Leucin, $(CH_3)_2$, CH, $CH_2(NH_2)$, CH, COOH	0.025g.	1380	1340	1280	1270	1360	1330
Aspartic acid, COOH, CH_2, $CH(NH_2)$, COOH	0.1g.	1460	1470	1460	1420	1500	1530
Asparagin, CO NH_2, CH_2, $CH(NH_2)$, COOH+ H_2O	0.1g.	1440	1410	1380	1380	1300	1370
Ammonium acetate, CH_3, $COONH_4$	0.1g.	1440	1490	1490	1500	1520	1500
Ammonium tartrate, NH_4OOC, CHOH, CHOH, $COONH_4$	0.1g.	1460	1470	1450	1520	1550	1400
Ammonium chloride, NH_4Cl	0.025g.	1300	1420	1260	1520	1600	1610
Ammonium phosphate, $(NH_4)_2HPO_4$	0.1g.	1470	1470	1470	1470	1440	1430
Sodium phosphate, Na_2HPO_4	0.4g.	1430	1450	1460	1400	1410	1420
Sodium bicarbonate, $NaHCO_3$	0.1g.	1330	1370	1350	1210	1170	1170
Sodium formate, H, COONa	0.1g.	1550	1530	1500	1470	1550	1500
Potassium nitrate, KNO_3	0.1g.	1500	1480	1440	1500	1520	1520

* These figures show the weights of material extracted.

The second table gives data concerning the effect of various substances on loaf volume. Bran extracts were used in quantities obtained from weights of bran in geometrical ratio. The larger amounts produced greater effects in the same direction. In the case of the loaf with which extract prepared with hot water was used, the largest amount caused a poorer texture of loaf, and with the other two cases the deteriorating effect of the increased quantities was manifested when the extract was used in still less amounts.

The effects of extracts derived from wheat scourings are, on the whole, undesirable, though in respect to loaf volume this does not appear in one of the trials. The doughs produced were sticky and undesirable, and the effects were more pronounced with the larger quantities of extract.

When peptones were added to the flour in amounts of from 0.1 gram to 1.0 gram but little effect was observed, but with larger quantities they were deleterious to the texture and loaf volume. Their most marked effect was in producing a notable stickiness in the dough. Peptones were tried because of their relation to proteids and amino acids, being intermediate in chemical complexity and structure.

Glycocoll was very pronounced in its effects, producing a dough that was sticky, runny and stringy. It would stretch out like taffy, but lacked in elasticity. It resembled the dough produced from flour made from badly germinated wheat. The loaf volume was distinctly reduced and the texture impaired.

The effects of leucin were similar to those of glycocoll, but not so pronounced. It caused, however, the development of a very disagreeable odor.

Aspartic acid did not have any very great effect, but such as was produced was beneficial rather than otherwise.

Asparagin, however—the amide of aspartic acid—was injurious in its effects. While it caused a shortening of the time of rising, probably by a stimulation of the growth of the yeast, it weakened the gluten, thus decreasing the oven expansion and loaf volume. Similar effects are observed with flour from germinated wheat, and asparagin is well known as one of the products of the proteid metabolism accompanying germination.

Of the ammonium salts tried, ammonium chloride had so marked an effect that the quantities used were cut down to a minimum of 0.025 gram. This amount and up to sixteen times as much, at least, had a most pronounced beneficial effect on the texture and loaf volume. The salt apparently assists the growth of the yeast, as the period of rising is shortened. Ammonium acetate has a similar but much less marked effect. In the larger amounts, however, it impaired the quality of the loaf in respect to texture. Ammonium tartrate had a very slight effect, and the same is true of ammonium phosphate. In the latter case the results upon the six loaves might almost be taken as an example of concordance of parallel uniform tests.

Sodium bicarbonate was distinctly detrimental in its effects, increasing the time of rising and diminishing the volume of the loaf. Sodium phosphate, sodium formate and potassium nitrate do not call for any special comment at this time.

On the whole, it is evident that chemical substances in many cases have distinct, and in some cases very pronounced, effects upon the baking qualities of flour, and it is believed that a field has been opened that will repay further working. It is highly probable that the differences in the baking quality of flours are due to small differences in their content of these and similar substances as much as to their differences in composition in respect to the chief constituents.

BAKING TEST ON FLOUR FROM GERMINATED WHEAT.

NUMBER.	Loss in germination and drying....	Loss in scouring.........	Per cent total loss....	Per cent of moisture....	Per cent of absorption..	Time of rising.	Weight of baked loaf, g.	Volume of loaf, cu. in..	Per cent gliadin is of protein.....	Amino-nitrogen × 6.25..
1...........................	83	75	5.5	11.07	59.2	1:52	515	83	52.4	0.136
2...........................	43	86	4.3	12.00	52.5	2:13	509	88	52.7	0.144
3...........................	100	80	6.3	11.37	50.8	2:03	504	93	55.8	0.184
4...........................	149	200	11 6	11.67	49.17	2:17	498	84	55.8	0.247
5...........................	250	452	23.4	10.65	47.5	2:55	492	84	56.5	0.351
6...........................	54	52	3.5	11.55	54.2	1:58	515	97	50.7	0.192
7...........................	160	63	7.4	8.50	56.67	2:25	524	69	43.4	0.512
8...........................	0	23	1.6	11.71	56.67	1:25	524	85	48.4	0.128

Considerable study has been made of the effects of germination of wheat upon the baking qualities of flour produced from it, and the effect of such flour when mixed with flour from sound wheat. As germination produces amino compounds, it was to be expected that somewhat similar results would be obtained with flour made from germinated wheat as with flour to which amino compounds had been added. This was found to be the case. The accompanying table shows part of the results obtained in this connection. No. 8 is the check, and shows the results obtained with sound wheat. Nos. 1, 6 and 7 were germinated one day; No. 2, two days; No. 3, three days; No. 4, four days, and No. 5, five days. In the germination the wheat was placed between layers of cheesecloth on a bed of wet sand, the whole being sprinkled four times a day. All of the samples but No. 6 were covered by muslin bags which had been soaked in a solution of formaldehyde. This was for the purpose of preventing mold. All of the germinated samples excepting No. 7 were spread out on a cloth on the floor to dry. No. 7 was dried for two days in a steam oven instead of on the floor. The weather was warm, and two days' exposure to conditions for germination gave results that were readily perceptible to the eye. The table shows the more interesting data obtained. Up to the third but little effect on the baking quality was observed. After that the loss on germination became very noticeable and the quality of the bread deteriorated. While the loaf volume was increased for the first three days, after that it dropped back, and accompanying this there was a noticeable deterioration in the texture of the crumb. In the case of No. 7, which was dried by steam heat, a very serious injury to the flour was observed. This is shown in part by the small loaf volume. The texture of the loaf was very poor, and the alcohol-soluble protein considerably diminished.

In a second series of experiments baking tests were made with standard flour, and with flour made from badly germinated wheat, and with various mixtures of the two. The deleterious influence of the flour from the germinated wheat was strongly manifested even when only one-thirtieth of the mixture was flour from such wheat. With larger amounts the product showed that the mixtures were wholly unfit for bread making. The evil effects of mixing wheat damaged by germination with sound wheat was brought out for the first time by these experiments. Such wheat may be manipulated so that when mixed in small quantities with sound wheat it can scarcely be detected.

II.

GEOLOGICAL PAPERS.

HISTORY OF WAKARUSA CREEK.

By J. E. Todd, Lawrence.

WAKARUSA CREEK presents several peculiarities which attract attention. It is one of the few streams of Kansas which run due east throughout its course. It has a valley rivaling in width that of the Kansas. It shows in unusual degree the presence of red boulders from the north, and these have a peculiar distribution. Moreover, there are a few cases of so-called "stream piracy" and changes of channel.

The writer's attention was drawn to this stream because of its evident relations to the glacial deposits of the state, the study of which he has undertaken for the State Geological Survey, and it is with the permission of the director, Doctor Haworth, that this paper is presented at this time.

The writer's acquaintance with the subject has been much accelerated by information received from Doctor Haworth, Mr. Bennett and others of the Survey and by articles published by Messrs. Mudge and Hay, and particularly from the papers of Mr. Smythe, who published a map showing some of the more significant features.

The basin of the Wakarusa is about fifty miles long and from ten to fifteen miles wide. Its topography is quite varied, which is a natural result of erosion on its geological structure. The bedrock consists of several thin layers of limestone alternating with thick beds of shaly clay, including some not very extensive lenses of soft sandstone. All these dip slightly to the northwest. The larger streams have an easterly trend, or in an opposite direction to the dip. Conspicuous features, therefore, are several zigzag escarpments, the eastern edges of as many narrow rock-terraces, crossing the country in a north and northeasterly direction. Where these cross divides they make them considerably higher; where they cross streams their valleys are narrow and rocky. The principal one, and farthest east, is that of the Oread limestone. That of the Topeka limestone is less marked, while that of the Burlingame is more prominent and crosses only the headwaters. Below the last are the Scranton and Severy shales, 125 to 150 feet thick, which correspond to the low divide south and southeast of Topeka. Beneath the Oread are the Lawrence and LeRoy shales, 250 to 275 feet thick, which account for the great width of the lower part of the Wakarusa valley and its junction with the Kansas.

Following Ferrell's law, the streams of the basin have generally shifted to the south as they have cut down, so that the terraces are generally on the north and the abrupt bluffs are upon the south. The few changes of channels are toward the north, or down the dip.

TRACES OF DIFFERENT DRAINAGE LEVELS.

Evidences have been found of three or four different levels of drainage:

1. The highest and oldest noted is marked by stratified chert gravels several feet thick, capping the divide, five to seven miles south of Auburn. Their altitude is about 1200 feet.

2. The second consists of higher bouldery patches, showing a comparatively level surface of deposition either of streams or of land ice. This feature shows particularly south and somewhat north of the middle portion of the stream and of its valley about Clinton and eastward. These patches lie from 150 to 200 feet above the present streams.

3. In the eastern portion of its valley, limited and detached fragments of a lower level, more distinctly resembling a boulder-capped terrace, are found, 125 to 175 feet above the Wakarusa. The Three Sisters and a similar flat-topped hill east are the best examples.

Possibly these are but a lower continuation of the preceding, below rapids, by which the Wakarusa may have first crossed the Oread limestone. These are more clearly the result of stream action, and no boulder patches of the preceding kind are known as far east.

4. The clearest marked level may be called that of the lower bouldery terraces. It is marked by very impressive strips of red quartzite boulders from six inches to six feet in diameter. These strips are frequently entirely composed of boulders for a thickness of ten or twenty feet, and the depth of the bouldery deposit, including much sand and finer material, is sometimes forty or fifty feet. The upper portion, where it has not been subject to erosion, is frequently quite fine loam. Where erosion has been most active and the adjacent deposits soft, these strips stand out as ridges, which from their bouldery composition and linear form have been mistaken for moraines. This condition is perhaps best exhibited near Burnett's mound, southwest of Topeka. More frequently one side is eroded, with cross ravines revealing a cross-section of the old stream bed, with one bank remaining. Such is the case near Berryton, Tevis and Auburn. Sometimes the banks are traceable on both sides, as north of Pauline and southwest of Clinton.

The system marking this level consists of the main stream, following approximately the present Wakarusa, and three branches from the north, viz.: The Auburn branch, which came over from Mission creek by a col. east of Dover, and down the present North branch, past Auburn; the Pauline, or Lynn creek, branch, which came over from Shunganunga creek, east of Burnett's mound, ran south and southeast a little north of Pauline, and then divided, part continuing southeast and the other turning more east, past Berryton and Tevis; the Stull branch, which came over the divide north of that place and followed the present course of Deer creek. The summit of these deposits is about 100 feet above the present streams toward the west, and less than eighty feet toward the mouth of the Wakarusa. From U. S. topographic maps and barometer readings, the following altitudes have been calculated: Col. east of Dover, 1050 A. T.; top of terrace near Auburn, 1100; top of ridge east of Burnett's mound, about 1050; top of alluvium covering channel, north of Pauline, 1030; the same southwest of Clinton, 950. At the latter place a good cross-section of the old filled trough is shown, by a more recent diversion of the stream to the north. It is about forty feet deep and one-third of a mile wide. The lower Oread limestone forms its bottom and the upper Oread the banks on either side.

5. Lower terraces are locally developed, and the present stream is twenty-five to thirty feet below the present narrow flood plain.

DISCUSSION OF THESE FEATURES.

A study of these features promises to be more satisfactory if we begin with the simpler first. This will be the direct reverse of chronological order. The lower terraces are easily understood and comparatively unimportant.

1. The lower bouldery terrace, from structure and position, shows clear evidences of having been formed when the ice sheet was close at hand. The flowing of copious streams over the divide between the Wakarusa and the Kansas shows conclusively that the valley of the latter was effectually blocked in some way, doubtless by the marginal portion of the great ice sheet of the so-called Kansan epoch of the glacial period. The excavation of the channels was evidently done by the water from the ice. The Auburn branch was probably an outlet from a glacial lake in the Mission creek valley, the Pauline branch one from a similar lake in the Shunganunga valley, and the Stull branch probably came directly from the edge of the ice. The second was the largest and longest occupied. In other words, they might be considered "valley trains"

from the ice front. The boulders accumulated as the strength of the current declined from the subsiding of the waters from some cause, either by diminution of the rate of melting or the diversion of the flood down the Kansas valley from the melting back of the ice front. That temporary floods still occupied the older channel from time to time is inferred from the deep silt capping overlying the gravel and boulders.

2. The problems furnished by the bouldery patches and the higher bouldery terraces are much more complex and difficult. We think best to treat them separately, though there are reasons for thinking them possibly contemporaneous. The bouldery patches are a mere veneering of boulders over elevated points not quite up to the general upland level. There is not enough of clay or gravel associated with them to show whether they are the deposit of land ice or of shallow streams or irregular lakes. It seems that they may be arranged into channel-like strips, but the patches are so detached that the appearance may be illusive. Four possible explanations present themselves: First, that they are the work of a pre-Kansan ice sheet. Second, the work of a more advanced stage of the Kansan sheet, postulating that that sheet lingered long enough afterward to erode channels 100 feet deep and to fill them as contemplated under the head already considered. Third, they may be the work of shallow streams wandering over the plain in front of the Kansan sheet before Wakarusa valley had been begun. A fourth view may be that that they are the deposits of a temporary glacial lake formed in the valley of a small tributary of the Kansas, which may have flowed northward along the line of Coon and Oakley creeks, and which was dammed by the advent of the ice sheet.

In favor of the first supposition, it may be urged that traces of such an advance of the ice have been found as near as southwestern Iowa, and that it would easily afford adequate time for the erosion of such a valley as we have found in existence during the Kansan stage in the terrace already discussed. Against such a conclusion, however, is the apparent impossibility of conceiving an ice sheet covering these areas south and southeast of Clinton, without leaving traces of its presence over wide areas where no trace is found. For example, no traces are found on the higher points of the divide north of the Wakarusa from north of Stull eastward, and no traces south of the Wakarusa on this level west of Rock creek.

In favor of the second theory, the size of some of the boulders, viz., five to six feet in diameter, would be some evidence of glacier action, rather than water, but the objection so strong against the former view would be quite as cogent here. Besides, the difficulty of conceiving the Kansan stage to linger long enough to erode a deep valley and partially fill it again is quite serious.

The third view harmonizes well with the possible arrangement of the patches in channel-like lines, with their being on lower levels than others near by which are bare of drift, and it also evades easily the difficulty of the patches being so far from other clear traces of glacial occupation. But it does not avoid the great erosion demanded during the Kansan ice stage. Some will find serious difficulty in accounting for transportation of such large and so many boulders by water. This may be obviated, however, by remembering the efficiency of river ice. Anchor ice may have been more efficient at that time, also, and ice blocks from the glacier front may have assisted.

The fourth explanation is favored by all that favors the last, and it reduces indefinitely the demand for so long a time for erosion during the Kansan stage, for there would be in this case only need for the cutting down of narrow divides under favorable conditions. Another difference would be that it conceives the distribution of boulders by lake ice more than by river ice, though both are involved more or less in each explanation. The conception is that instead of the single valley of the Wakarusa, there were two or three tributaries running northeast into the Kansas between Topeka and Eudora. The Oread limestone formed the divide between the eastern one and the one next west, which, as has been already stated, probably followed the line of Rock, Coon and Oakley creeks northward. There may have been another divide corresponding to the Topeka limestone crossing the valley somewhere near Richland. According to this view the coming of the ice blocked the lower courses of these tributaries, changing the one west of the Oread divide into a lake, in which for some time ice blocks from the glacier front floated, distributing boulders. Eventually the waters rose and broke over the divide eastward. The fall was at first considerable, for the stream then occupying the present lower course of the Wakarusa was not obstructed, but ran on the preglacial level of the Kansas, which was only about 100 feet above the present stream. The Three Sisters and other boulder-capped hills east were probably portions of the old channel of that time.

3. The stratified chert gravels were indefinitely older and of

streams of uncertain direction. Little time has been spent on them. They may be of Cretaceous time, the work of a stream flowing into the Cretaceous sea a little farther west; or, more likely, they may have marked the eastward course of a Tertiary stream, a pioneer of the present eastward drainage, flowing across the divide before the Kansas had swung into its present course, and long before it had excavated its present valley.

SKETCH OF THE HISTORY OF WAKARUSA CREEK.

Putting the foregoing conclusions into chronological order, we may sum up as follows:

Following or attending the elevation of the Rocky Mountains, at the end of Cretaceous time, the great plains became dry land and sloped more and more toward the east. As a result, rivers began flowing in that direction, possibly, though not certainly, outlining something like the present Missouri system. There is considerable evidence that at first they ended in playa lakes and that there was much aggradation and building up of alluvial plains. Eventually they made their way through to the line of the Missouri or its predecessor, and the chert gravels may have been formed about that time, before valleys had been deepened to any great extent.

During the Tertiary there was first deposition and building up of the Great Plains, but later erosion lowered the principal valleys till, at the beginning of the Pleistocene, or at least when the ice sheet arrived, they were about 100 feet higher than at present. This is attested by remnants of preglacial gravels near St. Marys and Topeka, and other marks of its position near Manhattan and St. George.

It is probable, as already suggested, that two or three short tributaries of the Kansas flowed northward across and along the present course of the Wakarusa. The eastern one may have headed west of Vinland and followed approximately the course of the Wakarusa eastward. The second may have headed in Rock creek valley, received waters from Camp creek and Deer creek from the west, and flowed along the line of Coon and Oakley creeks to the Kansas. This theory has not been tested in the field. The drainage of the area west of the Topeka limestone may have also gone northward independently, or it may have joined the stream just sketched.

DURING THE PRESENCE OF THE ICE SHEET.

The ice, gradually approaching from the north, doubtless swelled the streams receiving its water, and increased their erosion and the coarseness of their deposits. In fact, the gravels marking the preglacial channel have some northern pebbles mingled with the upper portion of the prevalent chert pebbles from the west. Eventually the ice reached the Kansas valley and soon filled it from near Lake View to Wamego. West of the latter point was formed a large lake, first recognized by Robert Hay twenty years ago, and named later by Mr. Smythe "Kaw lake." There were probably several other smaller lakes in various tributaries of the river, one of them being, as we have suggested, in the valley of Rock creek. It should be remembered that the whole western edge of the ice sheet from Montana south must have had its drainage turned first into the Kansas, and at the stage now considered, diverted over into and along the present valley of the Wakarusa. The result was that one after another the valleys became lakes and overflowed the divides, at first by very winding, irregular and shallow courses, scattering boulders, in some cases pushed along by the current of the stream, but frequently by river ice or by blocks from the glacier itself. To such conditions we are disposed to refer the highest bouldery patches south of the Middle Wakarusa. Soon the water began flowing over the Oread limestone into the easternmost valley and began to form the bouldery channel of which the Three Sisters are the more notable remnant. For a time, doubtless, quite a cataract existed a little west, as the Lawrence shales were cut out by the falling water, and the Oread was cut through rapidly. One effect of such a situation would be that the stream would frequently shift because the shale would cut away more rapidly than the bouldery bed of the stream. The course was cut back over the old channel south of Clinton, as already indicated.

The front of the ice sheet was meanwhile looking over the divide at several points, and streams past Stull, Pauline and Auburn were at their prime and rapidly eroding, for the slope was steep for such large streams. It might perhaps be supposed that most of the peripheral stream would have come over at Dover, but judging from the deposits, the Pauline branch was the largest and longest occupied. Before the ice had receded much, the streams had cut down to the level of this lower bouldery terrace. At that time the Wakarusa still flowed south of Clinton, and Deer creek did not join it till several miles further east. The latter stream, not having to cut down through the Oread so deeply—perhaps because it had taken advantage of the previous erosion of the preglacial stream, or, more likely, from some other advantage of direction of joints or softness of rock, or possibly because of the northern dip of the rocks or the more rapid filling of the channel of the other with drift—had cut lower than the Wakarusa a few miles south. The seepage from the latter, down the dip and in the direction of main joints, conspired to the final result. A branch from Deer creek finally captured the Wakarusa west of Clinton and diverted it northward past Belvoir along the course it has since followed. This may have been about the time the ice began to recede, but it cannot be stated with definiteness.

SINCE THE DEPARTURE OF THE ICE SHEET.

The Wakarusa was at its greatest development when the ice was at its prime. When warmer days forced the ice to recede, very soon the waters which had been forced over the divide south began again to follow the larger valley of the Kansas, as they had done before. This left the Wakarusa again to its own resources alone, to rainfall only. Erosion, therefore, was much slower. The level of its mouth, however, was still lowered by the cutting down of the Kansas valley. This for some time—*i. e.*, until the ice had receded perhaps to the mouth of the Platte river in Nebraska, at least until it had reached the Nemaha—must have been the main channel of the master stream of the western plains as well as of the west edge of the ice sheet. To this influence we ascribe the main part of the erosion of the lower hundred feet of the Kansas and of the Missouri below their junction.

As the "base level" of the Wakarusa was lowered, in this way, that stream cut out also its lower hundred feet, and at the same time shifted southward. This accounts for the general absence of northern drift south of the stream, even at low levels. Any erratics which may once have rested there have been undermined, rolled into the stream and buried or carried away.

This finishes our main story, but there is an appendix which may appropriately be added. As the Wakarusa was lowered with the Kansas, so were its other tributaries, including the Shunganunga. As that was lowered, erosion was very active east of Burnett's mound around the head of the Pauline branch, or "valley train." The shales were rapidly cut down, while the bouldery contents of the old channel resisted. Ere long a valley appeared on either side of the old channel, and each rapidly cut back southward, assisted by numerous springs in the shales. At length the eastern one cut considerably deeper, and then began seepage through the coarse gravel of the channel from the western channel to the eastern, with the result that a tributary of the latter tapped the western one and stole its headwaters. This interesting case of "piracy" may be seen two or three miles northwest of Pauline.

STILL IN THE LARAMIE COUNTRY, CONVERSE COUNTY, WYOMING.

By Charles H. Sternberg, Lawrence.

I LEFT Lawrence the 11th of July to join my three sons, who had established a camp at Horseshoe Bend, on the Cheyenne river. I traveled by rail to Lusk, Wyo., and then by hack to Warren, in the heart of the Laramie, fifty-eight miles north. The camp was located among the pines, twenty miles north of Warren post office. The heat was so severe that all in camp suffered much from its effects. The Cheyenne river at this point makes a horseshoe bend, and for half a mile ravines cut back in the center of the arc and gradually become shorter. The country here is cut up with cañons and deep gorges, with rough, serrated ridges or buttes between, almost entirely denuded of vegetation. The gorges are fully 600 feet deep, and expose to view nearly the entire series of the Laramie fresh-water deposits. A short distance to the northwest these are overlaid by the Fort Union beds, while below is the Fox Hills Cretaceous formation.

When I reached camp I learned that George had found a fine skeleton of the duck-billed dinosaur Trachodon. It consisted of the entire caudal series of eighty-seven vertebræ, having a length of fourteen feet three inches. The sacrum, three feet and four inches long, consisted of nine united vertebræ. The entire pelvis was in position, except one illium, with hind limbs that lacked but one inch of being eight feet long. There were also sixteen continuous ribs, half of the head, and part of the fore limbs.

This specimen has been sent to the National Museum of France. One might go into detail and speak of the great difficulties encountered before we finally succeeded in removing this specimen from the rough region in which it had been entombed, but to enumerate all this would be wearisome. Although greatly hampered by the heat, I was fortunate enough to find three skulls of *Triceratops*, and George found one. The one discovered by my son consisted of a most beautiful and perfect fringe, five feet across and three feet deep; all the back portion of the head was present, and part of the horn cores. This specimen has been opened in the Senckenberg Museum, Frankfurt, and greatly pleases the director, Doctor Dreverman. The second skull for the season I found on the main Schneider creek, just above the cabin of Mr. Nelson, who has a cattle ranch here. It lay on the crest of a ridge and was largely enclosed in a hard, concretion-like mass of grey sandstone, infiltered with siliceous material, giving it the consistency of flint. The entire skull was present except one manible, including the rostral and predentary bone. The distance from occipital condyle to end of beak is eighty inches; the horn cores twenty-nine inches long, with a diameter of nine inches; length of nasal horn, eleven inches. So this spendid specimen consists of the entire skull in front of the crest, with the right mandible and predentary. It is six and one-half feet long, and with it are many fragments of the crest, which, with some restoration, will, I hope, complete the skull.

The second *Triceratops* skull I found on the road along the divide between Boggy and Greasewood creeks. I found this under peculiar circumstances. After weeks of fruitless effort on Boggy creek, I concluded to return to our bone bed on Crooked creek. It was a very hot day, and as Charlie, my second son drove along, I nodded off to sleep most of the way; but suddenly my drowsy eyes opened, and I saw the skull, only a short distance from the road over which all the fossil hunters that have visited this country have traveled. It consisted of nearly the entire skull, with the exception of the crest. The third was lying within fifty feet from where my sons hauled out a load of fossils last year. It lay at the forks of a ravine on Crooked creek, and both horn cores had stood up two feet above the shale in which the entire skull was buried. A trail leading down to a spring farther down the ravine passed over the right horn, so it was ground to powder, but the other horn core stood up two feet above the rock For years men had ridden over this trail to the water hole, and had never seen the horn—another proof that we find in this world what we are looking for, and never notice the other things equally valuable. I supposed here I had a species of *Diceratops* until I saw a *Triceratops* skull in the Field Museum the following December, which is seven feet long, and is an exact counterpart of mine. With the exception of one horn core, the mandibles and predentary, the skull was complete, with the entire crest as well as the front part of the face present. This is the largest skull I have ever collected. These last two specimens I still have on hand. Professor Lull told me three years ago there were but thirteen skulls of this great land saurian known, which has the largest skull of any land animal. Since that time my party have discovered six. The one I sent to the American Museum last year, Professor Osborn writes me, with the exception of the grand one in the Carnegie Museum discovered by

Utterback several years ago, is the most perfect known, and is also new to science.

But all these specimens sink into insignificance compared to the one Charlie found of a *Trachodon* on the South Branch of Schneider creek, twenty miles northwest of Warren. He had had no success whatever, and when we made sport of it he always said that when he did find anything it would be better than anything so far found in the Laramie; and he proved to be a true prophet. There was a little patch of ground on the head of South Schneider we had not explored, and, owing to my discovery of a *Triceratop's* skull within a mile or so of this region, Charlie took advantage of the opportunity, and, with Levi, drove over to it, while I went on to the camp at the bone bed across the river, on the head of Crooked creek. He discovered the last sacral vertebra and one hind limb of a *Trachodon* sticking out of a high ledge of grey sandstone. On September 4 last we moved our camp over to this specimen. Our outfit consisted of four horses, a heavy lumber wagon, also a buggy and saddle, with tents and camp equipage. It took Charlie and George, with the assistance of Mr. Lon Galbreath, of Warren, over two months to take up and transport this specimen to Edgemont, S. D., where it is now stored awaiting a purchaser; it weighs about 10,000 pounds. I remained with my party until we had uncovered it, cut it in sections, and wrapped them securely with burlap soaked in plaster. One section weighed over 3000 pounds. After days of toil removing the sandstone above the floor on which our duck-bill lay buried, we find the following facts: He had sunk to his death in a bed of quicksand, and the entire skeleton is present except one hind limb and the end of the tail. Five and a half feet of the caudal vertebræ are present, continuous with the sacrum, making seventeen and a half feet altogether, including the complete trunk region. And more wonderful still, the whole skeleton is in the normal position at death, with ribs expanded about five feet across the abdominal walls, and the entire carcass is covered with the skin impressions. When the flesh decayed, and before the ligaments that held the bones in proper alignment one with another had disintegrated, the scales had left impressions on the yielding sand. As the flesh slowly decayed and was carried off by water, it was replaced with sand that took the impression of the skin upon it; so that at last the entire body as it was in death was here reproduced. The front limbs were drawn upwards along the sides of the body as the carcass slowly sank in the quicksand. The head, four feet long, was elevated as if gasping for breath, and the hind foot has the femur, tibia and fibula doubled on themselves, while the foot from the tarsal joint is stretched downward. The hind feet were thirty-one inches below the pelvis, and were, as I believe, in normal position. I am strengthened in this view by the fact that the "mummy" (so-called by Professor Osborn) that we found three years ago near this specimen, and that is now in the American Museum, had the hind limbs doubled under the body in the same way. This was also true of the specimen first mentioned in this paper. Consequently we must change the pose of these duck-bills from the erect position in which all but one in the American Museum have been mounted. Even that one, however, is simply in the position that an animal who walks on his hind limbs would assume if he fed off the ground. I therefore believe I have discovered sufficient evidence to prove that the *Trachodon* was a swimmer; in fact, we already know that from the one I sent Professor Osborn. The front feet were web-footed; and his skin, with minute scales, shows he was a water animal, instead of land as was always supposed. Now, in addition, I claim that he was far more like a lizard than has been imagined. He walked liked a lizard, with body close to the ground and tail dragging out behind. The great trouble with paleontologists has been that they have created a theory and want the facts to support it. For instance, it is taught that the dinosaurs partook of the characteristics of the three great living families, the birds, reptiles and mammals, and consequently they were largely a composite of these three families. Instead of that, as far as I have discovered, in the *Trachodon* line at least, they lived in the water, and only came on the land at the peril of their lives, as they had no means of defense against the king of carnivorous reptiles, *Tyranosaurus*—a fearful creature, with skull four feet long, and armed with horrid teeth four inches long.

The duck-bill lived in the bayous of the country. He was a powerful swimmer, and could use his great hind limbs, eight feet long, in the same manner as a frog uses his. Or, while feeding on the rushes that lined the sluggish streams, he could plant his powerful hind feet in the sandy bottom, while, with his front ones acting as arms, he could pull into his duck-billed mouth the succulent forage. And as the female went on shore to deposit her eggs in the sand, she crept along like lizards of to-day, the limbs doubled up on themselves, except from the tarsal and carpal joints, which acted as the knee of mammals. They lifted the body sufficiently high to clear the ground, but the tail dragged behind. Consequently he did not stand up like a kangaroo and walk on his hind feet and end of his tail; nor did he jump like a frog, as this would be a physical impossibility, with a weight of 5000 pounds or more. I greatly regret that our large museums are willing to make the absurd mounts they often make in order to satisfy the credulity of ignorant people. Marsh once said that to doubt evolution is to doubt science, and science is only another name for truth. Consequently men of science have no right to mount extinct forms in a sensational manner to satisfy a sensational public. This wonderful specimen is still in my possession, but I hope soon to ship it to some noted museum, where it may be correctly mounted and preserved.

I also discovered a wonderful deposit of figs a few rods from the *Trachodon* quarry. They fell in the sand among teeth and bones of reptiles and fishes, as well as the impressions of rushes and other water plants, and shell fishes. The sand packed solidly around them, and when they decayed their form was firmly molded in the sand. The cavity thus formed was filled with sand, and an exact cast of the figs was produced. Until now, less than a dozen fossil figs are known to me. I also discovered five beautiful palmetto palms eighteen inches in width, showing the country at the time they grew was like the everglades of Florida, ridges between great marshes, through the center of which ran sluggish streams almost at a level with the near-by ocean. The water was beyond tidewater, however, as it was sweet.

III.

BIOLOGICAL PAPERS.

1. "THE ORIGIN AND DEVELOPMENT OF PLANT AND ANIMAL INSTINCTS."
   By LYMAN C. WOOSTER, State Normal School, Emporia.
2. "THE JASSOIDEA OF KANSAS."
   By S. E. CHUMB, Clarksville, Tenn.
3. "ADDITIONS TO THE LIST OF UREDINEÆ OF BOURBON COUNTY."
   By A. O. GARRETT, Salt Lake City, Utah.
4. "LOCAL RECORDS OF ARACHNIDS PERSONALLY COLLECTED IN KANSAS AND TEXAS."
   By E. S. TUCKER, Bureau of Entomology, U. S. Bureau of Agriculture.
5. "BIRDS OF THE OLYMPIC PENINSULA, WASHINGTON."
   By ALBERT B. REAGAN, Orr, Minn.
6. "CATALOGUE OF THE FLORA OF KANSAS."
   By BERNARD B. SMYTH and LUMINA O. R. SMYTH, Topeka.

THE ORIGIN AND DEVELOPMENT OF PLANT AND ANIMAL INSTINCTS.

A Theory of Evolution in which Life is the Central Agent.

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

THE study of the origin and development of plant and animal instincts is inseparable from the larger study of the origin and development of the plant and animal kingdoms; that is, of their evolution. After fifty years of searching investigation of all phases of the doctrine of evolution of plants and animals, most naturalists are agreed that the evolutionist must solve four problems before he can claim that his theory is fully established. These problems are: variation, heredity, natural selection or adjustment to environment made from without through the destruction of the less fit, and segregation, or speciation, brought about through the separation of varieties by some natural barrier that prevents their mixing.

The potency of natural selection in cutting out the ill-adapted has been so abundantly demonstrated by Darwin, Wallace and others that many, for a time, thought that the solution of this problem carried with it the solution of the other three problems, and therefore established the doctrine of evolution of plant and animal life. This is now known to be an error, though many still cling to it.

Speciation by segregation has likewise been abundantly proved in this country by David Starr Jordan, O. F. Cook, C. H. Merriam, J. A. Allen, A. E. Ortman and others, and by many biologists across the Atlantic. This, the fourth problem, may therefore be laid aside as solved. Hugo de Vries, of Amsterdam, however, claims to have found another method of speciation, that of mutation, according to which a species is believed to spring into existence fully formed, but, as this method involves a freak or sport in variation and heredity, mutation must be referred to problems one and two.

The first and second problems, variation and heredity, still remain among the questions that persistently plague the naturalists. Outside influences and inner tendencies are respectively appealed to by opposing schools of biologists to account for variation; and heredity in its essence is acknowledged by all biologists to be in some measure a mystery.

In investigating the origin of instincts, I have been involved in these two problems and have been forced to propose a solution which is more or less in accord with the beliefs of the Neo-Lamarckians. My conclusions constitute the body of this paper.

THE THESIS.

Life on earth has been endowed from the beginning with at least seven powers or modes of activity. Three are concerned in nutrition and respiration, one enables life to reproduce its kind and multiply individuals, and the remaining three powers enable life to adjust itself to its environment, the last of these three being the power which makes it possible for life to do its work better to-morrow than it has done it to-day.

Life, in exercising this, its seventh power, or form of activity, did all its work consciously on the first day of its existence on earth, then, after some millions of years of earth experience, it did some of its work consciously, some habitually, and some reflexively and instinctively, all of which, the habitual, the reflexive, and the instinctive, had before been done consciously. Thus life makes provision through consciousness and the development of its reflexes and instincts for better and different adjustments to its environment, and in doing so may evolve higher and still higher types of organisms in the succeeding generations.

This fixation of conscious forms of activity, first as individual habits, then as race habits, or instincts and reflexes, and the growth or development of instincts and reflexes through conscious pioneer work, explains variation and heredity, the two hitherto unsolved problems of development, and therefore completes the establishment of the doctrine of plant and animal evolution. The attempted explanation by Weismann of heredity and variation by means of a hypothetical germ plasm consisting of biophors and determinants is entirely unsupported by observation, and assigns to matter qualities not dreamed of by any chemist or physicist while studying this entity. Life alone manifests the tendencies assigned to matter by Weismann. By substituting "life" for "germ plasm" with its biophors and determinants, the chief objections to his hypothesis are removed. Weismann admits that this substitution may properly be made, though he naturally prefers his germ plasm as the variant and bearer of hereditary qualities.

THE ARGUMENT.

Before considering the evidence in favor of the "life theory of evolution," we should remember that the term "instinct" belongs to biology, and refers to the power of life to do without present conscious effort many things necessary to the well-being of the individual; and that the ability to establish reflex activities enables life to make many mechanical sequences without conscious effort or direction. We must also remember that psychologists are now agreed that the mainspring of action lies in the sensibilities and not in the intellect, and that the syllogism cannot be used to test the truthfulness of the emotions. Therefore, an action may be felt to be necessary by the lower organisms when it cannot be thought to be necessary.

How life influences energy and matter without being itself a form of energy is one of the problems of philosophy for which many solutions have been offered, none of which are entirely satisfactory. No one, however, any longer believes in a vital force, though the biologist knows of many chemical transformations managed by life in protoplasmic cells which are beyond the power of our most eminent chemists to effect, and no machine constructed by our most skillful mechanics can approach in efficiency the human body built by the body-building instincts.

It should also be explained that no attempt will be made in this paper to find an explanation of the origin of the protoplasmic cell. Paleontology is necessarily silent as to the origin of this biologic unit, there is no known chemical laboratory where living protoplasm is being elaborated, and embryology finds that the embryos of the metazoa, in recapitulating the life history of their ancestors, invariably begin their development in a single protoplasmic cell which is either a conjugate of two cells or is an unfertilized cell.

In establishing the truth of this thesis, I wish to show first that it is in harmony with common experience. All are aware of the fact that conscious repetition of a certain mode of activity so impresses that form of action on the individual that it becomes a habit and may be repeated with a minimum of conscious direction thereafter. What is more natural than to believe that these habits persisted in by succeeding generations become permanent attributes of life and are established in time as race habits or instincts and reflexes. To fix an individual habit requires years of repetition; to establish a race habit must evidently require many centuries of effort.

In saying that race habits are established, I do not mean to say that they are fixed as a whole, but that they pass through stages of development, and are first in their infancy, then in their youth, then are adult, and, finally, may develop to higher levels or may slowly decay when they cease being useful.

These race habits, or instincts and reflexes, are known to function as body-building and body-using activities long before the conscious powers of the embryo are awakened; but this does not imply that instincts precede consciousness in evolution. Life may repeat the major, conscious, body-building experiences of the ancestors of the embryo in an instinctive way in producing body-structures, and then quicken the conscious powers of the individual at birth to meet the varying conditions of the environment and to seek better ways of living; but there could have been no instincts and reflexes at first, unless they were received from Jehovah. All work must have been pioneer work, and therefore work done consciously, if life came unequipped with earth-conquering habits from the hands of its creator.

If we desire the formality of a course of reasoning before we are willing to accept life with its many possibilities, we should remember that we gain truth in two distinct, though related, ways. The evidence of our five senses, if confirmed by many repetitions, is usually regarded as affording a satisfactory basis for action in those things that can appeal to the senses. But there is a very large field open to human investigation that lies beyond the world of sense, though contiguous to it. Here any theory that enables one to explain things is pragmatically true. In chemistry and physics, for example, the atom, the molecule, and energy and ether are concepts not derived from sensations, yet the chemist and physicist base their systems of chemical and physical theory on the actuality of these non-sensuous entities. The uncounted millions invested in manufacturing enterprises are so invested because the entire business world believes in the truthfulness of the theories embodied in chemistry and physics. These, in turn, are held by all scientists to be true because of their pragmatic value, though the atom, molecule, energy and ether cannot be grasped by their senses.

The biologist, in a similar way, accepts life as the basic entity in the world of organisms, though his senses take in no direct information concerning life and its essential qualities. By experience and observation he knows what it is to be alive, and he has learned that in some way, not revealed by his five senses, life controls matter through energy, whenever it is associated with these entities in living organisms. How energy influences matter, and how life influences energy, neither the biologist nor the physicist at present knows, but the fact of such control is patent to all observers.

Unfortunately, however, for the satisfaction of those mathematically inclined and the peace of mind of the biologist, life manifests in all its activities a conscious power which is a variable, a power that observes no physical law except when it needs to do so for its own highest good. Because life does not conform to such invariable laws as energy and matter, many physicists and mathematical biologists deny the existence of any such entity as life, and list it as a quality or property of matter, or as a form of energy not yet studied sufficiently to determine its laws.

Those who are biologists in spirit as well as in name, on the other hand, declare that life is as truly an entity as are energy and matter, and is just as necessary to any system of biology as are energy and matter to physics and chemistry. They declare, further, that evolution would be impossible did not life exist and possess conscious powers; for life must pioneer its own way in its earth environment, and, when best ways are discovered, it must fix its tendencies accordingly, first as individual habits, and second, after long trial by many generations of descendants, fully establish them as race habits, or instincts and reflexes, and transmit them by heredity.

This theory of evolution, with life as the central agent, as presented in this paper, merely assigns life to its natural place in the plant and animal kingdoms. Instead of ascribing to matter certain properties not usually considered as belonging to this substance, or giving to energy autocratic command in the cosmos, it places life at the head of these entities and gives it the power to manage matter through energy when these three are associated in plants and animals.

Why life was placed on earth to develop its powers; why it did not in the beginning inherit all the powers of Jehovah, are things the future alone can reveal to us; but of this we may be certain: continued and successful development is one of the life possibilities to him who labors for it and consciously chooses that which is best for his neighbor as well as for himself.

THE JASSOIDEA OF KANSAS.

By S. E. Crumb, Clarksville, Tenn.

THIS list includes material collected at Onaga by F. F. Crevecœur and at McPherson by Warren Knaus, as well as the collections of several years by the author at Galena and Lawrence. All the Kansas species in the collection of the University have been examined, and a few, noted as "in K. U. collection," are based on this record alone. No list of the species was contemplated when this material was accessible, and the numerous locality records in the University collection were not taken. Practically all the material seen by the author has been determined by Prof. E. D. Ball. Quotations from Crevecœur are taken from the Transactions of the Kansas Academy of Science, volume XIX, page 235. Those from E. S. Tucker are from the Transactions of the Kansas Academy of Science, volume XX, part 2, page 192.

Family Bythoscopidæ.

Pediopsis erythrocephala G. & B. Onaga, June 30.

suturalis O. & B. "On *Salix amygdaloides*, June." Crev.

sordida, V. D. Lawrence, September 29, walnut.

trimaculata Fitch. Can. Ent., v. 22, p. 249. Reported from Kansas.

flavescens. "Onaga, Kan., Crevecœur." U. S. N. M.

viridis Fitch. Davenport Acad. Sci., v. 7, p. 121. Reported from Kansas.

tristis V. D. "At light, July." Crev.

punctifrons V. D. "Onaga, Kan., Crevecœur. U. S. N. M."

Bythoscopus distinctus V. D. "On walnut, June." Crev.

Agallia quadripunctata Prov. Dav. Acad. Sci., v. 7, p. 47. Reported from Kansas.

sanguinolenta Prov. Galena, July 24, fallow field; Aug. 4, sassafras; Aug. 9, millet; September 9, pasture. Lawrenco, September 22, alfalfa; October 22, clover; November 5, alfalfa; November 8, weeds. Onaga, June 25, 30; July 2.

cinerea O. & B. Galena, June 20, weeds in pasture and redtop; September 9, grassy orchard. Onaga, June 30.

constricta V. D. Galena, June 26; July 29, meadow; July 24, weedy clover. Lawrence, May; September 22, alfalfa; "April, June, July, August," Tucker.

novella Say. Galena, July 8, shady woods; July 21, undergrowth in shady woods. Onaga, June 25.

Idiocerus duzei Prov. "At Westmoreland, Kan., July." Crev.

pallidus Fitch. "On weeds in pasture, July." Crev.

suturalis Fitch. "Lawrence, June, electric light." Tucker.

Idiocerus moniliferæ O. & B. "Lawrence, June" Tucker.
brunneus O. & B. In K. U. collection.
nervatus V. D. "Lawrence, April." Tucker.
verticis Say. Galena, September 8, at light. Onaga, June 30, August 6.
snowi G. & B. "Lawrence, June, at electric light." Tucker. Onaga, August 6.
alternatus Fitch. In K. U. collection.
Macropsis apicalis O. & B. In K. U. collection.

Family TETTIGONIELLIDÆ.

Oncometopia undata Fab. Galena, Aug., on *Sagittaria*. Common in eastern part of state.
lateralis Fab. Galena, July 27, grassy orchard; July 29, meadow; July 24, weedy clover and undergrowth in oak woods.
Aulacizes irrorata Fab. Galena, July 21, undergrowth in shady woods; Sept. 9, pasture; July 24, oak woods.
Kolla (Tettigonia) bifida Say. Galena, July 24, undergrowth in oak woods; Aug. 9, grassy orchard. Lawrence, Sept. 29, blue grass; Oct. 10, blue grass.
geometrica Sign. Galena, July 25, old timber road.
Tettigoniella (Tettigonia) hieroglyphica Say. Galena, Aug. Lawrence, Sept. 22, bluestem, alfalfa, and blue grass; Sept. 29, coffeebean tree; Oct. 10, pasture; Oct. 18, alfalfa. Onaga, June 25. Medora, Aug., Knaus.
gothica Sign. Lawrence, Sept., on *Aster*. Onaga, June 25.
Diedrocephala coccinea Forst. Galena, Aug. 12, on *Sagittaria*. Lawrence, Nov. 9, mulberry.
versuta Say. Galena, Aug. 4, on grape; July 6, sedge and weeds; July 8, shady woods; July 16, swamp weeds; Sept. 6, weeds in garden.
Dræculacephala mollipes Say. Galena, July 24, grassy orchard, low pasture and fallow field; Sept. 9, orchard; Sept. 24, *Sagittaria*. Lawrence, May, grasses; Sept. 22, white clover, bluestem and blue grass; Nov. 8, redtop. McPherson, Aug.
angulifera Walker. Proc. Ia. Acad. Sci., v. 8, 1901. Ohio Univ. Bull., ser. 5, No. 21, p. 36. Reported from Kansas.
Helochara communis Fitch. Galena, Oct. 21, on swamp grasses.

Family GYPONIDÆ.

Xerophlœa peltata. "On prairie, Oct." Crev.
viridis Fab. (Uhler). Galena, June 24, fallow field. Lawrence, Sept. 22, alfalfa.
Gypona octolineata Say. Galena, July 24, weedy clover; Sept. 29, smartweed. Lawrence, Sept. 22, alfalfa; Oct. 18, weeds; Nov. 9, mulberry; var. *flavilineata* also occurs.
melanota Spanb. "On weeds in timber, Aug." Crev.
dorsalis Spanb. "Lawrence, Aug." Tucker.

Gypona pectoralis Spanb. Onaga, "on prairie, June," Crev. Sept. 2, Aug. 19.

albimarginata Woodw. "On weeds in timber, June." Crev.

bipunctulata Woodw. Ia. Acad. Sci., v. 4, p. 181. Reported from Kansas.

Penthimia americana Fitch. "On weeds in timber, June." Crev.

Family EUACANTHIDÆ.

Neocœlidia tumidifrons G. & B. Galena, June 8, meadow.

Jassus olitorius Say. Galena, July 24, on *Benzoin*; Aug. 4, sassafras and a species of milkweed.

Family ACOCEPHALIDÆ. (JASSIDÆ.)

Subfamily ACOCEPHALINÆ.

Xestocephalus pulicarius V. D. Galena, Sept. 7, at light. "Lawrence, June," Tucker. Onaga, Aug. 7, at light.

fulvocapitatus V. D. "Lawrence, Aug." Tucker. Specimens in K. U. partially answer the description of *fulvocapitatus*, and are so lebeled.

Goniagnathus palmeri, V. D. Galena, June 13, timothy, also undergrowth in open woods.

Dorycephalus vanduzei O. & B. "Onaga, Kan., Crevecœur." U. S. N. M.

Spanbergiella vulnerata Sign. Galena, July 24, undergrowth in shady woods and grassy orchard; Aug. 9, undergrowth in oak woods. Onaga, Aug. 7, at light. McPherson, Aug.

Hecalus lineatus Uhler. Onaga.

bracteatus Ball. In K. U. collection.

Parabolocratus viridis Uhler. Galena, June 26, meadow; July 6; Sept. 9, pasture and grassy orchard.

flavideus Sign. "On weeds in pasture, June." Crev.

Platymetopius dorsalis Ball. Ann. Ent. Soc. Am., v. 3, No. 3, p. 224. Reported from Kansas.

acutus Say. "Lawrence, Oct.," Tucker. Onaga, June 25.

cinereus O. & B. Lawrence, Oct. 22, clover.

frontalis V. D. Galena, July 24, weedy clover. Lawrence, Oct. 16, *Elymus canadensis;* Oct. 21, crab grass; Oct. 22, clover; Nov., hedgerow. Onaga, June 25.

fuscifrons V. D. "On weeds in timber, May," Crev.

ornatus Baker. Can. Ent. v. 42, p. 49. "Taken at Horace, Kan."

scriptus Ball. Ann. Ent. Soc. Am., v. 3, No. 3, p. 228. Reported from Kansas.

Subfamily ATHYSANINÆ.

Scaphoideus auronitens Prov. Onaga, Aug. 11, 19.

consors Uhler. Lawrence. Oct. 18. A single specimen.

scalaris V. D. "Lawrence, July," Tucker. Onaga, June 29.

lobatus V. D. Specimens in K. U. collection are doubtfully referred to this species.

productus Osb. Galena, July 8, shady woods; July 21, undergrowth in shady woods.

intricatus Uhler. Jour. Cin. Soc. Nat. Hist., v. 19, No. 6, p. 203. Reported from Onaga, Kan.

Scaphoideus immistis Say. Galena, July 21, undergrowth in shady woods. Onaga, June 27, July 12, July 22, Aug. 8, all at light. McPherson, Aug.

melanotus Osb. Galena, July 21, shady woods. Onaga, Aug. 11, at light.

cinerosus Osb. Onaga, June 29.

Deltocephalus albidus O. & B. Psyche, v. 8, p. 115. Reported from Kansas.

reflexus O. & B. Galena, June 8, meadow; June 26, meadow; July 6, meadow; July 29, meadow. Lawrence, Oct. 18, pasture. Onaga.

ocellaris Fall. In K. U. collection.

debilis Uhler. Onaga, June 25. A single specimen.

sayi Fitch. Lawrence, Oct. 10, blue grass; Oct. 31, leaves; Nov. 8, grasses. "On weeds on prairie, Sept.," Crev.

minimus O. & B. Galena, June 8, meadow; July 9, shady woods.

affinis G. & B. Lawrence, Oct. 10, blue grass; Oct. 31, among leaves; Nov. 9, grasses.

oculatus O. & B. Galena, June 13, meadow; July 24, weedy clover and grassy orchard. Lawrence, May; Oct. 10, blue grass.

sylvestris O. & B. Lawrence, "May, July," Tucker; Oct. 6, blue grass.

inimicus Say. Galena, Sept., abundant on grasses. Lawrence, Sept., Oct., in pasture. Onaga, Sept. McPherson, Aug.

weedi V. D. Galena, July 21, undergrowth in shady woods; July 24, shady orchard; Aug. 9, millet; Sept. 9, grassy orchard. Lawrence, "June, Aug.," Tucker; Sept. 29, blue grass in grove; Oct. 10, blue grass; Nov. 8, weeds. Onaga, June 25. Effingham, July, VanDuzee.

obtectus O. & B. Galena, Sept. 6, weeds in garden; Sept. 16, pasture.

compatus O. & B. "On prairie, June." Crev. in K. U. collection.

flavocostatus V. D. Galena, July 24, grassy orchard; Lawrence, Sept. 22, redtop and alfalfa; Oct. 10, blue grass; Oct. 18, *Setaria glauca*. Onaga. McPherson, Aug.

nigrifrons Forbes. Galena, July 8, shady woods and weeds. Lawrence, "April, May, July, Aug.," Tucker; Sept. 29, blue grass; Oct. 6, blue grass; Oct. 10, *Elymus canadensis;* Oct. 31, among leaves; Nov. 8, weeds and grasses. Onaga, July 7, at light; Aug. 6.

Athysanus (Stirellus) curtisii Fitch. Galena, July 21, undergrowth in shady woods. Lawrence, Nov. 8, redtop and blue grass.

bicolor V. D. Galena, July 6, meadow; July 24, fallow field; July 29, meadow; Aug. 8, shady woods; Aug. 9, millet; Sept. 9, grassy orchard. Lawrence, Oct. 18, pasture.

Athysanus (Stirellus) obtutus V. D. Galena, Sept. 10, in pasture. Lawrence, Oct. 16, *Elymus canadensis;* Oct. 18, in pasture; Oct. 21, blue grass and crab grass.

Athysanus (Comellus) comma V. D. "On *Cassia chamæchrista*, Aug." Crev.

osborni V. D. Lawrence, Sept. 16, *Elymus canadensis*. Onaga, July 5.

plutonius Uhler. Ohio Nat., vol. 5, p. 240. Reported from Kansas.

anthracinus V. D. Ohio Nat., vol. 2, p. 241. Reported from Kansas.

vaccinii V. D. Onaga, June 25.

Athysanus (Athysanus) magnus O. & B. In K. U. collection.

exitiosus Uhler. Galena, July 8; Aug., Sept. 7; Onaga, Aug., Lawrence, McPherson, Aug., abundant.

striolus Fallen. McPherson, Aug.

parallelus V. D. Galena, July 4, weeds in swamp. Onaga, June 30.

Driotura gammaroidea V. D. Galena, July 6, meadow; July 29, meadow; Sept. 7, pasture. Variety fulva Ball also occurs.

robusta O. & B. Galena, July 24, grassy orchard. A single specimen.

Eutettix (Mesamia) nigridoesum Ball. "Lawrence, Sept.," Tucker. Onaga, July 25, Aug. 2.

straminea Osborne. "On weeds on prairie, June." Crev.

cincta O. & B. Onaga, Aug. 10, at light.

Eutettix (Eutettix) subaenea, var. picta V. D. Galena, July 24, undergrowth in oak woods. A single specimen.

tenella Uhler. In K. U. collection.

seminuda Say. Galena, Sept. 9, at light. Onaga, Aug. 7. McPherson, Aug.

strobi Fitch. Galena, Sept. 8, at light. Onaga, June 30. McPherson, Aug.

albida Ball. In K. U. collection.

Phlepsius excultus Uhler. U. S. Geol. Surv. Bull. 3, art. 14, p. 467. Reported from Kansas.

areolatus Baker. Onaga, July 25.

humidus V. D. Onaga, June 30.

majestus O. & B. Onaga, Aug. 19; Sept. 2.

decorus O. & B. Lawrence, Sept. 22, alfalfa; "July, Sept.," Tucker. Onaga, June 25.

turpiculatus Ball. In K. U. collection.

ovatus V. D. Onaga, June.

irroratus Say. Galena, June 13, 26, pasture; July 25, old timber road. Lawrence, Sept. 22. Onaga, June 30; Aug. 7. McPherson, Aug.

collitus Ball. Galena, July 24, grassy orchard; July 25, weeds.

altus O. & B. Onaga, Aug. 8.

Phlepsius punctiscriptus V. D. Onaga, June 30; July 2.
truncatus V. D. In K. U. collection.
incisus V. D. Onaga, July 30; Aug. 10, at light.
fulvidorsum Fitch. Onaga, Sept. 2.
infumatus. "On *Ambrosia artemisiæfolia*, Aug.," Crev.
superbus V. D. Onaga, Aug. 2.
cinereus Uhler. U. S. Geol. Surv. Bull. 3, art. 14, p. 460. Reported from Kansas.

Acinopterus acuminatus V. D. Galena, Aug.; var. *viridis* Ball also occurs.

Thamnotettix fitchii V. D. Lawrence, "July," Tucker; Nov. 8, grasses. McPherson, Aug.
clitellaria Say. Lawrence, Nov. 8, grasses. Onaga, "on hazel, June," Crev.; Aug. 10, at light.
inornata V. D. In K. U. collection.
kennicotti Uhler. Galena, June 26, on *Parsonia*, in pasture; July 24, on milkweed; July 29, meadow.
longula G. & B. Lawrence, "April," Tucker; Sept. 29, on *Ambrosia artemisiæfolia*.

Chlorotettix galbanata V. D. Onaga, July 20, at light.
viridia V. D. Galena, July 24, fallow field. Onaga, June 30.
spatulata O. & B. Galena, June 20, pasture. Lawrence, Oct. 18, on *Elymus canadensis*. Onaga, July 2.
tunicata Ball. Galena, Sept. 10, pasture. Onaga, July 2, 5; Aug. 10.
lusoria O. & B. Galena, July 24, grassy orchard; Sept. 6, garden weeds.
tergata Fitch. "On grasses, June," Crev.
balli Osb. In K. U. collection.

Balclutha (Gnathodus) impictus V. D. "Lawrence, June," Tucker. Onaga, Aug. 7, at light.
punctatus Thunb. In K. U. collection.
viridis. Lawrence, Oct. 22, clover.
abdominalis V. D. Galena, July 8, sedge and weeds. Lawrence, Sept. 24, blue grass; Oct. 18, weeds; Oct. 22, alfalfa, clover and crab grass.

Cicadula sexnotata Fallen. Galena, June 26, weeds in pasture; July 24, weedy clover; Sept. 9, grassy orchard. Lawrence, Oct. 18, grass in field; Oct. 31, among leaves. Medora, Aug.; "on weeds in pasture, May," Crev.
punctifron Fallen. In K. U. collection.
variata Fallen. "On weeds in pasture, Oct.," Crev.
lepida V. D. Can. Ent., v. 26, p. 139. Reported from Kansas.
exnotata. "On weeds in pasture," Crev.

Family Typhlocybidæ.

Alebra albostriella Fallen. Lawrence, Sept., rather common. Onaga, "on burr oak in orchard, July," Crev.

Dicraneura abnormis Walsh. Galena, June 25, *Parsonia* in pasture; July 8, sedge and weeds; July 21, undergrowth in oak woods. Lawrence, Nov. 8. weeds and grasses.
fieberi Low. Galena, July 26, weeds. Lawrence, "May, July,"

Dicraneura fiebri Tucker; Sept. 29, grape; Oct. 10, blue grass; Oct. 31, among leaves.
flavipennis Zett. Lawrence, Oct. 17, blue-grass pasture.

Empoasca smaragdula Fallen. Onaga, July, at light.
trifasciata Gillette. Lawrence, Sept., on grape.
albolinea Gillette. Lawrence, "July, Sept., at electric light." Tucker.
pura Stal. In K. U. collection.
unicolor Gillette. "On *Amorpha fruticosa*, July." Crev.
obtusa Walsh. Lawrence, Sept.
atrolabes Gillette. Onaga. One specimen.
mali LeBaron. Lawrence, Nov. 9, mulberry and cedar.
flavescens Fabr. Lawrence, Nov. 9, mulberry and grasses. Onaga, "under dead leaves in timber, March," Crev.
viridescens Fitch. Lawrence, "May, June, July, Aug.," Tucker; Sept. 29, grape and coffeebean tree.

Typhlocyba tricincta Fitch. Lawrence, Sept. 29, grape. Onaga, "under dead leaves in timber, March, April," Crev.
rubroscuta Gillette. Lawrence, Sept. Onaga, "under dead leaves in timber, March, April," Crev.
trifasciata Say. Lawrence, April 23; Sept. 29, grape and walnut. Onaga, "under dead leaves in timber, March, April," Crev.
obliqua Say. Galena. Lawrence, Sept. 29, grape and walnut; Oct. 16, among leaves. Varieties *dorsalis*, *næva* and *fumida* occur at Lawrence.
illinoiensis Gillette. Lawrence, Sept. 29, grape.
comes Say. Common over the state on grape. The following varieties occur: *comes*, *maculata*, *basilaris*, *vitis*, *ziczac*, *coloradensis*, *scutellaris*, *infuscata*, and *octonotata*.
vulnerata Fitch. Galena, July 8, weeds in shady woods. Lawrence, April, grape; July 22, at light; Sept. 29, grape. Var. *niger* occurs at Galena.
querci Fitch. Onaga, "in timber, May." Crev.
crevecœuri Gillette. Onaga, "under dead leaves in timber, March, April." Crev.
Rosae Linnæus. Lawrence, "May, July, Aug.," Tucker. Onaga, June 25, at light.

ADDITIONS TO THE LIST OF UREDINEAE OF BOURBON COUNTY.

By A. O. GARRETT, Salt Lake City, Utah.

IN THE seventeeth volume of the Transactions of the Kansas Academy of Science the writer had a paper entitled "A Provisional List of the Urenineæ of Bourbon County, Kansas." This list contained the names of forty-five species of rusts that had been collected by the writer during seven years' residence at Fort Scott. To this list is now added the following additional species, which, with the exception of No. 53, were collected during June and July, 1908, from two to three miles northeast of Fort Scott.

46. Cronartium quercus (Brondeau) Schröt. II.
On Quercus macrocarpa Michx. 1094. July, 1908.
47. Phragmidium potentillæ-canadensis Diet. II, III.
On Potentilla canadensis L. 1091. July, 1908.
48. Phragmidium rosæ-setigeræ Diet. II, III.
On Rosa setigera Michx. 1103. July 4, 1908, Strawberry Lake.
49. Puccinia anemones-virginianæ Schw. III.
On Anemone virginiana L. 1093. July, 1908.
50. Puccinia asparagi DC. II.
On Asparagus officinalis L. 1098. July 6, 1908.
51. Puccinia coronata Cda. II.
On Avena sativa L. 1097. July, 1908.
52. Puccinia fraxinata (Lk.) Arth. I. (Aec. fraxini Schw.)
On Fraxinus americana L. (?) 1102. July 4, 1908.
53. Puccinia lateripes Berk. & Rav. I, III.
On Ruellia strepens L. 66. July 15, 1902.
54. Puccinia marilandica. III.
On Sanicula marilandica L. (?) 1094. July, 1908.
55. Puccinia menthæ Pers. II.
On Monarda fistulosa L. 1101. July 4, 1908.
On Pycnanthemum sp. 1092. July, 1908.
56. Puccinia pattersoniæ Syd. II.
On Tripsacum dactyloides L. 1096. July 4, 1908.
57. Puccinia sambuci (Schw.) Arth. II.
On Carex frankii Smith. 1095. July, 1908.
58. Puccinia triticina Eriks. II.
On Triticum vulgare. 1104. July, 1908.

LOCAL RECORDS OF ARACHNIDS PERSONALLY COLLECTED IN KANSAS AND TEXAS.*

By E. S. TUCKER, Bureau of Entomology, U. S. Department of Agriculture.

A NUMBER of Arachnids collected by myself in two localities, one being Lawrence, Kan., and the other Plano, Tex., are herewith listed for local comparison. No special effort was made for collecting these creatures, and only such specimens as happened to be noticed at odd times were taken. The collection of the Kansas specimens preceded that from Plano, Tex., which were obtained during the season of 1907.

With further regard to the Kansas spiders, a revision of the specific names as given by Mr. T. H. Scheffer is made to conform so far as possible with the "Catalogue of Nearctic Spiders," by Mr. Nathan Banks (Bull. 72, U. S. Nat. Mus.). The list includes the following species:

Family CLUBIONIDÆ.

Trachelas tranquilla Htz. September, from beehive infested with wax-worms and moths (*Galleria mellonella* L.).
Anyphæna gracilis Htz. September.

Family AGELENIDÆ.

Agelena nævia Walck. August and September.

Family THERIDIIDÆ.

Theridium tepidariorum Koch. September.
Teutana triangulosa Walck. July, August and September.

Family TETRAGNATHIDÆ.

Tetragnatha extensa L. May and June.

Family EPEIRIDÆ.

Leucauge hortorum Htz. June, July and August.
Cyclosa conica Pal. July.
Mangora gibberosa Htz. August and September.
Epeira gigas Leach. October, web spanning window.
domiciliorum Htz. August and September.
globosa Keys. July.
ocellata Clerck April; and July, August and September, occurring near electric lights on bridge.
trivittata Keys. September.
verrucosa Htz. August.
Plectana stellata Htz. April.
Argiope trifasciata Forsk. July, September and October.

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Acrosoma gracilis Walck. July and August.
mitrata Htz. August.
spinea Htz. July.

Family THOMISIDÆ.

Xysticus gulosus Keys. September.
triguttatus Keys. June.
Runcinia aleatoria Htz. July and August.
Misumena vatia Clerck. September. New to Kansas list.
Misumessus asperatus Htz. April, May, July, August and September.
Tibellus oblongus Walck. April.

Family PISAURIDÆ.

Dolomedes mira Walck. August and September. (Not known to Banks.)

Family LYCOSIDÆ.

Lycosa avida Walck. September.
helluo Walck. April, young; July, female carrying cocoon; September, from beehive infested with waxworms and moths (*Galleria mellonella* L.); and October.

Family OXYOPIDÆ.

Oxyopes salticus Htz. July.

Family ATTIDÆ.

Phidippus audax Htz. April, July, September and October. Also, in October, dragging away a moth of *Galleria mellonella* L., on ceiling of room.
Dendryphantes octavus Htz. October.
Hyctia pickei Peck. October.
Marpissa undata DeG. May, September.

All of the following species from Plano, Tex., were determined by Mr. Nathan Banks:

ORDER SCORPIONIDA: Family SCORPIONIDÆ.

Centrurus vittatus Say. May and July, under litter and in house.

ORDER PSEUDOSCORPIONES: Family CHERNETIDÆ.

Chelifer cancroides L. July and August.

ORDER PHALANGIIDEA: Family PHALANGIIDÆ.

Mesosoma niger Say. Summer and fall months.

ORDER ARANEIDA.

(Spiders collected July to November.)

Family SCYTODIDÆ.

Loxosceles rufescens Duf.

Family THERIDIIDÆ.

Lathrodectes mactans Fab.

Family TETRAGNATHIDÆ.

Tetragnatha grallator Htz.

Family EPEIRIDÆ.

Epeira foliata Koch.
gigas Leach.
prompta Htz.
Argiope aurantia Lucas.

Family THOMISIDÆ.

Runcinia aleatoria Htz.

Family LYCOSIDÆ.

Lycosa carolinensis Walck.
rabida Walck.

Family OXYOPIDÆ.

Peucetia viridans Htz.

Family ATTIDÆ.

Phidippus audax Htz.
Ashtabula, sp. (Young.) May.

BIRDS OF THE OLYMPIC PENINSULA, WASHINGTON.[1]

By ABERT B. REAGAN, Ex-supervising Warden of the Olympic Bird Reserves.

THE Olympic peninsula extends from Gray's Harbor, latitude 46° 56′ north, to the Strait of Juan de Fuca, latitude 48° 24′ north. The region, as to the habitation of birds, divides itself into parts or belts: the islands along the coast; the coastal mainland region; the middle-upland country up to an elevation of 4000 feet; and the mountain district. As the observer will note, the high mountains form a circular area forty miles in diameter and 6000 to 8000 feet in height in the east-central part of the peninsula. From these mountains there extends northwestward to Cape Flattery a ridge ranging from 4000 to 1000 feet in elevation as one approaches the cape. The coastal strip is about twelve miles wide, skirting both the ocean and strait. The middle-upland region lies between the coastal strip and the mountain district. The whole mainland country is yet settled sparsely, hence is a paradise for birds. A dense underbush covers the land everywhere, so that the country might be said to be a jungle. For this reason birds in the interior region are hard to find, but along the coast and in the island districts they are in evidence.

The zones have a varied bird life. Mostly snow birds are found in the mountain zone. The middle upland zone has the meadow lark, robin, mourning dove, and so on. The lowland belt has a mixture of both land and sea birds, though as a rule only the land birds and ducks nest in this region. The island birds are practically all sea fowl.

On account of their prominence in bird life, the islands of the Pacific coast will receive further mention. They naturally divide themselves into three large segregations. Each of these segregations was created a bird reserve by executive order of President Theodore Roosevelt; and from the time of the issuing of said order till October 3, 1909, the author was supervising warden of these reserves. It was while in charge of these that he made the observations hereinafter recorded. The reserves are designated by the executive order as Copalis Rock reserve, Quillayute Needles reserve, and Flattery Rocks reserve. Copalis Rock reserve is near Grenville (Tahola), about thirty miles north of Gray's Harbor.

1. The only treatise that mentions the birds of this region, so far as the writer can learn, are Dr. W. Leon Dawson's "Birds of Washington," and the same author's "Bird Colonies of the Olympiades," in *The Auk*, for April, 1908, vol. XXV, pp. 153-166.

The Quillayute Needles reserve is in the vicinity of LaPush, Wash. The Flattery Rocks reserve, which also includes the Point of Arches group and Tatoosh island, at Cape Flattery, extends along the coast from the vicinity of the Ozette Indian village, some eighteen miles up the coast from LaPush, to Cape Flattery and the entrance to the Strait of Juan de Fuca. The islands of these reserves are the residual part of a sunken part of the continent. The country rock of the Copalis group is Cretaceous; of the Quillayute Needles group, lower Pliocene to possibly Miocene. The main Flattery segregation is likely cretaceous, and the Point of Arches is still older, while Tatoosh island belongs to the Clallam formation of rocks of the strait region and is Oligocene-Miocene in age.

The islands of this coast were all islands at least even as early as in Pliocene times. In the Pleistocene they were submerged. When, again, they lifted their heads above the surf after the troubled glacial epoch, each one had a Pleistocene cap of gravel and sand. Weathering, however, has removed this cap from all but the largest islands. It is in this Pleistocene cap that many of the burrowing fowls have their hidden homes.

Below is a description of the various islands of the respective reserves, beginning with the reserve farthest to the north:

FLATTERY ROCKS RESERVE.

The Flattery Rocks reserve comprises the following islands and groups of islands: Tatoosh island, Fuca's Pillar group, Point of Arches group, and Flattery Rocks proper.

Tatoosh island is situated at the entrance of the Strait of Fuca, on the western or American side. It is a low-lying, flat-topped, grass-bush-covered island, composed of conglomerate rocks, while near it are many pinnacles and points composed of the same rock formation. The main island is occupied by the government lighthouse and wireless station at the entrance of the strait.

Fuca's Pillar group lies in longitude 124° 43′ 30″ west, latitude 48° 22′ 30″ north. They contain a series of precipitous rock-points and pillars off Cape Flattery, of which Fuca's pillar is the most prominent. Most of the islands of the group are too much worn down to admit of safe nesting. The pillar and its immediate neighbors and the adjacent mainland promontory furnish good nesting places. These points and pillars, together with the adjacent headland, have been honeycombed and countersunk in a maze of places, hence are the best of nesting places.

The *Point of Arches group* is in longitude 124° 43′ west, latitude 48° 15′ north. The islands of this group extend from the shore line at the Point of Arches seaward in two parallel lines to a distance of about a half a mile. They are conglomerate in formation and the oldest rocks in age along the Pacific coast of Washington. They comprise about thirty under-cut and arched shafts and blocks. They stand out in bold and rugged outline. Bird colonies appear only on the western and northwestern members of the group, being densest in bird population on "Silversides."

Father and Son are two islands rising from the same base, 150 feet and 30 feet in height, respectively. They are situated in longitude 125° 43′ west. They are off shore about one-half mile. The two together comprise about a half acre in area. They are guano-covered shafts, with practically no vegetation.

Flattery Rocks proper are four islands of 200 feet in height just off shore at high tide; at least the easternmost one is connected with the mainland by a very rocky peninsula at low tide. They run in a west-northwest line from the Ozette Indian village; longitude 124° 45′ 6″, latitude 48° 10′ 45″ north. In total area they may be said to aggregate some thirty acres. The two nearest the shore are wooded, but the two others are steep-walled and barren. It is on these that the birds nest.

QUILLAYUTE NEEDLES RESERVATION.

The islands of the Quillayute Needles reservation, beginning at the north limit are: White Rock, the Jagged islet-Carrol islet group, Cape Johnson group, Doh-od-a-a-luh, Cake Rock, the James island group, Quillayute Needles proper, the Giants' Graveyard, Round islet, Alexander island, North Rock, and Destruction island.

White Rock, called "Peechwah" by the Indians, is located in longitude 124° 43′ 20″ west, latitude 48° 8′ 10″ north. It is about 140 feet in height. Its walls are abrupt, though scalable. Its grass-covered top aggregates probably half an acre.

Carrol islet is called by the Indians "Habaaht-aylash." It is about two miles north from Jagged islet, to which group it belongs. It is located in longitude 124° 43′ 30″, latitude 48° 10′. It is a huge island, covered with giant trees and underbrush, while projecting cliffs and benches add to making it an ideal bird home. In elevation it exceeds 250 feet, and in area it aggregates 15 acres. It is a bird paradise.

Paahwooke is an inaccessible pinnacle of 125 feet in height, located about a hundred yards nearly west of Carrol islet.

Jagged islet is an islet in the middle stages of decay. Its central-eastern part reaches an elevation of some 70 feet. It is barren of vegetation, but its fantastically eroded sandstone makes up in picturesqueness for its barrenness. It is composed of a long ridge of 250 yards in length, running in an east-and-west direction. From this ridge a long spur runs off to the northward. The islet contains about three acres. Its lower levels are just above tide. This lower area is the basking place for hundreds of sea-lions. The central high area is a bird home.

Wishaloolth is east-southeast of Jagged islet, about half way between it and the shore. It is about 21 acres in area. It is 200 feet high and 300 yards long. It is further characterized by its having its strata of metamorphic conglomerate rock dipped exactly opposite to the dip of the rocks of its sister islands, they dipping southwestward. Its sides are sharply sloping, but are covered with shallow earth and guano and the whole covered with grass and low flowering plants and a few scattering shrubs. Near this islet and between this islet and the shore are several smaller islets, composed of the conglomerate rock, but with strata dipping northwestward.

The *Cape Johnson group* comprises about fifteen rocky points and peaks extending from the shore line westward to a distance of one-half to three-fourths mile, in longitude 124° 42′, latitude 47° 58′. There are but few birds on these islands except on the most westerly ones.

Doh-od-a-a-luh is about one mile off shore, in longitude 124° 41′ west, latitude 47° 57′ north. It is a little less than an acre in area. It is quite steeply walled. It runs to a high point, but has several outlying spurs, which, together with the less perpendicular slopes, are covered with wire grass.

Cake island, or Chah-chah-lakh-hoos-set, to use the Indian name, is off shore about two and one-half miles from the mainland to the eastward and some three and one-half miles north of the Indian village of LaPush, in longitude 124° 41′ 30″, latitude 47° 55′ 50″ north. It comprises an area of about a dozen acres. It is almost elliptical in shape, with practically perpendicular walls of a height of 120 feet. It has an oval top densely covered with brush, under which there is a thick layer of turf and guano. It is unscalable at the present time, hence a bird paradise.

The James island group comprises several islands, principal of which is James island. Four of the so-called islands are only peninsulas at low tide, being then connected with the mainland. The off-shore islands here are small. James island and three other islands of the group are forested, the former densely forested. This island is easily accessible, though high and for the most part steep-walled. It contains over forty acres. It was on this island that the Quileute Indians had their stockade village in the old times and where they were making a last stand against the ravages of the Makahs at Cape Flattery. The old village site is to-day a garden. On account of the close proximity of these islands to the shore, they are not safe nesting places. Some Baird cormorants, however, venture to make nests on all the islands of the group, while several species of birds, including a Peale falcon, inhabit Chaa-uh, a few rods from James island.

The *Quillayute*[2] *Needles group* proper lies in a line circling somewhat to the northwestward from Tealwhat Point, a head of land that extends into the ocean about a mile southwestward from the agency office at LaPush. These islands, with James island to the northwestward, inclose Quillayute bay to the west of the Indian village. They are exceedingly picturesque, and range from pinnacle, oval sugar-loaf to flat-topped. In appearance from the agency quarters they remind one much of the volcanic buttes of New Mexico, especially those of the Cabezon group. The two largest islands are each over 100 feet in height, and each has a top area of about an acre. The easternmost of these two, called Keep-soostahl by the Indians, is the higher island. It is unscalable. The western island has precipitous walls except to the southeast, where it runs down toward the sea in shed-roof style. It is there easily scalable. The Coast and Geodetic Survey chart No. 6400 calls this island "Huntington Rock," but the Indians call it "Dhoyuatz," a shortened form of Dhuoyuachtal (the catch-petrel-place). In the summer of 1907 the writer, in company with Dr. W. Leon Dawson and a Professor Jones, spent a night on this island. From our observations we decided there were, besides other sea fowl, at least 40,000 petrels on this island alone. The night birds were so numerous that they would knock each other down on us in their rapid flight.

The *Giant's Graveyard*, longitude 124° 34′ west, latitude 47° 30′ 30″ north, comprises a group of jagged pinnacles of shore rock, ranging from just above the water to an elevation of 160 feet. They number some twenty islands. They represent the last stages of erosion of lower Pliocene (and Miocene) sandstone ledges that were elevated in a previous geological age to nearly a vertical position. The principal rock of this group is called Ghost Rock. It stands out in bold outline. It is narrow at base and higher than wide. It is a cormorant home and is everywhere white with excre-

2. The Indian office spells the word "Quileute"; geographers, "Quillayute."

ment. Gulls and Baird cormorants and scattering pairs of block oyster-catchers also inhabit the other islands of this group.

Round islet is a rounded mass of rock about 100 feet in height. It is off shore to the southwest about three-fourths of a mile from To-leak Point, longitude 124° 34′ west, latitude 47° 49′ 40″ north. It is domed at top and is covered with a dense vegetation of brush and coarse grass. It aggregates probably an acre in area.

Alexander island has a ten-acre top. It is off shore about two miles, in longitude 124° 30′ 30″ west, latitude 47° 47′ 40″ north. It is roofed with a conglomerate series, which in the interior-continental region seems to be the dividing line between the Miocene and the Pliocene formations. It is topped with green upon a thick turf ; grass, brush and dwarf spruce trees abound on it. In height it exceeds 110 feet. It has a sloping approach on the south, is perpendicularly walled on the north, and has a deep embayment on the south, being steep-sided on this side also.

North Rock is off shore about two miles, in longitude 124° 29′ 50″ west, latitude 47° 44′ 45″ north. It is a picturesque island, whitened by long use as a bird rookery. It is 90 feet in height, 100 feet in breadth, and about 50 feet in thickness. It is barren of soil and is unclimbable.

Destruction island is off shore from the mouth of the Hoh river about three and one-half miles, in longitude 124° 30′ west, latitude 47° 40′ 20″ north. The island proper covers about sixty acres; but its total area, including reefs at low tide, aggregates a little over a half a square mile in area. This island is covered over with a dense cap of Pleistocene deposits; gravel (and semi-conglomerate rock), clay, loam (composed in part of guano), in ascending series, the whole resting upon upturned, eroded sandstone of Oligocene-Miocene age. The reef areas are devoid of the Pleistocene cap, are extensive in area, and stand out above the surf at ebb tide as ridges and ribs of sculptured rock on all sides of the island. The island proper is so densely covered with grass, salal and salmon-berry bush and other low shrubbery that it is with difficulty that one is able to get about from one part of the island to another. On this island is located a government lighthouse and a life-saving station. It is a delightful place on which to live for one who cares not to have communication with the outside world but once in three months, when the government "light ship" makes its regular inspection tour. This island has many species of birds inhabiting it.

COPALIS ROCK RESERVATION.

Of the Copalis Rock reservation *Willoughby Rock* covers approximately three acres. It is off shore about one mile, longitude 124° 21′ 22″ west, latitude 47° 24′ 40″ north. It is 125 feet in height. It is capped with a metamorphic conglomerate rock, over which there is a thick earth-guano cap. It is climbable on the south, inaccessible on all other faces on account of its vertical walls. It is grassed over and is an excellent nesting place for birds.

Split Rock (which the Indian tradition says is the pair of tongs which the creator Kwatte hurled into the sea in his rage when his brother changed himself into a hermit crab), is about an acre in area. It is off shore about a mile, longitude 125° 21′ 45″ west, latitude 47° 24′ 20″ north. It is a barren double rock composed of conglomerate to metamorphic breccia of Cretaceous age. Its northern slope is covered with small holes that usually contain water. On the whole it presents a rough surface. In height it exceeds eighty feet. It is an elegant rookery.

Grenville Pillar is an unaccessible, grass-covered, earth-topped island of about a quarter of an acre in area, just off of Point Grenville (at Tohola), longitude 124° 17′ west, latitude 47° 18′ 20″ north. It is perpendicularly walled, except at the north, where it is under-cut. Seven species of birds nest on it.

Grenville Arch is a large rock off shore about a half mile southwest from Point Grenville. It is conical-oval in shape, is perpendicular on the east and north and is sloping on the west and south. As the name signifies, it is tunneled through the middle part by a wide arch, said to be forty feet in height. Seven bird species also inhabit this island in summer.

Erin's Bride is off shore 300 yards. It is situated to the southeast of Point Grenville, in longitude 124° 16′ west, latitude 47° 18′ north. It is an unscalable, narrow rock. It is 125 feet in height and aggregates one-half acre in area. It is covered with fresh guano.

Erin islet is near the last, and off shore about 200 yards. In area it covers about two acres. It is 125 feet in height and is climbable only on its north side. On top it is curb-roof shaped, with top sloping east, west and north. On its earth cap grows a dense mass of wire grass.[3]

Besides the above-named islands and groups of islands, there are

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3. Location and elevation of islands taken in the main from Coast and Geodetic Survey Chart No. 6400.

many unnamed points and rocks just at or above tide which serve as feeding ground for birds, also occasional nesting places.

The above island descriptions may prove tedious, but it is thought best to add them, that the reader may thoroughly understand the bird-life environments, and also have a definite idea as to where the islands and places mentioned are located.

In giving the species below, the islands inhabited by a named species will be given in succession, together with the estimated number of birds of that species nesting on each respective island, the total also being given at the close of the enumeration.

Unless otherwise stated, the birds mentioned in the list below are breeding residents. The number opposite the name of each respective species is the number of that species in "Handbook of Birds of the Western United States," by Forence Merriam Bailey.

BIRDS OF THE OLYMPIC PENINSULA, LISTED.

NOTE.—All measurements are in inches.

ORDER PYGOPODES: DIVING BIRDS.

Family PODICIPIDÆ: Grebes.

Genus *Æchmophorus.*

1. Æchmophorus occidentalis Lawr. Western grebe. Migratory. It occurs regularly along the coast in summer.

Description: Bill long and slender, tipped but not decurved, length five or more times the depth; head slender, without side crests; neck nearly as long as body; top of head and line down the back of the neck black; back slaty gray; under parts silvery white. When stretched for measuring it exceeds 27 inches from point of bill to toe tips.

Genus *Colymbus.*

2. Colymbus holboellii Reinh. Holboell grebe. Migratory. It visits the coast region in summer. Only a few of this species were seen by the writer.

Description: Head and bill about the same length; top of head greenish black to blackish black, often conspicuously crested; wings brown; back black; neck rufous; under parts washed with white or gray. Length about 20.

Subgenus *Dytes.*

4. Colymbus nigricollis californicus Heerm. Eared grebe. Rather common on the swamps up the river at LaPush. It is not known that they nest in the region. It is a pretty bird.

Description: A tuft of silky, yellowish, fan-shaped feathers on each side of the head; rest of head black; neck and chest black; back blackish; breast silvery white; sides brown. Length about 14.

Genus *Podilymbus.*

6. Podilymbus podiceps Linn. Pied-billed grebe; dadchink. Common, but not known to nest in the region.

Description: Bill stout and short, whitish, crossed by a black band; upper parts, chin and throat black to blackish; breast mottled gray veneered with a silvery gloss.

Family Gaviidæ: Loons.

Genus *Gavia*.

7. Gavia imber Gunn. Loon; great northern diver. Abundant in migration.

Description: Bill yellowish, upper ridge and top black to blackish horn color; crown, back and part of the neck pale brown to black, spotted with white; throat and sides of neck crossed by a series of white streaks; breast white. Length about 40. Female smaller than the male. Her under parts have a dirty yellowish tinge; she also has neither the streaked bands on her neck nor the white spots on her body that the male has. Tail feathers of both male and female are short and stiff; front toes fully webbed, hind toe small.

10. Gavia pacifica. Pacific loon. A migrant.

Description: Head and neck velvety, back of same whitish to smoky gray; throat black, with a greenish-purplish gloss; longitudinal white streaks show off the neck collar of black; back black, barred with four series of white streaks; lower parts white; tail feathers short and stiff; hind toe small; front toes fully webbed.

Family Alcidæ: Auks, Murres and Puffins.

Genus *Lunda*.

12. Lunda cirrhata Pall. Tufted puffin. Breeding resident.

Tatoosh Island, a few scattering pairs; Point of Arches group, 1000; Flattery Rocks proper, 2000; White Rock, 900; Carrol islet, 1100; Wishalooth, 1500; Doh-odaaluh, 100; Cake Rock, 800; Keeksoostahl, 1000; Dhuoyuatzactahl (Quillayute Needles group), 500; Round islet, 800; Alexander island, 8000; Willoughby Rock, 800; Grenville Pillar, a few scattering pairs; Erin islet, 3000. Total number, 21,500.

Description: This is a very picturesque sea bird, but shy and mostly a night bird in its movements. Its length is about 16 inches. Over each eye arises a tuft of whitish feathers about four inches in length. Bill high, much compressed, ridged transversely on the sides; bill strong and about as high as long. With this strong bill it crushes clams and other crustaceans on which it feeds; and, should it be captured, it will attack its captor with this beak with dangerous effect. I saw one cut a hole right through a coat as if it had been done with a pair of tin cutters. On account of the use of its beak in crushing things, together with the appearance of the beak, this bird has been termed "sea parrot." The upper parts of the body of this bird are sooty black; under parts dark gray; a fold of naked, reddish skin at the corner of the mouth; sides of face white, from which strip the silky yellowish-white crest above mentioned extends; feet and bill bright red; eyes white and conspicuous.

Nest: The nest is on the bare ground at the end of a burrow of some two feet in length. Not more than two eggs are laid. The young birds are ready to fly south about the first of September. Just before they were ready to fly in the year 1909, but after they had left the nest, a terrible wind storm and cold rain blew them into the charging surf and practically all the young perished.

Genus *Cerorhinca*.

15. Cerorhinca monocerata Pall. Rhinoceros auklet. A common resident of the island division.

Destruction island, 15,000, and a few scattering pairs on some of the other islands, make up the total number that nest in the region.

Description: Bill stout, much compressed, longer than deep, tip decurved, base with horn in breeding season; upper parts of body dusky; belly whitish; rest of under parts, throat and sides of head plumbaceous; two series of white-pointed feathers flank side of head. Length of bird about 15.

Genus *Ptychoramphus.*

16. Ptychoramphus aleuticus Pall. Cassin auklet; Cassin's guillemot; Aleutian auk. Common island resident.

Tatoosh island, a few scattering pairs; Carrol islet, 3000; Quillayute Needles, 1000; Alexander island, 2000. Total number, 6000.

Description: In general description this bird is about the size of a pigeon. It is whitish of color, slightly tinged with blue; bill broader than deep at base; under parts white. Length usually about nine inches.

This is the gayest and briskest member of the auklet family. It steps nimbly along on its toes when on shore; hides among the rocks. When out at sea it swims and dives with alacrity. Its nesting place is in a natural, obscured cavity in some suitable place among the rocks that have fallen upon the beach of some island. They nest in pairs. The single egg laid is whitish of color, slightly tinged with blue.

Genus *Cyclorrhynchus.*

17. Cyclorrhynchus psittaculus Pall. Paroquet auklet. A migratory visitant. Rare.

Description: Bill without knob at base; bill thin, high, dark red in color; lower mandible curved upward; under parts white; rest of body, including throat patch, sooty black; from the lower eyelid of each eye there extends backward over each ear a thin, white crest.

Genus *Simorhynchus.*

20. Simorhynchus pusillus Pall. Least auklet; Little auk; sea dove; dovekie. A rare migratory visitant.

Description: Bill with knob at base; crests of small, white feathers in front and back of eye; bird small, about the size of a dove; upper parts approaching black; under parts white to mottled or dusky; band of dark-colored feathers often across the breast.

Genus *Synthliboramphus.*

21. Synthliboramphus antiquus Gmel. Ancient murrelet; Black-throated Guillemot. A migratory visitor.

Description: This is a very handsome bird. Bill short and small; cutting edge of lower mandible convex; nostrils exposed; tarsus scutellate in front; under parts white; rest of body, head and neck black to slaty; strip of white, tassel-like filaments along back edge of crown, with sprinklings of same over back of neck; large white patch on each side of neck.

Genus *Brachyramphus.*

23. Brachyramphus marmoratus Gmel. Marbled murrelet. A numerous summer migrant. This is the most abundant migrant in July and August.

Description: In general, under parts white; upper parts dusky; upper parts barred with rusty brown; lower parts mottled with sooty brown. Length of bird about 10.

Genus *Ceppus.*

29. Ceppus columba Pall. Pigeon guillemont. An island resident in summer. Tatoosh island, a few scattering pairs; Carrol islet, 40; Destruction island, 36; Willoughby Rock, 20; Slit Rock, 12; Grenville Arch, 14. A total number of about 122.

Description: Feet pink in winter, red in summer; bill straight, slender, black; plumage black, except on base of wing, here a white patch incloses a black triangle. Length of bird about 14.

Genus *Uria.*

30*a*. Uria troile californica Bryant. California murre; Common, or Foolish, guillemot. A numerous island resident in summer.

Paahwoke-it, 300; Carrol islet, 1200; Jagged islet, 12; Willoughby, 400; Grenville Pillar, 800; Grenville Arch, 16; Erin islet, 30. Total number of murres, 2988.

Description: Under parts of body pure white; rest of plumage velvety sooty brown. Head rather small; a deep groove of feathers back of eye; nostrils concealed in feathers; bill slender, narrow. Bird about the size of a common duck.

Egg: The nest is the bare rock on which the egg is deposited. The egg is pear-shaped and much longer than a hen's egg. It is bluish green in color to yellowish green, with streaks and blotches of brown or black.

The young murres are ready to fly about the first of September. The young all perished in a storm mentioned above the latter part of August, 1909. When attacked, the mother bird will stay by her young till she is often captured. Sometimes she will shuffle herself over the rocks and drag her eggs with her; or, in case the hatched birds are nearly large enough to fly, she will shove them into the sea to save them. The Indians rob these birds' eggs; the gulls also destroy them. The young birds are also at the mercy of both the Indians and gulls. The nest is watched by day by one of the parents, by night by the other. The changing nest time is the scene of much quarreling and commotion.

Family LARIDÆ: Gulls and Terns.

Genus *Larus.*

42. Larus glaucus Brunn. Glaucus gull. A rare migrant.

Description: Back and top of wings, light pearl gray, rest of plumage white. Tail square across the end.

44. Larus glaucescens Naum. Glaucous-winged gull. An abundant island resident in summer. Many of the birds of this species stay in the region throughout the year.

Fuca's Pillar group, 800; Point of Arches group, 800; Father and Son, 150; Flattery rocks proper, 1000; White Rock, 800; Paahwoke-it, 10; Carrol islet, 1800; Wishaloolth, 4000; Jagged islet, 300; Doh-od-a-a-luh, 50; Cake Rock, 1500; James island group, 500; Quillayute Needles proper, 1000; Giants' Graveyard, 20; Round islet, 150; Alexander island, 100; North Rock, 20; Destruction island, 500. Total number of Glaucous-winged gulls, 13,500, + 5000 on the Strait of Fuca side; total, 18,500.

Description: Plumage same as No. 42 above, except quills are clear gray with white tips. Length of bird about 27.

Nest and eggs: The eggs are three in number. They are laid on the bare ground or rock surface. Sometimes, however, a makeshift of a nest is made for them. Nests are also had in grassy areas and among the seaweed.

The Western gull inhabits the southern half of the island groups, the Glaucous-winged gull the northern section. The commingling ground of the two species is in the vicinity of LaPush, Wash. The Indians rob these birds of their eggs and young. Birds of this species have been known to lay three settings of eggs in one season, in an endeavor to raise a brood. The government now protects the rookeries. With this protection the birds have begun to increase in numbers very rapidly.

49. Larus occidentalis Aud. Western gull. A resident both summer and winter, nesting on the islands in summer.

Tatoosh island, a few scattering pairs; Carrol islet, 75; Wishaloolth, 1000; Quillayute Needles, 12; Alexander island, 4; Destruction island, 20; Willoughby Rock, 150; Split Rock, 300; Grenville Pillar, 60; Grenville Arch, 100; Erin's Bride, 100; Erin islet, 10. Total number of Western gulls approximates 1832, + 1000 on the Strait of Fuca side; total, 2832.

Description: Mantle for the most part dark slaty gray. Length of bird 27.

Remarks to No. 44 above apply to this species also.

51. Larus argentatus Brunn. Herring gull. A migrant.

Description: Mantle a delicate pearl gray; red spot on terminal end of lower mandible, not otherwise spotted. Length of bird about 24.

52. Larus vegæ Palmen. Vega gull. A very rare migrant.

Description: Mantle a deep pearl, shading into a plumbeous gray. Size same as No. 51 above.

53. Larus californicus Lawr. California gull. An occasional stray migrant.

Description: Feet greenish; bill yellow, lower mandible red and black spotted near the end; mantle clear bluish gray. Length of bird about 22.

54. Larus delawarensis Ord. Ring-billed gull. Only one member of this species was seen:

Description: Color of mantle same as No. 44 above; that is, light pearl gray. The greenish-yellow bill is crossed near the end by a conspicuous black band; end of bill is tipped with yellow. Length of bird about 20.

55. Larus brachyrhynchus Rich. Short-billed gull A rare migrant.

Description: Color of mantle same as last above; bill greenish, yellow tipped, short. Length of bird about 18.

56. Larus canus Linn. Mew gull. A migrant.

Description: Similar to No. 55 above, but with outer quills mainly black.

57. Larus heermanni Cass. Hermann gull. A migrant.

Description: Under parts dark gray; tip of tail, upper neck and head white; back sooty gray, bill bright red. Length of bird about 20.

60. Larus philadelphia Ord. Bonapart gull. Migratory.

Descrition: Upper parts delicate pearl gray; head and bill black; band across end of tail blackish. Length of bird about 14.

Family PROCELLARIIDÆ: Fulmars and Shearwaters.

Genus *Fulmarus*.

86*b*. Fulmarus glacialis glupischa Stejn. Pacific fulmar. A migrant.

Description: Bill stout, short; not as deep as wide at base; possesses nasal tubes extending about half the length of the bill; tip of bill and opening to nasal tubes yellow; under part of body bluish gray; rest of body, neck and head white. Length of bird about 19.

86.1. Fulmarus rodgersi Cass. Ridger's fulmar. A rare migrant.

Description: This bird is similar to the Pacific fulmar above, except that its mantle is very much darker.

Genus *Puffinus*.

93. Puffinus opisthomelas Cous. Black-vented shearwater. A migrant.

95. Puffinus griseus Gmel. Dark-bodied shearwater. A migrant; rare.

Description: As is indicated by the name, the entire plumage of this bird is sooty gray to darker, as well as its feet and bill, the exception being its white under-wing coverts, which are also mottled at the tips.

Genus *Oceanodroma.*

105.2. Oceanodroma kædingi Anthony. Kæding petrel. An abundant summer resident in the island districts.

Carrol islet, 1000; Wishaloolth, 20,000; James island group, 200; Quillayute Needles proper, 40,000; Alexander island, 10,000; Destruction island, 100; Erin islet, 25,000. Total number, 96,300.

Description: Bill, feet and plumage black to sooty black, except upper and sides of lower tail coverts, white; wing coverts brownish; tail forked; bill weak and small, with nasal tubes elevated at tip. Bird about the size of a common blackbird. Length about 9.

When captured it ejects a bad smelling liquid from its nasal tubes, and thus defends itself with the bad odor.

Nests: The nest of this bird is on the bare ground at the end of a burrow it has made in a bank or in the peat among the wiregrass on some island. Sometimes the nests are lined with grass. The eggs laid are usually one. This is nearly always nearly plain white.

ORDER STEGANOPODES: TOTIPALMATE SWIMMERS.

Family PHALACROCORACIDÆ: Cormorants.

Genus *Phalacrocorax.*

120*b*. Phaladrocorax dilophus cincinatus Brandt. White-crested cormorant. An island resident in summer.

Father and Son, 30; Carrol islet, 130; Doh-od-a-a-luh, 30; Giants' Graveyard, 100; North Rock, 400; Destruction island, 100; Willoughby Rock, 50; Split Rock, 10; Grenville Pillar, 120; Grenville Arch, 100; Erin's Bride, 90. Total number, 1160.

Description: Back and wings slaty, neck feathers black, rest of plumage greenish black; throat pouch orange; a narrow crest of curved white feathers above and back of each eye. Length of adult bird about 33.

Nest: Nest is a mass of sticks and seaweed six inches or more in height. Usually five eggs are laid.

122. Phalacrocorax penicillatus Brandt. Brandt cormorant. An abundant summer resident of the island regions.

Paahwoke-it, 100; Jagged islet, 60; Grenville Pillar, 200. Total number, 360.

Description: Tail short, of 14 feathers; head not crested; neck and head glossy blue-black with brownish patch next to gular sack; body usually of a glossy greenish black color, with long yellow or white filaments along side of neck and shoulders; bill nearly straight, slender; throat pouch blue. Length of bird about 34.

The young of these birds are at the mercy of the hungry gulls.

Subgenus *Urile.*

123. Phalacrocorax pelagicus Pall. Pelagic cormorant. Migratory in this region.

Description: This is a much larger bird than No. 122 above. Head and body dark glossy green; neck rich purple; wings purplish green; tail and quills black; white patch on flank of each rump; loose white filaments on neck; head with purplish green crests; throat pouch dark red.

123*b*. Phalacrocorax pelagicus resplendens Aud. Baird cormorant. An abundant summer resident of the island region.

Tatoosh island, a few scattering pairs; Fuca's Pillar group, 1200; Point of Arches group, 300; Father and Son, 300; Flattery Rocks proper, 500; White Rock. 300: Paahwoke-it, 200; Carrol islet, 600; Wishaloolth, 100; Jagged islet, 150; Cape Johnson group, 100; Doh-od-a-a-luh, 120; Cake island, 150; James island group, 200; Quillayute Needles proper, 50; Giants' Graveyard, 120; Rounded islet, 250; Alexander island, 400; North Rock, 200; Destruction island, 300; Willoughby Rock, 1000; Split Rock, 10; Grenville Arch, 120; Erin's Bride, 120; Erin, 100; the Island of the Strait of Fuca on the American side, 1000. Total number, 7840.

Description: This bird resembles the Pelagic cormorant above, but is much smaller and has a much slenderer bill.

Nest: The nest is a pile of sticks on a flat rock, or in some protected crevice in the rock wall.

Family PELECANIDÆ: Pelicans.

Genus *Pelecanus*.

125. Pelecanus erythrorhynchos Gmel. American White pelican. A rare visitant. An Indian brought me the skin of one he had killed. I never saw one alive.

Description: Plumage mostly white; large pouch of naked skin, as a fish net, is attached to lower mandible and neck front. Length of bird nearly 6 feet.

127. Pelecanus californicus Ridgw. California Brown pelican. Only one individual of this species was seen. It was evidently a stray.

Description: Bird similar to No. 125 above, but brownish in color, with reddish pouch.

ORDER ANSERES: LAMELLIROSTRAL SWIMMERS.

Family ANATIDÆ: Ducks, Geese and Swans.

Genus *Merganser*.

129. Merganser americanus Cass. American merganser; sheldrake; water pheasant; diver; goosander; saw-bill, etc. A common summer resident. It nests in the up-stream regions, coming down the stream with the broods in the latter part of August. They sometimes stay all the year.

Description: This is a handsome duck, but coarse meated and poor flavored. Breast of male pale salmon-white in color; sides and neck white; tail and rump gray; middle of wing white, rest black; shoulders black; head and short crest a glossy greenish black. Upper parts of body of female bluish gray, except white on middle of wing; breast and chin white; head, neck and crest plumage light brown; bills of both sexes slender, with edges of mandibles armed with sharp, strongly recurved teeth.

These birds are good fishermen. They know how to drive the fish in places where they can catch them. Sometimes one bunch of goosanders will drive the fish toward another bunch of brother goosanders, and *vice versa*. Sometimes they will also fight over a fish. Their warning note is "Carr, corr." These birds are frequent visitors of the "lagoon" at LaPush.

130. Merganser serrator Linn. Red-breasted merganser. Not common.

Description: Head and crest a glossy greenish black; neck and middle of wings and belly white, the latter shading into cream color; rump and sides gray; back black; chest buffy brown.

Nest: The nest is placed a short distance from fresh water. It is made of dry weeds, sticks, moss and grass, and is lined with down from the breast of the female. The eggs vary from six to ten, are pale buffy in color to a dull yellow cream color, and measure about 2.5 by 1.6 inches.

Genus *Anas.*

132. Anas boschas Linn. Mallard. Common migrant both fall and spring; also breeds in the region, and occasionally winters in it.

The "quack, quack" of this bird is familiar to every one, the "quack" of the female being loud and short, that of the male duller. The conversational notes are "weck, weck"; the call note "waek, waek"; the alarm cry, "katch," or "rab, rab."

The nest is generally placed in a quiet, retired, dry spot, on the ground under a bush, or concealed by herbage. It is usually, also, placed near to some fresh water. The eggs are from 8 to 16 in number. They are somewhat elongated in shape, are hard, smooth-shelled, and of a pale olive to buffy green in color. The period of incubation extends over 28 days. Only the female sits on the nest.

Genus *Chaulelasmus.*

135. Chaulelasmus streperus Linn. Gadwell, gray duck. A migrant.

This is a gray duck resembling the mallards both in habits and appearance. It is prized by sportsmen on account of its gamy nature.

Genus *Mareca.*

137. Mareca americana Gmel. Baldpate: American widgeon. A migrant, also likely nests in the up-marsh regions.

Description: It receives its name "baldpate" from a large white strip which extends from the base of the bill up to and including the crown to the nape of the neck. Crown bordered with metallic green, rest of head and neck buffy over speckled with dusky; belly white; back barred with wavy lines of white, lavender, and black upon a dark gray background; sides and chest grayish lavender; bill blue, tipped with black. Length of bird about 20.

Nest and brood: The nest is placed upon the ground. It is composed of grass, leaves and down. The eggs are from 8 to 12 in number. They are a dull pale buff to a creamy, buffy white in color. They measure 2 by 1.5 inches.

The bird's call is "whew, whew, sweet."

Genus *Nettion.*

139. Nettion carolinensis Gmel. Green-winged teal.

This bird is distinguishable from the other teals by the wide crescent of green and black inclosing the eye and reaching to base of crest, also by its green wing.

Genus *Querquedula.*

140. Querquedula discors Linn. Blue-winged teal.

This bird is distinguishable from the other teals by its white crescent in front of the eye, also by its blue wing at base.

141. Querquedula cyanoptera Vieill. Cinnamon teal. A breeding resident.

Description: Wing with lesser coverts light blue; rest of plumage generally cinnamon brown in color, shading to dull brown on belly and blackish on crown and chin. This bird has sometimes been called the Red-breasted teal.

Nest: Its nest is on the ground, being built in swamp grass, near some stream, and lined with down. The eggs number from 8 to 12, and are of a creamy white color.

Genus *Spatula.*

142. Spatula clypeata Linn. Shoveller; spoonbill. A resident of the up-river regions. A common migrant both fall and spring. I have killed individuals of this species at LaPush in February.

Description: Bill long and shovel-like, with fine, comb-like teeth conspicuous along the sides when closed, black in color; neck and head black to greenish black on back and sides; belly, chestnut; chest white, with white extending around the collar at base and backward over the back in two wide strips when wings are folded, inclosing a strip of dark; wing coverts barred with white, rest light blue; speculum green; scapulars streaked with white, black and blue; feet orange. Female mainly spotted and streaked with dusky brown.

At the beginning of the breeding season these two ducks are as pretty a pair of water birds as are seen in the region. In flight, this bird resembles that of the Blue-winged teal; in flavor, its flesh rivals the meat of the teal. Though this bird often visited the "lagoon" at LaPush, I rarely ever saw it in salt water, and then when compelled to resort thither.

Nest and young: The nest is usually placed in a tuft of herbage near some fresh water in a place difficult of access. It is composed of fine grass and carefully lined with down from the female's breast. The eggs are from 8 to 14 in number, and are a buffy white, tinged with green to olive-greenish in color.

Genus *Dafila*.

143. Dafila acuta Linn. Pintail. Breeds in the region, also a migrant.

Description: This is a long-necked bird with a sharp-pointed tail of 16 feathers. It is large of size. Its throat and under parts are white, also a white patch extends from the white under part of the neck upward in a narrow stripe toward the crown almost on a line with the eye, but extends only to the base of the crown; head not crested; purple glossy brown to blackish in color; sides and upper parts wavy gray; wing slaty, with a line of buff bordering the purple speculum. Female: Back and root of neck above black, rest of plumage in general being colored in various shades of brown; breast and belly being brownish white, interspersed with white; back and wings mottled with black, brown and buffy. Length of bird about 30.

Nest: The nest is well concealed. It is lined with grass and interlined with feathers. The eggs are about 10 in number, and are of a greenish olive buff, shading into a pale greenish color.

Genus *Aix*.

144. Aix sponsa Linn. (?) Wood duck. Said to visit the region occasionally, but was not seen by the writer.

Genus *Aythya*.

146. Aythya americana Eyt. Redhead. A visitant of the region.

Description: This duck is readily distinguishable from the other ducks on account of its whole head and neck being a bright reddish chestnut in color. As a further description: The feathers at the base of the tail and those of the tail are black; belly, chest and shoulders white; back gray, streaked with ash and black; bill as long as head, dull blue in color, with a black belt at end. Length of bird about 22.

147. Aythya vallisneria Wils. Canvasback. Breeds in this region.

Description: Head and neck rich chestnut brown to darker brown on crown and face; back and sides light gray; belly grayish shading into white; chest and shoulders black; tail gray; base of tail blackish. Length of bird about 23.

Subgenus *Fuligula*.

148. Aythya marila Linn. Scaup duck: Blue-bill; Big Black-head; Broad-bill; shuffler. Resident and migrant.

Description: Belly white; sides of belly light grayish; rest of plumage black to black glossed with green on head; short, wide bill is tipped with black, rest of bill blue. Female: Belly and region around base of bill whitish; rest of plumage brownish in color. Male in nonbreeding season a

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dark brown, except on belly and at base of bill, which parts are whitish. Length about 20.

Nest not seen.

149. Aythya affinis Egt. Lesser Scaup duck. Migratory, and possibly a resident of the upper Olympic country.

Description: Similarly plumed as No. 148 above, except that the head is glossed with purple instead of green and that the gray lines on the side are a little more conspicuous. It also differs from the above in its being a smaller bird. Length 16.

Genus *Harelda.*

154. Harelda hyemalis Linn. Old-squaw. Migratory.

Description: Winter plumage: Dusky, ashy patch on side of head; middle tail feathers, back and breast black; rest of plumage white, shading into pearl gray on sides. Length about 22.

Genus *Histrionicus.*

155. Histrionicus histrionicus Linn. Harlequin duck. A summer visitor, visiting even the islands off the coast. It probably nests in the region also.

Description: This duck is characterized by its having a white collar, a white shoulder patch, a white patch in front of eye, one near the ear, and another running down the side of the crown nearly to the nape; all standing out from bluish-black-colored plumage surroundings.

Genus *Oidemia.*

Subgenus *Oidemia.*

163. Oidemia americana Swains. American scoter. I have seen this bird in July. September, however, is the time they are the most numerous.

Description: Bill swollen back of nostril; eyes brown; plumage black to sooty, without white markings. Length of bird 17.

Subgenus *Melannetta.*

165. Oidemia deglandi Bonap. White-winged scoter. A summer visitor, visiting even the islands off the coast as early as July. Great numbers of these ducks are to be seen on the "lagoon" at LaPush in September. It would seem from the numbers of young that are seen that they breed in the region, but I failed to ever find a nest.

Description: Eyes white, white eye patch on plumage extending backward from the eye taperingly toward the crown; wing speculum white; rest of plumage ranging from black to sooty. Length of bird about 20.

166. Oidemia perspicillata Linn. Surf scoter. This is a very common duck. I have seen it in all seasons of the year.

Description: Eyes white; bill swollen, white, red and orange yellow in male, black in female; white patch on back of head; triangular white patch on forehead; rest of plumage velvety black in male, sooty black to sooty gray in female. Length of bird about 20.

Genus *Erismatura.*

167. Erismatura jamaicensis Gmel. Ruddy duck. A breeding resident; also a migrant.

Description: Belly gray shading into silvery white; chin and cheeks white; top and back of head black; rest of plumage chestnut in color; bill bright blue, short and wide near end. Length of bird 14.

Nest: The nest is well hid among weeds and other water plants. It is composed of a mass of plant stems. Eggs numbering about 12, ranging from light buff to creamy in color.

Genus *Chen.*

169. Chen Hyperborea Pall. Lesser Snow goose. A common migrant.

Description: Wing with gray patch and black tip; rest of plumage pure white.

Genus *Anser.*

171*a*. Anser albifrons gambeli Hartl. White-fronted goose. A common migrant. On the 29th of August, 1906, 10,000 of these geese passed over LaPush, being driven southward in a storm. They were so low that I shot them from my front porch. They return northward in March and April.

Description: Tail coverts, posterior part of belly and face white; belly and sides spotted with black, or wholly black; rest of plumage dark gray; bill and feet orange, usually. Length of bird 30.

Genus *Branta.*

172*a*. Branta canadensis hutchinsii Rich. Hutchins goose. A common migrant. A settler at the Quillayute prairie killed 117 of these geese one winter.

Description: White band across the throat and neck; body of a deep gray; rest of plumage black. Length of bird 34. This bird resembles the Canada goose, but is smaller.

172*b*. Branta canadensis occidentalis Baird. White-cheeked goose. This is a common migrant.

Description: Cheeks white; throat patch between cheek patches black; rest of plumage practically similar to that of the Hutchins goose above.

172*c*. Branta canadensis minima Ridgw. Cackling goose. A common migrant. Length of bird 23.

174. Branta nigricans Lawr. Black brant. A migrant.

Description: Neck semi-encircled from the ventral side by a white band; anal region white; breast and head black, the former shading into slaty; rest of plumage sooty brown.

Genus *Philacate.*

176. Philacate canagica Sevast. Empire goose. An Indian killed the only specimen of the species I ever saw. He did not know what it was and brought it to me for identification.

Description: Tail, head and back of neck white; chin and throat brownish black; rest of plumage bluish gray; bill pinkish white. Length of bird 24.

Genus *Olor.*

180. Olor columbianus. Whistling swan. Common migrant. There are two pets, captives, at LaPush, one owned by Joe Pullen, one by Stanley Gray.

Description: Lores with small yellow spot; bill black.

Nest made of moss. Eggs usually 7, color a dull dirty white with brown markings, measuring 4 by 2.5 or more.

Order HERODIONES: Herons, Storks, Ibises, etc.

Family Ardeidæ: Herons, Egrets, Bitterns.

Genus *Botaurus.*

190. Botaurus lentiginosus Montag. American bittern. Reported from the region, but not seen by the writer.

Genus *Ardea.*

194*a*. Ardea herosias fannini Champ. Northwest Coast heron. A breeding resident both on coast and islands (Destruction and Alexander islands).

Description: Upper parts bluish slaty black, under parts streaked with white and black; occipital crest and sides of head black, top white; edge of wings and thighs cinnamon brown; shoulders black streaked with white. Length of bird 45. Length of wing 20.

The bird is often said to be mostly legs, neck and wings. It has a piercing eye and is always on the lookout for intruders. When it sees anything out of the ordinary it utters a coarse warning note that will not only warn its kind but will scare up all the ducks in the vicinity. For this reason this is the first bird that hunters kill when entering a region to hunt. While it is in the region there will be no successful hunting.

Nest and eggs: The nest is placed on a tree or rock. It is composed of a large bed of twigs, more or less matted together with moss and weeds. It is usually some three feet in diameter. From three to six eggs are laid, each measuring 2.5 by 1.5.

Order PALUDICOLÆ: Cranes, Rails, etc.

Family Rallidæ: Rails, etc.

Genus *Rallus.*

210. Rallus obsoletus Ridgw. California clapper rail. Rare in salt-marsh districts.

212. Rallus virginianus Linn. Virginia rail (?). Not common.

Order LIMICOLÆ: Shore Birds.

Family Phalaropodidæ: Phalaropes.

Genus *Phalaropus.*

223. Phalaropus lobatus Linn. Northern phalarope. A summer migrant, visiting even the islands off shore as early as July.

Description: In habits this bird is essentially an aquatic bird. In appearance it resembles the sandpipers, but differs from them in the shortness of its tail and slenderness of its long, sharp bill. Plumage: Belly and throat white; sides of neck rufous; chest gray; rest of plumage mostly dark plumbaceous, streaked with black and buff. Length about 8.

The calling note of this bird is a clear, sharp "tweet, tweet."

Genus *Steganopus.*

224. Steganopus tricolor Vieill. Wilson phalarope. A common migrant and likely a resident; these birds have been seen in full breeding plumage at LaPush.

Family SCOLOPACIDÆ: Snipes, Sandpipers, etc.

Genus *Tringa.*

Subgenus *Tringa.*

234. Tringa canutus Linn. Knot; Robin sandpiper. Common, visiting even the islands in July each year.

Description: This species is 10 inches long by 15 to 20 inches from tip to tip of wing. Under parts cinnamon; upper parts dusky gray, washed often with buff; tail coverts and rump white.

Subgenus *Actodromas.*

239. Tringa maculata Vieill. Pectoral sandpiper. Common, visiting even the islands in July each year.

Description: This bird is also known as Meadow snipe; Grass snipe; Jack snipe. Length about 9 inches. Plumage: Chest dark gray to dark gray streaked with duskia; upper parts mottled dusky or darker; rest of plumage white.

Subgenus *Pelidna.*

243*a*. Tringa alpina pacifica Cous. Red-backed sandpiper.

Description: This bird is about 8 inches in length and differs from the other sandpipers in having its back, crown and upper tail coverts bright, rusty ochraceous; sides and back part of belly white; chest grayish white; middle of belly black.

Genus *Ereunetes.*

247. Ereunetes occidentalis Lawr. Western sandpiper. An abundant migrant, returning southward in July, visiting also the islands off the coast.

Description: Under parts generally white in color; breast gray, spotted with dusky; sides same as breast; rest of plumage bright chestnut, mottled with gray, buff and black. Bird small.

Genus *Heteractitis.*

259. Heteractitis incanus Gmel. Wandering tatler. Common in summer, visiting also the islands off the coast in July and August each year.

Description: This is a bird of about 10 inches in length. Anal region pure white; throat white and dusky spotted; under parts barred with dusky and white; rest of plumage plumbaceous gray to slaty gray.

Genus *Numenius.*

265. Numenius hudsonicus Lath. Hudsonian curlew. A common migrant, visiting the region in July and August, extending its visits even to the islands off shore.

Genus *Ægialitis.*

Subgenus *Ægialitis.*

274. Ægialitis semipalmata Bonap. Semipalmated sandpiper. A common migrant.

Description: This bird resembles the killdeer but has shorter legs, is smaller and plumper; it has a heavy down under the feathers of the breast that makes it appear plump and round. Throat encircled with a white collar above a black collar; face black; forehead and under parts white; rest of plumage brownish gray. Length of bird about 7.

278. Ægialitis nivosa Cass. Snowy plover. Common migrant.

Description: A bird about the same size as No. 274 above, but with longer bill, black; black spot on chest, one just above the ear, and a black patch across the front of crown; face and under parts white; upper parts and crown pale buffy gray. Length of bird about 7.

Family APHRIZIDÆ: Surf Birds and Turnstones.

Genus *Arenaria.*

283. Arenaria morinella Linn. Ruddy turnstone. Migratory in fall and spring; seen in July near the islands off the coast.

Description: Head variously streaked; back coarsely mottled with black and rufous; black band across the chest; rest of plumage white. Length of bird 9.

284. Arenaria melanocephala Vig. Black turnstone. Very common in migration, also breeding in the region (?). I have seen these birds on the Pacific islands off the coast in July; I have also seen hundreds of them in the vicinity of Protection island, in the Strait of Fuca, in August. They are very common all along the strait at that time of year.

Description: White spot in front of eye; spotted on sides and forehead with white; chest, neck, throat and all of head but crown black; back and crown of head black, washed with a greenish bronzy gloss; rest of plumage white. Length of bird 9.

Family HÆMATOPODIDÆ: Oyster-catchers.

Genus *Hæmatopus.*

287. Hæmatopus bachmani Aud. Black oyster-catcher. An abundant resident; also a migrant. It nests on the islands of both the strait and Pacific coast throughout the region.

Tatoosh island group, 10; Fuca's Pillar group, 20; Father and Son, 4; Flattery Rocks proper, 12; Carrol islet, 10; Wishaloolth, 10; Jagged islet, 8; Cape Johnson group, 14; Doh-odaaluh, 14; Cake Rock, 6; Quillayute Needles, 8; Giants' Graveyard, 16; Round islet, 4; Alexander island, 16; North Rock, 8; Destruction island, 16; Willoughby Rock, 4; Split Rock, 6; Grenville Pillar, 4; Grenville Arch, 2; Erin and Erin's Bride, 2 each; on the islands and headlands of the Strait of Fuca, 100. Total number, 294.

This is a bird of some 17 inches in length, or a little larger than a common pigeon. It has a straight, flattened, chisel-shaped, long red bill. Its plumage is blackish, ranging from bluish black on head to brownish black on body. Its food is principally sea mollusks and crustaceans.

LAND BIRDS.

ORDER GALLINÆ: GROUSE, QUAIL, TURKEYS, PHEASANTS, ETC.

Family TETRAONIDÆ: Grouse, Partridges, Quails, etc.

Genus *Bonasa.*

300*c*. Bonasa umbellus sibini Dougl. Oregon Ruffled grouse. Common resident.

Length 18 inches. Upper parts black to reddish rusty brown; tail deep rusty brown; under parts marked heavily with blackish, washed with buffy brown.

Nest hidden in a hollow tree or under a fallen tree top. Eggs usually 10 to 12, of a pinkish buffy brown to white streaked with brown.

ORDER COLUMBIDÆ: PIGEONS.

Family COLUMBIDÆ: Pigeons.

Genus *Columba.*

312. Columba fasciata Say. Band-tailed pigeon. Very common.

Description: Back of neck with a white collar; tail with a broad, two-inch, pale gray band bordered with black above; upper parts, including the head, purplish pink, fading to whitish on belly. Length of bird 16.

Nest usually on the ground. Eggs usually two, color white.

Food: The food of these birds in this region is salal berries, salmon-berries, huckleberries, thimbleberries, red elderberries, and other wild berries.

A flock of these birds had their homes in the Red alder thicket near where I had a potato patch last year. I often worked late in this patch. While at this work my notice was called to this bird's peculiar "hooting." It was a spirited "Hoop-ah-whoo," and then again a "Whoo-hoo-hoo, whoo-hoo-hoo," followed by an occasional "qhoo-ugh."

Genus *Zenaidura.*

316. Zenaidura macroura Linn. Mourning dove. Common.

ORDER RAPTORES: BIRDS OF PREY.

Family FALCONIDÆ: Falcons, Hawks, Eagles, etc.

Genus *Aquila.*

349. Aquila chrysætos Linn. Golden eagle. I saw this bird only twice.

Description: Whole plumage dark brown, except tail, which is blackish and banded with a wide, grayish band. Length of bird 40; extent of width from wing tip to wing tip 7 feet.

Genus *Haliæetus.*

352. Haliæetus leucocephalus Linn. Bald eagle. Nests in the region, also on the islands, a pair nesting on Destruction island.

Description: Tail, tail coverts, neck and head snowy white; rest of plumage dark brown to blackish brown. Length 34, extent 7 feet.

Nest: The nest is composed of a bulky mass of weeds, sticks and vines, also turf, earthy rubbish, and moss and seaweed. Eggs: The eggs are two in number, of a bluish white color. They are each about the size of a goose egg. The young are at first covered with a cream-colored to whitish down which gradually changes into a bluish gray color.

Genus *Falco.*

365*a*. Falco peregrinus pealei Ridgw. Peale falcon. Common, nesting on the main land, also on James island, Carrol islet, and Destruction island.

Description: Head dark slaty, as is also the color of the rest of its upper parts, the tail and back of wings being barred also; chest marked with small black spots of almost tear shape; rest of under parts barred broadly in blackish. Extent of wing from tip to tip 12.

The nest of this bird is usually on some high cliff.

375*a*. Falco columbarius suckleyi Ridgw. Black merlin. Common, nesting on the mainland and on Destruction island.

Description: Throat white, streaked with black; rest of under parts blackish with whitish and tawny markings; tail tip whitish marked, rest of tail black, but barred with three slaty whitish bars; upper parts blackish brown shading into slaty on tertials and wing coverts, and into bluish slate on tail coverts.

Subgenus *Tinnunculus.*

360*a*. Falco sparverius deserticola Mears. Desert Sparrow hawk. Common; nests on Destruction island, also on the mainland.

Description: Wings bluish gray shading into rufous gray; back and tail rufous, latter with black terminal band; top of head bluish, with rufous crown patch; cheeks with two black stripes. Length of bird about 11; wing about 8; tail 6.

Nests usually in hollow trees. Eggs usually 5, of a cinnamon buff to pure white, sprinkled or blotched with brown.

Genus *Pandion.*

364. Pandion haliætus carolinensis Gmel. Fish hawk. Common.

Description: Head white streaked with blackish, with dark streak on side; breast blotched with brown; rest of under parts and neck pure white; tail narrowly tipped with white and barred with blackish bands; upper parts brownish to blackish brown.

Nest: The nest is usually built on a high tree. It is constructed of seaweed, rushes, moss, sticks, etc. Eggs 2 and 3, oblong in shape, of a grayish white color, speckled over with light reddish dots.

The food of this bird is fish.

Family BUBONIDÆ: Horned Owls, etc.

Genus *Syrnum.*

369*a*. Syrnum occidentalis caurinum Merriam. Northern Spotted owl. Rather rare.

Description: Head and neck coarsely spotted with round white spots; upper parts in general a dark brown; under parts whitish to slaty white. Length of bird 19.

Genus *Nyctala.*

372*a*. Nyctala acadica scotæa Osgood. Northwest Saw-whet owl. Common.

Description: Legs, feet and flanks refescent; eye rings whitish; face heavily streaked with dark brown; under parts white, heavily streaked with reddish brown. Length of bird 8.

Nest usually in a hollow tree or a deserted woodpecker hole. Eggs usually about 7.

Genus *Megascops.*

373*d*. Megascops asio kennicottii Elliot. Kennicott Screech owl. Rare.

Description: Upper parts sooty brown, much mottled and streaked with black, as are the lower parts also; legs and feet mottled with buff over a rich buffy brown.

Genus *Nyctea.*

376. Nyctea nyctea Linn. Snowy owl. Common. Two were killed by Indians and brought to me for identification. Both were killed in the village itself.

Description: Color of plumage practically wholly white in the male, some darker in the female; both sometimes marked with spots and bars of slaty gray. Length about 22.

Genus *Glaucidium.*

389. Glaucidium gnoma californicum Scl. California Pigmy owl. This is a very common owl.

Description: Under parts white, chest washed with reddish brown, rest of under parts streaked with dark brown; upper parts usually a rusty brown; tail brownish, barred with white; head speckled white over brown.

Nest: In a hollow tree or deserted woodpecker hole. Eggs, usually 4, white in color.

ORDER COCCYGES: CUCKOOS, ETC.

Family ALCEDINIDÆ: Kingfishers.

Genus *Ceryle.*

390. Ceryle alcyon Linn. Belted kingfisher. Common everywhere.

Description: Middle parts of tail, crest and upper parts of body bluish gray; nuchal collar and underparts white; blue-gray collar across the breast; tail black except middle part.

Nest: The nest is a burrow in the river bank or in the side of some bluff. The female usually lays from 6 to 8 white eggs. The young are kept in the burrow till quite large; then are taken out and taught to hunt for themselves.

At LaPush the crows and the kingfishers fight over the fish the kingfisher has been lucky enough to catch. As soon as the catch is made, a dozen crows will pounce upon the lucky fisherman and take his fish from him. But the crow pays for his fish. The kingfisher will follow the thieving crow and scold him till he tires out.

ORDER PICI: WOODPECKERS, ETC.

Family PICIDÆ: Woodpeckers.

Genus *Dryobates.*

393*c*. Dryobates villosus harrisii Aud. Harris woodpecker. Common.

Description: White stripe down the back; nape scarlet; upper parts generally black; wings lightly spotted with white; under parts light smoky brown. Length of bird 10.

This bird nests in the holes in the trees that itself has pecked out. Eggs usually white in color.

Genus *Sphyrapicus.*

403*a*. Sphyrapicus ruber notkensis Suckow. Northern red-breasted sapsucker. Common. (?).

Description: Back, wings and tail black, marked with white; belly olive-yellow; head, neck and chest all sometimes red; breast always a bright red. Length of bird 8.

404. Sphyrapicus thyroideus Cass. Williamson sapsucker. Rare, except in migration.

Genus *Ceophloeus.*

405. Ceophloeus pileatus abieticola Bangs. Northern Pileated woodpecker; cock of the woods. Seen only in migration.

Description: Entire top of head, malar stripe and occipital crest bright red; rest of head whitish sulphur-yellow; patches on wings white; feathers on belly tipped with whitish; rest of plumage generally grayish black.

Genus *Colaptes.*

413. Colaptes cafer collaris Vigors. Red-shafted flicker. Seen only in migration.

Description: "Mustache" and nuchal band red; rump white; tail black; general color of rest of body plumage, including head, brownish; under parts spotted with black; upper parts barred. Length of bird 14.

410*a*. Colaptes cafer saturatior Ridgw. Northwestern flicker. A common summer resident.

Description: Similar to No. 413 above, but darker.

Order MACROCHIRES: Goatsuckers, Swifts and Humming Birds.

Family Caprimulgidæ: Goatsuckers.

Genus *Chordeiles.*

420*a*. Chordeiles virginianus henryi Cass. Western nighthawk.

Description: Tawny white bars alternating with black bars on under parts; upper parts generally light grayish buff.

This bird is very common.

Family Micropodidæ: Swifts.

Genus *Cypseloides.*

422. Cypseloides niger borealis Kenn. Black swift. Common both on the mainland and on the islands, especially Destruction and Tatoosh islands.

Description: Velvety area in front of eye; tail forked; plumage generally blackish or dusky. Length of bird 7.

Nest not seen by writer.

Family Trochilidæ: Humming Birds.

Genus *Selasphorus.*

433. Selasphorus rufus Gmel. Rufus humming bird. Common everywhere.

Description: General body color bright reddish to reddish brown; gorget, orange, brassy green and fire red. Bird about 4 inches in length.

Order PASSERES: Perching Birds.

Family Corvidæ: Crows, Jays, Magpies, etc.

Genus *Cyanocitta.*

478. Cyanocitta stelleri Gmel. Steller jay. Common both as a resident and as a migrant.

Description: General color blackish blue shading into purplish blue on tail and wings and pale blue on belly and lower back. Length 12.

It is the handsomest jay I have yet seen, and about the noisiest. His "hollering" (squalling) is "chack-ah, chack-ah."

Genus *Perisoreus.*

485. Perisoreus obscurus Ridgw. Oregon jay. Seen only in the middle Olympic mountain region.

Description: Forehead and under parts white; neck and top of head blackish; rest of upper parts brownish gray.

Genus *Corvus.*

486. Corvus corax principalis Ridgw. Northern raven. Common at La Push, Mora, The Carn's Place and on Destruction island; but never numerous.

Description: Large bird, with large, heavy bill; a much larger bird than the eastern raven, but colored similarly; entire plumage black glossed with purple on upper parts, with dull greenish on belly.

Nest: In trees and on cliffs, composed of weeds, sticks and moss. Eggs about 7, pea green to olive, spotted with shades of brown.

486. Corvus caurinus Baird. Northwest crow. Almost as common as the common blackbirds in the eastern states, but confines its wanderings principally to the coast districts of the Pacific and inhabiting the islands off the coast also. They remain in the region throughout the year. It is believed safe to say that there are 100,000 of these birds in the region.

Description: This crow resembles the crow of the eastern states; but is smaller and smarter. In general its plumage is all black, but glossed with dull violet on upper parts.

Nest: In a crotch of some tree. It is made of fine sticks and mud, and is lined with the inner fibers of cedar bark. Eggs usually 5 to 8, ranging in color from olive buff to pale bluish green, also more or less spotted with gray and brown.

This crow will go into the hen house and steal all the eggs and little chickens. It will come in the house and steal even off of the table where cooking is going on if the windows and doors are open. One crow watches while the rest steal. A coarse "caw" is a warning that there is danger. They are hard to shoot, especially in an Indian village, because they will always do their thieving near some house and will fly close to the house in leaving the premises. Being suspicious, they are also hard to poison. When anything as bait is put out they will fly around it and look at it; then one or two will taste it and fly away to some high place and await the effects. If no evil comes from eating the bait, or suspicious morsels, the testers will fly back and eat of it again; then all the crows will come and partake of the food. Consequently, when trying to poison this bird, the settler puts out bait unpoisoned several times till the crows get used to eating the certain food in the certain place. Then he takes the same kind of food and mixes poison with it and gives it to them, and they unsuspecting, eat it all and pay the penalty. But the crow is hard to kill even with poison. I took the Pacific sardine (smelt) and poured a dropper full of carbolic acid down the throat of each fish till I had a common pail of such "doctored" bait. This I put out for the crows, and they ate every fish and then sat on the fence waiting for more smelt fish. Not one bird was killed with the acid. Again I used arsenic with no better effect—the birds sat on the hillside and cawed; that was all. Again our agency doctor, Charles L. Woods, of Neah Bay, tried all the poisons in our government medical supplies on these birds, but with no deadly effect. Strychnine only would kill them. In stealing, one bird would draw the attention of the watcher while the other bird would snatch the coveted morsel. The same is true of their robbing a hen of her chickens. One crow would chase the hen while the other (or others) would seize upon the little ones. Also, in stealing feed out of the chicken trough in the hen yard, some of the crows would chase the chickens while the others snatched up the bits of bread and other morsels. In catching fish the crow will dart into the wave, the same as the gull does, and snatch up a fish; no doubt, having learned this trait from the gulls. The crow also shows his scheming ability in his securing the meat of the clam. He finds a clam on the beach, probably washed up by the wave. Immediately he seizes it and flies high up in the air over some hard surface with it. He drops it to break it open, then darts down with the speed of an arrow to get it before a sister crow gets it.

Family ICTERIDÆ: Blackbirds, Orioles, etc.

Genus *Sturnella.*

501*b*. Sturnella magna neglecta Aug. Western meadow lark. Common, but seldom mates and nests. Only a few times was it ever heard to sing. It is a regular migrant.

Description: Color of plumage similar to that of the Eastern meadow lark. Crescent on breast and spotting on sides black; yellow of throat spreading over cheeks; upper parts grayish brown streaked with buff and barred with black; under parts yellow. Length of bird 8.

The song note of this bird is "tung-tung-tungah-til'lah tung"; its alarm note "tuck"; anxiety note "tyar." It is in this bird's singing that it differs mostly from the Eastern meadow lark.

Family FRINGILLIDÆ: Finches, Sparrows, etc.

Genus *Coccopthraustes.*

514*a*. Coccopthraustes vespertinus montanus Ridgw. Western Evening grossbeak. Common at Soleduck Hot Sulphur Springs; elevation 3600 feet.

Description: Under parts and forehead bright yellow, the former shading into lemon yellow; crown, wings and tail black; rest of upper parts olive; white patch on wing.

Genus *Loxia.*

521. Loxia curvirostra minor Brehm. Crossbill. Common on mainland; also visits Carrol islet and Destruction island.

Description: General color of plumage dull red, shading to bright red on rump; under parts shaded with gray; tail and wings dusky. Length of bird 5. The bill is the distinguishing feature; the tips are crossed in adults.

522. Loxia leucoptera Gmel. White-winged crossbill. Common in the middle mountain district, at the Soleduck Hot Springs. Here they are very numerous and very tame. I have seen them eat off of a man's back, the man posing on purpose to see just how tame they were. They seemed to be totally fearless. To-day they were there and to-morrow they were gone, and again they would come in flocks.

Description: Similar in color of plumage to 521 above, but of a more rose red and occasionally tinged with yellow orange; wing with two white bands.

Nest not seen, as the writer's two trips at the springs were in August each year, after the breeding season was over.

Genus *Passer.*

—. Passer domesticus Linn. English sparrow. An occasional stray visits the region to the west of the Olympics; common on the "sound" side of these mountains.

Genus *Chondestes.*

522*a*. Chondestes grammacus strigatus Swains. Western Lark sparrow. Common.

Description: Tail blackish brown with white corners; under parts white; upper parts of body brownish gray, streaked with blackish; head streaked with black and white, with chestnut patch on sides. Length of bird 6.

Nests in the region, but nest not seen by the writer.

Genus *Zonotrichia.*

557. Zonotrichia coronata Pall. Golden-crowned sparrow. Common in migration.

Description: Head striped; central stripe yellow in front, ash gray behind; rest of head stripes black; under parts generally gray; upper parts of body generally olive brown, streaked with black and blackish brown; tail and rump plain; wing banded with two white bands. Length of bird about 7.

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Family TROGLODYTIDÆ: Wrens, Thrashers, etc.

Genus *Olbiorchilus.*

722*a*. Olbiorchilus hiemalis pacificus Baird. Western Winter wren. Resident throughout the year, breeding, also, on the islands off the coast. The "scolder," called in the Quileute language "cho-cho."

Description: Upper parts dark brown, sometimes narrowly barred with black; belly and under tail coverts barred; breast and throat tawny; flanks darker.

Nest: The nest is usually in hollow chinks in dead logs and stumps. It is made of moss and shreds of the inner bark of trees and is lined with feathers. The eggs are usually 7 in number, minutely but sparsely spotted with reddish brown over a creamy white.

Wherever you go in the woods this bird is always present and is hopping about from log to log and from underbush to underbush as he keeps up a continual scolding chirp.

Family CERTHIIDÆ: Creepers.

Genus *Parus.*

Subgenus *Parus.*

735*b*. Parus atricapillus occidentalis Baird. Oregon chickadee. Common resident, an abundant migrant.

Description: Tail not long; under parts generally white; back dark gray, sometimes washed with olive brown; sides tawny brown; sides of head white; top of head, also back of neck, a shiny black. Length of bird about 5.

741. Parus rufescens Towns. Chestnut-backed chicadee. But two individuals of this species were seen.

Description: This bird is easily distinguishable from the other chickadees by its back, sides and flanks being reddish brown; under parts white; sides of head white, top of head and upper part of neck brown; throat blackish brown.

Family SYLVIIDÆ: Kinglets, Gnatcatchers, etc.

Genus *Regulus.*

748*a*. Regulus satrapa olivaceous Linn. Ruby-crowned kinglet. Common.

Description: Under parts dirty white; upper parts grayish, washed with greenish on rump; crown bright red; feathers of upper parts with yellow edges. Length of bird about 4.

Family TURDIDÆ: Thrushes, Solitaires, Bluebirds, etc.

Genus *Hylocichla.*

758. Hylocichla ustulata Nutt. Russet-backed thrush. Common, breeding both on the mainland and on the islands.

Description: Upper parts russet color; tail a brownish olive brown; chest pale whitish; under parts white; sides white, washed with olive brown; eye ring buffy; sides of head tawny; upper parts more or less spotted. Length of bird about 7.

Nest: The nest is composed of moss and shreds of bark. It is usually in some marshy place in some small tree. The eggs are about 5 in number, spotted with rusty brown over blue to greenish blue.

Genus *Merula.*

761*a*. Merula migratoria propinqua Ridgw. Western robin. Common.

Description: Hind neck, tail, head and wings black to blackish; rest of upper parts slaty gray; throat black; rest of under parts generally rufous. Length of bird about 11.

Eggs, usually 4, greenish blue in color.

Genus *Spizella.*

360*a*. Spizella socialis arizonæ Cous. Western Chipping sparrow. Common.

Description: Forehead and eye stripe black to blackish; sides of head dull gray, top rufous, with an occasional median line of ashy color, white line from bill passing to nape above the eye; back brownish to pale buffy; under parts white to ashy white. Length of bird about 5.

Genus *Junco.*

567*a*. Junco hyemalis oreganus Towns. Oregon junco. Common at coast in winter; common in the mountain districts in summer, spring and fall.

Description: Middle of back dark brown; sides pinkish brown; neck, head and chest black, or nearly so; under parts of body white. Length of bird about 6.

Genus *Melospiza.*

581*e*. Melospiza melodia morphna Oberh. Rusty Song sparrow. Common. Nests everywhere, even on the islands of Tatoosh, Carrol and Destruction, also James island. The Indians call it "Hus-hus" or "Hus-hos."

Description: Upper parts rusty olive streaked with obscured black streaks; flanks olivaceous; chest wavy rufous.

Genus *Passerella.*

585*a* (note). Passerella iliaca fuliginosa Ridgeway. Sooty Fox sparrow. This sparrow is very common, nesting both on the mainland and on the islands (Tatoosh, Alexander, Carrol, Destruction and James islands).

Description: Upper parts dark reddish brown, mixed with dark slaty gray; dark foxy to dark brown on tail, rump and wings; under parts white to a dirty white color, marked with large triangular dark brown spots that converge on the breast Length of bird about 6.

Nest: The nest is made in the crotch of some shrub three or four feet above the ground in some thicket. It is usually composed of moss and leaves.

Eggs: The eggs are speckled and blotched with brownish lilac over a general bluish-grayish green.

Genus *Pipilo.*

588*b*. Pipilo maculatus oregonus Bell. Oregon towhee. Common.

Description: General color of upper parts mainly black, inconspicuously marked with white, especially on wings; very little white on outer tail feather; belly white; sides dark rufous. Length of bird 7.

This bird is quite shy and hides its nest far back in the woods. I hunted many times for its nest, but failed to find it. The bird itself makes a mewing sound like a cat as it flutters from bush to bush to draw one away from its young.

This bird is sometimes called chewink, towhee bunting and marsh robin.

Family HIRUNDINIDÆ: Swallows.

Genus *Hirundo.*

613 (note). Hirundo erythrogastra palmeri Grinnell. Western Barn swallow. Common everywhere along the coast and on the islands.

This bird is similar in color to the common barn swallow, but with a smaller bill and longer wing and tail.

613. Hirundo erythrogastra Bodd. Common Barn swallow. Breeds throughout the region in the cliff regions of both the islands and on the mainland.

Description: Tail much forked; upper parts glossy steel blue; forehead dark brown; under parts tawny brown. Length of bird about 7.

Nest: The nest is a bowl-shaped wall pocket made of mixed straw and mud and lined with feathers. Eggs are usually about five in number, are brown and lavender speckled over white.

Genus *Tachycineta.*

614. Tachycineta bicolor Vieill. White-bellied swallow. Common.

Description: Upper parts steel blue; under parts pure white.

Nest: This bird's nest is usually in hollow trees. Eggs usually 5, color white.

615. Tachycineta thalassina lepida Mearns. Northern Violet-green swallow. Very common.

This bird is easily distinguishable from the other swallows by its violet-green plumage of upper parts; under parts white.

Nest: The nest is on cliffs, under the eaves of houses and in hollow trees. A colony has its home under the eaves of the agency house at LaPush. The nest is lined with feathers; and, in case it is built under the house eaves, it is otherwise made like the nest of the Barn swallow above. The eggs are about 5 in number, white in color.

Genus *Riparia.*

616. Riparia riparia Linn. (?) Bank swallow.

Genus *Stelgidopteryx.*

617. Stelgidopteryx serripennis Aud. Rough-winged swallow. Common both on the mainland and on the islands of the Pacific front.

Description: Under parts dirty gray to white on belly; tail coverts white; upper parts dull grayish brown; wing saw-toothed to roughened on edge. Length of bird about 5.

Nest: The nest is usually in holes in banks Eggs about 6, white in color.

Family LENIIDÆ: Shrikes.

Genus *Lanius.*

622*a*. Lanius ludovicianus excubitorides Swains. White-rumped shrike; camp thief; camp robber; butcher bird. Common. An Indian at LaPush kept one of these birds in a cage.

Description: Upper parts light slaty gray to whitish on upper tail coverts; under parts white; bill and beginning of front of head black.

Nest not seen.

Family MNIOTILTIDÆ: Wood Warblers.

Genus *Helminthophila.*

646*a*. Helminthophila celata lutescens Ridgw. Lutescent warbler. Common; nesting on both the islands and the mainland.

Description: Under parts bright greenish yellow; upper parts bright olive green.

Genus *Dendroica.*

652. Dendroica æstiva Gmel. Yellow warbler. Common, nesting on both the mainland and the islands.

Description: Upper parts yellow to tinged with orange on crown; under parts streaked with rufous.

656. Dendroica auduboni Towns.. Audubon warbler. Common on both islands and mainland.

Description: Upper parts generally bluish gray, streaked with black; under parts yellow, white and black; rump, throat patch and crown yellow. Length of bird about 5.

Eggs usually 4, of an olive-greenish to an olive-whitish color.

Genus *Sialia*.

767. Sialia mexicana occidentalis Towns. Western bluebird. Common.

Description: Throat purplish blue; upper parts dark purplish blue, shaded sometimes into chestnut; breast rufous; rest of under parts of body mixed gray, brown and dull purplish. Length of bird about 7.

Nest: The nest of this bird is usually in abandoned holes of the woodpecker. The eggs are pale blue, six in number.

CATALOGUE OF THE FLORA OF KANSAS, PART I.

By BERNARD B. SMYTH, Curator of the State Museum of Natural History, Topeka, assisted by LUMINA C. RIDDLE SMYTH, M. S., Ph. D., Topeka.

(Read by title before the Academy, at Ottawa, Kan., December 31, 1909.)

INTRODUCTION.

THIS catalogue is preliminary to the fulfillment of a complete catalogue of the flora of Kansas, in which it is designed to include every species of plant that grows spontaneously in the state, whether indigenous or naturalized, with some small account of its station, habitat and time of blooming, as well as its place in a systematic list. The lowest subkingdom, embracing all the orders of plant life up to the liverworts, and containing approximately 1400 species, is not yet ready for publication, but is reserved for further microscopic study, to be issued later. The catalogue of the higher subkingdoms will be divided into three or more parts, of which one part is here presented.

An attempt, partially successful, is made in this work to bring botanical classification into harmony with itself and give the various groups of a rank uniform endings. With that end in view, as far as possible, names of the great primary divisions (subkingdoms) end with *ata*, based upon some characteristic that pervades the group; primary subdivisions (*phyla*) end with *phyta*, as usual; the next great subdivisions (*subphyla*) end in *ones*; classes end with the customary *ineæ* or *iferæ;* subclasses with *floræ;* orders end with *ales*, and family names with *aceæ*, all based upon some typical generic name or some characteristic of the group.

Much study has been made of late years to learn all that may be learned of the microscopic vegetation of the state, which is no unimportant consideration and involves no small amount of persistent and well-directed labor. With three or more powerful and well-equipped compound microscopes under our hands and a perfect familiarity with them brought about by years of experience (many when all are added together as students and teachers), it is to be hoped that our labors will produce many useful facts and that our lists when presented will be well worthy of consideration.

It is due to John H. Schaffner, A. M., M. S., professor of botany at the Ohio State University, to say that in the early stages of preparation of this catalogue he has had much to do. His advice in arrangement, classification and nomenclature has been constantly sought and freely given, yet seldom has been religiously followed. Nevertheless, his counsel has necessarily been of great service.

In the following pages herbaria in which specimens of the plants of the state are contained are indicated by initials as far as known. (A) represents the herbarium of the State Agricultural College, which is very full as to representatives of the Kansas flora, as prepared by Doctor Kellerman, now deceased, and Prof. A. S. Hitchcock; (S) is the State herbarium, in charge of the principal author; also stands for the private herbaria of the authors as well as the herbarium of Professor Schaffner, which is richly supplied with Kansas plants and is a part of the foundation of this catalogue; (U) is the herbarium of the Kansas State University, of which the authors have a list.

A few names are included on the authority of Mr. Coville or some of the botanists of the Department of Agriculture at Washington. It is not the aim to include any plants not known to exist in the state.

That there should be errors in the present catalogue is unavoidable and rather to be expected. All such discovered in season will be eliminated in the permanent flora, publication of which will necessarily be some years off yet. Correspondents will be thanked for calling attention to any veiled errors; obvious ones are evident enough and will need no pointing out.

Until some student of mosses comes into the state and works up the material available, the public must be content with the desultory work of various students, who have always done the best they knew in making determinations, such as have been published in the various numbers of the Bulletin of the Washburn Laboratory of Natural History by Prof. F. W. Cragin; Smyth's "Check-list of the Plants of Kansas"; the papers of MM. Renauld and Cardot in *Botanical Gazette,* almost entirely from material collected in Saline county by Dr. Joseph Henry; and the collections of Miss Minnie Reed in Wyandotte, Pottawatomie, Riley and other counties, and published in vol. XIV of the Transactions of the Kansas Academy of Science. Since then almost the only work done in the state in collection and determination of mosses has been by Miss Grace Meeker, of Ottawa, which of itself has not been small. It is hoped now that some students will wake up to the importance of studying the mosses of the state.

All persons interested in the flora of Kansas are invited to correspond with the authors. Let us know what you have learned of the flora of any part of Kansas, whether we have listed it or not. Wake up and do something.

Herewith is presented a scheme of classification and arrangement that is adapted to the accompanying catalogue of the flora of Kansas:

SCHEME OF CLASSIFICATION AND ARRANGEMENT.

(As adapted to the Flora of Kansas.)

Subkingdom II. ARCHEGONIATA. Archegoniate Spore-bearing Plants.

Phylum I. BRYOPHYTA (Muscineæ). Mosses and Liverworts.

Class I. MARCHANTINEÆ (Hepaticæ). Liverworts.

ORDER I. MARCHANTIALES. THE THALLOID LIVERWORTS.

Family 1. RICCIACEÆ. Crystalwort family.
- Riccia.

Family 2. MARCHANTIACEÆ. Liverwort family.
- Marchantia.
- Preissia.
- Fimbriaria.
- Conocephalus.
- Asterella.

Family 3. ANTHOCEROTACEÆ. Hornwort family.
- Anthoceros.
- Notothylas.

ORDER II. JUNGERMANNIALES. THE SCALE MOSSES.

Family 4. JUNGERMANNIACEÆ. Scale-moss family.
- Frullania.
- Lejeunea.
- Ptilidium.
- Lophocolea.
- Chiloscyphus.
- Jungermannia.
- Fossombronia.
- Pallavicinia.
- Pellia.
- Aneura.

Class II. BRYINEÆ (Musci). Mosses.

ORDER III. PHASCALES. THE CLEISTOCARPOUS MOSSES.

Family 5. MICROMITRIACEÆ. Micromitrium family.
- Ephemerum.

Family 6. PHASCACEÆ. Phascum family.
- Phascum.
- Pleuridium.
- Microbryum.

Family 7. ARCHIDIACEÆ. Archidium family.
- Archidium.

ORDER IV. BRYALES. THE TRUE MOSSES.

Suborder A. ACROCARPI. Capsules Terminal.

Family 8. DICRANACEÆ. Dicranum family.
- Astomum.
- Gymnostomum.
- Weisia.
- Dicranella.
- Dicranum.
- Campylopus.
- Fissidens.
- Leucobryum.
- Ceratodon.

Family 9. POTTIACEÆ. Pottia family.
- Pottia.
- Didymodon.
- Leptotrichum.
- Barbula.

ORDER IV. BRYALES. THE TRUE MOSSES.

Suborder A. ACROCARPI. Capsules Terminal.

Family 10. GRIMMIACEÆ. Grimmia family.

Grimmia.
Coscinodon.
Ptychomitrium.
Orthotrichum.

Family 11. FUNARIACEÆ. Funaria family.

Pyramidula.
Physcomitrium.
Funaria.

Family 12. BRYACEÆ. Bryum family.

Bartramia.
Leptobryum.
Webera.
Bryum.
Mnium.
Timmia.

Family 13. POLYTRICHACEÆ. Polytrichum family.

Atrichum.
Polytrichum.

Family 14. FONTINALACEÆ. Fontinalis family.

Fontinalis.

Suborder B. PLEUROCARPI. Capsules Axillary.

Family 15. NECKERACEÆ. Neckera family.

Meteorium.

Family 16. FABRONIACEÆ. Fabronia family.

Fabronia.

Family 17. LESKEACEÆ. Leskea family.

Thelia.
Leskea.
Anomodon.
Pylaisia.
Entodon.
Climacium.

Family 18. HYPNACEÆ. Hypnum family.

Thuidium.
Brachythecium.
Eurhynchium.
Rhynchostegium.
Plagiothecium.
Amblystegium.
Campylium.
Harpidium.
Hypnum.

Phylum II. PTERIDOPHYTA. Ferns and Filicoid Plants.

SUBPHYLUM A. STEREOCAULONES (= FILICES). SOLID-STEMMED PTERIDOPHYTES.

Class III. PTERIDINEÆ (Filicineæ). Ferns and Allies.

ORDER V. PTERIDALES (Filicales). THE FERNS.

Family 19. POLYPODIACEÆ. Fern family.

Onoclea.
Woodsia.
Cystopteris.
Polystichum.
Dryopteris.
Camptosorus.
Asplenium.
Adiantum.
Pellaea.
Cheilanthes.
Notholaena.
Polypodium.

ORDER VI. OPHIOGLOSSALES. THE ADDER-TONGUES.

Family 20. OPHIOGLOSSACEÆ. Adder-tongue family.

Ophioglossum.
Botrychium.

ORDER VII. HYDROPTERIDALES. THE WATER FERNS.
Family 21. SALVINIACEÆ. Floating-fern family.
Azolla.
Family 22. MARSILEACEÆ. Water-fern family.
Marsilea.

ORDER VIII. ISOETALES. THE QUILLWORTS.
Family 23. ISOETACEÆ. Quillwort family.

SUBPHYLUM B. ARTHROCAULONES. JOINT-STEMMED PTERIDOPHYTES.

Class IV. EQUISETINEÆ. Joint-rushes.

ORDER IX. EQUISETALES. THE HORSETAILS.
Family 24. EQUISETACEÆ. Horsetail family.
Equisetum.

SUBPHYLUM C. LEPIDOCAULONES. SCALY-STEMMED PTERIDOPHYTES.

Class V. LYCOPODINEÆ. Club-mosses.

ORDER X. SELAGINELLALES. THE LITTLE CLUB-MOSSES.
Family 25. SELAGINELLACEÆ. Ground-fir family.
Selaginella.

Subkingdom II. ARCHEGONIATA.

Archegoniate Spore-Bearing Plants.

Aërial, terrestrial, moisture-loving, chlorophyl-developing plants, generally small, with a well-defined "alternation of generations," being in reality the different stages or phases of a cycle of life.

One is an *oöphoral*, or ovum-bearing, stage, called *gametophyte*. This is the final stage in the life cycle of a plant; though in the archegoniates it appears to be the first. In this stage the plants, entirely cellular and with or without chlorophyl, so differ that some of the plants, when diœcious, bear *antheridia*, or antheridial sacs, which carry till they ripen many antheridial bodies called *antherozoïds* or *spermatozoïds*, minute specialized bodies, endowed with the power of voluntary motion under water, that take part in the reproduction of their own species under certain fixed conditions; others of the plants bear what are called *archegonia*, sacs containing a single oöidal cell or *oösphere*, which, on being impregnated by fusion with it of an antherozoid from an antheridial plant, clothes itself with a cell wall and becomes an *oöspore*. When monœcious, both kinds of reproductive bodies are borne on the same plant; and the process gone through with is precisely the same. The derived oöspore is either a fertile thin-walled cell ready to germinate at once, or is a thick-walled cell analogous to a seed and must pass through a formative period of rest before germinating; then, conditions being favorable, may develop into a liverwort, a moss, a fern, or a horsetail, exactly as the parent plants were. The process is called *oögamy;* the minute functional bodies are called *gametes*.

The other is a *sporophoral*, or spore-bearing, stage, called *sporophyte*. It is a direct product of the oöspore; and is a plant in which reproductive bodies are not developed, but which is capable for a time of multiplying vegetatively, and finally of bearing nonsexual spores in uncountable numbers, any of which, falling in a suitable place, and conditions being favorable, may develop into and produce the oöphores, or gametophytes, as before.

This is the natural process of all creation. "The child is father to the man" is a very old and well-established saying. The man, we know, is father to the child. We have yet to learn of a man being father to a man like himself without the young man's first passing through the formative period of childhood. The passing of a youthful sporophyte into a numerously represented adult gametophyte through the intervention of a multitude of spores is one of the important differences between plant life and animal life. The feature belongs distinctively to plant life and is not to be explained by anything in animal life, which is an entirely different kingdom.

In all archegoniates creation is indeterminate. Only enough of the plant is organized in the oöspore to start the sporeling on a good, healthy growth. Creation, though it necessarily precedes, is continuous with development, as distinctly seen in the coil of the fern frond. Yet there is a limit to creation and development. Food supply, gravity and strength of materials, season, temperature, etc., are all barriers that limit growth.

There are two main phyla of this subkingdom, namely: (i) *Bryophyta*, or mosses and liverworts, and (ii) *Pteridophyta*, or ferns, horsetails and club mosses.

Phylum I. BRYOPHYTA (Muscineæ).

Mosses and Liverworts.

Chlorophyl-developing, nonsaprophytic, nonparasitic, cellular plants, usually small, rarely exceeding 10 cm. in height, often no more than one millimeter, germinating in moist, damp or wet places, and consisting of green, prostrate or erect stems and branches of various forms, with or without rudimentary leaves.

Gametophytes, which are conspicuous and comparatively long-lived, develop from a spore, and may multiply vegetatively by minute budlets (gemmæ), by offshoots (innovations), or by runners. Antheridial or archegonial bodies, or both, are later formed on the main stem or branches. These give rise to new forms (sporophores) situated upon them, that finally bear asexual spores as in the beginning. All phases of life are cellular; the sporophores, which are only parts of plants after all, like the stalked capsule of a carpellate plant, are never a separate generation, but are stationed on top of the oöphoral or gametophytic plants and depend upon them for existence.

The fruit-bearing bodies are (*a*) *antheridia*, which are simple, club-shaped, sperm-bearing organs, in which each antheridium bears numerous cells, each of which contains a single spirally-curved biciliated sperm or antherozoid; and (*b*) *archegonia*, flask-shaped bodies, each of which contains a single ovum or oöid cell at the bottom. Fecundation takes place under water by the antherozoids swimming to the summit of the archegonium and working their way down the narrow channel in its neck to the ovum at the bottom, with which one of the antherozoids, and one only, fuses. Rain, heavy dew or melting snow provides sufficient water for this purpose.

After impregnation the ovum germinates immediately and gives rise to a stalked spore-case (the sporophore) which contains very many nonsexual spores, any of which on escaping may develop into a nonchlorophyl-bearing thallus or protonema, from which the oöphoral liverworts or mosses later arise by budding.

There are two classes in this phylum, namely: (i) *Marchantineæ*, or liverworts, and (ii) *Bryineæ*, or mosses in general.

Class I. MARCHANTINEÆ (Hepaticæ).
Liverworts.

Prostrate bilateral chlorophyllose cellular thalloid creeping stems and branches, with or without a midvein; otherwise a filiform axis with two rows of rudimentary leaves having no midvein. Plants with two distinct surfaces, an upper, or dorsal, which develops the chlorophyl, and an under, or ventral surface, which bears the rhizoids or root hairs. Reproduction is by antheridia and archegonia in, on, or peduncled above, the dorsal surface of the thallus. The impregnated archegonium develops into a sporophore or spore-bearing capsule, sometimes called a *sporogonium*.

ORDER I. MARCHANTIALES: THE THALLOID LIVERWORTS.

Oöphores flat, prostrate, dorsiventral, radiate, dichotomously branching, chlorophyllose thalli, two plates of cells or more in thickness, and one or more centimeters in breadth, floating on quiet waters or growing on wet earth. Antheridia and archegonia imbedded in the surface of the thallus, the archegonia in flask-shaped cavities, none of which open till the antherozoids and ova are mature, the one to escape, the other to be impregnated.

Sporophores club-shaped or globose bodies, sessile or stalked upon the oöphores, after impregnation of the ova, and developing in the sporophyls many asexual spores, usually without columella or elaters.

Family 1. RICCIACEÆ: Crystalwort Family.

1. Riccia frostii Austin. Wet sands near river, Kaw valley; common. (S)
2. Riccia lescuriana Aust. Damp rocky ground, eastern Kansas; frequent. (S)
3. Riccia crystallina Linnæus. Mud flats, near Kaw river, etc.; common. (S)
4. Riccia fluitans L. Stagnant pools and wet mud flats; common.

Family 2. MARCHANTIACEÆ: Liverwort Family.

5. Marchantia polymorpha L. Damp ground, N. and E. K.; not common, but occasionally seen. (A S U)
6. Preissia commutata Nees. Damp shales, E. K.; common. (S)
7. Fimbriaria tenella Nees. Damp ground, S. E. K.; not common. (S)
8. Conocephalus conicus Dumortier. Shady banks, forming mats; common. (S)
9. Asterella hemisphærica Beauvois. On the ground, E. K.; frequent. September. (S)

Family 3. ANTHOCEROTACEÆ: Hornwort Family.

10. Anthoceros laevis L. Wet clay banks, along creeks, E. K.; frequent. (S)
11. Anthoceros punctatus L. Wet banks, E. K.; common. Elaters present.
12. Notothylas orbicularis Sullivant. Wet places, S. E. K.; occasional. Elaters not manifest.

ORDER II. JUNGERMANNIALES: THE SCALE MOSSES.

Liverwort-like plants, with a central prostrate stem and two lateral rows of leaves, usually crowded and overlapping, with sometimes a third row of smaller scales on the under side. Antheridia and archegonia may be on different plants (diœcious), on different branches of the same plant (monœcious), or mingled in the same flowers (synœcious).

Family 4. JUNGERMANNIACEÆ: Scale-moss Family.

13. Frullania virginica Lehmann. On bark of trees, E. K.; frequent.
14. Frullania squarrosa Nees. Rocks and bark of trees, E. K.; frequent. (S)
15. Lejeunea clypeata Sull. Rocks and base of trees, E. K.; common. (S)
16. Ptilidium ciliare Nees. Rotten log and stumps; common. (S)
17. Lophocolea minor Nees. Limy soil and limestone rocks, E. K.; occasional.
18. Lophocolea heterophylla Nees. Rotten logs in shady woods, E. K.; occasional. (S)
19. Chiloscyphus adscendens Hooker & Wilson. Rotten logs; rather common. (S)
20. Chiloscyphus polyanthos Corda. Damp ground among moss or on rotten logs.
21. Jungermannia schraderi Martius. On the ground and on rotten logs.
22. Fossombronia angulosa Raddi. Salt marshes, C. K.; frequent. Early spring. (S)
23. Pallavicinia lyellii S. F. Gray. Among moss on damp rocks, Franklin county. (S)
24. Pellia calycina Nees. Wet shales and limestone; occasional.
25. Aneura latifrons Lindberg. On rotten logs; frequent.

Class II. BRYINEAE (Musci.)

Mosses.

Plant-body (gametophyte) a leafy stem, usually erect, developing root-hairs (rhizoids) below and leaves above at right angles to the stem. Leaves consist of a single layer of cells, usually with a delicate midnerve. The round of life in the mosses begins with the spore formed in the capsule. From the spore is developed a protonema, which is a filamentous, pluricellular, usually chlorophyllose, always nonsexual, structure, upon which arises by budding the oöphore, which is the ordinary moss as we see it, and which bears, on its summit or in its axils, the flowers and reproductive bodies, the antheridia and archegonia, from which latter arise the capsules of spores (sporophores), usually on long stalks. The flowers may be synœcious, monœcious, or diœcious.

Mosses are not abundant in Kansas; some of the orders are not represented at all. There are only two orders, *Phascales* and *Bryales*, usually regarded as belonging to the one order, *Bryales*.

ORDER III. PHASCALES: THE SAC MOSSES.

Plants very low, scarcely more than a mere bud upon a filiform prothallium developed from a spore. Leaves clustered, soft and thin, sometimes nervėd. Flowers either synœcious, monœcious, or pseudodiœcious. Capsule globose, subsessile, or short-pediceled, with a columella and a true foot, indehiscent (*cleistocarpous*), the spores escaping only upon its disintegration.

Family 5. MICROMITRIACEÆ: Micromitrium Family.

26. Ephemerum spinulosum Bruch & Schimper. Moist clay ground, E. K.; common. (S)

Family 6. PHASCACEÆ: Phascum Family.

27. Phascum carniolicum Weber & Mohr. Sandy ground, and stones on the plains of W. K. (Lesquereux & James, Mosses of N. A., p. 42.)
28. Phascum cuspidatum Schreber. Dry soil, along fences, etc., E. K.; occasional. (Eugene Rau, in Bulletin of Washburn Laboratory of Natural History, i, p. 172.
29. Pleuridium bolanderi Mueller. Damp ground, Saline county. (Renauld & Cardot, in *Botanical Gazette*, xvii, p. 82.)
30. Microbryum floerkeanum Schimper. Sandy soil, Saline county; rare. (R. & C., Bot. Gaz., xiv, 91.)

Family 7. ARCHIDIACEÆ: Archidium family.

31. Archidium hallii Austin. Reported from Saline county by Dr. Joseph Henry and listed by Miss Reed in Transactions Kan. Acad. Sci., xiv, 164.)

ORDER IV. BRYALES: THE TRUE MOSSES.

Plants (gametophytes) low and tufted, seldom exceeding 10 cm. high, from a filiform prothallium. Leaves sessile and several-ranked, consisting of a single layer of chlorophyllose polygonal areolæ, with a midnerve of elongated cells. Flowers inclosed in perichætial leaves. Reproductive bodies terminal or lateral; archegones one or several to a flower, each developing into a stalked spore-case or capsule (sporophore), which has a columella in its center, and dehisces transversely near the top, leaving a small lid (operculum) like a little brownie cap, above. Mouth of the capsule (peristome) usually provided with one or two rows of slender hygroscopic teeth, either 4, 8, 16, 32 or 64 in the outer row; lid covered with a calyptra, like a minute, long-pointed lamp-flame extinguisher. There are two suborders according to whether the flowers (*a*) are on the ends of the stem and branches (*Acrocarpi*) or (*b*) are in the axils of the leaves (*Pleurocarpi*).

Suborder A. ACROCARPI: Capsules Terminal.

Flowers terminal, becoming lateral by innovations from under the flowers.

Family 8. DICRANACEAE: Dicranum Family.

32. Astomum crispum Hampe. Sandy soil, Saline county. (R. & C., Bot. Gaz., xvii, 82.)

ORDER IV. CRYACES: THE TRUE MOSSES.

Suborder A. ACROCARPI: Capsules Terminal.

Family 8. DICRANCEAE: Dicranum Family.

33. Astomum sullivantii Schimp. Meadows, Saline county. (R. & C., *l. c.*)
34. Gymnostomum rupestre Schwaegrichen. Shaded overhanging rocks, Riley and Pottawatomie counties. (Miss M. Reed, Trans. Kan. Acad. Sci., xiv, 168.)
35. Weisia viridula Hedwig. Sandy ground, E. K., as far west as Salina; frequent. (S)
36. Dicranella varia Schimp. Damp banks, E. K.; common. (S)
37. Dicranella heteromalla Schimp. Clay banks, E. K.; frequent. (Rau, Washb. Bull., i, 172.)
38. Dicranum scoparium Hedwig. Sandy ground, E. K., west to Salina and Barton; frequent. (S)
39. Dicranum fuscescens Turner. Old logs, E. K.; frequent.
40. Campylopus henrici Cardot. Sandy ground, Saline county; not common. (R. & C., Bot. Gaz., xiii, 198.)
41. Fissidens bryoides Hedw. Shaded ground, Saline county. (Rau, Washb. Bull., i, 172.)
42. Fissidens obtusifolius Wilson. Damp ground, E. K.; frequent. (S)
43. Fissidens kansanus Ren. & Card. Wet sandstone rocks, Saline county. (R. & C., Bot. Gaz., xv, 40.)
44. Fissidens osmundoides Hedw. On ground, N. E. K.; frequent. (S)
45. Leucobryum vulgare Hampe. Damp places in woods, E. K.; common. February. (S)
46. Ceratodon purpureus Brid. Common and very variable. (S)

Family 9. POTTIACEÆ: Pottia Family.

47. Pottia subsessilis B. & S. On clayey ground, stone walls, etc., Saline and Shawnee. (M. Reed, Trans. K. A. S., xiv, 170.)
48. Didymodon rubellus B. & S. On ground near water, E. K. (S)
49. Leptotrichum vaginans Lesq. & James. Clayey soils, E. K. (S)
50. Leptotrichum pallidum Hampe. Clayey soil, Saline, Wilson, Labette counties. (Rau, W. B., i, 172.)
51. Barbula unguiculata Hedw. Damp, black soil, along fences, etc., E. K.; very common and variable. (S)
52. Barbula cæspitosa Schwæg. Roots of trees in grassy places, Wabaunsee and Saline counties; frequent. October. (Rau, W. B., i, 61.)

Family 10. GRIMMIACEÆ: Grimmia Family.

53. Grimmia apocarpa Hedw. Damp rocks, walls, etc., middle and western Kansas. (Rau, W. B., i, 172.)
54. Coscinodon wrightii Sull. Rocks in S. W. K., northeastward to Salina. (R. & C., Bot. Gaz., xv, 41.)

ORDER IV. BRYALES: THE TRUE MOSSES.

Suborder A. ACROCARPI: Capsules Terminal.

Family 10. GRIMMIACEÆ: Grimmia Family.

55. Coscinodon renauldii Card. Saline county; not known from elsewhere. (R. & C., Bot. Gaz., xv, p. 41, pl. VI*b*.)
56. Ptychomitrium pygmæum L. & J. On stones in Neosho river; occasional. (L. & J., Proc. Amer. Acad., xiv, 136.)
57. Orthotrichum cupulatum Hoffmann. Limestone rocks, E. K.; variable but not common. (S)
58. Orthotrichum strangulatum Beauvois. On trees, Saline county; not common. (Rau, W. B., i, 172.)

Family 11. FUNANIACEÆ: Funaria Family.

59. Pyramidula tetragona Brid. Sandy soil, Barton to Saline (Henry). (S)
60. Physcomitrium pyriforme Brid. Wet open and shaded ground; common. Fruits in spring. (Rau, Washb. Bull., i, 18, 114.)
61. Physcomitrium hookeri Hampe. Meadows, Riley county (Kellerman).
62. Physcomitrium acuminatum B. & S. Moist earth, chalk region, N. W. K. (Carleton); also Wyandotte county (Reed); occasional. (Rau, W. B., i, 172.)
63. Physcomitrium kellermani Mrs. Britt. Moist sandy banks, near streams, Riley, Wabaunsee, Pottawatomie, Wyandotte, Phillips counties. (Mrs. Eliz. G. Britton, Bull. Torr. Bot. Club, xxi, 204.) Differs from *hookeri* in its smaller size, flaring mouth and single annulus.
64. Funaria hygrometrica Sibthorpe. Bare ground, moist sand and rocks, chinks of a well wall at Topeka, etc.; very common. (S)

Family 12. BRYACEÆ: Bryum Family.

65. Bartramia pomiformis Hedw. Shady banks and fissures of rocks, S. E. K.; occasional. (Rau, W. B., i, 114.)
66. Leptobryum pyriforme Schimp. Shaded sandy ground, E. K.; frequent. (S)
67. Webera annotina Schwaegr. Banks, Shawnee county. (Bull. Washb. Coll., i, 61.)
68. Webera albicans Schimp. Wet sand, E. K.; frequent. (S)
69. Bryum pendulum Schimp. On the ground and decayed trees; common. Capsule narrow-mouthed; lid acutely apiculate. (S)
70. Bryum bimum Schreb. South side of a well, Topeka. (Cragin, Washb. Bull., i, 114, 173.)
71. Bryum argenteum L. Sandy ground, etc., E. K.; common. (S)
72. Bryum caespiticium L. On ground, old walls, etc., E. K.; common. Capsule wide-mouthed; lid large, mammiform; peristome ferruginous. (M. Reed, Trans. K. A. S., xiv, 175.)

ORDER IV. BRYALES: THE TRUE MOSSES.

Suborder A. ACROCARPI: Capsules Terminal.

Family 12. BRYACEÆ: Bryum Family.

73. Bryum ontariense Kindberg. Old logs, sometimes on limestone rocks, Saline county; rare in Kansas. (M. Reed, Trans. K. A. S., xiv, 175.)

74. Mnium cuspidatum Hedw. Shaded places on the ground, E. K.; very common. (S)

75. Mnium affine Bland. Shaded banks or roots of trees, E. K.; very common. (Rau, Washb. Bull., i, 61, 173.)

76. Mnium elatum (B. & S.) Ground and shaded banks, E. K.; occasional.

77. Timmia megapolitana Hedw. Wet shaded banks, in woods, Shawnee, Riley and Pottawatomie counties; occasional. (S)

Family 13. POLYTRICHACEÆ: Polytrichum Family.

78. Atrichum undulatum Beauv. Sandy ground, in woods; not common. (Rau, Washb. Bull., i, 172.)

79. Atrichum altecristatum (R. & C.). Sandy ground, Saline county; not common.

80. Atrichum angustatum B. & S. Dry woods and gravelly soil; very common. (Rau, Washb. Bull., i, 18, 62.)

81. Atrichum xanthopelma L. & J. Saline (Henry), Riley and Wyandotte. (M. Reed, Trans. K. A. S., xiv, 176.)

82. Polytrichum juniperinum Willdenow. Barren plains, W. K., and Pottawatomie county. (M. Reed, *l. c.*)

Family 14. FONTINALACEÆ: Fontinalis Family.

83. Fontinalis, sp. indet. In springs near Deep creek, Franklin county (Miss Meeker). (S)

84. Fontinalis dalecarlica B. & S. Pottawatomie county. (M. Reed, Trans. K. A. S., xiv, 176.)

Suborder B. PLEUROCARPI: Capsules Axillary.

Fruit lateral; antheridial and archegonial flowers sessile in the axils of the leaves, either on the main stem or branches.

Family 15. NECKERACEÆ: Neckera Family.

85. Meteorium nigrescens Mitten. Riley county. (Reed, Smyth's Ch.-L., Supp., p. 36.)

Family 16. FABRONIACEÆ: Fabronia Family.

86. Fabronia octoblepharis Schwaegr. Saline county. (Reed, Tr. K. A. S., xiv, 176.) Peristome of 8 geminate dark brown teeth, bifid only when old.

Family 17. LESKEACEÆ: Leskea Family.

87. Thelia asprella Sull. Base of trees; frequent in E. K. November. (S)

88. Leskea polycarpa Ehrhart. On clay and limestone and foot of trees, N. and E. K. October. (S)

89. Leskea obscura Hedw. Base of trees in low grounds reached by floods, E. K.; frequent. (S)

ORDER IV. BRYALES: THE TRUE MOSSES.

Suborder B. PLEUROCARPI: Capsules Axillary.

Family 17. LESKEACEÆ: Leskea Family.

90. Leskea austini Sull. Trunks of trees, general in E. K.; quite common. (S)
91. Anomodon rostratus Schimp. Base of trees in woods, E. K.; occasional. October. (Rau, Washb. Bull, i, 61.)
92. Anomodon attenuatus Huebener. On mud deposited by floods, E. K., along rivers. (Rau, *ibid*, 173.)
93. Anomodon obtusifolius B. & S. Trunks of trees, near watercourses, E. K. (S)
94. Pylaisia intricata B. & S. Trees and old logs, Jefferson and Shawnee counties; frequent. (S)
95. Pylaisia velutina B. & S. Bark of trees, Riley, Wabaunsee and Shawnee counties; frequent. (S)
96. Entodon cladorrhizans C. Muell. (*Cylindrothecium* B. & S.) Decayed logs and on the ground, E. K.; common. (S)
97. Entodon seductrix C. Muell. (*Cylindrothecium* B. & S. Prostrate logs in moist shaded places, E. K.; common. (S)
98. Entodon compressus C. Muell. (*Cylindrothecium* B. & S.) Roots of trees near watercourses, E. K.; frequent. (S)
99. Climacium americanum Brid. Rotten logs in thickets, Shawnee county. (Dr. G. N. Best, Rosemont, N. J.) (S) Resembles *C. dendroides*.

Family 18. HYPNACEÆ: Hypnum Family.

100. Thuidium gracile B. & S. Decayed logs in shady woods, Shawnee county; quite common. (Dr. Best, Smyth's Ch.-L., Supp., p. 36.) (S)
101. Thuidium recognitum (Hedw.) Lindb. On ground, shade of trees, E. K.; very common. June. (R. & C., Bot. Gaz., xvii, 82.)
102. Thuidium abietinum (L.) B. & S. Barren ground bordering woods, Bourbon county. (M. Reed, Trans. K. A. S, xiv, 178, 180.)
103. Brachythecium lætum (Brid.) B. & S. Dead logs in damp woods, E. K.; common. December. (S) A very variable species.
104. Brachythecium acuminatum (Hedw.). On ground in woods, general in E. K.; very common. October. Dark green. (S)
104. Brachythecium setosum (S. & L.) (*Leskea setosa* Hedw.) Decayed logs in open woods, Shawnee county; apparently common. Pale yellow; capsule erect, straight; lid long-acuminate; peristome without cilia. November. (S) Undoubtedly a mere variety of the preceding species, differing in form, color, size, etc., as variations are expected to differ.
106. Brachythecium acutum Sull. Decaying tree trunks and similar places, Shawnee county. November. (S)

ORDER IV. BRYALES: THE TRUE MOSSES.

Suborder B. PLEUROCARPI: Capsules Axillary.

Family 18. HYPNACEÆ: Hypnum Family.

107. Brachythecium rutabulum (L.) B. & S. Shaded ground, etc., Shawnee county. (S)
108. Brachythecium rivulare B. & S. Wet ground in woods, Saline and Wyandotte counties; frequent in places. Diœcious. (Rau, W. B., i, 173.)
109. Brachythecium plumosum (Swartz) B. & S. Subaquatic; moist rocks by the Shunganunga, Shawnee county. Monœcious. (Rau, *l. c.*, i, 18, 173.)
110. Eurhynchium strigosum (Hoffm.) B. & S. Shaded sandy ground, Wabaunsee county. (*Ibid*, 114.)
111. Eurhynchium hians (Hedw.). Woods, Shawnee county; common. (S)
112. Rhynchostegium geophilum Aust. Wilson county (McClung). (Reed, Trans. K. A. S., xiv, 178, 180.)
113. Rhynchostegium serrulatum (Hedw.). On the ground, in dry woods, Jefferson and Shawnee counties. (Rau, W. B., i, 18.)
114. Rhynchostegium rusciforme Weis. Stones in rapid-running water, Shawnee county. (S)
115. Plagiothecium denticulatum (L.) B. & S. Decayed trunks in shady woods, E. K.
116. Plagiothecium sylvaticum (Huds.) B. & S. Clayey ground in woods, Saline county. (Rau, W. B., i, 173.)
117. Amblystegium confervoides (Brid.) B. & S. Moist shaded limestones, Rooks county. (Reed, Trans. K. A. S., xiv, 178, 180.)
118. Amblystegium serpens (L.) B. & S. Decayed wood in moist shady places, E. K.; frequent. (S)
119. Amblystegium radicale (Beauv.) B. & S. Wet ground and decayed trunks in shade, Riley county (Reed); Shawnee county; frequent. (S)
120. Amblystegium orthocladon (Beauv.). On the ground in springy places, C. and E. K.; common. (Reed, Trans. K. A. S., xiv, 178, 180.)
121. (?) Amblystegium irriguum (Hook. & W.). Riley county. (*Ibid.*)
122. Amblystegium fluviatile (Swz.) B. & S. Rocks in a well-wall, Riley county. (*Ibid.*)
123. Amblystegium adnatum (Hedw.). On stones or on the base of trees in shady woods, Saline, Riley; said to be common. (*Ibid.*)
124. Amblystegium porphyrrizon Lindb. Saline and Wyandotte. (R. & C., Bot. Gaz., xiv, 99.)
125. Amblystegium riparium (L.) B. & S. Stones, in water, northeastern and central Kansas. (Rau, Washb. Bull., i, 114.)
126. Amblystegium cariosum (Sull.). Saline county. (*Ibid.*, 172.)
127. Amblystegium serratum (R. & C.). Roots of trees, C. K. (R. & C., Bot. Gaz., xiv, 98.)

ORDER IV. BRYALES: THE TRUE MOSSES.

Suborder B. PLEUROCARPI: Capsules Axillary.

Family 18. HYPNACEÆ: Hypnum Family.

128. Amblystegium kochii Schimp. C. K. (Husnot, *Muscologia Gallica*, p. 362.)
129. Campylium hispidulum (Brid.) Mitten. On the ground in damp woods, E. K.; frequent. (Rau, W. B., i, 61.)
130. Campylium chrysophyllum (Brid.). On the ground, decaying trunks of trees, etc., S. E. K. (*Ibid.*, 114.)
131. Harpidium aduncum (Hedw.), var. Damp ground, Saline county. (*Ibid.*, 173.)
132. Hypnum curvifolium Hedw. Decayed and decaying logs in shady woods, Shawnee county. Abundant in spots. (S)

Phylum II. PTERIDOPHYTA.

Fernworts and Filicoid Plants.

Vascular plants, aërial, terrestrial, rarely aquatic, living two or more well-marked phases or conditions of life, namely:

(*a*) A *pteral* or sporophoral stage, conspicuous and long-lived, called sporophyte, in which the plants have erect annual stems and sporophores from perennial horizontal stems or rootstocks, all with well-developed fibro-vascular tissues. They bear, in specially constructed multicellular receptacles called sporangia, vast numbers of asexual spores, which may be of two kinds: (a) minute and all alike, in which case the plants are called *homosporous;* or (b) of two sizes, called *microspores* and *megaspores*, or *androspores* and *gynospores*, in which case the plants are called *heterosporous*. These nonsexual spores may, under certain favorable conditions, germinate and produce:

(*b*) A *prothallial*, or oöphoral stage, quasi-sexual, short-lived, and inconspicuous, called *gametophyte*, on which are developed the reproductive bodies, sometimes on the same and again on separate plants. This is a nonvascular thalloid growth, whose sole purpose in life seems to be the production of *oöspores*, minute bodies containing the germ of a future plant within and a hard cell wall or protecting case of cellulose without, and requiring that a long period of apparent rest be given to it before conditions are favorable for its germination. During this period the plant life within the cell is capable of withstanding extreme conditions of temperature and desiccation that would be fatal to active life. Indeed, it is often even necessary that the oöspore should pass through extreme vicissitudes before it will germinate.

(*c*) An *oösporal* stage, which is after all really the first stage in the life of a filicoid, and is just as essential as the two forms under consideration, the *pteral* being the second or principal stage, and the *prothallial* stage the final.

From the microspores are developed antheridial prothallia, bearing on the under or ventral surface *antherids* only; from the megaspores are developed archegoniate prothallia, which bear also on their under surface small sacs, each containing an archegonial cell or *oösphere* (ovum), ready to be impregnated by an antherozoid.

These antherozoids are microscopic spiral sperms, provided with two or more long cilia (sensitive muscular flexible hairs) by means of which they propel themselves through the water to the oösphere.

Fertilization must take place under water, as in a drop of dew or rain, which is usually ample. The oösphere in the archegonial plant, after fecundation, becomes an oöspore, a globular body analogous to a seed, which, when in a place adapted to its growth, after its period of rest (formative period) is ended, may develop and grow into a spore-bearing plant (a sporophyte), as at first.

There are three general subdivisions of these plants: (*a*) Those which in the sporophytic stage have solid stems, few highly developed leaves, and a moderately developed sporophore system; in the gametophytic stage they have a very primitive reproductive system (ferns). (*b*) Those which in the sporophytic stage have tubular jointed stems, rudimentary leaves, and a more complex and highly developed sporophore system; in the gametophytic stage they have a somewhat primitive reproductive system (horsetails). (*c*) Those which in the sporophytic stage have solid stems, very many minute simple leaves, and a highly developed sporophore system; and in the gametophytic stage have a more highly developed and more occult reproductive system (club mosses).

Subphylum A. STEREOCAULONES (Filices.)

Solid-stemmed Pteridophytes.

Archegoniate plants, in which the sporophytes have stems and leaves without large cavities, and in which the closed bundles of fibrovascular tissue are firm and continuous from end to end without articulation, but with the bifurcation necessary to produce increase of surface.

There are several classes, but only one represented in Kansas, unless Isoëtes be regarded as a separate class.

Class III. PTERIDINEÆ (Filicineæ).

Fernworts.

Plants which in the pteral or sporophyte stage have solid horizontal stems, erect sterile and spore-bearing leaves (fronds), and well-developed roots. The fronds are circinate or coiled in prefoliation and usually have dichotomous nervation. In the gametophyte stage the plants are small, flat, green, cellular prothallia, on the under surface of which the fruit-bearing bodies, antheridia and archegonia, are borne; in a few cases the gametophytes are enclosed in small globose bodies (sporocarps) which remain and develop on the sporophores, thus simulating seeds.

There are four subclasses, and four orders in Kansas coterminous with them, one order to each subclass, based according to whether the sporangia are developed on the surface of a frond (*leptosporangiate*) or are deep-seated (*eusporangiate*), and according to whether the spores borne by any sporophytic plant are all of one size (*homosporous*) and the resulting oöphores are monœcious; or whether the spores are of two sizes, as microspores and megaspores, in which case the sporophores are *heterosporous* and the resulting oöphores are diœcious. These four subclasses cross each other at right angles, two and two each way, as here shown, and cannot be arranged in a serial line except by combination, such as:

CLASS PTERIDINEÆ.

Subclasses.	*Leptosporangiata.*	*Eusporangiata.*
Homosporeæ.........	Pteridales..............	Ophioglossales.
Heterosporeæ	Hydropteridales.......	Isoetales.

Order V. PTERIDALES (Filicales): The Ferns.

(*Homosporous Leptosporangiate Stereocaulones.*)

Sporophytes herbaceous, terrestrial, consisting of a firm, strong, vascular, creeping, hypogean stem (rhizome), from which arise several large, erect, long-stemmed leaves (fronds) of various forms, coiled in prefoliation, including one or more fertile ones (sporophores) which bear asexual spores in great numbers, minute and all alike. Laminæ of sterile fronds usually green on both sides; fertile fronds (sporophores) brown or brownish beneath. Sporangia (spore cases) stalked, developed normally from single epidermal cells and borne in clusters, called *sori*, along the veinlets or the margin, on the under side of the leaves or their segments, sometimes with a delicate membranous covering of special and various form called *indusium*. Sporanges each provided with a strong, elastic, multicellular ring or bar, which bursts on maturity of the spores and flies open, scattering the spores with considerable force.

Gametophytes (oöphores) in the form of minute, two-lobed, green, flat, lichen-like expansions (*prothallia*) on the surface of the ground, produced from the spores, and which bear on their under surface the fruit-bearing organs, the antheridia and archegonia, both on the same plant (monœcious). In the bottom of each archegonium is a cellular sac containing a single ovum or large cell analogous to the embryo sac (ovulary) and ovule of the seed-bearing plants. The antheridia bear numerous multiciliated motile sperms, called *antherozoids*, which are to reach and impregnate or fertilize the ova in the archegonia. This process, which is one of the most important and necessary functions of life for the perpetuation of species, is ordinarily not seen, and would be wholly unknown without careful attentive observation and concentrated systematic study (peeping behind the curtains of nature, as it were). The oöspore, when ripe, and conditions being favorable, may germinate and develop into a sporophyte similar to the original ancestor, and bear infinite numbers of nonsexual spores as before, thus completing the cycle of life.

There is only one family in Kansas.

Family 19. Polypodiaceæ: Fern Family.

133. Onoclea sensibilis L. Sensitive fern. Moist wooded banks along the Missouri river; infrequent. August. (A)

134. Woodsia obtusa Torr. Blunt-lobed Woodsia. Rocks and northern slopes in woods, northeast Kansas, west to Mitchell, south to Chautauqua; frequent. July. (A S U)

135. Cystopteris fragilis Bernhardi. Brittle fern. Rocky woods and shaded banks, N. E. K.; common. (A S U)

ORDER V. PTERIDALES (Filicales): THE FERNS.

Family 19. POLYPODIACEÆ: Fern Family.

136. Polystichum acrostichoides Schott. Christmas shield-fern. Rocky woods and northern hillsides, Neosho to Cherokee county; occasional. July. (A S U)

137. Dryopteris noveboracensis Gray. New York shield-fern. Woods, Doniphan county; not common. July. (S U)

138. Dryopteris thelypteris Gray. Marsh shield-fern. Ravines, Doniphan county; rare. June. (A S U)

139. Dryopteris marginalis Gray. Evergreen shield-fern. Crevices of rocks, S. E. K.; occasional; abundant in spots. July. (A S)

140. Dryopteris intermedia Gray. Glandular shield-fern. Damp woods, Wyandotte county; rare. July. (S)

141. Camptosorus rhizophyllus Link. Walking fern. Top of limestone bluffs, counties bordering on Missouri river, also in Wilson and Labette counties; occasional. (A S U)

142. Asplenium parvulum Martens & Galeotti. Little ebony spleenwort. Limestone bluffs, Montgomery county; rare. June. (A S)

143. Asplenium platyneuron Oakes. (*A. ebeneum* Aiton.) Chestnut spleenwort. Limestone banks, S. E. K., to Neosho county; rare. July. (A S)

144. Asplenium acrostichoides Swz. Silvery spleenwort. Rich, moist woods, Miami to Cherokee county; rare. August. (S)

145. Adiantum pedatum L. Maidenhair. Shady ravines and dense woods, E. K., west to Shawnee county; rare. July. (A S U)

146. Pellæa atropurpurea Link. Black cliff-brake. Clefts in north and northeastern faces of limestone bluffs, E. K., west to Ellsworth and Comanche counties; frequent. June, August. (A S)

147. Cheilanthes lanosa Watt. (*Ch. vestita* Swz.) Woolly lip-fern. Moss-covered rocks, Woodson county; rare. July. (S)

148. Cheilanthes gracilis Mettenius. (*Ch. lanuginosa* Nuttall.) Slender lip-fern. Sandstone bluffs; rare. Found years ago in Ottawa county, at "Rock City," by Mr. S. C. Mason, and in northern Barton, near Cow creek, by Mrs. D. J. Evans, both now in Washington, D. C. Not since reported, though likely to be found yet at other points in central Kansas. July. (A S U)

149. Notholæna dealbata Kunze. Calcimine fern; Silver cloak-fern. Crevices in northeastern faces of calcareous rocks and quartzite boulders, N. E. to S. E. Kansas; not readily found without attentive searching. June. (A S U)

150. Polypodium polypodioides Hitchcock. (*P. incanum* Swz.) Hoary polypody; Resurrection fern. Mossy bark of trees, S. E. K.; rare. July. (S)

151. Polypodium vulgare L. Rock polypody. Northeastern faces of limestone bluffs, Morris county; rare. June. (S)

ORDER VI. OPHIOGLOSSALES: THE ADDER TONGUES.

(*Homosporous Eusporangiate Stereocaulones.*)

Terrestrial herbaceous pteridophytes, with group-celled sporangia, in two rows, on the lateral edges of the sporangiophore, the walls many cells thick, transversely dehiscent.

Sporophytes having each an erect frond-bearing stem, with one portion (frond) adapted to chlorophyl work, another portion (sporophore) adapted to fruit bearing. Sporophores (special fronds or branches of fronds) bear spores all of one size (microspores) from bivalvular sporangia developed from clusters of epidermal and subepidermal cells in lieu of pinnæ along the margins of special fronds or frond branches (sporangiophores).

Gametophytes (oöphores) monœcious, tuberous, within the surface of the ground, devoid of chlorophyl, and said to be usually associated with a symbiotic fungus-mycelium, but whether with injury or benefit to the plant does not clearly appear. From oöspores within the oöphore body arise the young sporophytes, which for a time nurse upon the body of the oöphore, then cast root and become erect independent plants. This is the beginning of the erect stem in vascular plants and of differentiation between chlorophyl-developing leaf and fruit-bearing branch; and although the stem and leaves are only partially differentiated in the frond, yet it is a long step toward an erect woody plant.

There is but one family.

Family 20. OPHIOGLOSSACEÆ: Adder-tongue Family.

152. Ophioglossum vulgatum L. Adder-tongue. Moist meadows and thickets, E. K.; infrequent. May. (A S U)
153. Botrychium virginianum Swz. Rattlesnake fern. Hazel thickets and wooded hillsides, N. E. K., west to Council Grove; frequent. July. (A S U)
154. Botrychium obliquum Muhlenberg. (*B. ternatum* Swz.) Grape fern. Moist woods and hillsides, Doniphan, Atchison and Shawnee counties; rare. Sept. (S U)

ORDER VII. HYDROPTERIDALES: THE WATER FERNS.

(*Heterosporous Leptosporangiate Stereocaulones.*)

Aquatic pteridophytes with horizontal stems and erect leaves with the dichotomous nervation and circinate prefoliation characteristic of ferns, and with spores that produce oöspores without leaving the sporocarp. Sporocarps have short stalks and are borne on certain modified leaves called sporophyls. Here the gametophytes are more hidden than in any previous order of plants.

Sporophores bear dimorphous spores, from sporangia developed from single epidermal cells; the smaller size, called *androspores*, develop into minute rudimentary gametophytic prothallia upon which grow single antheridia; the larger, called *gynospores*, develop into small globular oöphores containing each an archegonium with its ovum, which remains attached to the sporophore. Fecundation is effected by an amœbic movement of the antheridial inner cell wall, in the form of a closed tube, which protrudes from the androsporo-

ORDER VII. HYDROPTERIDALES: THE WATER FERNS.

carp and grows in the direction of a neighboring archegonium within its gynosporocarp, the tissues of which it penetrates after rupture of the outer wall; through this tube or tunnel the spermatozoids (antherozoids) pass to the ovum in the archegonium still within its sporocarp, which has ruptured its outer wall in order to allow of fertilization. This is another long step forward in the new mode of impregnation—a step that once taken is never afterward wholly abandoned, but pervades the fecundating mechanism of the entire carpellate subkingdom in the shape of a pollen tube. The mature oöspore, in a new protecting case which actually contains the entire archegonial gametophyte, in that respect resembling a seed, finally becomes separated from the parent sporophyte which may have perished, and, being in a suitable place, with all required conditions favorable, may germinate and grow into a new floating-fern or water-fern sporophyte. Thus this complicate process, commonly called "alternation of generations," or heterogenesis, under such adverse conditions, is continually repeated. No wonder the plants are rare in Kansas. They require a humid climate and gentle movements of air and water. But the process of fecundation is adopted by nearly all the seed-bearing plants; plants that perform their breeding functions in air, not in water; plants that are better adapted to the surrounding conditions than the poor little water-ferns.

Although they are very rare, yet the few to be found in Kansas belong to two distinct families.

Family 21. SALVINIACEÆ: Floating-fern Family.

155. Azolla caroliniana Willd. Carolina floating-fern. Found in Cloud county by Professoı Schaffner; also Burlington, Coffey county. (S)

Family 22. MARSILEACEÆ: Water-fern Family.

156. Marsilea vestita Hooker & Greville. Four-leafed water-fern. Wet or damp sandy hollows, such as old "buffalo wallows," which dry in summer, Washington, Cloud, Saline, Barton and Greeley counties; rare. July. (A S U)

ORDER VIII. ISOËTALES: THE QUILLWORTS.

(*Heterosporous Eusporangiate Stereocaulones.*)

Pteridophytic plants in which the sporophores bear two forms and sizes of spores, namely, very small androspores bearing the antherozoids, and very large gynospores bearing the ova. These are all developed in sporangia formed from groups of epidermal and subepidermal cells. The antherozoids within the androspores are motile, microscopic, multiciliate, and spiral. A single ovum with its case (sporocarp) fills each gynospore.

Sporophytes with an erect, exceedingly short and comparatively broad stem or trunk, with a dense tuft of rootlets and no cauline leaves. This naked, button-shaped stem is crowned with a compact rosette of broad, erect sporophyls with excessively prolonged chlorophyl-developing tips, sometimes a decimeter high, resembling

ORDER VIII. ISOËTALES: THE QUILLWORTS.

rushes or grass leaves somewhat. The outer cycles of sporophyls bear in their axils or on their inner surfaces solitary gynosporangia, with spheroidal gynospores measuring one-fourth to three-fourths of a millimeter in diameter, with a reticulated surface, an equatorial ridge and three meridional ridges from the equator to the initial pole, making the entire spore resemble a low tetrahedron attached by its base to the flat side of a reticulated hemisphere. In the inner cycles each sporophyl bears a single androsporangium, carrying minute, obliquely oblong prismoidal androspores, 25 to 40 microns in diameter.

Gametophytes diœcious; those produced from the androspores are here very much reduced and are very minute, microscopic in fact, and parasitic, each bearing but a single antheridium; the archegonial gametophytes, those produced from the gynospores, after fecundation of the ova, become small globular bodies developing within the sporophyte gynospore wall and not escaping therefrom, the wall being ruptured only to allow access of antherozoids. This is yet another long step toward the development of the seed-bearing plants. Indeed the resemblance of the quillwort to a seed-bearer is very strong; it is frequently mistaken for a grass or a sedge, else it might oftener be recognized as a quillwort. This eusporangiate-heterosporous combination is the one that pervades the entire carpellate subkingdom. It has proven effective in plants that breed in air, even more so than those that breed in water, and is never afterward wholly abandoned.

There is but the one genus, *Isoëtes*, in this anomalous order of Isoëtales, placed here for convenience without any claim that it belongs here more than elsewhere. The real truth is, it has fern and horsetail characteristics in its spiral multiciliate antherozoids, horsetail characteristics in the verticillate arrangement of its leaves, and club-moss characteristics in its solitary sporangia and the form of its gynospores. It differs from the stereocaulones in the form of its leaves and in its mode of fruit-bearing; from the arthrocaulones in being stemless and in its mode of spore-bearing; and differs from the lepidocaulones in having verticillate leaves and in its sperms being multiciliate instead of biciliate.

Family 23. ISOËTACEÆ: Quillwort Family.

157. Isoëtes butleri Engelmann. Butler's quillwort. Cherokee county (Hitchcock). (A)

158. Isoëtes melanopoda J. Gay. Black-based quillwort. Greeley county, in a shallow, clay-bottomed, water-holding, often dry basin west of Horace; rarely seen and recognized. Sept. (S)

Subphylum B. ARTHROCAULONES (Equisetæ).

JOINT-STEMMED PTERIDOPHYTES.

Archegoniate plants in which the sporophytes have tubular or hollow stems, with articulations or joints at intervals along the stem. There is only one class.

Class IV. EQUISETINEAE: Joint Rushes.

Erect, hollow, jointed and banded sporophytes, having a fluted or clustered-columnar structure, with solid nodes and whorled rudimentary leaves, arising from perennial, horizontal, hypogean stems or "rootstocks." The sporangia (spore-pockets) on the under side of the sporophyls, in a cone at the summit of a sporophore, develop from a cluster of epidermal and subepidermal cells (eusporangiate), and the spores are all of one size (microspores), each furnished with two strap-like hygroscopic appendages, attached by the middle, that coil close around the spore when moist, and uncoil when dry. In this class of plants the cone is adopted as a method of fructification, a system that reaches its greatest perfection in the Coniferæ, but is considerably modified in other classes.

Order IX. EQUISETALES: The Horsetails.

(*Homosporous Eusporangiate Arthrocaulones.*)

Sporophytes semiaquatic or terrestrial, herbaceous, with uniform spores which develop into irregularly-lobed green prothallia (oöphytes) on the surface of the ground. These prothallia are diœcious; some bear fertile antheridia, carrying spiral multiciliate antherozoids, somewhat like those of the quillworts; others bear flask-shaped archegonia, each with a single ovum or oösphere at the bottom. From a union of the antherozoids with the ova, or oöspheres, brought about through the agency of wind, moisture, rain, and other natural factors, new horsetail plants are produced.

Stems of two kinds: (*a*) A compound vegetative stem, normally well supplied with branches and branchlets, all chlorophyl-developing; and (*b*) a stout, simple, fertile stem that bears on its summit the sporangiophore, which consists of a closely-packed conical or spike-like cluster of stalked or pediceled peltate hexagonal or shield-shaped sporophyls, called *clypeolas*. Spore-bearing pockets (sporangia), 6 to 9, under the edge of each clypeola, one-celled, dehiscing by a longitudinal slit beneath. Leaves rudimentary, verticillate, at the summit of each joint, as many as the flutings, which alternate with the flutings in the joints above and below, and consisting of mere toothed sheaths having their edges joined together, thus making a leaf band at each node. This suggests the name *Equisetum—Equi*, equal, and *setum*, a bristle. The teeth are equal. Epidermis rough with silica. Stems and branches all chlorophyl-developing, making the possession of large leaves unnecessary.

Family 24. EQUISETACEÆ: Horsetail Family.

159. Equisetum arvense L. Field horsetail. Sandy soil, eastern Kansas, west to Barton and Republic counties, and even farther; common. (A S U)
160. Equisetum pratense Ehrh. Meadow horsetail. Sandy meadows, E. K.; frequent.
161. Equisetum fluviatile L. River horsetail. Banks of streams, E. K., west to Ford county; frequent. (A S U)
162. Equisetum robustum A. Braun. Big scouring-rush. Barton county; not common. (S U)

ORDER IX. EQUISETALES: THE HORSETAILS.

Family 24. EQUISETACEÆ: Horsetail Family.

163. Equisetum hyemale L. Common scouring-rush. Banks and wet places along streams, E. K.; frequent. (A S U)

164. Equisetum lævigatum A. Br. Smooth scouring-rush. Along rivers and streams, generally throughout the state; common. (A S U)

Subphylum C. LEPIDOCAULONES: Club-mosses.

SCALY-STEMMED PTERIDOPHYTES.

Archegoniate plants, in which the stems, which are solid, are closely invested with minute imbricated scale-like leaves, arranged singly. Fibro-vascular bundles remain separate and do not form a closed cylinder. Method of fruiting somewhat similar to that of the *Arthrocaulones*, by means of sporangia and sporophyls in terminal cones; but the sporangia are single behind each sporophyl, and the cones are slender and lengthened into spikes.

Class V. LYCOPODINEÆ: Lycopods.

Gametophytes small, globular or tuber-like, with rhizoids which barely reach the ground.

Sporophytes with solid branching stems, more or less prostrate, crowded with small scale-like cauline leaves (whence the name *lepidocaulones*) arranged in four or more ranks. Sporophores (fertile branches) erect, greatly elongated, often 3 dm. in height; sporophyls and sporanges in four or more ranks, in a lengthened spike or cylinder at the summit. Sporangia one-to-three-celled, solitary in the axils of the sporophyls or on their upper surfaces. Spores yellowish, minute and all alike (homosporous) in the lycopods proper, or dimorphous (heterosporous) in the selaginellas. These are in separate sporanges, usually in cycles; sometimes with the androsporangia in the upper part of the spike and the gynosporangia in the lower part, and again in alternating cycles or otherwise. When homosporous the spores give rise to monœcious prothallia; when heterosporous the resulting prothallia are diœcious.

ORDER X. SELAGINELLALES: THE GROUND-FIRS.

(*Heterosporous Eusporangiate Lepidocaulones.*)

Evergreen archegoniates, producing two kinds of spores: (*a*) *androspores*, which are minute and roundish-prismoid, and carry minute biciliate sperms, like those of the mosses; and (*b*) *gynospores*, which are comparatively large and globose-angular, like a low triangular pyramid with a hemispherical base, similar to those of *Isoëtes*, already described. From the gynospores, after fertilization by antherozoids from the androspores, are developed globular archegonial gametophytes resembling seeds. These plants are on the border line between archegoniate and carpellate; yet they are archegoniates all right, though only a few steps removed from the strobilophytes (cone-bearing plants).

Family 25. SELAGINELLACEÆ: Little Club-moss Family.

165. Selaginella rupestris Spring. Rock selaginella. Has been found nearly all around Kansas; not yet identified here.

IV.

MISCELLANEOUS PAPERS.

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1. "HISTORY OF CATALYSIS AND ITS UTILITY IN SYSTEMIC PHTHISIS."
   By WILLIAM P. MCCARTNEY, University of Illinois.
2. "THOUGHTS ON TUBERCULOSIS."
   By J. M. MCWHARF, M.D., Ottawa.
3. "FUTURE OF THE KANSAS ACADEMY LIBRARY AND BOOK COLLECTIONS IN THE STATEHOUSE."
   By J. T. LOVEWELL, Topeka.

HISTORY OF CATALYSIS AND ITS UTILITY IN SYSTEMIC PHTHISIS.

By WILLIAM P. McCARTNEY, M. S., L. L. B., (Univ. Ill.) Manila, P. I.

I. HISTORY OF CATALYSIS.

THERE were many reactions in chemistry which were known to take place and were made use of, but why they took place in the way they did was not understood until catalytic action was recognized as the important factor.

Thus we have one-billionth part of soluble chromic chloride rendering insoluble chromic chloride soluble; a little platinum chloride enables us to dissolve tin in cold hydrochloric acid; a little potassium permanganate will render soluble many insoluble or difficultly soluble compounds.

We find in organic chemistry many catalyzers, or substances acting very similar to catalyzers, working a great many chemical changes more or less essential to our existence; hydrolyzing the starches to glucose and the proteins to amino acids, changing the nitrogen of the air to nitrites and nitrates, and many other chemical changes necessary for the continuance of life.

Next we learned that by means of high potentials we are able to divide many metals so finely that they may be suspended in liquids in such minute particles that they have the appearance of solutions and require the intervention of animal membrane to separate them. Such suspensions are called colloidal suspensions. Those of gold are ruby in color; those of platinum, brown, and those of silver, yellow. These suspensions have many of the properties of the catalyzers and enzymes. They will liberate oxygen from hydrogen peroxide. There are a number of chemicals which stop or restrain this catalytic and ferment action; such bodies as corrosive sublimate, cyanogen iodide, carbon monoxide and arsenic. These substances will restrain the action of ferments, catalyzers and colloidal solutions for some time. They are called paralyzers, and it should be noted that the most deadly paralyzers to these catalytic actions are the most dangerous paralyzers of plant and animal life. So it was thought, since ferment action which is similar to if not identical with catalytic action is so essential to life, that a study of catalyzers should lead to further knowledge in the study of the maintenance of life.

I want briefly here to call your attention to a few of the great many ways in which catalyzers are cheapening and simplifying processes in technical chemistry. These processes were called to my attention on a trip through New York and Chicago, and are not intended to be a complete list of the uses of catalyzers in chemical industries.

Hydrochloric acid is changed to chlorine and water by being passed over hot bricks impregnated with copper chloride. Hydrogen sulphide from soda-tank waste of a soda factory gives up its sulphur by presence of acid and iron oxide, or passing hydrogen sulphide into an area of hot chlorides of sodium and copper they obtained sulphate of sodium and chlorine gas. Roasted sulphur gas mixed with air scrubbed over a platinized washboard yielded in one year 800,000 tons of sulphuric acid. Naphthalene is generated from coal-tar acid oxidized by sulphuric acid in the presence of mercury and copper yielded indigo.

A solution of the peroxide of hydrogen and ether on the negative photographic plate gives an invisible positive; this followed with manganous sulphate gave a beautiful brown and alkaline solution giving a carbon print on the sensitized paper used. Ammonia from illuminating gas passed with air over platinum yielded nitric acid. Lead and manganese are used as driers for linseed oil. A series of zinc tubes through which vapors from alcohol were passed yielded eighty per cent aldehyde. At the packing plants the manipulation of fats with oleic acid in the presence of nickel yielded stearic acid; an enzyme from the castor bean was used to saponify the fats, yielding a soap that was lye free. So catalysis is playing an important part in the synthesis used by manufacturers and cheapens numerous products more or less necessary to our present method of living.

Catalysis has also been very useful to the biological chemists. Recently the nitrogen of the air has been combined with lime to form cyanamide of lime, in which form it may be used as a fertilizer.

Doctor Löhnis of Leipzig has been able to change "sarcosin" by means of cyanamide of lime and nitrogen to kreatin, an animal protein. So that we can have our meat manufactured by the aid of catalysis in the chemical laboratory.

Doctor Koch of Germany, about this time, developed the opsonian theory to explain certain phenomena observed in the blood. The white blood corpuscles absorb certain foreign substances as bacteria when found in the blood, and under certain conditions will absorb them more readily than others. To prove this thesis to our own satisfaction we personally performed his experiment.

Segregated white blood corpuscles, exhaustively washed and plasma free, were maintained in a salt solution, and at body temperature, are indifferent to bacteria, but on the addition of blood plasma they consume their fill of the microbe life. This experiment proved one or the other of two things to be true: either there is something in the blood plasma that stimulates the white blood corpuscles or else the plasma must prepare the corpuscles so that they are ready to be absorbed. This suggested to the experimenter that the blood plasma must hold some catalytic agent toward the white blood corpuscle, the nucleus substance, which must prepare the microbe to be absorbed or taken up. We next discovered that a temperature of 65° C. annuls this microbe-destroying capacity. If, however, the microbes were incubated at a temperature approaching blood heat and the temperature then raised to 65° C., the corpuscles would take up the microbes. This indicates the opsonin to be a definite substance because it has a definite point of decomposition. From the observations of others coupled with those of our own we draw the following conclusions about opsonins:

(*a*) Opsonin will unite with dead innocuous microbes.

(*b*) This union will stimulate the body cells to produce more opsonin, in fact an excess of opsonin.

(*c*) The best agent to stimulate this action consists of the dead cells of that microbe which we are seeking to destroy.

(*d*) All bacilli stake their existence on the opsonian combat.

Doctor Koch in his experiments with tuberculosis along this line gave too large doses too close together, with unsatisfactory results. Doctor Wright by giving small doses was able to show that he could treat successfully many localized diseases by inoculating the menstra of the innocuous dead microbe cells. Since then, Doctor Wright and his assistants have been very busy supplying the demand for their opsonin.

Doctor Wright and his assistants did not understand the chemistry of the opsonin content and the albumen content of the excretions and the lesions of the tubercules. They said, "The lung tissue is filled with a substance which by chemical means exhibits albumen, salts, and nothing else that is characteristic."

The writer, as a result of his experiments, has reached the following conclusions:

(*a*) The opsonin content always contained nitrogen compounds of a high albuminous character.

(*b*) The albumen content of the phthisis-infected tissue is definite in its character. To determine just what it is and to change it to something soluble and nonparalyzing to the microbes is the secret of the solution in this opsonin battle.

(*c*) If the opsonin carrier and the morbid product stored in the cells by the bacteria can be changed into an inert (or better, into a nutrient), while passing the inoculation into the patient's system, we will thus fortify him against negative phases and make the dread tuberculosis bacillus the friend rather than the foe of its hosts.

The author has made a number of analyses of sputa and secretions from tubercular lesions. I have followed the methods described in the article, "Egg Albumen and Kindred Nitrogenous Compounds," thesis by Dr. S. J. Sammis of the University of Illinois, 1901–'02, on file in the library of that institution, and also used data compiled by Doctor Sammis in his albumen studies made under the auspices of the National Bureau of Animal Industry and published in his article "Cheese and Milk Products."

In these experiments we have used: (*a*) Internal sputa products, carefully collected by well-known scientists; (*b*) those from cultures on rabbits, guinea pigs and cats treated by the writer; (*c*) those submitted by others professionally interested.

For aid rendered in collecting the samples and the care taken in preservation and for the accurate history sent with samples, thanks are due to Dr. P. Anderson of California, to Prof. James Kinead, Doctors Ragsdal and Miller of Illinois, Dr. Jonathan Burrell and Dr. A. W. Palmer of St. Louis. For this aid, for samples so readily submitted, as well as advice and suggestions kindly offered from time to time, heartiest acknowledgment is hereby made. I also desire to thank the Rev. P. B. Peabody of Blue Rapids, Kan., for his aid in the proof-reading and transcribing of this report.

An examination, as given in the tables of the results attached, shows in one hundred and eighty-two samples out of two hundred tested with cyanamide of lime the conversion of the tubercular lesions into easily recognized alkali albuminates and easily absorbed casein, the presence of a definite base having been determined in the case of each sample.

Modern physical chemistry has, it would seem, caused us to burn all our old textbooks in chemistry and medicine. The indicated equations for reactions in chemistry were formerly set down as holding true *without fail*, "exceptions excluded." But when, at a later date, catalysis came to be known, it taught us why, in the majority of cases involving practical laboratory work, the actions theoretically indicated *did not occur.*

As long ago as the early eighties it was known to students, as a sort of marvel, that insoluble chromic chloride, when brought into the presence of a billionth part of the soluble chromic chloride, in water, became transformed in its nature, thus becoming soluble, like the latter salt. In those days we found that tin brought into contact with cold hydrochloric acid alone would yield us nothing. But we soon learned the trick of the master, and so, by the addition of a very small portion of platinum solution, presently had the metal dissolved. At a later date we were, in the quantitative laboratory, let into the secret of Fresenius, namely, that ever so small a portion of potassium permanganate would work the same miracle with almost all insoluble and "fractious" compounds.

In these determinations the strange thing of it all was this: the *catalyzing substance would remain, in every case, unaffected.* It could be used over and over again. Once initiated into the mysteries of the organic laboratory, we found that inorganic salts are not by any means the only catalytic substances. Microbes and bacteria we found to be the cause of all kinds of fermentations: the "yeast plant" causing sugar to change into alcohol; the "vinegar plant transforming alcohol into acetic acid; the "lactic ferment" changing sugar into lactic acid; "nitrous and nitric ferments" changing ammoniacal products into the nitrates of the soil. In all these cases the protoplasm of the organism had, in the presence of these compounds, wrought transfer without any change of the organic material. Diastase from barley malt, ptyalin from saliva, amplopepsin from pancreatic juice—all these we soon discovered to have the power of changing starch into sugar. Pepsin mingled with gastric juice would change insoluble albuminous forms into soluble forms, while rennet IN DIGESTO would work the miracle on 400,000 times its weight in the casein of milk.

Hardly had we become accustomed to thinking in terms of these last-named "enzymes" when we were introduced to the "colloidal suspensions." These, like the suspensions above noted as "solutions," required a membrane to separate the two elements. Incited by the wonder of these reactions, we set to work to make, for instance, the interesting platinum suspension, which is brown, in color. We then wrought out the ruby-colored suspension, of gold; the yellow one, of silver—performing these reactions at an electric plant where a high potential could be furnished. All these suspensions we found, when invited to determine them by means of the ultra microscope, to be nothing more than finely divided metal solutions; that's all.

Further experiments with these suspensions proved them to have the same properties as do the vegetable and the animal enzymes, when brought into the field with certain other products. For example, both these enzyme types will cause peroxide of hydrogen to split up into water and oxygen gas. One gram of enzyme in 300,000,000 grams of water is found to be sufficient, when added to any quantity of peroxide, to affect the peroxide in the same way. In trying to control these apparent powers of the enzymes and colloidal suspensions we were to find that there are certain well-defined "paralyzers" for these agents in the inorganic field; such, for example, as corrosive sublimate, cyanogen iodide, carbon monoxide, arsenic—all of them agents that will restrain the activity of the enzyme or suspension for a definite time, after which the affected enzyme resumes its normal character. In the making of these studies it was emphatically noted that the most deadly paralyzers of these enzymes and colloidals, in their reactions on salts in solution, were also most dangerous paralyzers of the functions of animal and plant life. Straightway, then, the idea forced itself upon the thoughtful student that, since the enzymes are most intimately associated with the life of the cell, even more so than is the protoplasm, since the enzyme will work outside of the field of its producing protoplasm, and since these catalysts are in every nook and corner of the body—therefore the study of "the why" of the poisonous activity in question should lead to further knowledge in the study of the maintenance of life. In our investigations we were able, in spite of the subtle and complex form of the organism which produced the enzyme used, to produce artificially, by synthesis, a something that proved a counterpart of the enzyme. But, as to how it might become possible to eliminate or dispense with the poisonous paralyzers of the excretions after these had been used, "Aye, there (was) the rub."

The science of technology was at that time, however, forcing the attention of all true students upon itself; and we were having the idea dingdonged into our ears that there was a crying need in the field for experts who could unlock mysteries of commercial exploitation by the cheapening of processes. Then, forthwith, the startling information was sent percolating through our brains that the very catalytic reactions above detailed were now being depended upon to convert the raw dross material of the earth into the riches of the dream of the alchemist through the tense-nerved and tireless intervention of the trained synthesist—that altruistic concomitant of every crying need.

Nor were proofs in any sense lacking. During a field trip to New York we saw hydrochloric acid passed over hot bricks that had been impregnated with copper chloride; the acid came out as chlorine and water, while the bricks, with the saturant, were undisturbed. During the same week we were shown that hydrogen sulphide from the soda-tank "waste" of a soda factory was made to give up its valuable sulphur by simply passing the gas above named into the presence of acid and iron oxide. In like manner, by the passing of the hydrogen sulphide into an area of hot chlorides of sodium and copper, there were derived two valuable products, sulphate of sodium and chlorine gas. Shortly after, upon being introduced into the mysteries of a sulphuric-acid plant, we saw how roasted sulphur gas and air, passed over, and scrubbed upon, and dried upon, so to say, a platinized washboard, had produced that year 800,000 tons of sulphuric acid. Across the street an indigo factory, where naphthalene was generated from coal tar and afterwards oxidized by sulphuric acid in the presence of mercury and copper, was daily tolling off a poem more glorious than any sung by Keats or Byron—namely, a triumph-song of the achievements of man; a panegyric of his power to harness and master the forces of nature. Note, now, that even in this field the results attained were wholly due to this same subtle catalytic power of certain substances over other elements.

In our daily rounds of sight-seeing in the metropolis we found the photo-maker using this same faculty of well-known salts to cheat Old Sol out of his rights of performance. For within that artistic laboratory the cato-photo was no longer a dream, but a reality. Be well assured we jotted down, right then and there, memoranda of the germane formulæ processes: A solution of peroxide of hydrogen and ether on the negative photographic plate gave an invisible positive, by reason of the catalysis of the peroxide on the silver-sensitized surface. Thereafter, by the use of manganous sulphate, there was developed a beautiful brown tint, an alkaline solution giving a perfect "carbon print" on the sensitized paper used. On the return journey from New York even more of these catalytic marvels were seen. In a Chicago laboratory we observed the passing of ammonia from illuminating gas over platinum, with air; the ammonia presenting itself, at the end of this process, as nitric acid. Next in order, lead and manganese were found in use as driers of linseed oil. A zinc-tube series, through which vapors

—20

of alcohol were passed, turned out 80 per cent aldehyde. Down at the packinghouses the manipulation of fats with oleic acid, in the presence of nickel resulted in that greatly useful by-product, stearic acid. An enzyme from the harmless castor bean was used in the saponifying of fats. The resultant consists of a soap that was lye-free, allowing the use of carbonates, at the very time when so stertorus a howl was going up about the detrimental effects of alkalies and arsenates in soaps.

While in Chicago we visited the general and experimental laboratories of chemistry in that great city. Here we found all experimenters at work upon some form or other of catalysis, the majority being on the *qui vive* for some process whereby the nitrogen of the air might be utilized in a number of ways to meet a number of imperative needs. Prominent among these needs was that of a soluble and efficacious fertilizer. Now note: hardly had the latter product been shown to be an indispensable factor in the cheapening of rations for mankind, when, upon our arrival at home, we saw the announcement that the great discovery had been made—cyanamide of lime, *ultima thule* of the aim of the alchemist, had recently been manufactured in Germany from atmospheric air.

Great are the contrasts in result wrought out by alchemy; and wide the range of its discovery-results: chemical odors so sweet as fairly to "shed a perfume on the violet," while at the opposite extreme is the awful nauseating whang of the torsin. Gunpowder has its triplet brothers, gun cotton and dynamite. Great is the sweep from the molding of the rubber dam of dental use to the wizard mystery of gold-extraction by cyanogen. And now all these, and other like discoveries of incalculable use to the human race, must give place, in point of marvel and utility, to the newly discovered nitrogen-of-the-air fertilizer.

But great as are the utilities already in sight, through this crucial discovery, in the stimulation and increase in the products of plant life, even more daring were the hopes that became speedily projected to the forefront of this discovery. Results more (literally) vital yet began to be anticipated, namely, even the metamorphosis of plant substance into the very muscle-cells of animals! Hardly had this projected hope begun to be discussed among chemic circles when, marvel of all marvels, there comes tripping over the heels of the former incredible bit of news the statement that the essential kreatin cells of cattle — real "extract of beef" — had just been made from beans and the kindred lentils of the vegetable world! Details of this discovery follow :

Doctor Löhnis, of Leipzig, had proved that certain bacteria that subsist upon nitrogen possess, by the catalytic action of their own excretions, the power of fixing the nitrogen of the air in the soil. Doctor Frank had produced cyanamide of lime from the nitrogen of the air, and he had demonstrated that when this cyanamide is brought into conjunction with sarcosin and air there is produced, by the catalytic action of the latter, the veritable flesh of animals — the cells, in fact, of extract of beef. This great achievement of the chemical catalytic transformation of vegetable into animal substance was announced in the terms of the following purely theoretical equation :

$$4\,C_3H_7O_2N + 5N + CaCN_2 = 3\,C_4H_2O_2N_3 + CaCN_2 + 2\,H_2O + 18H$$

Sarcosin + air + cyanamide = kreatin + cyanamide + water + hydrogen.

Astounding, indeed, is all this ; but why were we not to learn of some further development of this revolutionizing, potent catalysis, in that we have thus come the better to understand its laws.

II. CATALYSIS APPLIED TO THE MAN-LIFE.

Right at the above-indicated period physiological chemistry was following this perplexing theme of ours. By its light we were fast becoming aware that all of the body processes are no more, no less, than a series of well-developed catalytic actions. The theories of the leaders of our forerunners in physical chemistry were impregnated with the idea of the "opsonian" theory or hypothesis of the blood. Doctor Koch, of Germany, had developed this phase of experimentation ahead of any of the other chemists of his day. He had proved that white blood corpuscles have an appetite; that they do devour microbes when their appetite is keen. To prove this thesis to our own satisfaction we personally performed his suggested experiment, as follows:

Segregated white blood corpuscles, exhaustively washed and plasma-free, were maintained in a salt solution. It then developed, on experiment, that these corpuscles, even when raised to blood heat, are indifferent to bacteria. But upon the addition of blood-plasma they consume their fill of the microbe life. A process this of "benevolent assimilation."

The above experiment proved one or the other of two things to be true: either there is something in the blood-plasma that stimulates the white blood corpuscles, or else the plasma must prepare the microbes so that they are ready to be devoured.

Immediately, now, the thought was inwardly suggested to the experimenter that the blood-plasma must, in its effusions, hold out some catalytic agent toward the white corpuscle, the nucleus substance, which must prepare the microbe to be absorbed or taken up. This newly apprehended idea, in its possible relations with life, immediately added new stimulus and impetus to our study of physical chemistry. We now discovered by experiment that a temperature of 65° C. annuls this microbe-destroying capacity. If, however, it was found, the microbes were incubated at a temperature approaching blood heat, and the temperature then raised to 65° C., the corpuscles would devour the microbes. Thus was it clearly demonstrated that opsonin is a definite substance, because it has a definite point of decomposition.

Summarizing, now, the results just obtained with those already well known to those that had previously dealt with the subject, we now find the substance of the indicated facts and laws to be about as follows:

(*a*) Opsonin will unite with dead, innocuous microbes.

(*b*) This union will stimulate the body cells to produce more opsonin; in fact, an excess of opsonin.

(*c*) The best agent for the enhancing of this action consists of just the very cells of that microbe which we are seeking to destroy.

(*d*) All bacilli stake their existence on this opsonian combat.

III. RESULTS OF CATALYSIS UP TO A. D. 1900.

In the making of his corpuscle-plus-plasma-*versus*-microbe experiments, Doctor Koch gave fatal doses to his "patients," because unaware of the character of the phases produced, and ignorant of the fact that the bacilli which he was attacking with such perseverance were really aiming, in their work, at the achieving of a helpful product in the organisms which they were infecting. (This result they were, as we now know, unable to attain because of the excretive paralyzers produced in their work.)

At a later period Professor Wright proved beyond question that the successful treatment of any localized disease must consist in the inoculation of the *menstra* of the innocuous dead microbe cells themselves. But he did not understand the nature of that certain product toward which the tubercles were striving; nor did he realize that the tubercles were inhibited from carrying forward a helpful work for man by those very paralyzers which are an obstinate concomitant of their struggle—paralyzers that are always of a definite character, paralyzers which they are powerless to destroy.

In the pursuit of his experiments Professor Wright used doses of but the one-thousandth part of a milligram. Thus he was able to control all negative phases, and all phases of secondary occurrence (the flow-and-ebb phases of the opsonin treatment). On the other hand, Doctor Koch, in his studies, increased the negative phase of development by second inoculations, and his patients died. In other words, Doctor Koch had been striking out blindly, since he understood nothing as to the true rationale of the opsonin treatment. But since the successful issue of their experimental labors, Professor Wright and his assistants have been unable to find hours enough in both day and night for meeting the demands upon their clinical output. And yet they are unaware of the nature of that definite compound which is always produced by the phthisis microbe in human cells; and their work is thus hampered by their inability to spread the requisite information among medicos at large (a facilitation which, did they possess it, would enable physicians to assume the responsibility, or a share in it, for the inoculation processes). All physical chemists are agreed that the opsonin treatment, as a method of diagnosis, is a standard one; while yet, since this treatment stands without a "guard" or "aid" to assist the microbe in passing the so-called cheese-product-forming in phthisis, and the like substance-forming periods in other diseases, this inoculation lacks a vitally essential factor.

IV. A DEFINITE ALBUMIN CREATED BY TUBERCULAR BACILLI.

The experimenters of the decade just ended did not understand the chemistry of the problem under consideration. They were working from a "rule-of-thumb" process in all that pertained to the opsonin content and the albumin content of the excretions and the lesions of tubercles, in the case of phthisis and its allied forms in the human body. They therefore passed upon these elements and their phenomena in this manner: "The lung tissue is filled with a substance which, by chemical means, exhibits albumin, salts, and nothing else that is characteristic." Now, this is, from the writer's point of view, a very unscientific finding. Consequently the writer must now endeavor to establish, upon a reasonably secure basis, the verity and the applicability of the principles inwrought with the following discoveries which the writer has personally made:

(*a*) The opsonin content always contains nitrogen compounds of a high albuminous character.

(*b*) The albumin content of the phthisis-infected tissue is definite in its character. To discover this character and to accomplish the conversion of the albumin content into a substance potentially soluble and also nonparalyzing to the microbes which are (potentially) helpful in this eliminative work is the secret of the solution of this heretofore-described "opsonin battle."

(*c*) If we can convert the opsonin carrier and the morbid product stored in the cells of our patient into an inert (or, better, into a nutrient) albumin of higher or lower nitrogen content, while passing the inoculation into the patient's system, we shall thus fortify him, in the simple resulting reaction or catalytic transformation, against negative phases of development; and we shall thus make the dread tuberculosis bacillus the friend, rather than the deadly foe, of its host.

(*d*) We have already shown that by starting with the nonanimal product, sarcosin, we are able, by the introduction of the cyanamide of lime (nitrogen-of-the-air product), to change the sarcosin into kreatin—the veritable muscle, or flesh, tissue cells.

V. EXPERIMENTATION AND BIBLIOGRAPHIC REFERENCES.

Let us now try to show what we may further hope for in these directions, by the detailing of a few things that the writer has been learning in this domain through analytic work that has covered a period of several years. For details as to methods of separation and chemical determination of the albumins of sputa and lungular lesions herein tabulated, and for bibliographical references and a sample sterilization, the writer has followed the methods used as set forth in the article, "Egg Albumin and Kindred Nitrogenous Compounds," thesis, by Dr. S. J. Sammis, of the University of Illinois (1901–'02), on file in the library of that institution. He has also used further data since compiled by Doctor Sammis, in his albumin studies made under the auspices of the National Bureau of Animal Industry; the said studies being embodied in his article, "Cheese and Milk Products"—an article prepared by Doctor Sammis while he was located in the chemical laboratory at Madison, Wis. Sundry further addenda and variations, hereafter given, are the work of the present writer.

In our experiments we have used: (*a*) the internal sputa products of properly collected samples by well-known and reputable scientists; (*b*) those from cultures on rabbits, guinea pigs and cats treated by the writer; and (*c*) those that have been submitted by others that have been professionally interested. (The cultures on animals and those taken from human tissues have been properly sealed, hermetically, by the various bacteriologists and physicians that have so kindly assisted us in this tedious work. By consequence, these cultures, each with its own sample history attached, are guarded against the chance of serious error.)

For aid rendered in this important work thanks are due to Dr. P. Anderson, of California; to Prof. James Kinkead and Doctors Rags-

dale and Miller, of Illinois; and to Dr. Jonathan Burrill and Dr. A. W. Palmer, of St. Louis. (These are friends of our early student days; and for their aid in our investigations and for samples so readily submitted, as well as for advice and suggestions kindly offered from time to time, heartiest acknowledgment is hereby made.) I also desire publicly to thank Rev. P. B. Peabody, of Blue Rapids, Kan., for his aid in the proofreading and the transcribing of this report. This sort of aid is probably little appreciable by the average nonliterary layman; yet it is particularly acceptable to us, amid the stress of the finishing "strain" of this race.

An examination, as given in the tables of results attached, in 182 samples out of 200 intimately tested with this same cyanamide of lime, shows the conversion of the tubercular lesions into easily recognized alkali albuminates and easily absorbed casein, the presence of a definite base having been determined in the case of each sample. The series of changes thus far controlled were found to be as follows (empirically represented in series):

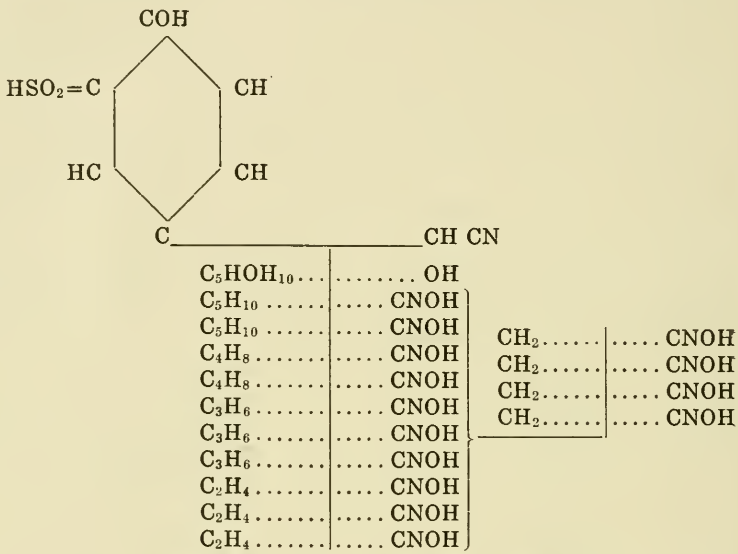
$C_4H_9N_3O_2$	Kreatin.
$C_4H_7N_3O$	Kreatinin.
$C_5H_4N_4O_2$	Xanthin.
$C_5H_{10}N_4O$	Xanthokreatinin.
$C_5H_4N_4O$	Hypoxanthin.
$C_7H_8N_4O_3$	Carnin.
$C_6H_{13}NO_2$	Leucin.
$C_9H_{11}NO_3$	Tyrosin.
$C_{11}H_4N_2O$	Urea.
$C_5H_4N_4O_3$	Uric acid.

The eleventh type of the above series, with sulphur and phosphorus (empirically represented), gives:

$C_{77}H_{120}N_{20}O_{26}$	Alkali albuminate.
$C_{144}H_{240}N_{40}S_2P_2$	Casein of milk.

VI. FORMULÆ AND DETERMINATIONS.

It may possibly be allowed to designate the formula of the molecule of the albumin-like substance "sarcosin," approaching as near to what it should be in structure as the imagination of man can possibly attain. I give the structural formula for sarcosin:



The soluble material then forms sarcosin; and gives with the product of CA C_2 plus 2N, or CA CN_2 plus C, = the kreatin or muscle-material; while it forms with the "lung-clog"--the casein—like material akin to cheese.

Content of Sputa and Lesions.

Table I. Percentage of Content of Affected Sputa.

The methods of determination herein followed were formulated by a modification of those laid down for "Content of Food Products," in Bulletin No. 108, U. S Department of Agriculture.

		Carbon........	Hydrogen.....	Nitrogen......	Sulphur.......	Oxygen.......	Phosphorus...	Total.........
Case I.—Infant, 18 months old; lung phthisis; September, 1908.	I..........	61.02%	6.89%	13.68%	4.61%	10.71%	2.92%	99.83%
	II.........	61.25	6.80	12.90	5.00	10.25	2.90	99.10
	III........	61.03	6.87	13.52	4.75	9.97	2.85	99.09
	IV........	60.95	6.82	13.41	4.52	10.50	2.98	99.18
	V.........	61.53	6.75	13.52	4.60	10 70	2.95	100.05
	VI........	60.97	6.91	13.00	5.28	10.75	3.00	99.91
	VII.......	62.92	5.50	13.21	4.06	10.80	2.95	99.44
	VIII......	61.00	6.92	13.71	4.59	10.72	3.00	99.94
	IX........	60.45	6.42	14.01	4.60	10.78	2.90	99.16
	X.........	60.21	6.83	13.92	4.09	10.70	2.00	98 59
Case II.—Lady, 38 years old; sputa collected at sanitarium; November, 1908.	I..........	61.09%	5.82%	12.68%	5.12%	10.75%	2.36%	98.72%
	II.........	61.75	6.82	12.99	5.00	10.91	2.85	100.32
	III........	61.50	6.66	13.65	4.52	10.81	2.98	100.12
	IV........	61.83	6.74	13.70	4.81	9.89	3.00	99.97
	V.........	61.71	5.98	13.71	4.61	10.71	2.98	99.76
	VI........	61.73	6.00	13.70	4.50	10.80	2.59	99.71
	VII.......	62.85	5.90	13.00	5.09	10.60	2.95	100.39
	VIII......	61.70	6.80	13 67	4.52	10.60	2.91	100.20
	IX........	61.09	6.89	13.50	4.55	10.70	2.90	99.63
Case III.—Young lady, 19 years; galloping consumption; hospital, Topeka, November, 1908.	I..........	62.05%	6.09%	13.71%	4.02%	10.98%	3.00%	99.85%
	II.........	61.75	6.80	13.50	4.55	10.62	2.90	100.12
	III........	61.03	6.85	13.52	4.75	9.97	3.85	99.97
	IV........	61.09	6.80	13.75	4.59	10.71	2.92	99.86
	V.........	61.07	6.89	13.60	4.60	10.90	2.90	99.96
	VI........	61.92	6.97	12.71	4.65	10.75	3.00	100.00
	VII.......	61.95	6.81	13.66	4.72	10.09	2.98	100.21
	VIII......	61.07	6.98	13.09	4.95	10.81	2.95	99.85
	IX........	61.23	6.89	13.42	4.60	10.78	2.90	99.82
	X.........	62.21	6.90	12.00	4.72	10.80	2.95	99.58

		Per cent.			Per cent.
CASE IV.—Patient 39 years; average of 10 samples garcosin from urine in Bright's disease. September, 1908.	Carbon......	60.95	CASE X.—Amnitic fluid of tertiary stage; 15-months-old Belgian hare; 3 months pregnant; tuberculosis bacilli easily discerned.	Carbon......	62.00
	Hydrogen...	6.80		Hydrogen...	5.85
	Nitrogen....	12.92		Nitrogen....	13.80
	Sulphur.....	5.95		Sulphur.....	5.81
	Oxygen.....	10.45		Oxygen.....	10.33
	Phosphorus,	2.98		Phosphorus,	2.01
	Total.......	100.05		Total.......	99.80
CASE V.—Patient 50 years; average of 10 samples from knee exudations. October, 1908.	Carbon......	61.23	CASE XI.—Abortive case; fœtus and amniotic fluid in female, age 22 years, secondary stage; lesion determination. December, 1908.	Carbon......	61.90
	Hydrogen...	6.74		Hydrogen...	5.05
	Nitrogen....	13.70		Nitrogen....	13.09
	Sulphur.....	4.81		Sulphur.....	6.72
	Oxygen.....	9.89		Oxygen.....	10.59
	Phosphorus,	3.00		Phosphorus,	2.09
	Total.......	99.37		Total.......	99.44
CASE VI.—Patient 6 years; average of 10 analyses; systemic phthisis from birth. November, 1908.	Carbon......	61.70	CASE XII.—Negress, 29 years; systemic phthisis; sputa for 10 days; average of ten samples. October, 1909.	Carbon......	62.03
	Hydrogen...	6.80		Hydrogen...	5.05
	Nitrogen....	13.67		Nitrogen....	13.02
	Sulphur.....	4.52		Sulphur.....	5.91
	Oxygen.....	10.60		Oxygen.....	10.76
	Phosphorus,	2.91		Phosphorus,	2.98
	Total.	100.20		Total.......	99.75
CASE VII.—Patient 34 years; ten determinations; amniotic fluid of mother in sixth month of pregnancy. December, 1908.	Carbon......	62.05	CASE XIII.—From cadaver (phthisic patient) at time of embalming, 4 hours after death. October, 1909.	Carbon......	60.98
	Hydrogen...	5.09		Hydrogen...	6.11
	Nitrogen....	13.60		Nitrogen....	13.05
	Sulphur.....	5.55		Sulphur.....	5.82
	Oxygen.....	10.62		Oxygen.....	10.70
	Phosphorus,	2.90		Phosphorus,	2.99
	Total.......	99.81		Total.......	99.65
CASE VIII.—Patient 42 years; systemic phthisis; laborer in gypsum mills; secondary stage. January, 1909.	Carbon......	61.01	CASE XV.—Guinea pig, 18 months old; fresh sputa; 90 days of tubercular affection produced by inoculations with tubercular bacilli. October, 1909.	Carbon......	61.90
	Hydrogen...	5.83		Hydrogen...	4.96
	Nitrogen....	13.71		Nitrogen....	13.71
	Sulphur.....	5.86		Sulphur.....	6.55
	Oxygen.....	10.60		Oxygen.....	10.93
	Phosphorus,	2.90		Phosphorus,	2.05
	Total.......	99.91		Total.......	100.10
CASE IX.—Patient 12 years; case hydrocephalous expectorations of tertiary phthisis. January, 1909.	Carbon......	61.21	CASE XVI.—Amniotic fluid; lesions of female greyhound; inoculation 33 days with tubercular bacilli; age 14 months.	Carbon......	....
	Hydrogen...	6.07		Hydrogen...	....
	Nitrogen....	13.72		Nitrogen....	....
	Sulphur.....	6.82		Sulphur.....	....
	Oxygen.....	10.62		Oxygen.....	....
	Phosphorus,	2.95		Phosphorus,	....
	Total.......	101.39		Total.......	....

REMARKS.

Cases IV, VII and XIII were samples with direct view to arrive at molecular weight of "garcosin."

Cases V, IX and XIII, special studies to determine whether a definite material was present.

Cases VI, X and XV are typical, and content of amniotic fluid was ultimately determined and published first in S. Ill. Med. Jour., 1897.

Cases VII, XI and XVI are in the nature of corroborative evidence.

VII. STUDIES IN AN ANTITOXIN ELIXIR, OR CARRIER, FOR CALCIUM CYANAMIDE.

USE OF $CaCN_2$ IN THE FURTHERING OF THAT CHEMICAL TRANSFORMATION, OR CATALYSIS' WHICH THE TUBERCULAR BACILLUS FAILS, BECAUSE OF THE SHORTNESS OF ITS LIFE' TO COMPLETE.

An elixir which performs the functions of a carrier for cyanamide of lime, in the case of minimum doses, without salivation effects, is the following:

℞—Calcium glycerophosphate, 8 gr.
Sodium glycerophosphate, 16 gr.
Iron glycerophosphate, 1½ gr.
Manganese glycerophosphate, 1 gr.
Quinine glycerophosphate ½ gr.
Aromatic elixir of cascara sagrada *q.s.* to make 1 pint.
Macerate in the above $\frac{1}{600}$ gr. of calcium cyanamide, pulv.
Sig.—Give 60 mm. three times daily, according to patient's needs, with hypodermic.

The foregoing elixir was used in the treatment of animals with cyanamide of calcium.

VIII. ACTION OF ELIXIR ON ANIMALS.

Two dozen guinea pigs of the healthiest type inoculated for a period of twenty-five to ninety days, in due course, with tubercules; were given hypodermically the foregoing formula for first five days, also internally, the said elixir, and all are healthy and to all appearances fat and well.

Cows with tubercular bacilli were given, hypodermically, the foregoing formula for the first five days; also internally. All are healthy, and, to all appearances, fat and well, gaining each day. The same is true of twelve infected Belgian hares infected to tertiary stage, there not having been a single one of them that did not recover fully in 171 days.

IX. HOPES AND CONCLUSIONS BASED UPON THIS INVESTIGATION.

We gather, therefore, from these studies—

First: That there is a definite organic basis to the exudations of the tubercular bacillus.

Second: That this organic basis is an analogue to the base of milk, known as casein.

Third: That it is possible to attack in animals that are physiologically similar to man the artificially produced systemic phthisis state (even after the subjects have reached the most direful pathological condition, after inoculation with tubercules), with success.

Fourth: That we have been in many cases more successful in the combating of the artificially induced disease than in the propagation of cultures of bacilli.

Fifth: That the comparative study of certain cancerous effluvia or deposits, due to poisoning with fish fins, has revealed lesions closely analogous in basis to the sputa albumin of tubercular bacillus growths.

Sixth: That a carrier, or elixir, has been made which will successfully convey the deadly cyanamide of lime into and out of the human system, producing in its passage the desired catalytic action. (This, thus far inferentially, from analogous success with animals physiologically similar to man.)

Pregnant evidence of success is on the side of the experimentation which we have carried on during the past nine years. If it thus becomes possible to transform the sad-eyed patient, awaiting sealed doom, into a healthy being, radiant with life joy, the cup of this writer will run over and over. And surely we are now on the right road to reach ultimately the long-sought end. As ever, that end will be found, whenever it shall be found, in the laboratory of the skilled enthusiast. And the final, comprehensive solution of the long baffling and ultra-complex tuberculosis problem will mean unparalleled boon of physical well-being for human kind, involving results that superabound in mercy shown, in gladness unspeakable attained.

ADDENDA.

During this year of grace 1910 the writer has had the pleasure of trying the virtue of the catalytic action of this now famous cyanamide of lime from coast to coast in America. Friends, surgeons of the Red Cross Society, have day by day found patients who were willing to submit to inoculation with cyanamide elixir. Here in the white-walled city of Manila, P. I., have been discharged five children of the first families of the Luzon island, pronounced cured, the same having been originally possessed of variant forms of tuberculosis in the several stages of development. To see some of these playing child games, further, to see of an evening the half-dozen young men, sixteen weeks ago in all but hopeless condition with tuberculosis, now apparently hale and hearty, playing tennis and indoor base ball, is the crowning joy of this long-drawn-out period of experimentation. Added to their number appears upon the roster of the cured, in all parts of the United States, the writer's friends made glad to the number of fifty-five; and the writer awaits with anxiety the development of a manufactory for production of materials, that no delay may further be necessary, and to give to his beloved Academy in the Sunflower state, U. S. A., the results herein set forth.

THOUGHTS ON TUBERCULOSIS.

(ABSTRACT.)

By J. M. McWharf, M. D., Ottawa.

BY THE TERM PHTHISIS, or consumption, we understand that it is a disease characterized by wasting or emaciation Tubercle, tubercular disease and tuberculosis have gradually come to be regarded as identical with the term phthisis. As we study this important morbid condition it is essential that we consider it under general heads, as its pathology, symptoms, diagnosis, prognosis, and treatment. Its pathology involves a consideration of the histology, chemistry and general pathology of tubercle; that is, its cause, natural progress, and the theory of its production. The term tubercle would include the various forms, as infiltrated, milliary, cretaceous, and calcareous; its morbid anatomy, the lungs, the pleura, bronchial glands, alimentary canal, peritoneum, trachea, larynx, liver, mesenteric and lymphatic glands, spleen and kidneys, with other textures and organs.

Causes of tuberculosis are age, sex, hereditary tendency, vitiated air, climate, contagion, and occupation. Time or space will not permit me to enter more fully into detail. A discussion of the subject at this time must be upon a broad and general sense. During the ebb-and-flow tide of medicine, great changes have been evolved, and yet I doubt not that there are many yet in store for future delivery. Since A.D. 1810 our ideas and conceptions of this disease have radically changed. To-day we hold that tuberculosis is a specific, infectious, inflammatory condition, nonvascular, and nodular; that it holds the parasite in its substance; that it attacks any and every part of the body. When the tubercle is limited to the foci, there is a strong possibility of its spreading to other parts of the body. This tubercle is the most serious enemy to the human race. First, it contains the germ; secondly, this germ slays its thousands in many ways. Meat and milk of tuberculous animals are very important factors in the production of this disease. The researches of bacteriologists have proven beyond a doubt that there is an unceasing contest being waged between the invading bacillus upon the one side, and the living organism or leucocytes upon the other. The leucocytes stand guard while the bacterial invaders make the onslaught, and should the latter prove victorious the disease will be established.

It has been found by investigation that a certain per cent of all cases of tuberculosis, especially in children, was through the direct result of the introduction of bovine bacillus into the human body through the use of milk from cows that were tainted with the disease. Carnet made an investigation with regard to tubercle bacilli being found in the air. This exposition was exceedingly interesting. There were taken into consideration twenty-one wards of seven hospitals, three asylums, two prisons, and the living rooms of sixty-two tubercular patients, besides outdoor patients, public streets, and inhalation experiments. Ninety-four susceptible animals were inoculated with the dust from hospital wards. Of these twenty became tuberculous. Negative results were obtained from the dust of surgical wards and from that of the streets. One hundred and seventy animals were inoculated with the dust secured from the living rooms of consumptives. Of this number thirty-four became infected, and ninety-one of the 170 died from septic diseases. We therefore infer that, as the dust was taken from the walls, furniture and picture frames, it does not show an accurate, specific virulence. During the years from 1863 to 1888 one of the city wards of Philadelphia became of great interest. One-third of the houses in the ward were infected, and one-half of the deaths from tuberculosis occurred in the infected houses.

During a term of twenty-five years a careful record was kept of thirty-eight Catholic convents, whose yearly average was 1428 persons. Strenuous efforts were made to secure only healthy inmates, and yet the mortality from the great white plague was one-seventh to one-fifth of all the deaths. We have to-day writers upon the subject of tuberculosis who make the statement that it is intensely contagious, that it is never hereditary, and that it is readily amenable to treatment. These assertions, in the main, are extravagant. No physician can make such unqualified statements, and they are not justifiable. He has no data to prove that the disease is intensely contagious, nor can he assert with any degree of assurance that it is never in any sense hereditary. Neither can he say truthfully that it is readily amenable to treatment. Our knowledge of the disease and its treatment is as yet too crude to warrant us in making such positive assertions.

The infection of tubercle may take place on a mucous surface, as the ear, nose and mouth, and by ingestion of the bacillus; or it may be transmitted through the agency of the blood. The primary cause being the tubercle bacilli, when they reach a point of least resistance, then and there the destructive process begins, the focus is established, and from this systemic point of attack the disease may be extended.

What is the state of tuberculosis to-day? A very appropriate and suggestive question; one more easily asked than answered. Before Koch, the scientist, came on the field, drugs and food had played their part and gone. Cod-liver oil, phosphorus, hypophosphite, arsenic, iron, digitalis, phenol, quinia, creosote, and coal tar, each has been lauded as a cure-all; to-day they are considered simply as adjuncts. Sulphureted hydrogen gas at one time presented a bold front, but its memory is unsavory. Compressed air, one of the has-beens, is to-day relegated to the dim distance of the past. Climate at this time is in the forefront of the battle that is being waged against the great white plague.

It was considered that New Mexico possessed the finest climate possible. But what are the facts? The native Indians have perished there with this disease by the thousands. We are forced, therefore, to admit that climate is the least essential of the consumptive's necessities. The fact is, climatic treatment presents a problem to the physician that is surrounded by many difficulties. It is a question that is complex in character. When required to give advice, a large number of pertinent questions confront us: Will the financial and physical condition warrant the desired change? Would it be advantageous? If the change is to be made, what climate is preferable? Each case must be considered from an individual standpoint. Eschew from your mind the thought that all tuberculosis patients must go west, or that they must have a special climate in which to live. Such an idea is harmful, for it brings distress, blasting of hopes and throttling of courage. Disabuse the minds of the people upon the climate cure, for it is not a concrete, specific thing which can be secured only for the asking. The profession should encourage the building of sanitariums in the East, a much neglected territory. Hundreds of such institutions are needed to care for a large class who are unable to seek a special climate.

Tuberculosis is, as a rule, a protracted and rebellious disease. Is it incurable? No. Nor does a cure mean the complete eradication of every lesion, scar, alteration, transformation, or complication in the structure, functions or natural conditions of the organs that may result from the disease. I have no doubt but that the medical profession has suffered from the radical stand taken by Koch. The results obtained did not justify the unqualified position taken. So long as the pathology and treatment of tuberculosis occupies its present status, just so long will we find the medical journals teeming with new ideas and extravagant statements.

We are confronted to-day with the idea of eradication. Working along this line, we find early and prompt action necessary. Every physician should work in harmony with his fellows to secure this end. That class of patients who need a change, and who would be helped by it, should be promptly placed under the best supervision possible. Our methods are slipshod and haphazard, and as a result thousands are forced from their homes at a time when there is not a particle of hope in store for them. This is unfair to the patient, and cruel in the extreme. There are various reasons why a large class of tuberculuos people cannot go from home. They not only need, but demand, sanitarium privileges at home. Correct environment is an important factor, and should be coupled with proper care, and the very best therapeutics possible in each individual case. Aid Nature, and thus increase her powers of resistance to disease, and perchance destroy the cause.

Scientific data are constantly accumulating which emphasize the danger of injections in tuberculosis. I believe Koch was mistaken in the premises taken. We find that he made a mistake when he stated that bovine and human tuberculosis were distinct and noncommunicable diseases. The British Royal Commission investigated Koch's theory and stated that the German scientist was wrong in his conclusions. The commission, desiring a fair and correct conclusion, made still further investigations, but arrived at the same conclusion, viz., that bovine bacillus is, or may be, introduced into the human body by the use of infected material. Recent investigation demonstrates the fact that tuberculous material from cattle has the highest virulence for all tested species, and that tuberculous material from man has a much lower virulence. These findings are sound, based, as they are, upon positive experimental evidence.

When we take into consideration the present conditions, coupled with a desire to arrest the fearful death rate from consumption, it will be necessary to interest the general public as well as the profession in all that pertains to the welfare of tubercular cases. Methods of prevention should be thoroughly understood and applied. Educate the masses upon sanitary laws and how to apply them to the best interests of all the people. This would be the most effective way to reach the end desired. It must be secured in the home, in the school; in fact, in all places, public and private. Should the people fail to recognize and practice the things essential to the preservation of life and health, then let the strong arm of the law be brought to bear upon or enforce the principles that should govern in these cases.

FUTURE OF THE KANSAS ACADEMY LIBRARY AND BOOK COLLECTIONS IN THE STATEHOUSE.

By J. T. LOVEWELL, Topeka.

THERE are in our statehouse collections of books which, if united under one administration, would give us by far the largest library in Kansas.

First, we have the state library, which is directly under the management of the justices of the supreme court, who appoint the librarian and make rules for the acquisition, care and use of books, in accordance with the statutes enacted from time to time. Naturally, it was at first a law library, and this feature must ever continue its foremost purpose. The exchanges among the states of court reports and legislative proceedings bring a constantly increasing influx of books which are indispensable to lawyers, and no other law libraries can claim to equal our state libraries in the extent and richness of this class of books.

But our state library is not limited to legal treatises. Annual appropriations are made for the purchase of books of any kind, and exchanges are also made of our state publications for books of every character published by other states or institutions. It is a repository to which are sent all publications of the government at Washington, many departments of which are prolific of books. The statutes provide for all expenses of this library, and its printing and binding are done at the state printing plant, on requisition of the librarian. The Stormont medical library is a distinct department of the state library, under charge of the state librarian, who acts with a committee of the State Medical Society in making rules and purchasing books from the income of the Stormont fund of $5000.

The traveling library is under charge of another commission, three of whom are appointed by the justices, and the fourth is the president of the Social Federation of Clubs. This organization was started by the Kansas Federation of Women's Clubs, and designed to disseminate the advantages of books throughout the state where there are no large libraries, and is proving very acceptable to the general public. The legislature of 1909 made provision for still another branch of the state library, to be known as "the legislative reference library," but it is not a distinct commission, and, so far as at present developed, is in the hands of an assistant, who uses all the resources of the library and makes clippings bearing upon all important questions that may be before the public; and here the legislators may find help in preparing bills, etc.

The law provides for assistant librarians and clerical help in each of the departments, and appropriations are made for office expenses, postage, and $200 each year for buying books.

The Historical Society, established primarily for the purpose of collecting and preserving historical records, especially of Kansas, is made a trustee of the state for the historical objects and books that may come into its possession. It also is a repository to which are sent all government publications at Washington, and probably has the most complete sets of these of any of our statehouse collections. It maintains a system of exchanges, not only by means of its own bulky biennial volume of Collections, but the state gives it for exchange purposes sixty bound copies of each of the several publications of the state and of its societies and institutions, except the supreme court reports. This provision is made with the express object of facilitating exchanges, and the result has been that in number of volumes of books and pamphlets it far outranks the other combined collections in the statehouse. State, county or other officials may turn over to the Historical Society, for preservation, any books, manuscripts or newspaper files, which are to be catalogued or kept by the society as a part of the public records. On application, certified copies may be made of these by the secretary.

Another unique feature of this collection is its files of newspapers. The statutes make no direct reference to these, but the fact that both its secretaries have been newspaper men has enabled the society to appeal successfully to newspaper publishers to turn over copies of their papers to the society, until its collection of bound files of newspapers exceeds that of any other western state. While mainly interested in Kansas papers, it has files of some prominent papers of the great cities, like St. Louis, Chicago and New York. It takes a great amount of space to care for such a collection, and requires a clerical force of nearly a dozen persons to assist the secretary in all parts of his work. In the great flood of books and curios that are ever drifting into this society there is a good percentage of "junk" which must eventually be cleared out, for there is a limit to the use of a public museum as a haven for worn-out and antique furniture and discarded books.

Next to these in extent and importance is our own collection of books. These have been acquired by exchanges and donations, and a few have been purchased with funds of the Academy. The collection of a library was not a prominent object in the thought of its founders. As by incorporation it was regarded as a department of the State Board of Agriculture, so in its earlier years its Transactions were published as appendices to the biennial report of that board. After a few years it became a matter of mutual convenience to have the Transactions published in separate volumes, and so it has continued to the twenty-third volume, which is now in the hands of the printer. These volumes are regarded as valuable contributions to scientific inquiry, and contain the best papers of our scientific men. They have been received as acceptable exchanges by large numbers of scientific journals and publications, both domestic and foreign, and such exchanges have been carried on till now the Academy has a library of more than 6000 volumes. Many of these are in foreign languages, and come from every country where scientific contributions are published. The earlier editions of the first seven volumes having been exhausted, the Academy, using the funds which had accumulated from membership dues, had 500 copies of these volumes reprinted, so that now fifty or more complete sets of the Transactions can be sold or used in exchanges. This will be a valuable asset in the future development of the library. Not much has been done in cataloguing this library beyond a card index which shows the titles of volumes on hand and the sources from which they come. The Academy has received from the various government departments at Washington their scientific publications, and many of the sets are near enough complete to be of great value.

The removal of the library and collections of the Academy from the basement to the fourth floor of the statehouse, and the subsequent clearing of a room where our books were stored, have been great obstacles to getting the library into a usable condition, and now there is little encouragement to make permanent arrangements, when in a year or two there will be another removal to the new Memoral building.

Most of the exchanges coming in pamphlet form, it has been a great advantage to the Academy to have the state printer do the binding, as it does for the state library and for the Historical Society. Each of these organizations working separately and independently in the matter of exchanges naturally brings to the statehouse collections many duplicate and triplicate copies of the same scientific publications. This is especially true of the publications received from Washington. When these are bound by the state there is also considerable expense which might be saved, since one book in a combined library would serve the purpose of three in separate collections. The greatest benefit, however, of a consolidated library is in the complete cataloguing which would then be possible. This is a task of considerable magnitude, and could hardly be attempted with the present resources of the Academy. The cataloguers in the state library, besides professional training, have now had considerable practical experience and could work with much advantage on the combined collections.

The whole matter of the consolidation of libraries is doubtless in the province of the legislature, and should be taken up in a broad and generous spirit, and with the purpose to make a great state library, as useful as possible to the people of the state. It is natural that the Academy and the Historical Society would not consent to lose the identity of their libraries in this consolidation. We have considerable pride in our book collection and have invested in it quite an amount of the Academy's funds. It is a matter that should be thoroughly discussed and referred to a committee.

In our collection of scientific books in foreign languages, we surpass both the state and historical libraries. While this feature does not appeal to large numbers of those who consult our libraries, yet there are occasions when such books are of the highest value, and they are an important adjunct to our state library. In many instances sets of this class of books may be made more complete by exchanges of our Transactions, to which reference has been made, and the international book exchange, through the Smithsonian, makes this possible at small expense.

In presenting the facts set forth in this paper it has been the purpose to call attention of members of the Academy to the possibilities of improvement in onr library so as to make it one of our most important agencies in scientific progress. In the consolidation suggested above, it seems fitting that a strictly scientific department be created in our state library, and placed under control of the Academy, under similar conditions to that of the Stormont library in its connection with the State Medical Society. This would require another assistant librarian, and all the details could be arranged by mutual conference of the parties interested. The time to take this up is at hand when we are to move into the new Memorial building.

V.

NECROLOGY.

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1. JOHN DEMPSTER PARKER.
   By J. T. WILLARD, Manhattan.
2. JAMES RICHARD MEAD.
   By J. T. LOVEWELL, Topeka.

JOHN DEMPSTER PARKER.

By J. T. WILLARD, Manhattan.

IN THE death of Dr. John D. Parker probably the last of the early pioneers in science organization in this state has gone from us. For many years he has lived elsewhere, and the news of his passing did not reach us for many months, thus preventing fitting recognition of his services to the Academy at the time of its last meeting.

JOHN DEMPSTER PARKER.

John D. Parker was born in Homer, N. Y., September 8, 1831. He was of New England blood, his mother being from Connecticut and his father from Massachusetts. When he was four years of age his parents moved to North Adams, Hillsboro county, Mich.

Here he passed his boyhood days and obtained a common-school education. He prepared for college at Jonesville, Mich., and at nineteen years of age entered the State University at Ann Arbor, where he completed a classical course. After his graduation he served one year as principal of a private academy in Indiana, and then taught for four years in the graded schools of Illinois. He entered the Chicago Theological Seminary, from which he was graduated in 1865. He was called to the pastorate of the Congregational church at Plymouth, Ill., where he remained two years. During this period he studied and took the examinations at Illinois College, Jacksonville, and received the degree of doctor of philosophy. In 1867 he was called to the chair of natural science in Lincoln College, Topeka, Kan. This institution afterward became Washburn College. In 1875 Doctor Parker removed to Kansas City, Mo., and during his residence there organized the Kansas City Academy of Science. In 1881 he was commissioned by President Arthur as a post chaplain in the United States army, and served with distinction in that capacity for fifteen years at various army posts in Kansas, Nebraska, Texas, Arizona and California. His last station was at San Diego, Cal., where he was retired from active service in 1896.

While stationed in Nebraska Doctor Parker participated with others in the organization of the Nebraska Academy of Science, at Lincoln; and during his residence in San Diego, although in poor health, he maintained his activity in the cause of science and education. He was president of the University Extension Society, and secured eminent men as lecturers under its auspices. He organized the California Scientific Association. The location of the State Normal School at San Diego was largely due to his efforts. This has been of great value to the southern part of California. Having recovered his health to some degree, he went to Washington, D. C., and later to New Haven, Conn. He passed three years among the congenial surroundings of that classical city, but failing health again compelled him to seek the more congenial climate of California, to which he returned in 1906, making his home in Berkeley. In 1907 he had the happiness to celebrate with his estimable wife the golden anniversary of their marriage, at which time they received messages of congratulation from sixteen states, Cuba and the Philippines.

Doctor Parker died of arterial sclerosis, in the general hospital at The Presidio, San Francisco, March 8, 1909. Funeral services were held in the post chapel, where Chaplain Jones, assisted by

Chaplain Scott, gave a sketch of his life and service in the army. He was buried with full military honors in the national cemetery at The Presidio.

Doctor Parker was the author of numerous articles of a scientific nature, appealing for the most part to the general reader rather than to the specialist. Some of these appear in the Transactions of the Academy; others were published in the Kansas City *Review of Science.* While in the East he published a book, "The Sabbath Transferred," now in the second edition. He was a life-long student of science, philosophy and theology, and was associated with Maj. J. W. Powell, Dr. Joseph Le Conte, Doctor Howison, Dean Stringham and other eminent men, besides his Kansas confreres. His venerable widow resides at 2903 Wheeler street, Berkeley, Cal.

Doctor Parker's connection with the Kansas Academy of Science extended through many years. With sixteen others he united in an invitation to all persons in the state interested in natural science to meet at Lincoln College, Topeka, September 1, 1868, for the purpose of organizing a State Natural History Society. Among those associated with him in this cause were Professors Fraser, Mudge, Hougham, Carruth, McVicar, Snow and Whitney. At the fourth annual meeting of this society, at Leavenworth, October 25 and 26, 1871, the constitution and by-laws were amended and the name changed to Kansas Academy of Science. Doctor Parker had been secretary of the Natural History Society, and continued to hold that office in the Academy of Science until 1873. He was vice president of the Academy from 1873 to 1875, and again from 1885 to 1886, and was elected president in 1886. At the meeting in 1887 he delivered the retiring presidential address on the subject, "The Progress of Astronomy." In 1896 he was elected an honorary member. The Kansas Agricultural Report for 1872 contains from the pen of Secretary Parker an account of the origin and history of the Academy up to that time. The Transactions of the Academy for 1900 contains the latest reference to him found in our Transactions, consisting of a letter to Librarian Smyth, dated December 20, 1900. This was filled with the humor and spontaneity of his nature, and with quiet satisfaction in his own work in the organization of scientific associations and his connection with men of science. He was a whole-souled, genial man who will never be forgotten by those who had the pleasure of his friendship.

JAMES RICHARD MEAD.

By J. T. Lovewell, Topeka.

IN THE death of Col. J. R. Mead our Academy has lost one of its life members and one of the oldest living members of our organization. He was a typical Kansas man and a pioneer of frontier life, whose word was always recognized as authority in all questions of history and early life on the plains.

JAMES RICHARD MEAD.

Born in Vermont in 1836, his parents removed with him, when three years old, to Davenport, Iowa, where he grew up and obtained his school education. In early manhood he was led by the reports and persuasions of Col. Jas. R. Lane and others to move to the plains of middle and western Kansas, where for the next fifty years he continued to reside, and he took a prominent part in all the vicissitudes of frontier life. These opportunities furnished him with a vast fund of information, which he used in addresses and communications published in the Transactions of the Academy, in Proceedings of the Historical Society, and in various public journals and magazines.

He had a lively interest and took an active part in all work of the Academy, and it was always a treat to hear him recount his early experiences, when thousands of buffalo, elk, deer and other game animals pastured on the plains of western Kansas and crossed them in their migragrations northward and southward. Here were the great hunting grounds of the Indians, among whom Colonel Mead established several trading posts, the most important of which was on the present site of Wichita, which thereafter became his home. Its name was adopted from his suggestion that the place had been occupied for years by the Wichita Indians and appropriately should bear their name. In these early days he had great influence with the Indians and was much esteemed by them. He knew many of their chiefs, like Satanta, and Heap-a-bear, as well as the celebrated scouts, Kit Carson, Buffalo Bill and other pioneers; and so, in the time of our civil war, he was able to do much in preserving our frontiers from Indian ravages. He was active in all public affairs, and contributed largely to bring Wichita into prominence and make it the metropolis of southern Kansas. He represented his locality both in the house and in the senate of the Kansas legislature, though political life was not relished by him. He was a leading member in the Academy, in the State Historical Society and in several other organizations, and his numerous contributions to these societies are held in high esteem, exhibiting rare powers of observation as well as a racy piquancy which made their presentation very delightful.

His ancestry were of puritan stock, landing on our shores in 1642, and were prominént in colonial and revolutionary days. His father was a graduate of Yale and was a Presbyterian minister in Vermont and Iowa. Colonel Mead is survived by his third wife and two young daughters, and by a son and two daughters of his first wife. In these descendants his name will be worthily perpetuated.

Our Academy has been fortunate in its comparatively few losses by death in late years, but we are reminded that the ranks are closing up and there are not many left who can bring personal testimony of the conditions that obtained here when our commonwealth was young.

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