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TRANSACTIONS
OF THE
KANSAS
ACADEMY OF SCIENCE
VOLUME XXVI.

CONTAINS

LIST OF OFFICERS AND PAST PRESIDENTS; MEMBERSHIP
LIST JANUARY 1, 1914; MINUTES OF FORTY-SIXTH
ANNUAL MEETING; PRESIDENT'S ADDRESS;
SOME PAPERS READ.

December 23 and 24, 1913.

KANSAS STATE PRINTING OFFICE.
W. C. AUSTIN, State Printer.
TOPEKA, 1914.
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OFFICERS OF THE ACADEMY, 1914.

<i>President</i> , W. A. HARSHBARGER.....	Topeka.
<i>Vice President</i> , J. A. G. SHIRK.....	Pittsburg.
<i>Vice President</i> , J. E. TODD.....	Lawrence.
<i>Treasurer</i> , L. D. HAVENHILL.....	Lawrence.
<i>Secretary</i> , J. T. LOVEWELL.....	Topeka.

EXECUTIVE COUNCIL.

Ex officio the PRESIDENT, TREASURER and SECRETARY.

Elective for 1914.

E. H. S. BAILEY.
F. B. DAINS.

L. C. WOOSTER.
J. T. WILLARD.

MEMBERSHIP OF THE ACADEMY.

January 1, 1914.

Dates signify date of election to membership in the Academy.

HONARARY MEMBERS.

- G. P. Grimsley, Ph. D., 1904, Martinsburg, W. Va.
Edw. L. Nichols, Ph. D., 1897, Cornell Univ., Ithaca, N. Y.
W. S. Franklin, Sc. D., Lehigh Univ., South Bethlehem, Pa.
Geo. Wagner, Ph. 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 MEMBER.

- Mrs. R. J. Brown, 1903, Leavenworth.

LIFE MEMBERS.

- E. H. S. Bailey, Ph. D., 1883, Univ. of Kansas, Lawrence.
Edward Bartow, Ph. D., 1898, director of water survey, Urbana, Ill.
Joshua William Beede, Ph. D., 1894, associate professor of geology,
Bloomington, Ind.
F. W. Bushong, Sc. D., 1896, Mellon Institute, Univ. of Pittsburg, Pa.
F. W. Cragin, Ph. D., 1880, economic, geologic and historical research,
Colorado Springs, Colo.
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, Manhattan.
E. C. Franklin, Ph. D., 1884, Stanford Univ., Palo Alto, Cal.
I. D. Graham, 1879, Live Stock Com., Panama Ex., San Francisco, Cal.

- 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.
 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 Orinthological Collection, Topeka.
 Mrs. L. C. R. Smyth, M. S., Ph. D., 1902, curator of Goss Orinthological Collection, Topeka.
 E. G. Smyth, 1901, entomology, Santa Rita, P. R.
 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.

ANNUAL MEMBERS.

- Frank G. Agrelius, A. M., 1905, State Normal School, Emporia.
 Bennet M. Allen, 1913, professor of zoölogy, Lawrence.
 H. C. Allen, 1904, Univ. of Kansas, Lawrence.
 Agnes Anderson, 1913, chemist.
 John J. Arthur, 1904, Topeka.
 Wm. R. Arthur, B. A., 1903, dean of law school, Washburn Coll., Topeka.
 W. M. Bailey, 1906, teacher, Holton.
 Elam Bartholemew, M. S., 1905, mycologist, Stockton.
 W. J. Baumgartner, 1904, professor of zoölogy and histology, Univ. of Kansas, Lawrence.
 Frank G. Bedell, 1904, Dodge City.
 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.
 Frank P. Brock, 1911, Ind. research, Univ. of Kansas, Lawrence.
 E. W. Brown, B. S., 1909, Chehalis, Wash.
 Edw. Bumgardner, M. D., Univ. of Kansas, Lawrence.
 L. D. Bushnell, 1909, professor of bacteriology, Agr. Coll., Manhattan.
 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, State Agr. Coll., Pullman, Wash.
 V. B. Caris, 1911, professor mathematics, M. T. S., Pittsburg.
 F. P. Clark, M. D., 1909, Univ. Hospital, Kansas City, Kan.
 W. A. Cook, M. S., 1907, Baker Univ., Baldwin.
 R. A. Cooley, 1910, Ag. Expt. Station, Bozeman, Mont.

* Deceased.

- Rev. John T. Copley, 1903, clergyman, Manhattan.
 E. G. Corwine, 1905, Mulvane.
 E. F. Crevecœur, 1899, entomologist, Onaga.
 S. J. Crumbine, M. D., 1909, secretary State Board of Health, Topeka.
 Frank Burnett Dains, Ph. D., 1902, professor of chemistry, Univ. of Kansas, Lawrence.
 B. J. Dalton, C. E., 1909, Univ. of Kansas, Lawrence.
 Geo. A. Dean, M. S., 1912, professor of entomology, Manhattan.
 O. P. Dellinger, professor of biology, M. T. S., Pittsburg.
 S. A. Deel, 1913, professor of physics, Baker Univ., Baldwin.
 Emil O. Deere, 1905, Bethany Coll., Lindsborg.
 *Robt. K. Duncan, B. A., 1906, professor of industrial chemistry, Univ. of Pittsburg, Grand Boulevard, Pittsburg, Pa.
 R. B. Dunlevy, M. A., 1896, S. W. Kansas Coll., Winfield.
 E. H. Dunmire, B. S., 1895, Lawrence.
 J. W. Eby, 1903, banker, Harvard.
 C. W. Edmondson, Ph. D., 1909, professor of geology and histology, Eugene, Ore.
 H. W. Emerson, B. S., 1904, Univ. of Kansas, Lawrence.
 B. F. Eyer, B. S., E. E., 1904, professor of electrical engineering, Manhattan.
 T. L. Eyerly, 1906, high school, department of physiography, Dallas, Tex.
 Fred. Faragher, A. B., 1904, with Alden Spear's 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.
 Mary Herman, Ph. D., 1912, Agr. Coll., Manhattan.
 H. J. Harnly, B. S., 1903, professor, McPherson Coll., McPherson.
 L. D. Havenhill, D. Phar., 1904, professor of pharmaceutical chemistry, Univ. of Kansas, Lawrence.
 Thomas J. Headlee, Ph. D., 1907, professor of zoölogy and entomology, Rutgers Coll., New Brunswick, N. J.
 W. C. Hoad, B. S., 1904, Univ. of Kansas, Lawrence.
 D. A. Horton, 1913, entomologist, McPherson.
 W. F. Hoyt, A. M., 1902, State Normal School, Neb.
 Albert K. Hubbard, Ph. D., 1904, Univ. of Kansas, Lawrence.
 I. W. Humphrey, 1912, Mellon Institute, Univ. of Pittsburg, Pa.
 Thomas M. Iden, 1897, State Normal School, Emporia.
 H. Louis Jackson, B. S., 1909, state food analyst, Univ. of Kansas, Lawrence.
 *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., Manhattan.

* Deceased.

- John H. Klopfer, 1904, collector and mining expert, Topeka.
 Pierce Larkin, A. B., 1902, geology, Univ., Norman, Okla.
 W. S. Long, 1913, food laboratory chemist, Lawrence.
 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.
 R. Matthews, D. D. S., 1898, dental surgery, Wichita.
 J. W. McCulloch, 1911, field agent, Agr. Coll., Manhattan.
 David F. McFarland, Ph. D., State Univ., Urbana, Ill.
 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, State Normal, Bellingham, Wash.
 Roy L. Moodie, Ph. D., 1909, instructor, Baylor Univ., Dallas, Tex.
 Merle M. Moore, 1909, student, Ottawa Univ., Ottawa.
 Celia Mulvehill, A. B., 1911, high school, Pittsburg.
 R. K. Nabour, 1910, instructor in zoölogy, Agr. Coll., Manhattan.
 C. A. Nash, 1907, Univ. of Cincinnati, Ohio.
 C. F. Nelson, 1913, chemist, Lawrence.
 N. P. Neilson, 1906, architect, Topeka.
 A. M. Nissen, 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.
 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, Ohio.
 Wm. S. Prout, M. D., 1904, Emmet, Kan.
 D. L. Randall, Ph. D., 1911, professor of chemistry, Baldwin.
 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.
 J. Risser, 1913, professor of zoölogy, Washburn Coll., Topeka.
 B. R. Rogers, D. V., 1907, Agr. Coll., Manhattan.
 Eulalia E. Roseberry, 1909, teacher of physiography, Pittsburg.
 J. C. Russell, 1911, professor of agricultural chemistry, Univ. of Minnesota, Minneapolis, Minn.
 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, Ohio.
- Theo. S. Scheffer, M. S., 1903, Dept. Agriculture, Washington, D. C.
- J. W. Scott, Ph. D., Agr. Coll., Manhattan.
- M. Sebastian, 1911, Parochial School, Parsons.
- 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, Ottawa.
- J. A. G. Shirk, 1904, professor of physics, Pittsburg, Kan.
- Eva Schley, A. B., 1903, natural history, Univ. of Chicago, Chicago, Ill.
- Ralph C. Shuey, 1905, Univ. of Pittsburg, Pa.
- S. G. Stewart, M. D., 1904, physician and surgeon, Topeka.
- Chas. M. Sterling, A. B., 1904, Univ. of Kansas, Lawrence.
- Frank Strong, LL. D., Ph. D., 1905, chancellor of University, Lawrence.
- E. F. Stimpson, 1904, Univ. of Kansas, Lawrence.
- M. C. Tanquary, Ph. D., 1912, instructor of entomology, Agr. Coll., Manhattan.
- E. L. Tague, A. M., professor of chemistry, Washburn Coll., Topeka.
- 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, Bethany Coll., Lindsborg.
- E. S. Tucker, 1904, associate professor of entomology, Dept. Agriculture, Baton Rouge, La.
- W. H. Twenhofel, 1910, professor of geology and paleontology, Univ. of Kansas, Lawrence.
- Edith M. Twiss, Ph. D., 1910, professor of botany, Washburn Coll., Topeka.
- W. A. Van Voris, 1907, State Normal School, Emporia.
- Henry L. Viereck, 1913, entomologist, Lawrence.
- P. F. Walker, 1905, Univ. of Kansas, Lawrence.
- J. D. Walters, M. S., 1894, Agr. Coll., Manhattan.
- Laurance A. Walworth, 1913, taxidermist, Baldwin.
- E. C. Warfel, A. M., 1909, lawyer, Topeka.
- H. J. Waters, B. Sc., 1909, president Agr. Coll., Manhattan.
- E. R. Weidlein, 1911, Univ. of Pittsburg, Pa.
- J. E. Welin, A. M., M. S., 1899, professor of chemistry, Bethany Coll., Lindsborg.
- Archie J. Weith, 1906, 636 W. Twenty-second st., Chicago, Ill.
- J. B. Whelan, 1909, professor of chemistry, Univ. of Kansas, Lawrence.
- E. A. White, 1909, chemist, Kansas City, Mo.
- Stanley D. Wilson, B. A., 1910, instructor in chemistry, Univ. of Chicago, Chicago, Ill.
- W. B. Wilson, B. S., M. S., 1903, professor of biology, Ottawa Univ., Ottawa.
- 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.

SECRETARY'S MINUTES

FORTY-SIXTH ANNUAL MEETING, KANSAS ACADEMY OF SCIENCE.

J. T. LOVEWELL, Ph. D., *Secretary.*

BALDWIN, KAN., Friday, Dec. 26, 1913.

The Academy met for its forty-sixth annual meeting at Baldwin, Kan., in Science Hall of Baker University, and having come to order, the president, A. J. Smith, called for the secretary's report of the last meeting of the Academy. This report having been published in the last volume of the Transactions, its reading was dispensed with, and the president announced the standing committees of the present meeting as follows:

Program: Dains, Wooster, Harshbarger.

Press: Sayre, Groner, Cook.

Audit: Shirk, Knaus.

Membership: Agrelius, Knaus, Mrs. Smyth.

Time and Place: Havenhill, Miss Anderson, Randall.

Nominations: Bailey, Wooster, McWharf.

Resolutions: McWharf, Sterling.

The treasurer's report, as given below, was read; from which it appeared that there is a balance in the treasury of \$900.62. This report was referred to and approved by the auditing committee, and adopted by the Academy.

Treasurer's Report to the Kansas Academy of Science, Dec. 26, 1913.

RECEIPTS:

Dues	\$82.00	
Sale of Transactions	2.08	
Interest on deposits	25.17	
Total	\$109.25	
Balance from 1912	818.68	
Total receipts	\$927.93	

DISBURSEMENTS:

Expenses, Publication Committee	\$7.57	
Expenses Executive Committee	4.24	
New York Botanical Gardens	3.00	
Standard Encyclopedia	12.50	
Total	27.31	

Total cash on hand Dec. 26, 1913 \$900.62

Signed, L. D. HAVENHILL, *Treasurer.*

Approved December 26, 1913. J. A. G. SHIRK,
W. KNAUS,
Auditing Committee.

TITLES OF PAPERS.

Following are the titles of papers in the order received by the Secretary. The time of reading will be announced by Program Committee.

1. An Experiment in Irrigation. A. A. Graham, Topeka.
 2. Frying Eggs in the Sun. A. A. Graham, Topeka.
 3. How to Keep Cool. A. A. Graham, Topeka.
 4. How to Scratch. A. A. Graham, Topeka.
 5. How to Relieve Stomach-burn. A. A. Graham, Topeka.
 6. Phenomena Beautiful. W. A. Cook, Baldwin.
 7. Lowering of the Ground-water Level. W. A. Cook, Baldwin.
 8. A Graphic Method of Determining Food Values for Different Food-stuffs. D. L. Randall, Baldwin.
 9. On Ammonium Molybdate. D. L. Randall, Baldwin.
 10. An Exhibition of Folley's Photographs of Sound Waves. S. A. Deel, Baldwin.
 11. A Description of the New Waterworks for Baldwin City. S. A. Deel, Baldwin.
 12. Some of the Exhibits in the University Museum. C. S. Parmenter, Baldwin.
 13. Improvement in the Commercial Supply of Spices and the Cause for the same. L. E. Sayre, Lawrence.
 14. Corn Oil as a Substitute for Olive Oil and Cottonseed Oil in Certain Preparations. L. E. Sayre, Lawrence.
 15. Glacial Epoch: A Discussion of Theories of Scientists—What Are the Critical Periods of the Earth, and Why Do They Occur? A. B. Reagan, Orr, Minn.
 16. A New Automatic Electric Bell System. J. A. G. Shirk, Pittsburg.
 17. On Some Thiohydantoin Derivatives. F. B. Dains and A. E. Stevenson, Lawrence.
 18. The Action of Acid Reagents on Substituted Ureas. F. B. Dains and R. C. Roberts, Lawrence.
 19. "Witching" for Water and Other Substances. J. T. Lovewell, Topeka.
 20. Determination and Records of Insects Collected at Plano, Tex. E. S. Tucker, Baton Rouge, La.
 21. Progress in Power Development in the Last Decade. F. E. Sibley, Lawrence.
 22. Flora of Kansas—Part III. L. C. R. Smyth, Topeka.
 23. Vocational Education in Kansas. Dean P. F. Walker, School of Engineering, University of Kansas.
 24. Osmosis as a Chemical Phenomenon. Prof. C. F. Nelson, University of Kansas.
 25. The Source of Food Supplies. Prof. E. H. S. Bailey, University of Kansas.
-

26. Animal Life in Puget Sound. W. J. Baumgartner, University of Kansas.
27. The Composition of Natural Gas Occurring near Junction City, Kansas. H. H. King, Manhattan.
28. Insects in Western Kansas. W. Knaus, McPherson.
29. Insects Among the Sand Hills. W. Knaus, McPherson.
30. Geological Development of Kansas. L. C. Wooster, Emporia.
31. Determination of Acetic Acid in Vinegar. Miss Anderson, Lawrence.
32. Weed Seed. L. D. Havenhill, Lawrence.
33. Preservation of the Rocky Mountain Sheep. Mr. Walworth.
34. Acidity in Wheat Flour. Its Relation to Phosphorus and Other Constituents. C. C. Swenson, Manhattan.
35. Preliminary Study of the Conditions which Affect the Analytic Enzymes in Wheat Flour. C. C. Swenson, Manhattan.

Professor Sayre called attention to the importance of a strong legislative committee who should also look after the Academy's interests in the Memorial Building. On motion, Sayre, Bailey, and Knaus were appointed as such committee. A lecture on University Extension was next given by Professor Croissant, and on motion of Professor Sayre the secretary was requested to prepare a report of this lecture to publish in the Transactions.

The Academy next proceeded to the reading and discussion of papers. The Program Committee selected from the published numerical list of titles the following papers, which were next read and discussed: Nos. 7, 8, 9, 10, 13, 14, 17, 18, 25, 28, 29, 31, and 35.

The reading of these papers introduced some interesting discussion, which was enjoyed and occupied the Academy till time to adjourn for the evening session.

EVENING SESSION.

The address of the retiring President, A. J. Smith, was read by its author, and then followed a lecture on The Early History of Explosives, by Dr. F. B. Dains. This was historical, and was illustrated by many lantern projections showing how the old methods of hurling projectiles had been supplanted by the use of gunpowder. President Smith's subject was Progress in Sanitary Engineering Practice. Both of these able productions were listened to with marked interest.

Professor Randall announced that a stenographer had been secured, who would be on hand in the morning to make a full

record of discussions on the papers. The session adjourned till 9 o'clock to-morrow morning.

When the Academy assembled at the appointed hour the Committee on Time and Place announced that Topeka would be the place of our next meeting, and the time would be determined after the question had been settled whether the Academy should merge with the Engineers. Professor Willard, taking up the discussion of this report, thought this was a matter of great importance. First, while there are ten times as many people engaged in scientific work as there were thirty years ago our membership has not correspondingly increased. Why are they not here? The dates of our meetings must be arranged so that they can come. Running around over the state is not conducive to the strongest membership. We must bring younger people into our meetings. There is a tendency to specialization. Our institutions have science clubs, but there is never a time when all departments of science are represented. We do not come here mainly to hear and read papers, but primarily to get acquainted. The most important thing now is to secure a good meeting at Topeka next year.

Professor Wooster thought that while this is an age of specialization we can't be good specialists unless we keep in touch with the rest of the world. There are general phases in the work which affect each one of us. Authors of papers should prepare abstracts giving the points which are of interest to all of us. Most of us would like to have our papers published immediately. The time before they appear in the Transactions is too long. In regard to time it would be better to get away from the holiday season. We should have a time when we can have excursions. Professor Dains thought Topeka the most satisfactory place to meet, and we must make vigorous effort to get people out.

Professor Shirk is very much interested in the proposed union with the Engineers, and said they would like the date of the annual meeting sometime in February. The holiday season is not the best time for all concerned. Each of the different sections must have some one to push it. Professor Cook thinks the holiday season is bad for then is the time when people go visiting. It is too near the time of other important meetings which many of us wish to attend. President Smith said that from the discussion we can get an idea of the sentiment. It is impossible to arrange a time that will suit every

one, and each will find it necessary to make sacrifices. Professor Bailey presented the following report from the committee on the proposed merger with the Engineers, which, on motion, was adopted:

REPORT OF COMMITTEE ON A MERGER WITH THE KANSAS
ENGINEERING SOCIETY.

Your committee, in considering the question of a possible merger with the Kansas Engineering Society, would recommend:

1. That the present funds of the Academy, including the receipts of the current year, be set aside as a fund in trust for the following specific purposes:

- a. Necessary additional furniture for rooms.
- b. Additions to library.
- c. Publicity for the Academy.
- d. Procuring speaker for Memorial Hall dedication.
- e. Other necessary expenses for the furthering of the objects of the Academy as it now exists.

2. We further recommend that a bonded trustee be appointed, who, in conjunction with the president, secretary and treasurer, shall be charged with the expenditures of this fund, as above indicated.

3. We further recommend that on the completion of this merger a new general fund be created for the joint benefit of the merged societies, if effected, consisting of the two affiliated organizations.

4. That we instruct the Executive Council to take all necessary steps toward furthering this merger, to bring about the broader usefulness of this Academy.

5. That if the Engineering Society desires to merge with the Academy of Science, we instruct the Executive Council to extend to it an invitation on the above conditions.

6. We recommend the appointment of a committee of three on publicity, of which Secretary Lovewell shall be one, whose duty it shall be to promote the interests of the Academy by publicity, and that the sum of \$50 be appropriated for the purposes of the committee.

(Signed) L. E. SAYRE.

W. KNAUS.

E. H. S. BAILEY.

Secretary Lovewell read the report of the Committee on Merger made at the meeting one year ago.

P. F. WALKER: I make a motion that a committee be appointed to consider the questions which have been discussed here this morning, and to report this afternoon; the committee to be appointed by the chair.

The motion was seconded and carried.

Committee appointed: P. F. Walker, J. T. Willard, J. A. G. Shirk.

E. H. S. Bailey presented the report for the Committee on Dedication of Memorial Hall.

A motion to adopt the report was made and seconded.

DISCUSSION.

SECRETARY LOVEWELL: In regard to name of the speaker: We have two distinguished members of the Academy, Doctor Wilson and Doctor Nichols, either of whom would be desirable. I must say that I prefer the selection of the committee. If Doctor Nichols should be selected I do not believe we could do better.

The question was put and carried.

SECRETARY LOVEWELL: Report on obituaries: I have previously reported four, and there is nothing further to report.

Report of Nominating Committee:

Officers: President, W. A. Harshbarger, Topeka; first vice president, J. A. G. Shirk, Pittsburg; second vice president, J. E. Todd; treasurer, L. D. Havenhill, Lawrence; secretary, J. T. Lovewell, Topeka.

Additional members of Executive Council: E. H. S. Bailey, F. B. Dains, L. C. Wooster, J. T. Willard.

Motion was made to accept the report of this committee. Seconded. Carried.

Motion was made that the secretary be instructed to cast a ballot for these candidates. Seconded. Carried. Secretary was so instructed and reported the ballot cast and the officers and members of the Executive Council duly elected.

L. E. Sayre read report on Publicity, for Committee on Publicity. Motion made to adopt report. Carried.

There being no further business before the meeting, the time was given to the reading and discussion of papers as follows:

Paper No. 36, Weed Seed, by L. D. Havenhill, Lawrence. Exhibits were presented and a few questions asked.

Paper No. 11, A Description of the New Waterworks for Baldwin City, by S. A. Deel, Baldwin.

Charts were used for this, and the paper was followed by discussions as to the permanency of the water supply.

J. T. WILLARD: I am of the opinion that there will be very little let up of the water supply.

J. A. G. SHIRK: We have been doing a little figuring, and estimate that the rainfall averages about three million gallons per day for the year, on the area described.

E. H. S. BAILEY: In regard to the quality, this is one of the very best waters in the state. There are very few localities where we have this sandstone water, and sandstone water is especially good. In regard to the drainage area, are there many farms?

S. A. DEEL: There are nine farms, but only one that would be at all dangerous because of drainage.

PRESIDENT SMITH: I believe that the arrangement will fail after a few years. It is not to be supposed that this 1300 acres is all going to take up rain water and that all the rain water which it does take up will run down to the filter wells. When the water that is already stored in the sandstone is drawn out the supply is going to fail.

W. A. COOK: Indications are that the land all drains through a point where the filter galleries are located.

PRESIDENT SMITH: From other experiments in other places, notably in California, such supplies always fail.

Paper No. 10, An Exhibition of Folley's Photographs of Sound Waves, by S. A. Deel, Baldwin.

This was given with the lantern, and no discussion followed.

Motion was made to fix the time of adjournment at 12:30, which was carried.

Motion was made to present papers by authors not present by title and refer to Committee on Publication.

Paper No. 6, Phenomena Beautiful, by W. A. Cook, Baldwin.

DISCUSSION.

L. E. SAYRE: The speaker has been able to see thirty miles in the distance. I should like to ask whether on shipboard, for example, where you have no obstruction, is not the range of vision about fifteen miles? Ordinarily it is impossible to see beyond fifteen miles. The distance in this case is doubled. This is due, of course, to the refraction.

F. E. SIBLEY: From the shore of Lake Erie I have been able to see a town sixty miles away across the lake, the city appearing upside down.

MISS MEEKER: Asks as to time of year affecting the mirage.

W. A. COOK: They may be seen at all times of the year.

J. A. G. SHIRK: In Texas and eastern New Mexico, in the middle of the summer after a heavy rainfall when the low places are filled with water, it is hard to tell the mirages from the real pools.

———: In Arizona I have seen lakes of water reflected from at least twenty-five to thirty miles from the Colorado river, or it may have been a reflection from Salton Sea. In regard to this halo about the moon, I made a diagram of the phenomena as I saw it, only I think it was a halo around the sun instead of the moon. There was a large halo, with smaller halos on each side.

PRESIDENT SMITH: In regard to Salton Sea, I have also seen this phenomenon. When we finally came to the sea itself it looked just as it had looked in the mirage. We could not tell which was which until we got within about one hundred feet of it.

Paper No. 27, The Composition of Natural Gas Occurring Near Junction City, Kan., by H. H. King, Manhattan.

DISCUSSION.

F. B. DAINS: Asks concerning amount of carbon dioxide in the three samples. (Mr. King reports same in all three.)

E. H. S. BAILEY: The percentage of methylene is remarkably low. The percentage of nitrogen is high. From analysis obtained in the South we find that the illuminating percentage of methylene is gradually diminishing. The oxygen does not increase. CO₂ increases.

MINUTES FOR AFTERNOON SESSION.

DECEMBER 27, 1913.

Session opened at 1:45 by Pres. A. J. Smith.

P. F. Walker offers resolution on organization.

Motion made and seconded to adopt. Carried.

DISCUSSION.

Mr. WALKER: This was not arranged especially in the interest of chemists and physicists. We have intended that this resolution should be entirely general, with the provision that there will be at least one general session of the Academy.

E. H. S. BAILEY: Does this contemplate having a separate chairman for each division?

Mr. WALKER: It does.

Mr. BAILEY: I think this will stimulate the men in the different lines to write papers and take an interest in the meeting. If we can in this way concentrate the efforts I think it will advance the interests of the Academy very much.

Question put, and carried.

The following papers were presented by title:

No. 15, Glacial Epoch: A Discussion of Theories of Scientists—What are the Critical Periods of the Earth, and Why do They Occur? by A. B. Reagan, Orr, Minn.

No. 20, Determinations and Records of Insects Collected at Plano, Tex. E. S. Tucker, Baton Rouge, La.

No. 24, Osmosis as a Chemical Phenomenon. Prof. C. F. Nelson, University of Kansas.

No. 26. Animal Life in Puget Sound. W. J. Baumgartner, University of Kansas.

Motion made by P. F. Walker that a committee be appointed by the president, of which the retiring president be the chairman, to confer with the Engineering Society at their next meeting and discuss with them plans for the affiliation of their society with the Academy of Science.

Seconded. Carried.

Committee appointed: A. J. Smith, W. A. Harshbarger, P. F. Walker.

Membership Committee reports two names. Motion made to accept report and that the secretary be instructed to cast a ballot for the new members. The secretary reported ballot cast and new members duly elected.

L. C. Wooster raises a question as to those who do not pay their membership dues.

Secretary LOVEWELL: All those who have not paid their dues have been and will be notified. Some pay and some do not pay. In regard to that matter I will say that the dues are payable in advance at the beginning of each year, but it has been the custom recently for a good many to postpone payment of dues until the end of the year. I think that is the practice of the majority at this time. There is a ruling under which I do not send out the Transactions to those who have not paid. The members of the Academy not paying their dues will not receive a copy of the reports. The paper-covered reports were sent to all members, but the cloth-covered volumes will not be sent to those who have not paid their dues. There is another ruling in regard to the proceedings of the annual meeting, and that is that abstracts be presented of all papers, but that rule has not been followed.

L. E. Sayre moved that the action of the secretary be approved.

Seconded. Carried.

Paper 23, Vocational Education in Kansas, by P. F. Walker, School of Engineering, University of Kansas.

Discussion omitted because of lack of time.

Paper 38, The Preservation of the Rocky Mountain Sheep, by Mr. Walworth.

Paper 21, Progress in Power Development in the Last Decade, by F. E. Sibley, Lawrence.

Mr. Sibley concluded his paper by stating: "It is not a question of what shall we do for power, but will we have brains enough to develop the power we have.

Paper 19, "Witching" for Water and Other Substances, by J. T. Lovewell, Topeka.

DISCUSSION.

Mr. LOVEWELL: There has been considerable investigation made and the conclusion has been that when the experiments were properly conducted there was nothing to warrant us to believe that there was any divination to locate water. The experiment shows that people are predisposed to accept things as proved which are not proved, which are really mere chance. Some claim that the method will not answer unless there is a stream of water, not merely the water in the strata. If the water has an affinity for the twig, how about snow? It is claimed that it applies just as well then as at any time. But the question is, does it

apply at any time? I think we shall find it is on a par with table tipping, the clairvoyant, and others of the same nature. There is a great deal of superstition in the human mind that likes to explain things by applying some mysterious force. There is much to be said, which I hardly consider worth the consideration of a scientific body, only that so many people believe it.

S. A. DEEL: The value given for methylene is 45 pounds per cubic foot, according to the Smithsonian report. We find the gas in the pipes here is much heavier, running about 47 pounds per cubic foot.

E. H. S. BAILEY: It is repeatedly asserted that air is mixed with the gas, but from repeated analyses this has not been found so.

P. F. WALKER: With the existing rock pressure on the gas as it comes from the ground, it would be more expensive for the gas companies to pump air into the pipes than to use the gas, and also very dangerous.

Motion made that when we adjourn, we adjourn to 1:45 P. M., and to fix the hour for adjourning the afternoon session at 3:45. Carried.

The Committee on Membership reported the following applications and moved that they be admitted to membership:

H. A. Horton, entomologist, McPherson College.

Miss Agnes Anderson, chemist, Lawrence.

J. Risser, zoölogist, Washburn College, Topeka.

Eugene G. Smyth, entomologist, Ensenada, Porto Rico (for life member).

Henry L. Viereck, entomologist, Lawrence, Kan.

Bennet M. Allen, professor of zoölogy, Lawrence, Kan.

Laurance A. Walworth, taxidermist, Baldwin, Kan.

S. A. Deel, professor of physics, Baker University, Baldwin.

C. F. Nelson, physiological chemist, Lawrence.

L. T. Reser, professor of botany, Baker University, Baldwin.

On motion, the rules were suspended and the secretary requested to cast the ballot admitting to membership the persons above named. The secretary reported the ballot cast and motion carried.

RESOLUTION ON ORGANIZATION.

Resolved, That in order to advance the work of the Academy and promote the active interest of science workers in specialized lines, sections in various branches be formed from among the membership, the basis for such organization being as follows:

1. A section may be formed when not less than eight members so request.

2. Papers which bear directly upon the line of work represented by any section shall, at the option of the Executive Council, be presented before that section; provision for the separate section meetings to be made at each regular meeting of the Academy.

3. Each section shall elect its chairman, who shall be a vice president of the Academy, and other officers as it may desire.

4. Each section is expected to make special effort to secure papers for its own meeting.

5. Each section may take such action as it may see fit to raise funds to further its own work, this to be in addition to the regular dues of the Academy.

6. These provisions contemplate the holding of at least one general session for the reading of papers of general interest at each annual meeting of the Academy.

Submitted by: P. F. WALKER.
J. T. WILLARD.
J. A. G. SHIRK.

Adopted.

President Smith appointed as a Committee on Publicity, in accordance with the report of the Committee on Merger, J. T. Lovewell, L. E. Sayre, W. A. Harshbarger.

Paper 28, Sandhill Collecting in Coleoptera in Reno county, by W. Knauss, McPherson.

DISCUSSION (general on last four papers).

MR. WOOSTER: Estimates made concerning rainfall show that there is $37\frac{1}{2}$ cubic miles each year, on an average. One-half of that flies off in evaporation. One-third runs off and comes out as springs. One-sixth, only, soaks in. So of that three million gallons, only about 500,000 gallons soak in. There are under Kansas about forty years of rainfall, and from that you can figure your water supply.

P. F. Walker moved that the Executive Council be given power to make such expenditures as appear to be necessary for the proper furnishing of the rooms in the new building at Topeka.

Seconded. Carried.

Secretary Lovewell was instructed by the Academy to look after the wiring in the new building for the use of a lantern.

Meeting was adjourned to meet at time and place as arranged by Executive Council.

ADDRESS OF RETIRING PRESIDENT.

PROGRESS IN SANITARY ENGINEERING PRACTICE.

By ALVA J. SMITH.

FIFTY years ago there was no class of men devoting their entire time and attention to the subject of sanitation. Engineering covered such a broad and indefinite field that little was accomplished along the lines of what is now sanitary engineering. In 1828 civil engineering was described as the art of directing the great sources of power in nature for the use and convenience of man. Then the practice of the civil engineer might cover most of the numerous subjects now classed under the six widely distinct departments of engineering—mechanical, mining, marine, sanitary, chemical, and electric. But there were philanthropists and public-spirited men interested in the public-health questions who strove to better the condition of their fellow men, to lower the death rate of the community, and to inculcate into the minds of the people the wise saying of Benjamin Franklin that "Public health is public wealth," and that of John Wesley that "Cleanliness is next to godliness." Specialization in matters pertaining to sanitation gradually set in, however, until there developed a new class of individuals in sanitary affairs, namely, sanitary engineers and inspectors and health officers, whose efficient and praiseworthy efforts have been a prominent factor in giving us the high standard that is held to-day in sanitary affairs. Sanitary engineering is now a profession concerned with matters pertaining to public health. Since pure food, pure water and pure air are essential to public health the sanitary engineer busies himself mostly with the design, construction and inspection of the two systems so vitally important to every community: first, for furnishing an abundance of pure water, and, second, for the sanitary disposal of sewage.

Before noting the great strides that have been made since sanitary engineering became a profession, let us consider the *real* beginning of its development. We find it almost lost in antiquity. "It always has been and always will be an art to preserve health and ward off disease," says Seneca Egbert.

in his book on Hygiene and Sanitation. Hippocrates, about 400 B. C., in his treatise on Air, Water, and Places, defined the principles of public health or sanitation, and summed up the knowledge of his day on the subject. The excellence of the Mosaic code of the Hebrews is acknowledged by all sanitary authorities, and in the comparative longevity of the race we see its effect. Therefore the present may be said to be a second advent of sanitary engineering as a profession, for the importance of sanitary problems was recognized very early in the history of man.

In Egypt artificial lakes were made to provide an adequate supply of water in places where the natural supply from the Nile was insufficient. Remains of gigantic water basins have been found in Peru and Mexico. In Ceylon there is found the remains of a great artificial lake 40 miles in circumference.

Necessity drove the ancient Mound Builders of Yucatan to dig hundreds of wells as sources of water supply, some of which were of large dimensions. In one case a winding passageway 1400 feet long led to a supply of water at a depth of 450 feet. Many of their wells were constructed the shape of our modern cisterns, *i. e.*, with a small opening at the top, a form favorable to resisting contamination. From the number of wells constructed in this form one is induced to believe that the builder's purpose was to protect the quality of the water.

About 312 B. C. the early Greeks and Romans met our problem of supplying the people with water of sufficient quality and quantity, and considered it a problem of importance. They were compelled by the demand for more and better water to abandon their wells and construct their great systems of aqueducts. These aqueducts are masonry conduits from two to eight feet in diameter, constructed in tunnels through the hills and on series of arches over the valleys for hundreds of miles. It was here that municipal water supply reached its zenith as to quantity. The first great aqueduct supplied Rome with pure water drawn from a distant mountain. At the end of the first century A. D. Rome had 14 aqueducts supplying 375,000,000 gallons, or about 300 gallons per capita, daily. This water was mostly supplied through public fountains to which the people came in great numbers; however, some of the houses had direct connection with the aqueducts through lead pipes.

Two thousand years later Emporia built a waterworks wherein the purification process is sedimentation and a treatment with alum, instead of sedimentation and a treatment with salt as was the method of the Romans; the only apparent progress in the method of treatment in 2000 years in this case being a substitution of alum for salt.

If the Romans had to vote bonds to build their waterworks, there is no record of the usual fight against the proposition. Neither are we told who was the Doctor Crumbine of that day who insisted that such a system be installed.

Paris and Lyons in France, Metz in Germany, and Segovia and Seville in Spain were well supplied with water at about the time the Roman aqueducts were built.

Wells were constructed by the Chinese at a very early date. These wells were often very deep and some were sunk through solid rock.

Among the ruins of nearly all large cities of ancient civilization are found remains of both tile and masonry sewers. The oldest sewers of which I have found any record were built by the Assyrians about 900 B. C. These sewers were constructed of stone masonry with flat bottoms and arched roofs. One of the earliest applications of the principle of the arch to structural purposes is found in these Assyrian sewers.

Some of the great sewers of ancient Rome were built 700 years B. C. and are in such a good state of preservation that they are still in use after a lapse of 2600 years.

It is evident that the ancient Greek, Roman and Assyrian engineers were not only proficient in accuracy, with ability to plan enduring construction work, but they had developed engineering science to a point where considerable efficiency in the matter of sanitation was reached. Roman engineers especially had at this early date developed some excellent and systematic sanitary engineering methods.

For a thousand years following the fall of the Roman Empire, 476 A. D., sanitary engineering, with other branches of science, suffered great degeneracy. As a result of neglecting sanitary precautions through the Dark Ages following, impure water supplies contaminated by accumulations of filth predominated, resulting in the prevalence of disease and pestilence throughout the period. The neglect of their great system of drains was so complete during this period that some of

them became filled up and the people actually forgot what they were for.

In the eighteenth century the subject of sanitation was revived and again brought before the people. In a monograph entitled "A New Method of Purifying Water by Ascent," issued by James Peacock in 1793, we have the first published account of a water filter. This filter was constructed of sand and gravel, much as filters are made to-day, and its operation was much the same, excepting that the water passed through the filter from bottom to top instead of descending through it as is customary at this time. The filter was washed by reversing the flow of the water through it.

This filter may have operated fairly well on English waters, but could not have been long successful if applied to the highly turbid waters of our Kansas streams. However, this little publication proves that the principles of water filtration were being carefully studied at that early date and that considerable progress had been made in developing the practical features of the process.

Even before this date development in other lines of waterworks improvement had begun. A system of waterworks was built in Boston in 1652, and improvements were made in the London and Paris waterworks about the year 1700. More rapid advancement was marked by the introduction of steam pumping machinery, which came into use about one hundred years later. The development of modern waterworks systems has progressed much more rapidly since 1850, and radical changes in processes of pumping and purification are still taking place. About the middle of the nineteenth century Charles Kingsley, an English clergyman, struck some mighty blows for reform and urged the clergy of England to agitate the subject of sanitation as part of their bounden duty to their flocks.

In following the history of the human race we find that many methods have been used in the removal of waste material. During the time that the functions of microorganisms were unknown, and even their presence unsuspected, elaborate preparations were made in the larger communities for the more or less prompt removal of what they realized from experience to be dangerous accumulations. The first effort to dispose of these accumulations were probably made in the way

of burial, as indicated in the 23d chapter of Deuteronomy and in the early Hindoo writings. Later came the use of vaults and cesspools, removal by carts, dry-pail methods, burning, compressed air, and water carriage, with its final development into methods of aiding bacterial decomposition in the modern disposal plant.

In the operation of the biological machine known as the human body a large quantity of waste material is produced. In the elimination of this material millions of bacteria of various kinds pass from the body. McNeal, Latzer and Kerr report an average of 33,000,000 millions excreted from the normal adult in one day. These facts, which are matters of common knowledge with us, were generally unknown to the earlier generations of the human race. That any escape the dangers from the accumulation of this excretal material scattered by millions of flies and other insects is almost a marvel. To effectually destroy the pathogenic species of these microorganisms in order to prevent recontamination of food and water supplies of human habitations is one of the problems confronting the present-day sanitary engineer.

While many of the complex processes that enter into the decomposition and mineralization of sewage contents are yet imperfectly understood, the work of the chemist and bacteriologist are yielding definite results in this line, as is indicated by the recent construction of many sewage-disposal plants designed more nearly than ever before to meet the requirements of theories developed in the laboratory. By careful study of putrefactive processes, and accurate comparison of structural features with results in sewage-disposal plants now in operation, the necessary requirements to produce a satisfactory effluent under different conditions as to kind and quantity of sewage are well defined. Good results are now certain with properly constructed plants.

The functions of the various types of bacteria in the purification of sewage are now being carefully determined in the numerous experiment stations and laboratories for sanitary research throughout the country. The results obtained by experiments on Boston sewage by the sanitary research laboratory and sewage experiment station of the Massachusetts Institute of Technology have done much to bring exact knowledge of the necessary processes in sewage purification to the

attention of sanitarians. In carrying on their investigations they tapped the main sewer of the city of Boston, which carries sewage from 500,000 people, and installed pumps for lifting the sewage as needed by the experimental apparatus. The sewage was then treated in different kinds of tanks; sprinkling, trickling and contact filters, and the mineral, bacterial and other contents of both influent and effluent sewage carefully noted. The recorded results of these experiments, which were conducted by a corps of expert engineers, chemists and bacteriologists, have been recognized as authoritative, and their findings have been adopted in large measure by those who are intrusted with the design and construction of sewage-disposal works.

At Lawrence, Mass., experimental methods have been put in practice by the State Board of Health since 1886 when the Lawrence experiment station was established. Experiments have been conducted at this station in both sewage and water purification continuously since 1887. This station, through its long series of annual reports extending over a quarter of a century, has gained perhaps the highest reputation of any organization working in the experimental field of sanitary science. Other prominent stations for the study of conditions relating to sewage purification are located at Worcester, Mass., Pawtucket, R. I., Berlin, Ont., Columbus, Ohio, Waterbury, Conn., Reading, Pa., Baltimore, Md., Gloversville, N. Y., Philadelphia, Pa., and Chicago, Ill.

The purposes to be attained in sewage purification are twofold. First, is the decomposition and oxidation of the organic matters into stable forms that will not putrefy and create a nuisance. Second, is the elimination of pathogenic bacteria, so that streams into which the effluent is discharged may not become contaminated, and thus endanger the health of the people living below the outfall. Disposal plants are now being built that are reasonably effective as to the first object, but in bacterial efficiency much remains to be desired.

The average bacterial efficiency of a large number of American plants which are operating without the application of a germicide is 58 per cent, with a minimum of 21 per cent and a maximum of about 90 per cent. Some of the other plants, where the effluent is disinfected with copper sulphate, have a bacterial efficiency as high as 99.95 per cent.

With the establishment of the fact that bacteria are the cause of many of the diseases that afflict the human race came the main incentive to the progress that has recently been made in the development of sanitary engineering. Bacteria being the cause of disease, the elimination of these pathogenic organisms from the air, food and water that enter the human system was the logical method of preventing disease.

In following scientifically the course above suggested the sanitary engineer has done much to aid the medical profession in developing the methods that now prevail in modern sanitation, as is well witnessed by the remarkable results obtained in the Panama Canal Zone. The success of scientific methods applied to water purification is splendidly illustrated by the results obtained in the operation of many plants.

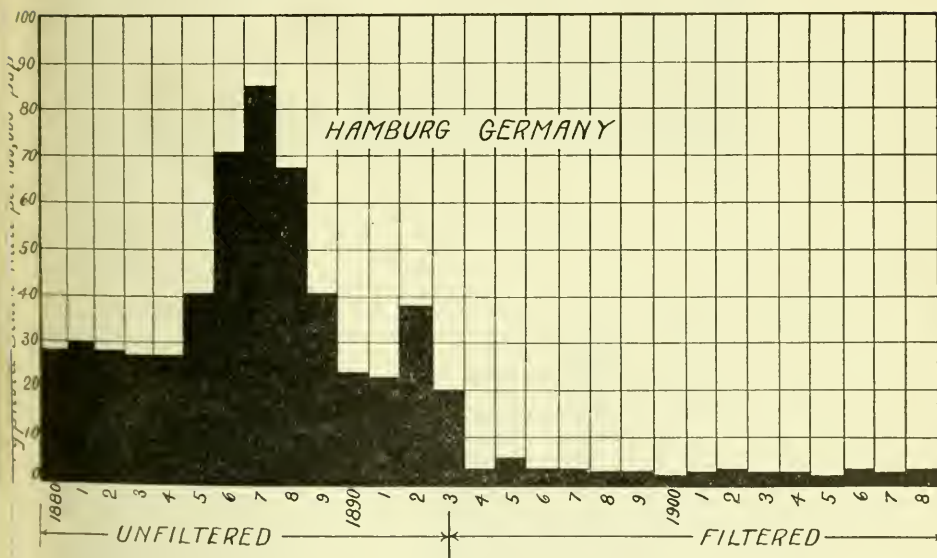
The lack of vital statistics in Kansas covering sufficient time to allow reliable deductions to be drawn therefrom prevents me giving at this time some local data that point very strongly to satisfactory results in the future. I am, however, presenting statistical charts of Hamburg, Albany and Cincinnati and a death-rate table of a number of other cities, giving the drop in the typhoid death rate resulting from the installation and operation of up-to-date filtration equipment at these places. We know from results of bacterial analyses made of the water being furnished many Kansas cities and towns at the present time that similar gratifying results may soon be reported from local plants.

The first filter applied to a large public water supply of which we have a record was installed by the Chelsea Water Company of London in 1829, and was a success in improving the wholesomeness of the water from the start. Owing to the good results obtained from this filter, the city of London in 1855 made compulsory the filtration of all water supplied the city from rivers.

Berlin, which draws its water supply from the river Spree, installed filters in 1856. These filters served the city in continuous use until 1893, when they were replaced by a new plant at Lake Muggel. About 1875 Berlin developed an additional supply of water from a well system, but this water contained enough iron to encourage the growth of crenothrax to such an extent that the supply was abandoned in 1883 and

another filter plant was constructed to purify water taken from Lake Tegil.

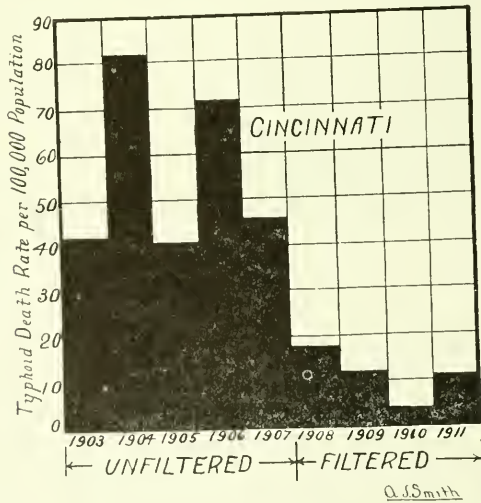
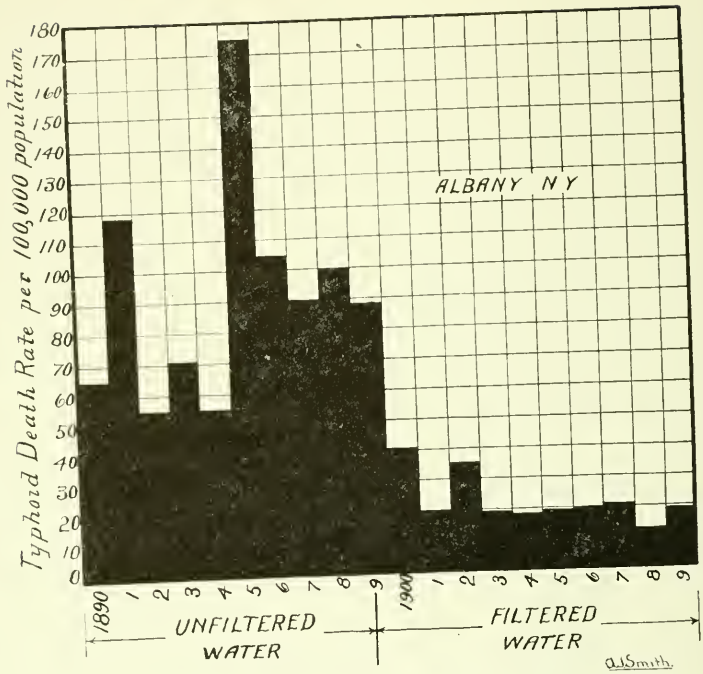
At Hamburg the waterworks were built with the intention of installing filters, but for some reason delay was occasioned, and work on their construction was not begun until 1891. It was originally intended to devote three years' time to the work of building the filters, but a cholera epidemic occurred in 1892 and swept away 8605 of the city's inhabitants. This served strongly to emphasize the need of a filter plant. The cause of this epidemic was traced directly to water pollution, and to prevent a recurrence of the scourge work was continued on the filter night and day until it was completed in 1893.



AJSmith

The wonderful success of the Hamburg filter plant is shown in the remarkable drop in the typhoid death rate in the city of 91.6 per cent. The Hamburg death-rate chart, which I have the pleasure of showing, with others, gives a graphic illustration of the actual results that have been achieved by the efficient operation of the modern filter equipment.

The largest filters built in America, at least prior to 1900, are those at Albany. These filters were constructed in 1898 and 1899 at a total cost of \$496,633, and have a rated capacity of 14,700,000 gallons daily. They are of the slow sand type



and have developed a bacterial efficiency of over 99 per cent. The supply of water, which is often muddy and always contaminated with sewage, is taken from the Hudson river about four miles below Troy. After treatment the water is clear, sparkling and wholesome. The effect of filtered water on the

typhoid death rate in Albany will be shown on the screen later, in the Albany death-rate chart. Since the filters were placed in operation in 1899 a reduction of 74.3 per cent in the typhoid death rate has occurred.

The Cincinnati filter plant was completed about the close of 1907, and is now furnishing the city of 400,000 people an abundance of wholesome filtered water. The operation of these filters has resulted in reducing the typhoid death rate in the city from 280 per 100,000 to 48, or approximately 93 per cent. The typhoid death rate both before and after the installation of the filters is shown graphically in the accompanying death-rate chart.

TABLE OF TYPHOID DEATH RATE PER 100,000.

	Plant installed.	Before.	After.	Per cent reduction.
Binghamton, N. Y.....	1902	47	15	68%
Columbus, Ohio	1908	78	11	86
Hoboken, N. J.....	1905	19	14	26
Paterson, N. J.....	1902	32	10	69
Watertown, N. Y.....	1904	100	38	62
York, Pa.	1899	76	21	72
Lawrence, Mass.	1893	114	25	78
Washington, D. C.....	1905	57	33	42
Passaic, N. J.....	1902	36	13	64

All streams in an inhabited country are more or less polluted. As the population within the watershed of a stream grows larger the probability of the dangerous contamination of the stream is proportionately increased. Therefore the necessity of purifying the water that is taken from the surface stream for domestic consumption is an increasing one. This necessity, however, is being met in a very creditable way by most of the cities of Kansas where surface water is consumed, though some are yet slow to recognize the importance of the matter.

Of thirty-nine municipal water plants in the state taking their supply from surface water twenty are equipped with filters, nine with sedimentation basins and coagulation apparatus, and ten have no provision for purifying the water. All of the filter plants except two are in good condition, and are yielding a satisfactorily pure water when properly operated. In most of the cases where coagulation and sedimentation only is the method of purification the treatment is inadequate.

More than half of the cities of Kansas secure their water supply from wells. This well water in a few cases is aerated and passed through a sedimentation basin before entering the

mains. Ground-water supplies are generally quite satisfactory where a sufficient quantity is available, though the deep-well waters of southeastern Kansas are not so acceptable as some, on account of the large amount of sulphureted hydrogen contained.

The total number of cities in the state having waterworks is 187. There are only seven cities having a population of over 1000 that are without waterworks. There is none having a population over 2000 without such plants.

TABLE OF CITIES HAVING WATERWORKS.

12	with a population over.....	10,000
16	“ “ of	5,000 to 10,000
20	“ “ “	3,000 to 5,000
23	“ “ “	2,000 to 3,000
55	“ “ “	1,000 to 2,000
61	“ “ “	under 1,000

TABLE OF CITIES IN KANSAS HAVING SEWER SYSTEMS.
Census of 1911.

12	cities of over 10,000....	total population, 320,211
16	“ 5,000 to 10,000....	“ “ 113,311
18	“ 3,000 to 5,000....	“ “ 63,908
16	“ 2,000 to 3,000....	“ “ 38,515
18	“ 1,000 to 2,000....	“ “ 25,467
1	city under 1,000....	“ “ 763

81

Total population, 562,175

TABLE GIVING CITIES IN KANSAS HAVING NO SEWER SYSTEM.

2	cities of 3,000 to 5,000....	total population, 6,491
7	“ 2,000 to 3,000....	“ “ 15,213
44	“ 1,000 to 2,000....	“ “ 61,631

53

Total population, 83,334

There are 50 sewage-treatment plants in the state, purifying the sewage from 40 cities. There are 22 septic tanks operating alone, and 3 Imhoff tanks and 25 septic tanks operating in connection with contract filters.

To-day 87 per cent of the Kansas people living in towns having a population over 1000 have the privilege of connecting with sanitary sewers.

In comparison with other states, Kansas ranks sixth in the number of towns sewerred and fourth in the number of sewage-treatment plants in operation. This and the number of waterworks installed go to show that Kansas is one of the leading states in modern sanitary practice.

The application of sanitary science in the state is very largely due to the efforts of the State Board of Health. In this Board we have united in congenial coöperation a corps of medical advisers, engineers, chemists, bacteriologists and inspectors, of whom the people of the state should be proud. The work of this Board has been aggressive, efficient and effective, as is shown by the results that have been attained in the cities and towns, and now the work is being pushed into the country districts with the same energy that was applied to the city problems.

I sincerely hope that the entire membership of the Academy of Science will enlist in earnest coöperation with the members of the State Board of Health in their work, and thus aid in bringing to Kansas an era of sound practical sanitation.

Although the progress that has been made in sanitary engineering in the past decade is worthy of compliment, only a furrow has been made in the field that lies before. What may be achieved in the future depends on the joint efforts of the scientist and the experienced workman. Let the people become awake to the truth and join in the effort to eradicate disease, and sanitary engineering will advance to an important place in the life of the twentieth century.

HISTORICAL SKETCH.

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

The first meeting was held in September of that year, in Lincoln College (now Washburn), and the Kansas Natural History Society was organized and officers elected. The object, as stated in the original draft of the constitution, "shall be to increase and diffuse a knowledge of the natural sciences, particularly in relation to the state of Kansas." At the fourth annual meeting, held in Leavenworth, in 1871, the name was changed to the Kansas Academy of Science. In 1873 the Academy became a 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 thirty-seven annual meetings, of which eighteen have been held in Topeka, five in Lawrence, four in Manhattan, two in Leavenworth, two in Emporia, and one each in Atchison, Baldwin, Iola, McPherson, Ottawa, and Wichita.

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

The Academy is now installed in the east 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 in the adjacent corridor a museum.

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

This sketch shows that Kansas was early to recognize the importance of science in building up a state, and the Academy has long since justified the expectations of its early founders. It has contributed as a body and through individual members to the discovery and development of our resources. The state coal mines at Leavenworth is an instance of one of the contributions of the late Professor Mudge, one of our Academy's founders. We do not often think of the wonderful mineral resources of Kansas, but our clays and shales, no less than coal, oil and gas, are assets that must be counted. Science must be coupled with toil and these natural resources will bring no less profit than corn, wheat, and alfalfa now furnish. It has come to be seen that farming is applied science, and there is no department of industry in the shop or on the farm where the teaching of the schools fails to bring good returns. The Academy is a bond of union between scientific workers whether in or out of the schools. Such institutions as our Academy are recognized as indispensable in all our progressive states. They fill a place in correlating and binding together our other educational agencies. The leading scientific publications of the world are on our list of exchanges and are constantly increasing the valuable resources of our state library.

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.

II.

CHEMICAL AND PHYSICAL PAPERS.

1. "THE VALUE OF CORN OIL AS A SUBSTITUTE FOR OLIVE OIL AND COTTONSEED OIL."
By B. E. POOL and L. E. SAYRE.
2. "IMPROVEMENT IN THE COMMERCIAL SUPPLY OF SPICES AND CAUSE OF THE SAME."
By L. E. SAYRE.
3. "THE DEVELOPMENT OF MECHANICAL POWER IN THE LAST DECADE."
By F. E. SIBLEY.

THE VALUE OF CORN OIL AS A SUBSTITUTE FOR OLIVE OIL AND COTTONSEED OIL.

By B. E. POOL and L. E. SAYRE.

CORN OIL may be considered as a by-product from cereal manufacturing, and is made principally by the Corn Products Refining Company of New York. It is comparatively cheap, being quoted at 50 cents per gallon for the refined grade. Olive oil and cottonseed oil are quoted at \$3 and 75 cents per gallon, respectively.

The cheapness of corn oil suggests the possibility of wise economy in substituting it in place of the more expensive oils wherever this can be done without injury to the product in which it may be employed. The investigation of this subject embraces the following:

First, a comparison of the chemical behavior of the corn oil with those of the other more expensive oils mentioned. Second, a comparison of the products resulting from the substitution of corn oil for the other oils, in cases where the other oils are prescribed, in such preparations, for example, as ointments, liniments, plasters, etc., where the nature of the oil does not have any physiological or therapeutical significance.

In the examination and comparison of corn oil with other oils the following data have been sought:

- I. Physical properties.
- II. Saponification number.
- III. Iodine absorption number.

Corn oil has a pale yellow to a golden yellow color, a slight characteristic odor, a pleasant taste, very similar to that of freshly ground corn meal. The solubility in various solvents, as absolute alcohol, acetone, and glacial acid, is as follows:

Solubility at 15° C. in 100 parts by volume.	
Absolute alcohol	3
Acetone	26
Glacial acetic acid	3

This compared to cottonseed oil and olive oil is as follows:

	Cottonseed oil.	Olive oil
Absolute alcohol	2	2
Acetone	27	24
Glacial acetic acid	4	3

The congealing point, composition and refractive index of the three oils may be seen from the subjoined table:

	Corn oil.	Cottonseed.	Olive.
Congealing point	-10 to 15° C.	-0 to -5° C.	-0 to -5° C.
Composition:			
Solid fatty acid*	27%	32%	15%
Liquid fatty acid†	73%	68%	85%
Refractive index by			
Strohmert at 15.5° C.	1.4768	1.4743	1.4698

In order to test and compare the corn oil with the other oils mentioned, a large number of medical preparations were made up, substituting this oil for the other oils prescribed by the United States Pharmacopœia and National Formulary. The various classes of preparations experimented with were as follows:

Liniments—Ointments—Cerates.
Plasters—Oleates.

In most every case where the corn oil was substituted for either olive or cottonseed oil as prescribed in the formula, a product was made which was equal in most if not every particular.

This being the case the question is pertinent, Would it not be a matter of economy to use corn oil in many preparations where a nondrying oil is used for other than medicinal preparations; for example, food preparations? Suggestions along this line of substitution are worthy of further study.

In conclusion, we would summarize our observations as follows:

In the assay of corn oil it was found to have properties very similar to the cottonseed and olive oil and, by comparison, it is found to be very similar in appearance. After testing it by direct substitution in the various medicinal preparations in which the other oils are used, and finding so very little change, it would seem not only to be a good recommendation to make that corn oil be recognized by the U. S. P. and N. F. for certain medicinal preparations, but it would also serve as a means of economy, bringing into use this cheap and valuable oil for which there is, at present, very little or comparatively no market.

* Solid fatty acid, in all cases, was composed of Palmetic and Stearic.

† Liquid fatty acid, in all cases, was found to be Linoleic and Oleic.

IMPROVEMENT IN THE COMMERCIAL SUPPLY OF SPICES AND CAUSE OF SAME.

By L. E. SAYRE.

IT is instructive to note that the commercial supply of spices has improved to a marked degree since the enactment of the food and drugs law. At one time the common spices, such as cloves, pepper, cinnamon, allspice and ginger, were so freely adulterated that the public became accustomed to the use of large quantities of spices for flavoring. Recently the chef not aware of recent improvements in quality has been somewhat surprised that such small quantities of these aromatics are required to produce the desired effect.

Recently, commercial samples of spices were collected from different grocery stores and examined in order to study the question of market supply—whether an improvement existed. First, two recognized spices were collected—cloves and allspice. Examination was made, under supervision, by Mr. John F. King, a senior student. The data obtained from these were:

1. Moisture.
2. Ash.
3. Volatile ether extract.
4. Nonvolatile ether extract.
5. Crude fiber.

This was considered sufficient for the purpose of this investigation.

It may be remarked that adulteration always implies added foreign substances. Cloves, for example, sometimes contain a large percentage of stocks upon which the clove buds are borne. These are imported in considerable quantities. They yield about 5 or 6 per cent of volatile oil, while the genuine cloves should contain from 15 to 20 per cent. Another product of the clove plant is the nearly ripe fruits, which are designated as mother cloves. They are dark brown, ovoid, one-seeded berries, crowned by the remains of the calyx teeth. They contain but little volatile oil. Both clove stocks and mother cloves have been used to adulterate ground cloves.

Clove stocks may be detected by the presence of numerous characteristics, nearly isodiametric, sclerenchymatous cells—

the latter by the large starch grains which the seeds contain. Blown cloves, also an adulterant, are those which have been collected after the petals have expanded. Both the petals and stamens have been broken off, leaving the thick portion of the clove crowned by somewhat prominent calyx teeth.

It is evident from the above that the microscopist has a ready means for detecting these spurious admixtures, and coupled with the chemical analysis furnishes data which is legally satisfactory.

In connection with the chemical examination, we note, from the results of a prominent food inspector, R. O. Brooks, the following maximum and minimum limits of constituents, found in eighty-six analyses of botanically pure cloves:

	Minimum. Per cent.	Maximum. Per cent.
Moisture	2.90	11.80
Volatile ether extract (oil).....	11.03	20.53
Nonvolatile ether extract.....	4.87	12.00
Quercitannic acid	11.28	24.18
"Protein" (N \times 6.25)	4.20	7.06
"Starch" (by diastase method).....	2.08	3.15
Crude fiber	6.18	9.75
Ash (mineral matter).....	5.03	13.05
Ash, insoluble in acid (sand).....	0.00	0.13

This author, speaking of clove stems as a common form of adulteration, says the federal standard provides for a reasonable and unavoidable presence of clove stems, viz., 5 per cent. The skilled spice microscopist can tell very closely whether this limit has been over-stepped, although it is doubtful if strictly chemical means would prove it, unless the adulterant is present in large amounts. The most noticeable difference, chemically, which would upset the chemical values of pure cloves, if a considerable admixture were attempted, is the decidedly greater portion of fiber found in the stems. The following he gives as the mean results of two analyses of clove stems:

	Per cent.
Moisture	8.74
Volatile ether extract.....	5.00
Nonvolatile ether extract.....	3.83
Quercitannic acid	18.79
"Protein" (N \times 6.25)	5.88
"Starch" (by diastase method).....	2.17
Crude fiber	18.71
Ash (mineral matter).....	7.99
Ash, insoluble in acid (sand).....	0.60

In order to adulterate a clove with clove stems, the clove must be very rich in oil, because of the low volatile ether ex-

tract which clove stems yield, which would preclude them as favorable adulterants.

Other adulterants which have been reported as having been occasionally found in ground cloves are allspice, exhausted ginger, cereal products, ground nut-shells, olive stones and charcoal. It is needless to say that microscopical analysis readily shows any such sophistication.

Analysis of a recently secured sample of pure cloves gave the following results:

Moisture	1.84%
Ash	5.80%
Volatile ether extract	12.49%
Nonvolatile ether extract	8.21%
Crude fiber	8.64%

Tabulated below will be found the results of analysis of four samples, which fairly exemplify the average condition of the present market. These samples were selected out of a number of others as representative for the investigation. It will be noticed that no estimation was made of the tannic acid, which is always present in the form of gallotanic, or quercitannic, acid in cloves. This constituent is usually present to the extent of about 13 per cent. The most essential constituent, of course, is the volatile oil contained in the ether extracts.

Sample.	Moisture.	Ash.	Total ether extract.	Volatile ether extract.	Nonvolatile ether extract.	Crude fiber.
No. 1	1.52	8.43	16.39	9.44	6.95	10.03
No. 2	2.43	7.91	18.06	11.10	6.96	9.38
No. 3	2.05	6.54	21.04	12.97	8.04	8.10
No. 4	2.69	6.58	19.72	11.41	8.31	8.97

Microscopical examination showed the powder to be the product of the clove fruit without foreign admixture of extraneous substances.

ALLSPICE.

This condiment is composed of the full-grown *but unripe* fruit of the "Jamaica Pepper" plant. The berries are gathered before they are fully ripe, as the aroma is partly lost if the fruit is permitted to mature completely. On drying the berries become almost black. Sometimes they have been made more attractive by coloring them with a brown ochre, a sophistication of which may readily be detected.

Allspice, like mother cloves, contains starch, which under the microscope appears as nearly circular granules with a central spot or hilum, and often arranged in groups as are

buckwheat starch granules. There are other starchlike or gummy substances in the fruit which by acid inversion yield a considerable amount of reducing material.

R. O. Brooks' analysis of twenty-five samples of pure allspice has yielded the following maximum and minimum percentages of proximate constituents:

	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
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 \times 6.25).....	4.03	6.37
Quercitannic acid	4.32	12.48

Our analysis of commercial allspice as collected promiscuously on the market is represented fairly well by the following selected analyses from a number of samples:

Sample.	Moisture.	Ash.	Total ether extract.	Volatile ether extract.	Nonvolatile ether extract.	Crude fiber.
No. 1	1.43%	3.17%	9.56%	...	5.09%	13.39%
No. 2	4.19	4.76	8.22	2.38%	5.84	17.45
No. 3	1.17	5.29	8.49	3.11	5.38	14.51
No. 4	3.12	5.53	9.21	3.35	5.86	14.10
No. 5	3.17	4.36	8.77	5.61	15.03

These results, both microscopically and chemically, show that since the enactment of the pure food and drugs law few samples of these spices on the market are adulterated. However, before the enactment of the law, the majority of spices were found to contain much foreign material.

It should be added, in this connection, that the same statements hold true with regard to black pepper. At the time of the enactment of the food and drugs law it was stated it was a question whether ten per cent of the spices that were on the market previous to the passage of the law were unadulterated, the adulteration sometimes running as high as 92 per cent of ground olive pits. The examination of the samples of the market of recent date show that the actual percentage of low-grade pepper amounts to less than ten per cent. This is a good showing for the administration of the food and drugs law.

THE DEVELOPMENT OF MECHANICAL POWER IN THE LAST DECADE.

F. H. SIBLEY, *Lawrence.*

EVEN as we are accustomed to think of history as divided into epochs, having more or less well-defined limits, so the future historian will undoubtedly define the present era probably as the age of the industrial revolution. One of the chief agencies, probably the principal agency, in this revolution is the production of mechanical power.

Few realize, as they go about their daily affairs, how indispensable is this commonplace thing to modern life. Subtract all of its results and see what we have left: rapid transit by stage coach, every convenience depending upon the application of electricity eliminated; home-spun clothes, little variety of food, little or no ice; little communication between distant individuals, few books and no newspapers. In short, subtract everything that is wholly or in part dependent upon power, and how much of the progress of the last thousand years would be apparent?

While we have gone far and fast in the production of power to meet the continually increasing demands of an industrial age, when we consider the lavish supply of materials for its production with which the earth is stored, and the fact that most of it is wasted through ignorance and inefficient methods, we must humbly admit that the art of producing mechanical power is still in its infancy.

In the most successful attempt that man has made to utilize the forces of nature for this purpose, the development of the water fall, he is able to realize only about 33 per cent of the actual power of the water in useful work performed. In plants which derive their power from stored heat energy the showing is much less favorable, the work of the street car in ton miles or the candlepower of the electric lamp being commonly less than two per cent of the equivalent heat energy stored in the coal.

Percentages make little impression on the mind unaccustomed to dealing with these matters. Let us put the statement in a little more startling way. In 1908, an average year,

the production of coal in the United States was approximately 400 million tons. Of this amount 8 million tons actually did some good; the rest was wasted, and wasted at an enormous expense outside of the mere intrinsic value of the fuel. If we figure the cost of mining and marketing coal at two dollars per ton, the loss represented by the handling of 392 million tons of wasted coal amounts to the tidy sum of 784 million dollars, or almost enough to run the United States government for a year. This is over and above the value of the coal.

The actual power value of the coal lost may be illustrated by another example. Take a pound of coal—a lump, say, as large as a man's fist. If all of the energy of the lump could be instantaneously liberated the force would be sufficient to lift its own weight about two thousand miles into the air. If the 490 million tons which are now nonproductive of useful work could all be made available, it would produce 585 million horsepower for a year, twenty-four hours a day. In other words, it would produce all the power used in the United States for twenty years at the present rate of consumption.

For natural gas and petroleum, the other two great sources of power, the showing would be somewhat better.

Consider now all the loss of life at the mines and in transportation, the cost and discomfort of polluting the atmosphere and spoiling structures with smoke, and we begin to get some conception of our enormous inefficiency in dealing with this matter. Our future historian, commenting on the useless waste of life and property in an era like the French Revolution, may have some uncomplimentary things to say about our industrial revolution.

After this discouraging statement of waste and inefficiency, we can appreciate more fully the fact that real progress in improving our methods has been made in the last quarter of a century, and in the last decade the progress has amounted to as much, perhaps, as in the whole previous period of development.

In the earlier designs of prime movers the efforts of inventors were directed mainly to making the wheels go around—no small task in itself—and the attendant waste of fuel was looked upon as more or less unavoidable, or not considered at all. The old wooden water mill wasted fifty times as much water as it used, but it sawed the logs, ground the corn, and

drove the loom. Watt's steam engine, working at an efficiency of probably less than a tenth of one per cent, made the steam plant possible and made the industrial community independent of the water-power site. Stephenson's link motion put the railroad, such as it was, on the map; Fulton built a marine engine that propelled a boat, in spite of the predictions of his friends, and the clumsy and noisy old free-piston engine of Otto and Langen demonstrated the possibility of the modern internal-combustion motor.

Ten years ago the situation in the power world was about as follows:

The perfecting of electrical apparatus had made possible the construction of water-power plants at some distance from the site of the industry to be served. The original American plant of the Niagara Falls Power Company, with its 5000 kw. generating units and 22,000-volt transmission line, was in operation, and represented advanced practice, although more recent designs were in process of construction.

In steam-engineering practice the compound engine had been carried to its logical limit in the huge triple- and quadruple-expansion engines of such ships as the Kaiser Wilhelm. These engines were built in units as great as 15,000 horsepower, and would develop a horsepower-hour on a pound and a half of coal or a little less.

The steam turbine, which began to assume commercial importance about 1900, had reached an efficiency about equal to the best steam engine when built in large sizes. There were two distinct types, called the impulse and the reaction, and one or the other of these types was rigidly adhered to in the construction of a single machine. They were not regarded with great favor for marine propulsion, because they are not reversible. The largest units for land service were 5000 horsepower, and these were looked upon as wonders.

The internal-combustion motor, which began its commercial career about 1890, had reached its greatest perfection in the automobile motor of the period and in the small marine motor. Gas engines for power purposes were built in sizes as large as 50 horsepower, but this was regarded as about the limit. The gas producer was just coming into existence, and gas-engine designers were beginning to think about the problem of larger and more efficient units.

Ten, perhaps fifteen, years ago began what may be called the up-to-date period of power development. As might be expected, efforts in this period have been directed mainly to producing better efficiencies from machinery already developed, yet this period has produced two entirely new power motors and the experimental investigation of a third.

In water-power development, after the successful completion of the American plant at Niagara, many other projects were undertaken. These are of three general classes: medium head plants like the one just mentioned; high head plants like those in California, where the fall is several hundred feet; and low head plants like that at Keokuk, where the head is only about thirty feet. At Niagara the turbine wheels are 5 feet 4 inches in diameter and at Keokuk they are 16 feet 2 inches, while for the high heads that are developed on the Pacific coast an entirely different type, known as the impulse wheel, is used. Progress has been along two main lines: the perfection of wheels to give best efficiency for these different sets of conditions, and increase in transmission voltages. We have advanced along these two lines to the point where any sort of a water power may be successfully developed, from an immense volume with little fall to a small volume with a high fall. Voltages have increased from 22,000 to 150,000, and power may be successfully carried 150 miles or more, so that the industry and the town is in a sense independent of the location of the power site.

In steam engineering there has been a return from the complicated triple- and quadruple-expansion engine to the older two-stage compound type. This has been made possible by superheating the steam, that is, raising it to a temperature above that due to its pressure. Development and change in the use of steam turbines has been so rapid in the last decade that it is almost impossible to say what the best practice is at the present time. We are able to distinguish two directions in which changes are being made, but whether they indicate permanent progress the future only can reveal. One of these is increase in size. Where ten years ago 5000 horsepower was regarded as a monster unit it is now regarded as a small one, 30,000 horsepower being the large one. The other direction in which change is being made is in mixing the types, impulse and reaction in a single machine. This enables the designer to take better advantage of the high and low pressures of the

steam as it flows from a state of high to a lower temperature. The turbine is also combined with the reciprocating engine, each forming a stage in a compound unit. In this way the turbine is enabled to get as much power out of a pound of steam after it has expanded to a pressure at which it would be thrown away in a noncondensing plant as the noncondensing steam engine would get out of that pound of steam above that pressure, thus adding a large percentage to the efficiency of the plant.

With every new invention in power machinery comes the statement that the steam engine is doomed and about to be relegated to the museum as a curiosity. This happened when the steam turbine came into use, and it is happening again with the advent of the Diesel motor; but that the steam engine has managed to hold its own is evidenced by the fact that of the total horsepower produced in the United States, after fifteen years of the steam turbine and gas engine, 75 per cent or more is by the reciprocating steam engine. Not only has it held its own as a mechanical device, but its thermal efficiency has been increased to keep pace with improvements in other lines. Speaking roughly, we may say that the efficiency of the steam engine has been practically doubled, both for small and large units, in the last decade. The agencies that have brought this about are the invention of the German uniflow engine, which has an ordinary efficiency about equal to the best multiple-expansion engine working under the most favorable conditions; the locomobile, a combined engine and boiler which will give an efficiency for small plants about as good as the best multiple-expansion engine under the most favorable conditions; the elimination of smoke and consequent saving of fuel; the superheating of steam, which saves the losses from condensation and reëvaporation.

The development in the production of gas power has been mainly in the direction of reliability. In this period gas engines have been perfected to the point where they will *start*, and *run* after they get started. With the perfection in details has come an increase in the size of the units, so that whereas fifteen years ago a gas engine of over 40 horsepower was the exception, we now find them running successfully in units of several hundred horsepower.

The gas-producer plant has shown less development, perhaps,

than any other type of power plant during this period. Perhaps the time for its development has not yet arrived. It may be waiting for the notion of the great central power plant to get more firmly fixed. Distributed over the country are enormous deposits of lignite coal. This coal is worthless as an ordinary fuel, but it may be burned in properly constructed producers and give a fuel efficiency nearly as great as that of good steam coals. Probably this type of plant will not be greatly used until the railroads and scattered industrial plants give up their own little wasteful units and learn to take their power from great central plants located at the mines and distributed through high-voltage transmission lines, as is now coming to be the practice in water-power installations. In connection with gas engines this decade has seen the invention of a new type of unit that, so far, excels in efficiency anything previously devised. This is the constant-pressure engine, known as the Diesel motor. The thermal efficiency of this engine is over 30 per cent under actual working conditions. What this means may be gathered from the fact that it has reduced fuel consumption from one and a half to less than a half pound per horsepower-hour. As a marine engine it has multiplied the steaming radius of vessels by three, and the fact that its fuel is liquid makes it possible to store and handle it with much greater economy than is possible with coal. Engines of this type have been in operation in Germany on the tarry by-products of petroleum and asphaltum, heretofore wasted; so that power has actually been produced, not only at no cost, but its production has disposed of an otherwise inconvenient waste material. Why should not the gas producer, using lignite fuel, produce gas for the common gas engine, and at the same time supply fuel for the Diesel motor in the form of the troublesome tarry products that now form one of the disadvantages of the producer plant. We should then have our great central station operating at an efficiency now unthought of, and using a fuel which is at present almost useless. This development remains, perhaps, for the next decade.

III.

GEOLOGICAL PAPERS.

1. "THE GEOLOGICAL DEVELOPMENT OF KANSAS."
By LYMAN C. WOOSTER.
2. "THE GLACIAL EPOCH."
By ALBERT B. REAGAN.
3. "LOWERING OF THE GROUND-WATER TABLE."
By W. A. COOK.

GEOLOGICAL DEVELOPMENT OF KANSAS.

By LYMAN C. WOOSTER.

THE RAIN OF PLANETESIMALS.

THE nebular hypothesis of Kant and Swedenborg has failed to meet the tests applied by modern men of science, and soon will be remembered as being merely one of the dreams of philosophy. Finding that the nebular hypothesis is unsupported by scientific data in many vital parts, the writers of the later scientific texts have substituted the planetesimal hypothesis of Chamberlin, believing that it gives a truer explanation of the development of the earth. According to this hypothesis the earth began as one of several nuclei in an arm of a spiral nebula, a form of nebula very common in the heavens at the present time, and has slowly reached her present size through the accretion of myriads of small planetesimals which were drawn in from the neighboring regions of the nebula.

As the planetesimals accumulated the pressure within the young planet eventually became so great that many absorbed gases were forced from their enclosing cavities and driven to the surface. When the earth had reached nearly her present size the escaping nitrogen and oxygen were recaptured by gravity and remained as an atmosphere; heated hydrogen and oxygen united to form water vapor somewhere in the earth's crust, and on escaping into the atmosphere it cooled and condensed into rain, which returned to the earth and filled up all the depressions on her surface and became the seas and oceans; some of the oxygen picked up carbon and became carbon-dioxide gas, which escaped into the atmosphere through fissures or volcanoes or bubbled up through the water and became one of the greatest agents in the reconstruction of the earth's surface and one of the substances of the highest importance to the future plants and animals; hydrogen and carbon also united somewhere in the interior of the earth, and possibly became the petroleum and natural gas so highly prized in the arts.

FOOTNOTE.—The limits of this paper forbid giving more than the story of the geological development of Kansas. The data in full and the scientific arrangement of these data will be found in the various reports and manuals that give the geology of the states occupying the Great Plains.

Most of the heated gases on escaping from the earth's interior made various chemical unions on reaching the cooler crust and served various uses in nature's laboratory. It has recently been learned that the water of tropical Atlantic ocean is twice as rich in oxygen at a depth of 4000 feet as at 400 feet.* This may be partly explained by regarding the crust of the earth beneath the ocean as a storehouse of oxygen.

The earth's nucleus and the planetesimals in the spiral nebula were probably cold, according to Chamberlin, but the force pulling the tiny solids towards the center of the mass became in time so great that the nucleus with the inner planetesimals became very hot under the compressing force. The surface of the earth, however, remained cold and solid, except where the molten interior poured forth through fissures and buried the crust beneath great sheets of molten lava. In the earlier history of the earth this happened so frequently and at so many places that little, if any, of the primitive crust remains at the surface.

AND HIGH LAND APPEARED.

So far as the geologist now knows, the first permanent high land to appear above the general level of the earth's crust in what is now North America arose as great mountain ranges, which (1) stretched along our Atlantic border; (2) bounded Hudson Bay on the east, south and west; (3) followed the general course of what are now the Rocky Mountains; and (4) reared aloft granite summits a little east of where are now the Sierras.

The winds and rains of a moisture-laden atmosphere and the waves of mighty seas and oceans beat upon these great mountains for fifteen or twenty million years, wearing them down and sorting and scattering debris in the seas and oceans till low-lying mountains, bordered by shallow-water sand flats and mud flats, were all that remained of the mighty ranges of granite and lava. Before these mountains were formed, life may have established itself in the seas and oceans. No one knows whence it came, but the geologist finds evidence that the waters teemed with life in the Archeozoic era; first plants, and then animals of simple organization.

While the mountains were being denuded in the Proterozoic era, worms and primitive crustaceans had their habitats on

* Science, October 17, 1913, p. 546.

the sandy bottoms or on the mud flats beyond, for the fossil remains of a few of them have been found in the indurated rocks formed of this sand and mud. Besides this direct evidence, indirect evidence of life having flourished in these seas and in fresh-water swamps on the flanks of the mountains is abundant. Beds of graphite are not uncommon, which possibly may represent the metamorphosed peat of the swamps. Beds of limestone occur, and these are usually considered as being proof of the previous existence of marine life, with skeletons of carbonate of lime. Then, too, beds of iron ore of great thickness are found interstratified with the debris of these ancient mountains. Iron ore is deposited from solution through the chemical action of organic compounds set free in the decay of the tissues of plants and animals. Probably bacteria helped in the deposition of the ore, either by causing organisms to decay or by robbing compounds of iron of all the other elements except oxygen. Copper and silver were precipitated in the same sand and mud flats and concentrated later, especially where Lake Superior now lies, possibly by the same organic reagents or by bacteria.

DRY LAND INCREASED IN AREA.

The development of the earth's topographic features has always been hastened and emphasized by periods of mountain-making. Each great range of mountains was thrown up after millions of years of comparative stability of the earth's crust. It was once believed that the great ranges of mountains came up in a few weeks, or, at most, in a few years, but it is now known that they require thousands, probably millions, of years to reach maturity.

The most ancient mountains known to the geologist, the ones already described, were forced above the general level at the close of the Archeozoic era. Then followed the fifteen or twenty million years of erosion and deposition. The interior of the earth continued to shrink very slowly because of loss of heat, while the sand, clay and calcareous mud and the various ores and organic compounds were being deposited in the seas bordering the ancient mountains, or in swamps on their flanks, till finally the accumulated stresses in the crust of the earth compelled it to wrinkle, and thus enabled it to rest on the smaller interior. The wrinkles followed lines of weakness, and these have been shown over and over again to be along ancient

mountain ranges worn nearly to the level of the sea, and especially in the belt of debris on one or the other flank, or sometimes on both flanks.

In this second yielding of the crust of the earth, this time at the close of the Proterozoic era, the ranges of the Archeozoic era were rejuvenated, the sand and mud flats on their flanks were folded, the folds were crushed together, and the sediments were metamorphosed; that is, semifused and compacted or crystallized. By this metamorphism the sand and sandstone were converted into quartzite, like that in the drift hills south of Topeka, shoved down from Minnesota and South Dakota by the Kansan glacier; and the more or less pure clay was compacted into slate and various schists. The limestone became marble, and the coal graphite.

Among the mountains of the United States that date from the close of the Archeozoic or Proterozoic eras are the Blue Ridge of Virginia, the Adirondacks of New York, the low mountains about the synclinal trough now occupied by Lake Superior, the Ozarks of Missouri, the Arbuckle and Wichita mountains of Oklahoma and some near-by mountains of Texas, various granite ranges along the belt now occupied by the Rocky Mountains, and some scattered ranges east of where now lie the Sierras.

WHERE WAS KANSAS?

During all these millenniums, and many more, Kansas lay peacefully sleeping beneath the waters of old ocean, at least what there was of her, little disturbed by the mountain-making east, south and west. Sediments were undoubtedly deposited within her borders, but of these we know nothing by observation. Of this much we are pragmatically certain, however: during the twelve million years of the Cambrian and Ordovician periods of the Paleozoic era, the winds, rains and ocean waves tore down the mountains, squeezed up at the close of the Proterozoic era and continued the work of filling up the oceans, making in them the foundations of continents and islands that appeared above the sea later, on which land life was to flourish. Of this debris Kansas undoubtedly received her share.

Before the dry land appeared, the sands were cemented into sandstone, the clays became shale, and in the deeper, clearer waters great beds of limestone were formed of the skeletons of coral polyps, crinoids, brachiopods, clams, snails, chambered

shell animals, and of the lime carbonate and silica of sea weeds and sponges.

THE THIRD PERIOD OF MOUNTAIN-MAKING.

At the close of the Ordovician period the earth's crust was again forced to wrinkle as it adapted itself to a shrinking interior, and old mountains were rejuvenated and new mountains appeared along their borders or along new lines of weakness. Among the new mountains and ridges formed at this time were the Green and Taconic mountains, and a great anticlinal ridge of especial importance to Kansas. It stretched south and southwest from what are now Put-in-bay islands of Lake Erie, along the western border of Ohio, and through Kentucky, Tennessee, Arkansas and Oklahoma. In Oklahoma the Arbuckle and Wichita mountains were rejuvenated by this geanticline, and in Missouri this great earth fold reëlevated the Ozarks and thus gave a mighty impetus to the development of Kansas.

Unknown billions of tons of clay, sand and gravel from the Ozarks and the Oklahoma mountains were poured into the Kansas basin, and myriads of ocean plants and animals added their skeletons to this debris from the mountains. At about the close of the six million years of the Silurian and Devonian periods the accumulation of sediment and the continued forcing up of the neighboring mountain regions probably brought the southeastern portion of Kansas above the level of the ocean, the first dry land in the history of the state.

The crust of the earth is never stable, especially in regions of mountain-making, and Kansas had to oscillate up and down many times before she reached her present condition of comparative stability. After being dry land for some thousands of years, southeastern Kansas sank beneath the level of the sea and received a stratum of limestone mud six or seven hundred feet thick in which were included great quantities of flint derived from plants and animals, which secrete silica (the chief mineral of flint) from sea water for their skeletons. Another oscillation and southeastern Kansas became dry land again, and the thick coating of limestone mud became hardened into rock now known as the Mississippian limestone. This time southeastern Kansas remained dry land so long that the rains wore away more than one-third of this formation. Part of the rain water followed the joints of the limestone deep into

its interior and dissolved out the rock, making great caves like those of Missouri, Kentucky and Indiana. Then Kansas sank beneath the waters of the ocean once more and the water of the crust of the earth, charged with various minerals which it had dissolved from distant portions of the limestone, surged into the caves and proceeded to fill them with flint, zinc sulfide, lead sulfide and calcite.

WHENCE CAME THE MATERIALS OF THE SHALES AND SAND-
STONES OF KANSAS?

There seems to be little question that the clay and sand of the shales and sandstones of eastern Kansas came from the granites and lavas of the Ozarks of Missouri and the Arbuckle and Wichita mountains of Oklahoma. Sand, clay, carbonate of lime (calcite), and flint (silica) have little physical resemblance to granite, gneiss and lava, but chemically they are near relatives. The granites and gneisses consist chiefly of orthoclase feldspar and quartz. This feldspar is a double silicate of alumina and potash. Carbonic acid of rain water takes away the potash of the feldspar and leaves the simple silicate of alumina, which is the chief ingredient of common clay. The carbonic acid unites with the potash, making carbonate of potash. This remains in the water and eventually serves a very important function in food-making in green plants. The clay residue from the feldspar is washed away and floats out to sea, where it settles in deep water, leaving the quartz of the granite and gneiss to follow more slowly to the seashore, where the waves soon grind it into beach sand.

The feldspar of lava is quite different from that of granite and gneiss. It is usually a triple silicate of alumina, soda and lime. Carbonic acid of rain water unites with the soda and the lime, making carbonate of soda (washing soda) and carbonate of lime (the material of limestone), leaving the silicate of alumina, the chief ingredient of clay, as before. Carbonate of soda is very common in volcanic regions. Should it encounter nitric acid in rain water it becomes sodium nitrate, a very important plant fertilizer; if it meets hydrochloric acid it becomes sodium chlorid or common salt, so abundant in the ocean and in salt lakes. The carbonate of lime has also a very important history, and is very acceptable to some plants and many animals for use in their supporting hard parts.

Carbonate of lime can not stay in solution in water unless there is an excess of carbonic acid present. Green plants use great quantities of this acid in elaborating their foods, such as the sugars, starch and the proteins, and hence water plants produce a scarcity of carbonic acid in the water, and consequently the lime carbonate is precipitated and they are buried in it, making much limestone. But where there are many water animals near by they relieve the plants of the carbonate of lime and use it for their skeletons, later to become limestone. In this way are produced shell beds, crinoidal limestone, fine chalk like that of England, France and western Kansas, and coarse chalk like that quarried at Cottonwood Falls, coral rock, and common limestone made of calcareous mud derived from any or all the preceding.

Some of the quartz of granitic rocks is dissolved in water containing alkali, from which it is removed in several interesting ways. Certain rhizopods, sponges and the diatoms use it in making their skeletons. Hot alkaline water will drop silica on cooling, as in the overflow of geysers. A very interesting form of deposition occurs wherever the alkaline water of lakes, ponds and rivers holding silica in solution encounters organic acids derived from the decaying bodies of plants and animals. In this way great quantities of wood in Kansas and elsewhere have become petrified (silicified), and cavities have been filled with flint, as in the Mississippian limestone (together with zinc and lead sulfids), and in the Wreford (Flint Hills) limestone and in other limestones of the state.

Before all the strata of the Mississippian period were laid down in Missouri, Kansas and Oklahoma, the earth forces proceeded to squeeze up the Ozarks and the Wichita, Arbuckle and neighboring mountains of Oklahoma to an altitude commensurate with the earth's needs and thus made dry land again in eastern Kansas and Oklahoma. How many thousand years eastern Kansas continued dry we do not know, but we do know that certain readjustments which always attend mountain-making resulted in the downfall of the crust between the Ozarks and the Arbuckle and Wichita mountains. Indeed, in eastern Oklahoma, beneath where the Arkansas river now flows, the crust sank more than a mile, involving eastern Kansas in the downthrow. This breakdown did not occur suddenly or continuously, but was accomplished during

some thousands of years. The downward movement was slow enough for the mountains to yield enough clay and sand, mostly clay, to fill the basin nearly as fast as the bottom sank. This deposit became the Cherokee shales and sandstone. Long before the Cherokee shales were all laid down, swampy places existed here and there in eastern Kansas and in eastern Oklahoma, which continued to grow swamp vegetation long enough to make all the peat for all the coal now mined at McAlester, Weir City and Lansing. Nor is this all, for in the sandy places, in the shale, enormous quantities of petroleum and natural gas accumulated, which either originated in the decaying bodies of plants and animals under the sand beds, or poured up through fissures in the bottom of the trough from deep in the interior of the earth, no one is certain which. This great synclinal trough must be still sinking, at least the stress on the strata of shale which filled the syncline is not fully relieved, for bottom shale in the McAlister coal mine buckles up here and there to the great alarm of the miners.

For four million years after the deposition of the Cherokee shales the eastern third of Kansas changed its physical geography scores of times, with the shore line much of the time in Missouri and Oklahoma. Scores of times the ocean would be free from clay, and layers of limestone would be laid down, made from the skeletons of plants and animals; then the seas would be deep and muddy and shales would accumulate, or the shore line would advance westward and sand for sandstone would spread over the southern and eastern portions of the state. At times sweet water swamps would exist long enough for peat to form, later to be buried, and finally to become beds of coal such as the Osage bed in Osage county and many others in eastern Kansas. These alternations were repeated so many times that a list of the more important strata would comprise more than fifty names, but every millennium saw some substantial gain, for the shore line was pushed westward nearly one-third across the state when the fourth great time of mountain-making came which drove the ocean permanently from the eastern half of the continent.

WHEN THE APPALACHIAN MOUNTAINS WERE MADE.

The fourth great period of mountain-making, the Appalachian revolution, completed the Appalachian system of mountains, elevated somewhat and permanently established the

Ozarks, Arbuckle and Wichita mountains, and probably elevated some of the ranges of the Rocky Mountains above the level of the sea.

About this time middle Kansas experienced the greatest drouth of its history. The water of several great interior seas evaporated, the basins were filled with salt water, the water again evaporated, the basins were filled again with salt water, the water once more evaporated—this process being repeated till hundreds of feet in thickness of rock salt accumulated, and many feet of gypsum, in deposits which extend from Kingman to Kanopolis. Next, all that remained of the Kansas-Oklahoma basin was filled with sand and some gypsum, probably from the Wichita mountains and some mountains in Colorado and New Mexico, and the work of the Paleozoic era in Kansas was completed.

THE AGE OF REPTILES.

For more than four million years Kansas was as level as Iowa is to-day, and as free from ocean water. Reptiles fought in her swamps and rivers and cycads dominated in her forests. The life of the coal period had largely vanished. Ferns continued in the swampy places, but the great lepidodendrons, sigillaria and calamites, whose fossilized trunks we find in eastern Kansas, are represented by very different descendants. The amphibians of the coal swamps of the preceding period had likewise changed to adapt themselves to new conditions. The ocean life, also, kept pace with the land life in a general advance to higher structures.

This Jura-Trias period of three and one-half million years closed in America with the fifth period of mountain-making, this time on the Pacific side. The Sierras, Cascades and several ranges of the Rocky Mountain region were squeezed above sea level.

For many thousand years after the close of this period of mountain-making the entire plains belt from North Dakota to Texas was covered with a sea of shifting sand that must have drifted from the old Rocky Mountains. This sand became cemented into a sandstone known as the Dakota.

The Cretaceous system of rocks in Kansas, of which the Dakota sandstone is the first member, consists of the usual alternation of shale, sandstone and limestone, all salt-water formations except the Dakota. The shales associated with the

Dakota contain much salt and gypsum and a bed of lignite. Part of the limestone of the Cretaceous is composed of the shells of rhizopods and is a chalk of the same age as the chalk of England and France. The life of this period is quite modern. Flowering plants, nectar-loving insects, bony fish, reptilian birds and reptilian mammals had been developed from the lower forms of life which preceded them. Among the fossil leaves found in the Cretaceous of Kansas are those of the tulip tree, willow, maple, sassafras, walnut, sequoia and fig. The fruits of the last two have been found well preserved. Reptiles, however, continued to be the dominant type of life.

At the close of the Cretaceous many of the western mountains were rejuvenated and the western half of the continent emerged from the ocean with nearly the present outline, but with much less elevation. Great interior seas occupied the basins throughout the western interior and received the abundant sediments from the mountains.

THE AGE OF MAMMALS.

The Tertiary period followed the Cretaceous and is noted for the reign of mammals and the rise of the Rocky Mountains. At first the drainage of Kansas was westward into the interior seas, but later in this period with the rise of the Rocky Mountains the slope was reversed and the drainage as we know it to-day became established. The mountains slowly increased their elevation for more than a million years, and the crushed and metamorphosed strata yielded readily to the combined action of the wind, rain and carbonic acid. The high gradient produced by the rise of the Rocky Mountain plateau to an elevation finally exceeding three miles enabled the torrents of rain water which fell at that time to spread coarse and fine debris over the entire plains region as far eastward as central Kansas and Nebraska. The sediments with which western Kansas was flooded at that time consisted of gravel four and five inches in diameter, grading down to fine sand. The pebbles represented the common rock species of the Rocky Mountains. In the list are pebbles of granite, syenite, porphyry, rhyolite and basalt, not yet disintegrated, and polished pebbles of quartz. Great lakes occupied the plains of western Kansas and received this debris. As their basins filled, the sediments became on the whole finer and constitute the surface soils in that part of the state.

The gravel layers have furnished an excellent channel for a subsurface flow from the mountains of surplus waters, and are the source of the invaluable sheet water of the western part of Kansas and neighboring states. The Staked Plains are underlaid by the same stratum of Tertiary gravel, and thousands of acres are now irrigated with water from wells that penetrate this source of water supply.

Among the strange mammals which roamed the plains of Kansas were camels, mastodons, three-toed horses, rhinoceroses, saber-tooth tigers and wolves, but man had not yet appeared.

THE AGE OF ICE AND OF MAN.

By the close of the Tertiary and the opening of the Quaternary periods the great interior seas were much smaller, and many of them were completely filled with sediment. The forms of life became more nearly what we find in Kansas to-day. Early in the new period the climate became so cold that finally the snow stayed on the ground summer as well as winter, and the great Kansan glacier pushed into the state from the north as far as the Kaw and Big Blue rivers and a little farther. This glacier, as do all others in a plains region, pushed the hills into the valleys, dug deeper into the soft shales than into the hard limestones, and shoved great quantities of northland boulders and gravel into southern latitudes. The limestone in Nemaha county shows the planing work of glaciers, and the hills south of Topeka are full of quartzite and granite boulders from Minnesota and South Dakota.

While the glaciers were still plowing the northern states man made his appearance, whether in Europe first, in Asia, Africa, or America, no one knows; but of this we are sure, he dominated the world when he made his entrance in it. He soon became intensely interested in flocks and herds, in crops and soils, and in forests and rainfall. Wherever these are directly influenced by the geological development of Kansas, we shall find material for profitable study. Therefore with soils and water supply this paper must close.

THE SOILS, SUBSOILS AND CROPS.

As explained in the preceding pages, Kansas owes the clays, sands and calcite of her shales, sandstones and limestones, respectively, first, to the disintegrating granites and lavas of the Ozarks and Oklahoma mountains; second, to the floods that

shifted enormous amounts of debris from the crushed strata of the earth's crust pushed up in the Rocky Mountains; third, to the disintegration of the miscellaneous assortment of bowlders, gravel and finer drift pushed into Kansas from the states north, by the Kansan glacier; and lastly, to the myriads of plants and animals that have used the calcium carbonate and silica in solution for their skeletons, and then in the course of nature laid down their skeletons in beds of limestone.

Then, in turn, the shales, sandstones and limestones disintegrated where exposed to air and rain, and the various subsoils were formed. The relationship is so close between the subsoil and the underlying shale, sandstone or limestone, except where running water or the wind has shifted the subsoil, that a map showing the shales, sandstones and limestones of the state serves equally well for a map of clay subsoils, sandy subsoils or calcareous subsoils. The overlying soils differ from the subsoils chiefly in the possession of humus, without which no crop, except some of the legumes, will mature. The fourth visible essential of soils and subsoils is water, and the relationship between water and all growing vegetation is so intimate that tillage is chiefly concerned in conserving the water supply. The fifth essential of a productive soil and subsoil is porosity, that air may circulate freely about the roots of plants. The best soils and subsoils, then, must be composed of clay and sand to give consistency and penetrability, and of humus to conserve air and water and to serve as food for bacteria.

KANSAS SOILS.

The proper admixture of clay, sand and humus determines the physical qualities of a fertile soil; but these ingredients may be present in best proportions and the soil remain unproductive. Certain chemicals must be present and be in solution in water or not a plant will grow. The following compounds serve two great purposes in the plant economy: 1. Water, carbon dioxide, and the nitrates, sulphates and phosphates furnish the chemical elements used in food elaboration. 2. Compounds containing potash, iron, lime and magnesia together with common salt and silica are necessary in the chemical physiological processes, but are not found in plant foods.

These minerals so essential to the continued existence of plants and animals on the earth come directly or indirectly from subjacent or neighboring rocks. As has been stated,

clay is derived from shales, slates, granites and lavas; quartz sand comes from disintegrated sandstones and granites and from pulverized quartzites; potash is taken from the feldspar of granite, and soda and lime from the feldspar of lava.

Potash, soda and lime were taken away by carbonic acid and exist in the waters as carbonates or bicarbonates; but the carbonic acid will vacate in favor of almost any other acid. Carbonate of potash becomes nitrate of potash in the presence of nitric acid generated by bacteria or by flashes of lightning in thunderstorms. The carbonate of soda, so abundant in lakes in the craters of volcanoes, may be changed to a nitrate on encountering nitric acid, or to chloride (common salt) in the presence of hydrochloric acid. In a similar way potash carbonate may become a chloride.

The bicarbonate of lime in rivers, lakes and ocean is used in skeleton-making by myriads of animals, which, however, reject half of the carbonic acid. Great quantities of the bicarbonate of lime are precipitated as a carbonate by sea weeds which rob it of half of its carbonic acid.

The sulphates are among our most abundant minerals. The plants and animals of Kansas will never suffer from lack of sulphur so long as gypsum (lime sulphate plus water) is such a common mineral, and epsom salts (magnesium sulphate) is so generally present in spring water.

Phosphatic minerals are fortunately widely distributed in the crust of the earth, especially the mineral apatite (in tricalcium phosphate). Chemists say that nine one-hundredths of one per cent of the crust of the earth is phosphorus. From the first, life has found phosphorus indispensable as an ingredient of its protoplasm, and no soil will produce crops without it. All sedimentary rocks in Kansas contain small amounts of this element and on disintegration yield it to the soils and subsoils. The amounts are very small and must be expressed in hundredths of one per cent. Sandstone has about seven, shale about seventeen, and limestone, not weathered, forty-two. As an argument in favor of deep plowing it must be remembered that the subsoils are richer in phosphorus than the soils because of leaching.

Potash is necessary, in some way not well understood, to plants in their work of food-making, and where lost to soils by leaching must be supplied in a fertilizer. The other minerals listed above are necessary to the work of plants but are

supplied by our rocks in such quantities that plants are not likely to suffer from a lack of them. To this statement there is one important exception: Water is necessary and the supply is scanty, in all the state sometimes and in part of the state all the time.

THE CONSERVATION OF WATER.

In spite of its scarcity at times and in places it is evident that water has played the leading part in the geological development of Kansas, and in the industrial development as well. It is fitting, therefore, that the paper should conclude with a brief discussion of water supply and how it may be best conserved. The estimates given below are adapted to Kansas from some statistics quoted by President C. R. Van Hise in his book, "The Conservation of Natural Resources of the United States."

The annual rainfall of Kansas totals on the average thirty-seven and one-half cubic miles. Of this amount about one-half, eighteen and three-fourths cubic miles, flies off very soon after a rain into the air (by evaporation). Six and one-fourth cubic miles are consumed by plants, or sink very deeply into the earth, so far that they do not get back again except through volcanoes. At any rate, they are lost to the statistician. One-third, or twelve and one-half cubic miles, runs off directly or sinks into the ground and feeds springs and rivers by seepage. Possibly one or two cubic miles of this ten run off at the surface and make Kansas floods, and the balance flows slowly through the ground to the rivers and keeps them going between rains. Many in times past have believed that wells are fed from near-by rivers, but careful experiments have shown that water in wells near streams stands higher than it does in the stream and that the ground-water flows towards the watercourse. This is true at all times except when heavy rains towards the source of the river cause temporary flood, when the reverse is true.

Below this shifting surface water, to a depth of seven miles, are forty times as much more, or twelve hundred cubic miles of water under Kansas, which flow slowly back and forth, up and down, or in a circle, deep in the crust of the earth, distributing and concentrating the ores and other minerals.

All these forms of water present to the observer interesting material for study, but the run-off of ten cubic miles of water, rich in all the minerals that plants and animals need, demands

immediate study into ways and means for preventing this waste. Obviously, if the water can be kept on the land where it fell as rain, most of the waste of soil fertility will be prevented. Two ways of doing this will be stated very briefly.

One, that of constructing dams for reservoirs to keep the water away from the rivers as long as possible, is already practiced by our wisest farmers. Forests on the hillside serve the same purpose. Both methods conserve stock water, and timber as well.

The second plan consists in opening up the soil and subsoil very deeply, so as to make a reservoir of the fields. This plan is also practiced by wise farmers, especially where rainfall is scanty. The rainfall of two years is made to serve the crops of one year. The one harvest is more than twice as bountiful in the dry belt as two harvests where the old plan of a yearly crop is followed.

· With water properly conserved, rains will increase their value to the people of Kansas, costly gullies and small creeks will disappear, and the surface of the state will approach a stability long absent from her borders. Man's kingship of the earth will consist in the scientific mastery of his environment, and not in the haphazard mastery so long practiced. This scientific mastery must come, if it come at all, through a thoughtful study of the geological development of the state, given point by making such a study terminate in the present condition and needs of the entire state. Man can not be truly happy, he can not be truly prosperous, till he forgets what seem to him to be his immediate personal interests, and works for the good of all. When he does this he will strive earnestly to conserve soil, rainfall, plants, including forests, the useful lower animals, and the human race.

THE GLACIAL EPOCH.

By ALBERT B. REAGAN.

DISCUSSION OF THEORIES OF SCIENTISTS REGARDING THIS INTERESTING PERIOD OF THE WORLD'S HISTORY—THE AUTHOR PRESENTS A NEW THEORY—WHAT ARE THE CRITICAL PERIODS OF THE EARTH'S HISTORY, AND WHY DO THEY OCCUR?

OF ALL SUBJECTS in geology, with probably the exception of the subject of evolution, the glacial epoch is the most interesting, the most discussed, and one of the least understood.

The questions: Why did the earth's climate change from the universal tropical Tertiary to the frigid ice-drift climate? Why did the animals, without respect to kind, seek shelter, at the beginning of said epoch, in caves and in every conceivable place, where they were overcome, as their fossil remains indicate? Why did the then large tropical species allow the ice drift to overtake them, instead of moving towards the equator as it advanced? and What force lifted the water into the air, which, when condensed, constituted those world-cloaks of frozen water? are still in conjecture.

Many theories, it is true, have been advanced to explain the causes of the glacial climate of said epoch; but a mere glance at them will show that they all have objectionable points, the deluge theory as the cause of the drift having already lost credence.

The theory advanced by many geologists and scientists, that the change of climate was caused by the combined influence of northern elevation in high latitudes, which elevation caused a broad connection of North America and Europe in the higher regions; of the sinking of the Central American lands, thus changing the Gulf Stream from its present course into the Pacific ocean, therefore depriving the North Atlantic of the Gulf Stream's warming influence, and also of the tendency of cold to perpetuate itself by ice accumulation, like the theories that will be mentioned later, has many objectionable phases. In the first place, the above-mentioned cause would not produce an ice sheet one mile in thickness as far south as the city of Des Moines, Iowa, which city is situated in the glaciated region,

because even now the non-ocean-current-influenced plateau of eastern Turkestan, nearly one-half of which country is north of that city, has an altitude of more than two miles greater than that of the above-mentioned city of Des Moines (Swin-ton's Geography, p. 110); yet, though cold, it is not covered by an ice sheet one mile in thickness, 6000 feet being the supposed thickness of the ice sheet in the New England and North Central States (Le Conte's Elements of Geology, p. 576), nor by any ice sheet at all in the summer. And furthermore, the plateaus of the Desert of Gobi and Mongolia, which are situated, for the most part, wholly north of said city, and whose altitudes are more than one and one-half miles greater than that city's altitude, are not covered by perpetual ice, though the balmy and moisture-carrying breezes from the Pacific ocean are shut out by the Khingan mountains. Not only that, but there are places in interior Asia, on the same latitude as St. Petersburg, that are over 2000 feet—the supposed elevation of glacial times (Le Conte)—higher than that city, yet perpetual snow does not rest upon them. Another serious objection to the elevation theory is, that now we are having northern elevation of land and southern depression of the same. Nevertheless, the antarctic ice sheet is at present larger and thicker than the now existing ice cap in the northern hemisphere. (Le Conte's Elements of Geology, p. 613.) Still another serious objection is that, had the arctic plains been elevated and afterwards depressed, as the theory suggests, they would have faulted as has the basin region; but no such faults are to be found. Geological causes alone, therefore, are quite insufficient to explain the causes of the frigid climate of the glacial epoch. To use the words of Mr. T. J. Bonney, "Each attempt to account for the glacial epoch solely by terrestrial causes places us on the horns of some dilemma." (Story of Our Earth, p. 495.)

To meet the objections to the above theory, Mr. Croll has advanced the theory that the glacial epoch was caused by the combined influence of the precession of the equinoxes and the secular changes in the eccentricity of the earth's orbit. (See Lyell's Principles of Geology, vol. I, p. 275.)

This condition, says this accepted authority on the subject, would make the northern winter twenty-two days longer and

20° colder than now, and the summers twenty-two days shorter and much hotter. (See Le Conte's *Elements*, p. 614.)

As a first objection, the winter temperature at Des Moines, Iowa, which city, as is stated above, was in the glaciated region, is about 16° above zero, and the summer average is 77°. Now the winter average in glacial times, according to the above theory, was 4° below zero and the summer average much hotter than now. This would not give a glacial climate at that city, for even now the average yearly temperature for St. Petersburg is much lower than that of the site of the city of Des Moines in glacial times, to use the above figures. Notwithstanding that, St. Petersburg does not enjoy perpetual winter. This theory does not also account for the long continuation of the glacial epoch, which is supposed to have lasted 160,000 years (see Le Conte's *Elements of Geology*, p. 617), because within this period the equinoxes would have made more than seven complete precessions, 26,000 years being a precession (Lyell's *Principles of Geology*, vol. I, p. 275), and would therefore have been in complete opposition to a glacial climate more than seven times during the epoch.

To meet the many objections in Croll's theory, Mr. Wallace combines all the above-mentioned theories in one and says that the glacial epoch was due to the combined influence of aphelion winter, maximum eccentricity of the earth's orbit, and northern elevation. (See Le Conte's *Elements of Geology*, p. 616.) To this theory there are many objections. Croll says that the highest-latitude northern regions were not elevated in that epoch, but were lower then than now, the elevation theory only being used as a hypothesis to account for the cold. (*Climate and Time*, p. 391.)

H. B. Norton also agrees with Mr. Croll in believing that northern elevation of land did not then exist. His remarks on the subject are as follows:

"When we come to study the cause of these phenomena (the phenomena of the ice age) we find many perplexing and contradictory theories in the field. A favorite one is that of vertical elevation. But it seems impossible to admit that the circle inclosed within the parallel of 40°—some 7000 miles in diameter—could have been elevated to such a height as to produce this remarkable result. This would be a supposition hard to reconcile with the present proportion of land and water on the surface of the globe and with the phenomena of

terrestrial contraction and gravitation." (Popular Science Monthly, October, 1879, p. 833.)

On the same subject Geikie says:

"It has been demonstrated that the protuberance of the earth at the equator so vastly exceeds that of any possible elevation of mountain masses between the equator and the poles that any slight changes which may have resulted from such geological causes could have only an infinitesimal effect upon the general climate of the globe." (The Great Ice Age, p. 98.)

We must, therefore, fall back to Croll's theory, which Mr. Wallace and many other scientists and geologists say was not sufficient to produce so protracted a glacial epoch as is supposed to have existed. But if Mr. Croll's theory, or even Mr. Wallace's, is accepted it is simply because no better one has been advanced, for it does not account for a contemporaneous southern ice sheet which, as is proved below, did then exist.

As evidence of contemporaneous glacial action, Le Conte says that the glacial action in the glacial epoch was as extensive in the southern hemisphere as in the northern. (Elements of Geology, p. 596.)

In reference to the same, Dana says:

"In South America in glacial times, indications of great ice masses are met with from Fugia as far toward the equator as 37°, and especially, as Agassiz has shown, in the great valley between the Andes and the coast mountains to the latitude of Conception."

He also states on the same page that there were glaciers in that epoch in New Zealand, and also in Australia and Tasmania. (Manual of Geology, 4th ed., p. 977.)

Now, since the above-mentioned men are recognized authority on this subject, it is evident, beyond the least shadow of a doubt, that the glacial epoch was not caused by the combined influence of northern elevation, the precession of equinoxes, and maximum eccentricity of the earth's orbit, for as Mr. T. J. Bonney says (Story of Our Earth, p. 502), the precession of the equinoxes and aphelion winter in conjunction would produce a cold climate in one hemisphere and the direct opposite in the other, because if said aphelion winter and the precession of equinoxes in conjunction would make the winters twenty-two days longer than now in the northern hemisphere,

and the summers twenty-two days shorter than at present, as Croll's theory suggests (see above), the summer in the southern hemisphere, since in said hemisphere the seasons are the opposite of ours, would be twenty-two days longer than our present northern summer, and, no doubt, on the whole much hotter, and the winters of that epoch in said hemisphere would be twenty-two days shorter and less cold than now. It is, therefore, necessary to look for some other cause for the frigid climate of the glacial epoch—a cause that will account for the contemporaneous ice sheets, the one in the northern hemisphere and the coexisting and equally extensive one in the southern hemisphere.

To find the real cause of the climate of said epoch, it is necessary, it seems to me, to inquire, What was the glacial epoch? What epoch, in comparison with the other epochs of the earth's history, does it represent? To use the words of Professor Le Conte: "The Quaternary, of which the glacial epoch was the first part, is a critical period." (Elements of Geology, p. 619.)

This definition leads to other and more complicated questions, some of which are: What are the critical periods of the earth? and, Why do they occur?

In answer to the first question, Le Conte says (Elements of Geology, p. 619) that the critical periods of the earth's history have been periods of oscillation of the earth's crust between the great eras, periods of rest, and therefore of changes of physical geography, marked by unconformity of strata; and of changes of climate, marked by apparently abrupt changes of species, *i. e.*, periods of revolution and rapid change. Again, Le Conte says, on the page opposite to the one mentioned above, that three of the known critical periods have been periods of cold in one or the other of the hemispheres or in both, the latter being known to have occurred in the glacial epoch.

The second question, "Why do critical periods occur?" is very hard to answer and involves a cosmical cause, a cause which when once understood will explain not only the causes of the glacial epoch, but most if not all of the geological phenomena of our globe as well. As an answer to this question the author will submit the following.

In the American Encyclopedia, vol. XV, page 471, it is stated that our sun moves in space, and that it is moving from west to east at the rate of more than 150,000,000 miles per annum. And concerning the same subject Mr. Todd says that the sun is moving in space from a point midway between Sirius and Canopus toward the constellation Vega (New Astronomy, p. 431); and another astronomer says (see an astronomical article in the July number of McClure's Magazine for 1899) that though our center has been known to be moving in space since the early days of the Chaldeans, yet it is not known whither he is going or where he is transporting his entire family of planets, satellites, and comets.

Now, since astronomers have proved that the sun moves in space it evidently, therefore, must have an orbit, because all bodies moving in space, whose courses can be traced out at the present time, have orbits, and the sun, like all other bodies in space, is composed of matter and does move, and consequently must obey some attractive law. It therefore has an orbit, but one of immense size, for Mr. Todd says (see above):

"So vast is this orbit of the sun that no deviation from a straight line is as yet ascertained, although our motion along that orbit is about twelve miles per second."

Now if the sun has an orbit, as Mr. Todd and all of our leading astronomers say it has, and which the very facts in the case indicate, it must have a central attractive center the same as all other bodies so far as known which have orbits. This attractive center, most likely, is a central sun, as was a favorite hypothesis in the middle of the nineteenth century; or, if not a central sun, it is at least a great central magnetic center, whose attractive influence controls not only our sun, with his attendants, but all matters throughout limitless space.

Just where this attractive center is located is unknown, but it is easy to conjecture with a great deal of accuracy that it is located in the northern heavens, in the vicinity of or beyond the dippers, or in the opposite heavens, because not only our earth, but all the brother planets and even the sun himself have their axis inclined toward the plane of their respective orbits toward a point in the northern heavens (American Encyclopedia, vol. XV, p. 471). Now, if this center be positive it is located in the northern sky, because the north magnetic pole of our earth is negative, but if negative it is situated in the

southern heavens, for the reason that our south magnetic pole which would be attracted by it is positive. For this discussion, however, the author will suppose that this central magnetic center is situated in the northern heavens nearly in line at present with Polaris, and around this center our sun, in conjunction with the universe, is making his grand journey.

Now, the sun's orbit is not an exact circle, but, like all the orbits that have been traced out, it is elliptical. Again, when the sun reaches the point in his orbit nearest the great center, at which point he probably is near now, for reasons which will be given hereafter, his axis together with the axis of his attendants must incline more and more as he advances from said point in order to still keep in line with said great magnetic center, as they do now; and should our system advance in space to or even beyond Vega before making the turn in his journey, it is not beyond the possible that the earth's axis will then be inclined 30 degrees to the plane of its orbit in order that its magnetic axis still be in line with said magnetic center. To this, of course, astronomers and geologists will object by saying that no such change in the inclination of the earth's axis due to said cause has been detected. As answer to the above, may it be sufficient to say, as Mr. Todd says (see above), that though the solar system has been observed to be moving in space since the early infancy of our race, yet so vast is its orbit that no deviation from a straight line has been observed it would be impossible as yet to detect any change in the inclination of the earth's axis due to said cause? Nevertheless, if the sun does move in space, the axes of our earth, the other planets and even of the sun himself must change their angles of inclination, as a simple experiment will show.

As the earth's axis becomes more and more inclined, after the sun reaches the nearest point in his orbit to the great center while he is making his grand journey toward Vega, the arctic and antarctic circles will advance toward the equator till the frigid zones will reach from 60 degrees or even less to the poles, instead of $66\frac{1}{2}$ degrees as now. This greater inclination of the earth's axis will cause a greater difference of temperature between summer and winter and between the equator and the poles than now exists, which Croll says is of itself sufficient to produce a glacial epoch; but we will go a

step farther. This greater inclination will cause during winter a higher barometer than now, *i. e.*, greater atmospheric pressure over the high latitudes and a low barometer in the tropics. In addition to this, the much heavier winter snowfall will greatly increase the pressure in the high latitudes. In summer, of course, the condition of things will be reversed. It is evident, therefore, the the northern hemisphere will then be enjoying a higher pressure, while the southern will be enjoying a lower one than now, and *vice versa*. Besides this, the attractive power of the sun and also of the moon upon the higher latitude regions of the earth will vary more between summer and winter than at present. Now, Mr. Alexis Perry has shown conclusively from the comparison of a tabulated list of nearly all the earthquakes that have occurred in our history:

1. That earthquakes are a little more frequent when the moon is on the meridian than when she in on the horizon.

2. That they are a little more frequent at new and full moon than at half moon.

3. That they are a little more frequent when the moon is nearest the earth than when she is farthest away.

(See Le Conte's Elements of Geology, p. 139.) Also, Le Conte says that by an extensive comparison of this same list of earthquake occurrences with the seasons it has been shown that earthquakes are more frequent in winter than in summer. And furthermore, Professor Knott has shown (see Le Conte's Elements, p. 139) that the earthquakes of the present time are brought on for the most part by the change of excess of pressure between summer and winter and between the equator and the poles. It is conclusive, therefore, that if the present changes of pressure between summer and winter and between the poles and the tropics, and the variation of the attractive power of the moon upon the earth from full moon to full moon again, and her variation of attraction in conjunction with the sun's upon the middle latitudes and the polar regions from summer in one hemisphere to summer in the other are the main causes of the quaking of the earth's shrinking crust to-day, this greater change of excess of pressure and of the sun's attractive influence, and also of the moon's, from winter in one hemisphere to winter in the other, will cause the earth's crust to yield in all its weakest points, which Le Conte says is at or

near the coast line where the thickest sediment has been deposited. This thick sediment will yield to the lateral pressure and will be mashed together and upswollen into a mountain range. Not only will it be upswollen into a mountain range, but in that very act the sea bottom and land surface will be faulted and fissured, the former while yet beneath the seas. The sea water will rush in to fill the opened space. The water will come in contact with the heated rocks; steam will be instantaneously generated; explosions will follow, explosions that will rend the earth from pole to pole, the debris being hurled beyond our atmosphere, probably thousands of miles. (Read the account of the eruption of Krakatoa in the Strait of Sunda, whose erupted dust particles remained suspended in the atmosphere for over two years.) Gases destructive to life will also be generated; the air will become vitiated with said obnoxious gases and dust particles; the then existing animals will seek refuge in every conceivable place from this poisonous gaseous deluge, where they will be either overcome by it or by hunger and thirst, or by the great lava flood which will be mentioned below. Other animals will preserve their kind by migration, while still others will live in more favored parts of the earth, the gases, of course, being most destructive approximate to the disturbed districts. There will be, coincident with and continuing after the great explosions, eruptions of lava both on land and sea throughout the full length of the faulted disturbed regions; the former devastating the land surface; the latter, together with the contact rock heat and now greatly heated atmosphere, will evaporate much of the ocean, whose vapors, rising to higher atmospheric regions, will be wafted toward the poles, where, when the reaction sets in, they will be condensed and fall as snow. This snow will continue to fall and the temperature to decrease till the high latitudes will be covered with immense ice sheets, because, as Mr. Newton has proved, to every action there is an equal and opposite reaction. Not only that, but the change will be brought on so suddenly that many of the remaining species of the earth that have survived the fiery lava and gaseous dust storm will be overtaken by it and there perish with cold. This is the next future critical period of our earth, and also a glacial epoch, not in one hemisphere only, but in both, in which the ice sheets will be equally extensive and coexisting. Was the

glacial epoch of prehistoric times brought on by similar causes? Let us see.

At the beginning of the Tertiary age our sun was at a point in his orbit nearest the central magnetic center in his journey toward Sirius. The axis of the earth was probably inclined less than now, likely not more than twenty degrees; a perpetual summer prevailed from pole to pole. To use the words of T. J. Bonney (*Story of Our Earth*, p. 496): "Switzerland, and in fact all Europe, was 16 to 20 degrees warmer than at present in Eocene and Miocene Tertiary times; and Le Conte says that in the Miocene Greenland, Iceland and even Spitzbergen were covered with luxuriant temperate vegetation.

Another writer says: "This, the Tertiary period indeed for America, was the golden age of animals and plants. . . . The country was more interesting and picturesque than now. . . . This state of things, doubtless, continued throughout many thousands of years." (*Popular Science Monthly*, October, 1878, p. 648.)

A more recent writer says: "The middle era of this age—the Miocene Tertiary—was characterized by tropical plants, a varied and imposing fauna, and a genial climate, so extended as to nourish forests of beeches, maples, walnuts, poplars and magnolias in Greenland and Spitzbergen, while an exotic vegetation hid the exuberant valleys of England." (*American Antiquarian*, July, 1881, p. 280.)

On the same subject Dr. Dawson says: "This delightful climate was not confined to the present temperate or tropical regions. It extended to the very shores of the Arctic sea. In North Greenland, at Atanekerdulk, in latitude 70° north, at an elevation of more than two thousand feet above the sea, were found the remains of beeches, pines, walnuts, limes, and vines. The remains of similar plants were found in Spitzbergen in latitude 78° 56'. (*Earth and Man*, p. 261.)

Dr. Dawson continues: "Was not the Miocene period on the whole a better age of the world than that in which we live? In some respects it was. Obviously, there was in the northern hemisphere a vast surface of land under a mild, equable climate and clothed with a rich and varied vegetation. Had we lived in the Miocene we might have sat under our own vine and fig-tree equally in Greenland and Spitzbergen and in those more southern climes to which the privilege is now restricted." (*Earth and Man*, p. 264.)

The earth, therefore, in the Tertiary was a fair and lovely world; it was a garden, a paradise; but this condition of things could not last forever. As the Tertiary began to wane a change came over the fair face of nature, more terrible than we have language to describe. The sun was nearing Sirius in his western journey, the earth's axis had become inclined to probably thirty degrees, an ice-cap had begun to form, the great difference in temperature between summer and winter and between the equator and the frigid zones, the great change of atmospheric pressure from summer to winter and from the tropics to the poles, and, furthermore, the great difference of the sun's attraction and also of the moon's on the higher latitudes between summer and winter, caused a tremendous strain upon the earth's crust, a strain that the earth's crust could not withstand; and as a consequence, it yielded in all its weakest points. This event ushered in the Pliocene Tertiary.

To use the words of Professor Le Conte (*Elements of Geology*, p. 567): "At the end of the Miocene, *i. e.*, the beginning of the Pliocene, there occurred the greatest event of the Tertiary period, one of the greatest in the history of the American continent. At that time the sea bottom off the then Pacific coast was crushed together into the most complicated folds and upswollen into the coast chain, and at the same time the fissures were formed in the Cascade range, with the outpouring of the great lava sheet of the northwest, covering 150,000 square miles with a lava sheet from three thousand to four thousand feet in thickness. Coincidentally with this there was a settling down of the basin region and the plains. Then after a short lapse of time, speaking geologically, there was a general upheaval of the continent. Coincident with this general uplift, mountain-making by crust-block tilting occurred on a grand scale. The Sierra, the Wasatch, and the Basin ranges assumed their present form and height; and the great north-and-south fault cliffs of the plateau region were formed. At the same time there were great disturbances in the Old World. The Himalayas were raised above the sea; the great Deccan lava flow, covering 200,000 square miles with a lava sheet 6000 feet thick, occurred; Europe assumed its present form; Asia added much of her southern lands; and large parts of the African continent were raised above the sea; the Pacific ocean continent went down, and most likely the

Lost Atlantis also. The gases generated by volcanic action proved fatal to life. (Consider the destructive sulphurous gases generated by Vesuvius in one of her eruptive periods, or of Mount Pelee, for example, and then remember that an eruptive period of Vesuvius or of Mount Pelee represents only in miniature the great volcanic fissure eruptions of Pliocene Tertiary and glacial Quarternary times. It is no more, in comparison with the eruptions of that period, than a single atom in comparison with the volume of the whole earth.) The animals sought shelter in caves and grottoes and in whatever place protection could be found from the hot-ashy-dust-gaseous invader, and there huddled together they perished, and their remains are known to-day as the lime-cavern fossils. In this terrible catastrophe there perished in America the horse, bos, mastodon, camel, elephant, and many of the other then tropical and temperate species which roamed over her plains. In addition to this, many of the animals that had escaped the gaseous storm were overtaken by the lava flood which followed. A few species, however, migrated to more favorable parts of the earth and in this way preserved their kind. Coincident with the lava eruptions on land there occurred greater eruptions and disturbances at sea, because the crust mashing was inaugurated beneath the sea; and the sea water was heated by coming in contact with the heated rocks and incandescent lava and the now heated atmosphere, the temperature of which had been raised by coming in contact with the molten lava hurled out on the land surface. The seas were, at least a great deal of them, evaporated. (Mr. Thomas Belt, in the *Quarterly Journal of Science*, says that the formation of the ice sheets at the poles in the glacial epoch must have lowered the level of the oceans of the world at least two thousand feet.) The vapors thus formed, having been wafted on high, so to speak, were carried toward the poles, where, on being cooled, they were condensed and fell as snow. Also the volcanic dust hurled by the volcanic explosions beyond our atmosphere, and surrounding the earth as rings of dust, would take up much of the sun's heat before it could reach the solid earth, thus increasing and maintaining the cold.

This great change was as sudden as was the almost instantaneous earth-crust disturbances and lava eruption, which was the immediate cause of the excessive evaporation. So sudden,

indeed, was it that the cold wave overtook many of the living tropical and temperate species of the earth, and their remains are to-day found frozen in the northern ice, where they are often found heaped up in such quantities, at places in which they huddled together for protection from the icy invader, that Admiral Wrangle tells us that in certain parts of Siberia he and his men climbed over ridges and mounds composed entirely of their bones. (Agassiz, *Geological Sketches*, p. 209.)

That the coming of the cold wave was sudden, and that the animals were slaughtered outright by it, is attested by more than one scientific author. On this subject Louis Figuier says: "The northern and central parts of Europe, the vast countries which extend from Scandinavia to the Mediterranean and Danube, were visited by a period of sudden and severe cold; the temperature of the polar regions seized them. The plains of Europe, but now [Miocene Tertiary] ornamented by the luxurious vegetation developed by the heat of a burning climate; the boundless pastures, on which herds of great elephants, the active horse, the robust hippopotamus and the great carnivorous animals grazed and roamed, became almost instantly covered with a mantle of ice and snow." (*The World Before the Deluge*, p. 435.)

Figuier continues: "We can not doubt, after such testimony, of the existence in the frozen North of the almost entire remains of the mammoth. The animals seem to have perished, suddenly enveloped in ice at the moment of their death; their bodies have been preserved from decomposition by the continual action of cold." (*The World Before the Deluge*, p. 496.)

And again Cuvier says: "If they [the animals] had not been frozen as soon as killed, putrefaction would have decomposed them; and, on the other hand, this eternal frost could not have previously prevailed in the place where they died, for they could not have lived in such a temperature. It was, therefore, at the same instant when these animals perished that the country they inhabited was rendered glacial. These events must have been sudden, instantaneous, and without any gradation." (*Ossements, Fossils; Discourse sur les Revolutions de Globe*.)

The above-mentioned snow continued to fall for ages, till an ice sheet of immense thickness was formed, not at one pole, but at both. This is the glacial epoch.

The sun, with his attendants, had passed the turning point of his orbit near Sirius, and was now advancing toward Vega; and notwithstanding the tendency of cold to perpetuate itself by ice accumulation, the ice sheets had begun to recede, and would have continued to do so in both hemispheres if aphelion winter and maximum eccentricity had not intervened and caused the northern ice sheets to advance again; but their combined influence, together with the still great inclination of the earth's axis, could not make it advance as far south as it formerly had been; and when the eccentricity of the earth's orbit began to wane from its maximum point the ice sheets again receded and inaugurated the Champlain flood epoch, which, after it had filled the bays and gulfs up to their former level, sedimented up the river troughs cut during the time that the oceans were lowered by evaporation. (Notice here the difference: Instead of the lands being elevated during the glacial epoch, the seas were lowered by evaporation.)

Since the ushering in of the Champlain epoch the ice sheets have been gradually receding, and will continue to recede as the sun advances toward the nearest point in his orbit to this central magnetic center, till they may disappear altogether, and a paradise on earth be established similar to the one that existed in Miocene Tertiary times, though it is conclusive that the climate will be less hot than in that period, because our sun is a waning star.

LOWERING OF THE GROUND-WATER TABLE.

By W. A. COOK, Baker University, Baldwin, Kan.

SINCE the dry season of 1901 the people of the eastern half of Kansas have been more or less concerned about the water supply; and the dry weather of 1910 and the drouth of last summer have increased the growing anxiety about water for domestic purposes. For the past three years the streams of eastern Kansas have been low, at times very low, and for the greater part of that time many have been dry; in fact, in some localities creeks and wells which went dry in 1901 have never recovered their former stability. This statement holds good in spite of the fact that the major streams of this part of the state have passed through two of the greatest flood areas known in their history.

Surface wells and water courses dependent on surface water are likely to go dry during any period of decreased rainfall. Such cases are of more or less local extent in their happening. However, when the eastern half or two-thirds of the state begins to experience such a condition, it becomes more than a local question, the seriousness of which, like the cause of the condition, seems to be little understood by the people in general. Creeks and rivers that were seldom dry or very low in former years are now dry a large part of the time. Wells that were inexhaustible now have only a meager supply of water, and many have had to be dug deeper. Thus, many people ask: "Why do the creeks go dry in two or three weeks after a rain has filled them bank full?" The answer is easy, but hard to get the average person to understand and believe. The ground-water has been perceptibly lowered, and the ground-water table has sunk below the beds of the streams. Hence, instead of the ground-water flowing through the ground and feeding the streams, causing a continuous flow, the water from the streams in a very short time soaks into the banks and bottoms of the streams and settles to the level of the ground-water table, leaving the streams dry except in the deepest pools.

In the western part of the state the wells and springs and creeks fed by springs which are connected with the under-

flow have not varied perceptibly in the period of time that the writer has known western Kansas, which is nearly thirty years. Thus it is well established that the underflow is not dependent on the rainfall in that section of the state. Another proof of that fact, if another were needed, is that creeks and ponds dependent on surface water, or that coming from local rainfall, are dry most of the time. The underflow varies but slightly in wet and dry years, and often the variation is contrary to would be expected.

In eastern Kansas the ground-water table is a different proposition. The water that falls on the surface and does not run off in the streams or is not used up immediately by vegetation percolates through the ground and settles down to a certain level known as the ground-water table, or the top of the permanent water supply. In general, this table is marked by the top of the water in the streams in any part of the state. The location of the table in any particular locality depends on the condition of the aquifer. Also, the underlying and overlying rocks being pervious or impervious influence the amount of water received by the aquifer as well as the retention of the same.

To say that the ground-water table has been lowered four feet, or six feet, or eight feet, does not refer to any particular locality, but means that the area comprising the eastern half of Kansas taken as a whole has had the ground-water depleted until it has sunk somewhere in that range. In the vicinity of Baldwin some creeks are dry that had pools as deep as eight feet, while in others the water maintains its level at about five feet below the former level. On the other hand, the writer knows of one well of living water that lowered nearly twelve feet, and several others that were lowered from five to eight feet. Nor is this locality very different from those all over this part of the state. From reports gathered from this entire end of the state the writer estimates that since 1901 the water table has been lowered an average of five or six feet. And what makes the condition all the more serious, in many places several feet of dry earth intervene between the water table and the surface water from the late fall rains. The amount of rainfall necessary to thoroughly soak the ground all the way down to the ground-water table is very problematical. However, this is one of the conditions to be met before the raising of the table begins.

Granting that the above facts are approximately correct and disregarding the last-named condition, it is interesting to note some of the estimates necessary to restore the ground-water table to its former level. It will take all the rainfall for two average years to restore it; or, it will take twenty per cent above average for ten years or ten per cent above average for twenty years. A gain of two inches per year for thirty-five years would make up the loss. As the surface water is seldom sufficient in any part of Kansas to last through the dry parts of the year, it is evident that stockmen and municipalities should seek a water supply well below the present water table to be sure of a permanent water supply. Although the records since 1836 show a gradual increase in the rainfall in eastern Kansas, at the same rate it would not restore the shrinkage in the next fifty years. Then the question naturally arises, will the former ground-water table ever be restored? Is there a probability that there will be an excessive rainfall in the next ten or twenty or even fifty years, sufficient to restore the former level? Can a system of ponds and small lakes be built by damming the draws and creeks sufficient to restore the old table or to aid in maintaining the present level? Will the creeks continue to build up their flood plains? And if so, will they become permanent surface-water streams? Such questions can not be discussed in this paper, but they suggest that the lowering of the ground-water table is one, not only of much scientific interest, but also one of great economic importance to farmers, stockmen, and city authorities who have to provide a permanent water supply for domestic purposes.

IV.
BIOLOGICAL PAPER.

1. "ADDITIONS TO THE LIST OF KANSAS COLEOPTERA FOR 1910-'11-'12."
By W. KNAUS.

(87)

ADDITIONS TO THE LIST OF KANSAS COLEOPTERA FOR 1910-'11-'12.

By W. KNAUS, McPherson, Kan.

ADDITIONS to the list of Kansas Coleoptera since 1909 have not been very numerous. The State University has had collecting parties in the field each summer, but so far the most of the material in Coleoptera gathered in these expeditions has not been worked out.

The writer has done only occasional collecting the past four seasons, and the list is due principally to the monographic work of Major Thos. L. Casey, of Washington, D. C., who has worked over a number of generic groups. The results of his taxonomic work have not been accepted by all scientific Coleopterists, and it will probably be some years before these differences of opinion are adjusted.

Notes, whenever of interest, are appended to the species of the list.

1. *Cicindela sterope* Csy. Memoirs of Coleoptera IV.
This is the species commonly recognized as *12-guttata* Dej. in Kansas collections of Coleoptera.
2. *Cicindela circumpecta* Laf.; subspecies *ambiens* Csy. Memoirs of Coleoptera IV.
This is a deep blue variety of *circumpicta*.
3. *Cicindela globicollis* Csy. Memoirs of Coleoptera IV.
Clark county. This is evidently a small form of *Cicindela*, var. *apicalis* W. Horn, which occurs on Kansas salt marshes.
4. *Cicindela lepida* Dej.; subspecies *insomnis* Csy. Memoirs of Coleoptera IV.
The Seward county form of *lepida*, with blue-green head and thorax.
5. *Pasimachus vernicatus* Csy. Memoirs of Coleoptera IV.
6. 215 *Pasimachus duplicatus* Lec.
One specimen. Dodge City.
7. *Diplochila oblonga* Csy. Memoirs of Coleoptera IV.
8. *Diplochila cliens* Csy. Memoirs of Coleoptera IV.
9. *Dicælus ocellatus* Blatchley.
One specimen. Wilson county.
10. *Calathus obesulus* Csy. Memoirs of Coleoptera IV.
Mount Hope, Kan.

11. 1111 *Harpalus oblitus* Lec.
One specimen. Scott City; July.
12. *Helophorus*, sp.
One specimen. Wheeler, Cheyenne county.
13. 1662 *Sphæridium scarabæoides* Linn.
A European species of a hydrophilid, or scavenger, that has been gradually working westward for the last seventeen years. First taken in Kansas by the late E. A. Popenoe, near Topeka, in November, 1910, and a single specimen taken near McPherson, October 23, 1911.
14. 1720 *Sphærites glabratus* Fab.
One specimen referred to this species by the late E. A. Popenoe, of Topeka.
15. 1957 *Rhexius insculptus* Lec.
Four specimens from Onaga, collected by F. F. Crevecoeur.
16. *Apalonia divisa* Csy. *Memoirs of Coleoptera* II.
Mount Hope.
17. *Atheta kansana* Csy. *Memoirs of Coleoptera* II.
Sedgwick county.
18. *Dimetrota sentiens* Csy. *Memoirs of Coleoptera* I, page 105.
Onaga. Collected by Crevecoeur.
19. *Sableta* (*Anatheta*) *planulicollis* Csy. *Memoirs of Coleoptera* I, page 112.
Meade county. Collected by W. Knaus.
20. *Platandria deductor* Csy. *Memoirs of Coleoptera* I, page 173.
McPherson. Collected by W. Knaus; description drawn from two ♀.
21. *Quedius compransor* Fall.
Cotype, Manhattan. Taken by Theo. Schaeffer, January, 1911, from nest of the pocket gopher.
22. 2179 *Philonthus longicornus* Steph.
One specimen. Topeka. Taken by Popenoe; November.
23. 2539 *Lathrobium ventrale* Lec. *Trans. American Ento. Soc.* VIII.
24. *Bledius armatus* Say.
Kansas. Near Superior, Neb., June 1, in sandy mud on banks of Republican river. Incorrectly given in *Transactions of Kansas Academy of Science* for 1895-'96 as *Bledius ineptus* Csy. See *Misc. Notes on N. A. Coleoptera*, by H. C. Fall, *Trans. American Ento. Soc.*, vol. XXXVIII, pages 102, 103.
25. 3329 *Læmophlœus nitens* Lec.
Salina, Kan.; August, September. Under cottonwood bark, occurring with *Bactridium striatum* Lec., heretofore recorded from this state by a single specimen taken at Benedict, Kan.

26. *Saprinus*, sp.
A very large specimen, unlike any species of this genus seen from this state. Taken October 6 from under a decaying watermelon, by H. A. Horton, near Salina, Kan. Now in possession of A. B. Wolcott, of Field Museum of Natural History, Chicago, Ill., for description.
27. 3779 *Stephostethus liratus* Lec.
Onaga, Kan. Collected by Crevecoeur.
28. *Porcinolus crescentifer* Csy. *Memoirs of Coleoptera* III, page 32.
Baldwin, Kan.
29. 4048 *Entomophthalmus rufiolus* Lec.
One specimen. Onaga, Rare. Collected by Crevecoeur.
30. 4307 *Melanotus decumanus* Er.
One specimen. McPherson.
31. *Melanotus diversicornis* Blatch.
One specimen. McPherson, Kan.
32. *Amphicerus gracilis* Csy. *Studies in Ptinidæ, etc.* *Journal of N. Y. Ento. Soc.*, vol. 6, page 69.
33. 5404 *Ennearthrus thoracicus* Zieg.
Benedict, Kan. In fungus. Common.
34. 5429 *Canthon probus* Ger. *Coleopterorum Catalogus*, part 38.
35. *Prionus*; subgenus *Riponus debilis* Csy. *Memoirs of Coleoptera* III.
36. *Prionina simplex* Csy. *Memoirs of Coleoptera* III.
Wallace county.
37. *Physocnemum densus* Csy. *Memoirs of Coleoptera* III.
38. *Crossidius*, subspecies *retractus* Csy. *Memoirs of Coleoptera* III.
39. *Crossidius debilis* Csy. *Memoirs of Coleoptera* III.
Northwest Kansas.
40. *Cyllene angulifera* Csy. *Memoirs of Coleoptera* III.
41. *Cyllene*, subspecies *kansana* Csy. *Memoirs of Coleoptera* III.
42. *Brachyleptura dehiscens* Lec. *Memoirs of Coleoptera* IV.
43. *Typocerus confluens* Csy. *Memoirs of Coleoptera* IV.
44. *Typocerus caligans* Csy. *Memoirs of Coleoptera* IV.
45. *Monilema nubucula* Csy. *Memoirs of Coleoptera* IV.
Hamilton county.
46. *Monilema*, subspecies *demissa* Csy. *Memoirs of Coleoptera* IV.
47. *Pogonocherus simplex* Lec. *Memoirs of Coleoptera* IV.
48. *Mecas saturnina* Lec. *Memoirs of Coleoptera* IV.
49. *Mecas brevicollis* Csy. *Memoirs of Coleoptera* IV.
50. *Oberea ferruginea* Csy. *Memoirs of Coleoptera* IV.
51. *Tetraopes velutinus* Csy. *Memoirs of Coleoptera* IV.
Hamilton and Finney counties.
52. *Tetraopes brevisetosus* Csy. *Memoirs of Coleoptera* IV.
53. 6657 *Pachybrachys striatus* Lec. *Trans. Am. Ento. Soc.*, vol. VIII.

54. 6770 *Graphops simplex* Lec.
One specimen. Wheeler, Cheyenne county.
55. *Glyptasida turgescens* Csy. *Memoirs of Coleoptera* III.
Kansas University collection.
56. *Glyptasida*, subspecies *obesa* Csy. *Memoirs of Coleoptera* III.
Wallace county.
57. *Glyptasida*, subspecies *furtiva* Csy. *Memoirs of Coleoptera* III.
58. *Glyptasida procrustes* Csy. *Memoirs of Coleoptera* III.
Wallace county.
59. *Glyptasida strigipennis* Csy. *Memoirs of Coleoptera* III.
Western Kansas.
60. *Gonasida compar* Csy. *Memoirs of Coleoptera* III.
Gove county.
61. *Gonasida*, subspecies *reducta* Csy. *Memoirs of Coleoptera* III.
62. *Gonasida*, subspecies *prolixa* Csy. *Memoirs of Coleoptera* III.
63. *Euschides*, subspecies *retusus* Csy. *Memoirs of Coleoptera* III.
64. *Euschides globicollis* Csy. *Memoirs of Coleoptera* III.
Northwest Kansas.
65. 7281 *Euschides convexus* Lec. *Memoirs of Coleoptera* III.
Western Kansas.
66. *Euschides gracilior* Csy. *Memoirs of Coleoptera* III.
67. *Euschides facilis* Csy. *Memoirs of Coleoptera* III.
Western Kansas.
68. *Asidopsis*, subspecies *opaca* Csy. *Memoirs of Coleoptera* III.
69. *Asidopsis*, subspecies *futilis* Csy. *Memoirs of Coleoptera* III.
70. *Asidopsis collega* Csy. *Memoirs of Coleoptera* III.
State University collection.
71. 7898 *Xylophilus melshimeri* Lec.
Onaga, Kan. Collected by Crevecoeur.
72. *Anthicus lutulentus* Csy.
Meade county; September.
73. 8045 *Gnathium texana* Horn.
Englewood, Kan.
74. 8051 *Zonites rufa* Lec.
One specimen. Salina, Kan. Rare.
75. *Apion*, sp.
Medora, Kan.; October.
76. *Thecasternus affinis* Lec.
Western Kansas.
77. *Ephicerus sulcatus* Csy.
Western Kansas.
78. 8427 *Phytonomus punctatus*.
One ♀. North Topeka; September 17, 1910. Collected by E. G. Titus.

79. *Phytonomus trisittatus* Lec.
80. 8430 *Phytonomus comptus* Say.
81. 10824 *Macrops dorsalis* Dietz.
One specimen. Scott City; July.
82. *Miarus consuetus* Csy.
83. Near 11173 *Nicentrus ingenuus* Csy.
Onaga, Kan. Collected by Crevecoeur.
84. 8996 *Sphenophorus sayi* Gyl.
Onaga, Kan. Collected by Crevecoeur.

V.
MISCELLANEOUS PAPERS.

1. "PHENOMENA BEAUTIFUL."
By W. A. COOK.
2. "WITCHING FOR WATER AND OTHER THINGS."
By J. T. LOVEWELL.
3. "UNIVERSITY EXTENSION."
By DEWITT C. CROISSANT.

PHENOMENA BEAUTIFUL.

By W. A. COOK, Baker University, Baldwin, Kan.

THE human eye, one of the most valuable of our members, is one of the easiest to deceive of our sense organs. Looking through a screen door, the plane of which is at right angles to the line of vision, the rising moon seems to send its rays in straight lines forming a Greek Cross, the arms running parallel to the wires in the screen. Turn the screen to an angle of forty-five degrees and the horizontal bar of the cross divides into two bars making an angle of from forty-five to sixty degrees with each other, depending on the mesh of the screen. The rays of light coming through the screen between the arms of the cross are deflected until they do not reach the eye, hence only those coming through in straight lines are seen.

The mirage, which may well be termed "Phenomena Wonderful," is one of the greatest illusions the eye beholds. The sights and scenes depicted in the old poem of "Seeing Things at Night" do not approach the wonderfulness of the mirage. But the mirage has another quality, that of beauty, and the more appropriate name would be "Phenomena Beautiful." So leaving out the physical principles involved in the mirage, which are familiar to all, the writer will present with the use of charts some illustrations that it has been his privilege to see, and which will warrant the name "Phenomena Beautiful."

Traveling westward from Salina, along the Smoky Hill river, an observer may see the most wonderful and most beautiful shifting scenery. Hills suddenly rise out of the midst of the blue of beautiful lakes, to shiver and smoke like active volcanoes for a few minutes and then as suddenly sink back into the lake, or being torn into fragments gradually vanish away into nothingness. The beautiful lakes themselves are ever just a little beyond, settling in among the hills or spreading away to limitless distances over the prairie. Around the borders of these lakes familiar objects appear near at hand, as if by magic, or assume grotesque shapes as they come and go in the kaleidoscopic view. Hence the name Smoky Hill river.

Imagine yourself traveling over the level prairie where sight travels for twenty or thirty miles unobstructed, and see three miles before you a herd of cattle stringing across the prairie at right angles to your road. Then suddenly find yourself on the shore of one of those beautiful shimmering lakes. While you are viewing with wonder the beauty spread before you, you soon have it spoiled by the grotesque, for the cattle coming up to the edge of the lake find legs fifty feet long on which they waded out into the lake and disappear. Travel a mile farther and you again come in sight of the cattle wending



their way across the prairie on their ordinary short legs and none the worse for having passed through the magic waters in their "Seven League Boots." Such scenes are very common where the buffalo grass causes the unequal heating of the atmosphere so that you look, not straight ahead, but along rays of light that lead upward into the smoky blue of the atmosphere, and the objects which chance to be on the margin of

this illusion struggle to maintain their proper shapes, with results both fascinating and ridiculous.

The mirage does not belong to any particular season of the year. On New Year's morning in 1896 the writer stood on the north slope of Hackberry creek in Gove county, and looked over a bluff more than one hundred feet high on the south side of the creek, and saw distinctly a train of cars on the Missouri Pacific railroad fully thirty miles to the south. Not only did the train stand out clear and plain, but above it, with wheels upward and the smoke of the two merging, was another; and immediately above this one, with wheels against wheels, was the third train. This view lasted for about three minutes in fairly perfect form. There was a coat of sleet and ice on the ground at the time, and as the sun's rays struck the ice they were reflected back into the air, super-heating a layer some distance from the ground, thus the three layers of atmosphere produced the extraordinary view.

In April of 1891, and again in the morning, I viewed the most extensive mirage I have ever seen. This mirage was of especial clearness and of about seven minutes' duration in all directions, and lingering as long as fifteen minutes in some directions. I saw this mirage from the prairie about half way between Gove City and Grainfield, from a point where ordinarily none of the points to be mentioned were visible. On the Union Pacific railroad I saw Collyer, Quinter, Park, Grainfield, Grinnell and Oakley; to the north of these Hoxie was in view; toward the south I could see Gove City, Tiffany Rocks, Castle Rock, Orion, Jerome, Shields, and Pendennis. I had the feeling of standing in the bottom of a huge basin and looking outward and upward to where the various places were located. My range of vision was fully thirty miles to the north and about forty miles to the south. Toward the southwest was the only place where the view was not clear, and in this direction the hills of the Smoky Hill river were blurred with haze.

One of the most beautiful of these phenomena was observed in October of 1892. This, however, was observed at night and was different, although involving the same principles as the mirage. The moon was nearly full and nearly overhead. Around the moon was a very clear primary halo or ring, and outside a well-defined secondary ring. There was a second primary ring one edge of which passed through the moon and

the other through the secondary ring. There was also a mere trace of another secondary ring around this second primary ring. This extraordinary occurrence was seen by many people, and some of the more superstitious thought it a portent of some dire calamity. It was only another manifestation of the "Phenomena Beautiful," showing that the physical laws governing light were applicable at night as well as in the day.

As stated in the beginning, the writer has not attempted to discuss the physical laws governing these phenomena, but has presented only a few of the extraordinary illustrations of the mirage seen in a twenty-year residence in the midst of the magic scenery of the Smoky Hill country of western Kansas.

“WITCHING” FOR WATER AND OTHER THINGS.

By J. T. LOVEWELL, Topeka.

FROM time immemorial, at least for hundreds of years, there has existed a widespread belief that certain persons have the ability to discover underground streams of water through the agency of a forked twig of witch-hazel, peach or willow, which, held in a certain way, is moved downward on passing over a subterranean stream or body of water.

The forked twig is not essential, for a watch, suspended by its chain, or any heavy body similarly supported pendulum-wise, will, it is said, set up vibrations on being carried over subterranean water. We had in Topeka a believer in water-witching, who found his carriage whip held by its slender end was an effective indicator of water, bowing down under its influence. The common name with us for persons who thus locate wells is water-witches. In England they call them dowzers or dippers, while in France they are termed sourciers, or discoverers of sources. The Germans have a term with similar meaning, wasser finders. Their business is important enough so that we may call it a trade, to which is added generally the prosaic occupation of well digger. They commonly are persons with little pretension to culture or scientific knowledge, and it is surprising how many who want a well dug are willing to contribute a fee for witching it. They may not admit a belief in the witch-hazel, but justify the practice by saying that everybody knows in digging a well it makes a great difference where you put it, and these diggers by long experience can tell the best place by general appearance of the locality or by the divining rod, it matters not which, and so they earn their fee.

We propose to examine the validity of these claims of the water-witches with the candor due to many people of acknowledged ability and integrity who believe in them. There is a great deal of mystery in the construction of this earth on whose surface we live. We can not penetrate it more than about one mile, nor can we rise above it more than about five miles. Geology enables us to guess more or less closely what is the construction of this thin shell less than one ten-thou-

sandth part of the diameter of the earth. The seas, lakes and rivers send up into the air their tribute of vapor, which is finally precipitated upon the earth and is carried by gravity back to Mother Ocean. Part of this precipitation soaks into the soil, as we say; it settles down, saturates the surface deposits and the rocks below, and finally reaches a ground-water level where it never dries out, and this is the layer which our wells must penetrate. Gravity still acts upon the water at this level and it still continues its onward journey to the sea.

There are very likely rifts in rocks where are underground rivulets and our wells strike some of them, but more often the movement is a percolation through gravel and sand where capillary forces come into play, modifying and retarding the flow. Most wells simply enter this porous stratum and in no proper sense do they tap a flowing stream.

They only act as reservoirs and gather up the water as it flows into the cavity of the well. In some instances water will come into a well which at first appears to be dry, and after a time there will be a supply of water sufficient for domestic use. This means that the flow of water into the well cavity, at first imperceptible, after a time becomes stronger as obstructions dissolve out and is sufficient for the demands of the well. With these facts before us with reference to the sources of water in our wells, we may consider the pretensions of the source finders. It is evident that water may be found almost anywhere in the crust of the earth if penetrated to the ground-water level, but the question is, Can the favorable or unfavorable place for a well be discovered by the divining rod? It is claimed that there is a sort of attraction of water upon the rod but this is not manifested except in the hands of persons of peculiar temperament. This exception is the stumbling block in the way of any accurate tests. It introduces a psychological inquiry and begs the question if we are to decide it by the established principles of science.

It would seem that the first question to settle is whether such discoveries are actually made by the means employed, and here we are met with abundance of conflicting testimony. Many people of good faith and intelligence have asserted that water has been found in this way much oftener than the doctrine of chance would justify, and yet just the same evidence may be found for table tipping, clairvoyance, "spirit rappings," etc.

When the French scientists asked Franklin to explain why a fish swimming in water loses its weight that philosopher wisely asked if the fish really did lose its weight, and testing by experiment they found the fish weighed just as much in water as out of it, and there was nothing to explain.

So when we investigate the witch-hazel our first inquiry should be whether it is drawn down when passed over a stream or body of water. Our test is not quite so simple as was the case with Franklin's fish. In the first place it costs considerable to verify by digging and the chances are that we shall find water anywhere. In the second place the "witch" must be a person of peculiar temperament, and so we have a psychological problem thrust upon us and must argue with spirit rappers, clairvoyants, table tipping, levitation, and witches pure and simple, such as Cotton Mather, Luther, and many others have believed in. All who enter this realm may as well abandon science. Nevertheless experiments have been made in Germany, France, and in this country, with the result that no valid proof has been found to substantiate the claims of the water-witches, and few scientists give them any credence.

But there is another phase of the subject which "queers" the whole proposition. It is claimed that the divining rod can discover oil and gas just as certainly as it reveals water. It can also show where are deposits of lead, zinc, and the precious metals. This, of course, opens up a profitable trade to the "fakirs," who never lack victims.

The credulous believers try to silence their critics by quoting the old Shakesperian adage, "There are more things in heaven and earth than are dreamed of in your philosophy." Then they talk about electricity, radium, the constitution of matter, as if these puzzles of science were excuses for belief in "old wives' fables." My conclusion is that all the claims of water-witches are delusions unworthy scientific consideration.

UNIVERSITY EXTENSION.

By DEWITT C. CROISSANT.

AS A REPRESENTATIVE of the Extension Division of the University of Kansas I very greatly appreciate the opportunity to appear before you and to present the question of the possibility of our mutual coöperation. Your purpose is the discovery of knowledge; the purpose of the Extension Division is the dissemination of knowledge and of education. The Extension Division is trying to make available to all of the people of the state all of the facilities of the University and of such bodies as your own. We are trying to make the state more efficient by giving it the material with which to increase its own efficiency by its own efforts. Your purpose is along the same line, for all research has as its ultimate aim the benefit of humanity.

The Extension Division does not restrict itself to the strictly University activities, but seeks the material which it endeavors to communicate to the various citizens of the state in whatever direction it may be found. We are giving, for instance, courses through correspondence in fire protection, and are conducting other courses in coöperation with the Board of Health of the state, and stand ready at any time to introduce work which may be a benefit to the citizens of the state wherever that work may be found. We are glad to coöperate with this or any other organization in disseminating knowledge which may be of value to the state. We are, for instance, preparing to send out material to all sorts of people on weights and measures; we prepare outlines for clubs or private studies; we furnish material to go with these outlines; and we are glad to list lectures by men of established ability who have something worth while to communicate.

There are various activities of the Extension Division, all of which are available to you, if they are practicable, for spreading a knowledge of the work that you are doing for the benefit of mankind. In the first place there is our Correspondence-study Department, which is not limited to purely academic work or to academic men. We are giving, through this department, work in vocational lines for men who are

working in the trades, and who are not able to go to regular schools; we are offering a course by the fire marshal of the state, and we are conducting a course in vital statistics by the state registrar. If you have work that can be put into this department we shall be very glad indeed to use it.

The Municipal Reference Bureau deals with all sides of the life of the various communities; it deals with the engineering, with the legal, with the social, with the administrative phases of community life. In connection with this Municipal Reference Bureau we are maintaining a library, and if there are any of your publications, papers, or special information which any of you may possess which will bear on municipal problems, we shall be very glad indeed to have them and to file them with our other material so that they may be available for the uses of those whom they would benefit the most.

So in our club-study work, in which we prepare outlines for dozens of clubs in the state, and in which we furnish a great many lecturers for the various communities, it may be that you are possessed of information or are able to suggest lines of work that would be of benefit to the serious and studious women and men of this state. If so, we should be very glad to have such suggestions as may come from your experience along special lines, and shall be very glad indeed to base our outlines and to furnish the material along these lines.

One of the most important phases of the University Extension work is the furnishing of what are called package libraries, which are clippings from various publications and which are furnished free of charge to those who may be interested in writing for them. The articles on various subjects are bound together and are furnished to those who are working in the subject. We suggest subjects to these people by publishing every year a list of the principal package libraries, and we shall be glad indeed in this field to have any contributions that you may make.

So, too, we publish from time to time various bulletins on subjects of general or public interest, and we are glad to have contributions from any source whatever towards the making of these bulletins. The only question involved is as to the public and general value and interest of the material that we present.

The University Extension Division, which you see is primarily an intermediary for the distribution of information and knowledge, is trying to get results. We try to attack our problems from the practical side, and are always willing to give credit to those who do the real work. Coöperation is one of the modern tendencies, and we of the University are glad to offer you our facilities for spreading the gospel of knowledge and of efficiency.

VI.
NECROLOGY.

1. ROBERT KENNEDY DUNCAN.
2. ALTON HOWARD THOMPSON.

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ROBERT KENNEDY DUNCAN.

WAS born in Brantford, Ontario, November 1, 1868, and died in Mercy Hospital, Pittsburg, Pa., February 18, 1914. His Scotch-Irish descent was quite characteristically shown in his logical thinking and farsightedness and in his optimistic outlook and happy disposition.

He graduated from the University of Toronto in 1892, with first-class honors in physics and chemistry. He was Fellow in Chemistry in Clark University in 1892-'93, and a graduate student in Columbia University in 1897-'98. The University of Pittsburg conferred upon him the honorary degree of Doctor of Science, in 1912, during the exercises celebrating its 125th anniversary.

He was instructor in physics and chemistry in the Auburn (N. Y.), Academic High School, 1893-'95, Dr. Julius Sachs' Collegiate Institute (N. Y.), 1895-'98, the Hill School, Pottstown, Pa., 1898-1901, Professor of Chemistry in Washington and Jefferson College, 1901-'06, Professor of Industrial Chemistry in the University of Kansas, 1906-'10, Director of Industrial Research and Professor of Industrial Chemistry at the University of Kansas and at the University of Pittsburg, 1910-'13.

Doctor Duncan became a member of the Kansas Academy of Science when he came to Kansas in 1906. He was a member also of the American Chemical Society, the Society of Chemical Industry, the American Association for the Advancement of Science, the Society of the Sigma Xi, the Royal Society of Arts, and a Fellow of the Chemical Society of London.

In 1899 he married Miss Charlotte M. Foster, of Brantford, Ontario, who survives him, as do also his only daughter, Elspeth, and his brothers, Dr. Norman Duncan, the well-known story-writer, and Ernest H. Duncan, of Willoughby, Ohio.

In the years 1900, 1903, 1904 and 1906 Doctor Duncan studied abroad, gathering material to be used in his chosen field of literary activity—the interpretation and popularizing of chemical science—in which his clear and charming style made him an acknowledged master. In addition to his nu-

merous contributions to the magazines—notably Harper's—he was the author of "The New Knowledge," published in 1905, "The Chemistry of Commerce," 1907, and "Some Chemical Problems of To-day," 1911.



ROBERT KENNEDY DUNCAN.

He made a thorough investigation of the conditions under which the chemists employed in American manufactories do their work, and promoted their welfare by advocating the betterment of these conditions and the greater recognition of the value of their services. A leading motive in his later writings was to bring together the scientifically and technically

trained researcher and the American industrialist into mutually advantageous correlation for the solution of important manufacturing problems and the attainment of increased efficiency. This culminated in the birth of a new idea in education—the Industrial Fellowship—which was conceived while he was attending the Sixth International Congress of Applied Chemistry, held in Rome, in 1906, and was put into actual operation in the University of Kansas in January, 1907. The experiment soon attracted the attention of industrialists throughout the country, and in 1910 the University of Kansas authorized Professor Duncan, while retaining his full position as Director of the Department of Industrial Research in Kansas, to accept as well a similar position at the University of Pittsburg, in order that these Fellowships might be established in the East as well as in the West.

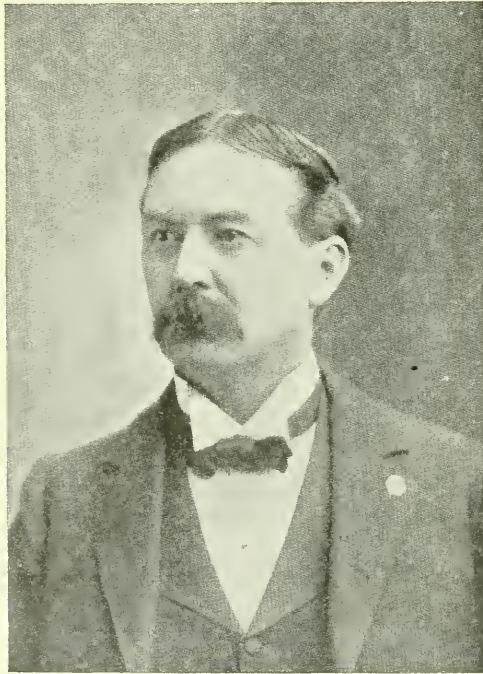
At the time of Doctor Duncan's death a new granite structure was being erected to be the home of the Mellon Institute of Industrial Research and School of Specific Industries. Its completion has been amply provided for and it will be a monument to his unselfish devotion to a glorious vision.

What was it that enabled this man, genius though he was, to accomplish such extraordinary results in so short a time? Two very simple words fully answer this question: faith and love—faith in God—faith in humanity—faith in "his boys"—love for God—love for humanity—love for "his boys." He was a father to those who were privileged to work under his guidance and inspiration. Their joys and sorrows were his—and his were theirs. Whenever one of them made a discovery his first expression was, "How fine for the boy!" From the very beginning he impressed upon them the importance of maintaining the "spirit of the laboratory," which was expressed in the motto on its walls:

"Quæcunque igitur volueritis ut faciant vobis homines, ita et vos facite eis, ita enim est lex et prophetæ." (Matt. vii, 12.)

A. H. THOMPSON, D. M. D.

ALTON HOWARD THOMPSON was born April 8, 1849, at Logansport, Ind., his parents coming from Juniata county, Pennsylvania, and his childhood was spent in Logansport, Ind., Juniata county, Pennsylvania, and in Dalton, Ga., where his father was in the banking business. In 1866 he studied dentistry in Mifflintown, Juniata county, Pennsylvania, and after practicing in country towns came to Topeka, Kan., in 1869, where he has practiced till the present. In 1872 he graduated



ALTON HOWARD THOMPSON.

from the Philadelphia Dental College, and during the season of 1899-1900 lectured in that institution. He assisted in the founding of the Kansas City Dental College in 1880, and has lectured there almost continuously ever since, principally on comparative dental anatomy. He has given short courses on the same subject in various other dental colleges.

Having from childhood been much interested in natural science, he soon became attracted to the Academy, and joined it at Lawrence in 1873, and ever since has been a devoted member. At that early day the noble men who were the founders were the active members—Professors Mudge, Parker, Frazer, Snow, and others, who were just in their prime—and furnished a program that was a delight to an enthusiastic amateur. In 1883 he was elected president of the Academy, and gave an address on its history. All through the long years since then he has taken an affectionate interest in it, and cherished as one of the most precious memories of his life the friendships formed there.

He has been a contributor to the Transactions upon anthropological and evolution subjects. He wrote also extensively for dental and medical journals on professional subjects—comparative dental anatomy, and the connection of anthropology and evolution with his profession. He was the author of a small textbook on comparative dental anatomy for dental students. He also wrote some articles on anthropological subjects for dental journals.

He is a fellow of the A. A. A. S.; one of the founders of the American Anthropological Association; member of the American Folk Lore Society, the National Dental Association, the American Medical Association, of two International Dental Congresses, of the Society of Americanists of Europe, and of various state and other dental societies.

In 1875 he married Miss Fannie Geiger, who died in 1903. Two children were born—Isabel, who died in 1897, aged 17, and a son, Wallace. Doctor Thompson was married in 1906 to Miss Helen Moon.

Doctor Thompson has been a prolific writer for dental journals, an essayist before various dental societies, mainly on topics relating to his specialty of comparative dental anatomy, on which subject he wrote a textbook, "Comparative Dental Anatomy," for dental students, which was published in 1899 by the S. S. White Dental Manufacturing Company. This book is now being revised by Dr. Martin Dewey, and will be published during the summer.

Following this, with his other hobbies, archæology and anthropology, Doctor Thompson has carried his studies of the comparative anatomy of the teeth to the different races, and

made some extensive investigations on the Peruvians, Mexicans and Mound Builders. The list of scientific articles by Doctor Thompson covers the field of dentistry as few others have done.

In 1880 Doctor Thompson assisted in founding the Kansas City Dental College, and he was identified with it continuously, until his sickness, as professor of "odontography, human and comparative." In the winter of 1899-1900 he went to Philadelphia, and was connected with the Philadelphia Dental College for the session, teaching comparative anatomy. He has given courses at various times at Northwestern University Dental School, University of Tennessee, and other schools.

Doctor Thompson was a member of the Presbyterian church. He has served as president of the Kansas State Dental Association and has been connected with a number of societies of his profession.

Doctor Thompson had symptoms of paralysis some years ago, and the disorder steadily increased, and for the past year he has been incapacitated for his profession. His mind remained clear till a few days before death came to his relief, on May 13, 1914.

By his death our Academy loses one of its early and most useful members. We all enjoyed his enthusiastic and delightful comradeship, and shall cherish his memory.

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