TRANSACTIONS

OF THE

KANSAS ACADEMY OF SCIENCE.

VOL. XXI, PART I.

CONTAINS

LIST OF OFFICERS, PAST AND PRESENT; MEMBERSHIP LIST JANUARY 1, 1908; SKETCH OF THE ACADEMY; CONSTITUTION AND BY-LAWS; MINUTES OF FORTIETH ANNUAL MEETING; PRESIDENT'S ADDRESS, AND SOME PAPERS READ.

December, 1907.

STATE PRINTING OFFICE,
TOPEKA, 1908.
1195

STATE CAPITOL BUILDING.
Containing rooms of the Kansas Academy of Science.

TRANSACTIONS

OF THE

KANSAS ACADEMY OF SCIENCE.

VOL. XXI, PART I.

CONTAINS

LIST OF OFFICERS, PAST AND PRESENT; MEMBERSHIP LIST JANUARY 1, 1908; SKETCH OF THE ACADEMY; CONSTITUTION AND BY-LAWS; MINUTES OF FORTIETH ANNUAL MEETING; PRESIDENT'S ADDRESS, AND SOME PAPERS READ.

December, 1907.

STATE PRINTING OFFICE,
TOPEKA, 1908.
1195

OFFICERS OF THE ACADEMY, 1908.

President	E. HAWORTH	Lawrence.
Vice-president	F. B. DAINS	Topeka.
Vice-president	J. M. McWHARF	Ottawa.
Treasurer	ALVA J. SMITH	Emporia.
Secretary	J. T. LOVEWELL	Topeka.

Past Presidents of the Academy.

1869,'70..... B. F. Mudge.
1871-'73..... John Fraser.
1874-'78..... F. H. Snow.
1879,'80..... B. F. Mudge.
1881,'82..... J. T. Lovewell.
1883........ A. H. Thompson.
1884,'85..... R. J. Brown.
1886........ E. L. Nichols.
1887........ J. D. Parker.
1888........ J. R. Mead.
1899........ T. H. Dinsmore, jr.
1890........ G. H. Failyer.
1891........ Robert Hay.
1892........ E. A. Popenoe.
1893........ E. H. S. Bailey.
1894........ L. E. Sayre.
1895........ Warren Knaus.
1896........ D. S. Kelly.
1897........ S. W. Williston.
1898........ D. E. Lantz.
1899........ E. B. Knerr.
1900........ A. S. Hitchcock.
1901........ E. Miller.
1902........ J. T. Willard.
1903........ J. C. Cooper.
1904........ Edward Bartow.
1905........ L. C. Wooster.
1906........ F. O. Marvin.
1907........ J. A. Yates.

PAST VICE-PRESIDENTS.

1869,'70..... J. S. Whitman.
1871........ B. F. Mudge.
1872,'73..... B. F. Mudge and Dr. R. J. Brown.
1874........ J. A. Banfield and J. D. Parker.
1875........ B. F. Mudge and J. D. Parker.
1876,'77..... B. F. Mudge.
1878........ B. F. Mudge and J. H. Carruth.
1879-'82..... J. H. Carruth and Joseph Savage.
1883........ J. R. Mead and G. E. Patrick.
1884........ F. H. Snow and Joseph Savage.
1885........ E. L. Nichols and G. H. Failyer.
1886........ J. D. Parker and N. S. Goss.
1887........ J. R. Mead and E. H. S. Bailey.
1888........ E. H. S. Bailey and T. H. Dinsmore, jr.
1889........ E. H. S. Bailey and G. H. Failyer.
1890........ D. S. Kelly and F. W. Cragin.
1891........ F. W. Cragin and O. C. Charlton.
1892........ F. O. Marvin and Mrs. N. S. Kedzie.
1893........ J. T. Willard and E. B. Knerr.
1894........ I. D. Graham and J. D. Hewitt.
1895........ I. D. Graham and S. W. Williston.
1896........ S. W. Williston and D. E. Lantz.
1897........ D. E. Lantz and A. S. Hitchcock.
1898........ C. S. Parmenter and L. C. Wooster.
1899........ A. S. Hitchcock and J. R. Mead.
1900........ E. Miller and J. C. Cooper.
1901........ J. C. Cooper and L. C. Wooster.
1902........ Edward Bartow and J. A. Yates.
1903........ Edward Bartow and J. A. Yates.
1904........ L. C. Wooster and B. F. Eyer.
1905........ F. W. Bushong and W. A. Harshbarger.
1906........ B. F. Eyer and J. E. Welin.
1907........ E. Haworth and F. B. Dains.

Past Officers of the Academy — Concluded.

SECRETARIES.

1869-'73	J. D. Parker.
1874,'75	John Wherrell.
1876,'77	Joseph Savage.
1878-'89	E. A. Popenoe.
1890-'92	E. H. S. Bailey.
1893	A. M. Collette.
1894-'98	E. B. Knerr.
1899-1901	D. E. Lantz.
1902-'04	G. P. Grimsley.
1905-'07	J. T. Lovewell.

TREASURERS.

1869-'73	F. H. Snow.
1873-'75	R. J. Brown.
1876,'77	W. K. Kedzie.
1878-'83	R. J. Brown.
1884,'85	A. H. Thompson.
1886-'90	I. D. Graham.
1891	F. O. Marvin.
1892-'95	D. S. Kelly.
1896	L. E. Sayre.
1897-1900	J. W. Beede.
1901,'02	E. C. Franklin.
1903-'07	Alva J. Smith.

KANSAS ACADEMY OF SCIENCE.

CAPITOL BUILDING,
TOPEKA.

Compliments of

J. T. LOVEWELL,
Secretary.

Office and part of Library.

CONTENTS OF THIS VOLUME.

MEMBERSHIP OF THE ACADEMY,

January 1, 1908.

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

HONORARY MEMBERS.

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

ASSOCIATE MEMBERS.

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

LIFE MEMBERS.

E. H. S. Bailey, Ph. D., 1883, Univ. of Kansas, Lawrence.
J. C. Cooper, 1877, mineralogist, Topeka.
F. W. Cragin, Ph. D., 1880, Colorado Springs.
L. L. Dyche, M. S., 1881, Univ. of Kansas, Lawrence.
Geo. H. Failyer, Ph. D., 1879, Dept. of Agr., Washington, D. C.
E. C. Franklin, Ph. D., 1884, Stanford Univ., Stanford Univ., Cal.
I. D. Graham, 1879, with *Kansas Farmer*, Topeka.
Erasmus Haworth, Ph. D., 1882, Univ. of Kansas, Lawrence.
Warren Knaus, M. S., 1884, editor, McPherson.
D. E. Lantz, M. S., 1887, Biological Surv., Washington, D. C.
J. T. Lovewell, Ph. D., 1878, chemist, Topeka.
F. O. Marvin, C. E., 1884, Univ. of Kansas, Lawrence.
J. R. Mead, 1879, Wichita.
Ephraim Miller, Ph. D., 1873, Univ. of Kansas, Lawrence.
E. A. Popenoe, A. M., 1872, Kansas Agr. Coll., Manhattan.
L. E. Sayre, Ph. M., 1885, Univ. of Kansas, Lawrence.
Alva J. Smith, 1903, county surveyor, Emporia.
B. B. Smyth, 1880, curator Goss ornith. coll., Topeka.
F. H. Snow, Ph. D., 1868, Univ. of Kansas, Lawrence.
C. H. Sternberg, 1896, explorer and collector, Lawrence.
A. H. Thompson, D. D. S., 1873, Topeka.
M. L. Ward, D. D., 1880, Ottawa Univ., Ottawa.
J. T. Willard, M. S., 1883, Kansas Agr. Coll., Manhattan.
S. W. Williston, Ph. D., 1880, Univ. of Chicago, Chicago, Ill.

ANNUAL MEMBERS.

L. O. Adams, 1903, Univ. of Kansas, Lawrence.
Orr Adams, 1898, Telluride, Colo.
Frank G. Agrelius, 1905, Lawrence.
Wm. Aitkinhead, 1906, Washburn Coll., Topeka.
H. C. Allen, 1904, McPherson.
Carroll D. Armstrong, M. D., 1905, Salina.
John J. Arthur, 1904, Topeka.
C. H. Ashton, 1903, Univ. of Kansas, Lawrence.
W. M. Bailey, 1906, teacher, Holton.
Harvey W. Baker, 1902, Kansas Agr. Coll., Manhattan.
Elam Bartholemew, M. S., 1905, Stockton.
Edward Bartow, Ph. D., 1897, State Water Surv., Urbana, Ill.
W. J. Baumgartner, M. D., 1904, Univ. of Kansas, Lawrence.
Frank G. Bedell, 1904, Iola.
J. W. Beede, Ph. D., 1894, Univ. of Indiana, Bloomington, Ind.
Julius Brandt, 1907, student, Lindsborg.
H. H. Braucher, 1907, teacher, Emporia.
F. W. Bushong, B. S., 1896, Univ. of Kansas, Lawrence.
H. P. Cady, 1904, Univ. of Kansas, Lawrence.
M. E. Canty, 1903, Buffalo.
Charles I. Corp, 1905, Univ. of Kansas, Lawrence.
Ewing N. Collett, 1903, Indian Univ., Bacone, I. T.
Rev. John T. Copley, 1903, Clinton.
R. W. Coppedge, 1905, teacher high school, Topeka.
E. G. Corwine, 1905, Mulvane.
Ralph K. Crawford, 1904, Univ. of Kansas, Lawrence.
F. F. Crevecœur, 1899, Onaga.
F. B. Dains, Ph. D., 1902, Washburn Coll., Topeka.
Emil O. Deere, A. M., 1905, Bethany Coll., Lindsborg.
James Dickson, 1904, Univ. of Kansas, Lawrence.
Robert K. Duncan, 1906, Univ. of Kansas, Lawrence.
R. B. Dunlevy, B. S., 1896, Southwest Kan. Coll., Winfield.
E. X. H. Dunmire, 1905, Univ. of Kansas, Lawrence.
H. W. Emerson, 1904, Univ. of Kansas, Lawrence.
B. F. Eyer, B. S., 1894, Kansas Agr. Coll., Manhattan.
T. L. Eyerly, 1906, Canadian, Tex.
W. F. Faragher, 1904, Univ. of Kansas, Lawrence.
Thomas B. Ford, 1905, Univ. of Kansas, Lawrence.
Lillian E. Fowler, 1905, teacher high school, Ottawa.
A. O. Garrett, 1901, teacher high school, Salt Lake City, Utah.
Frank Gephart, 1906, medical school, Evanston, Ill.
R. W. Gragg, 1907, laundry, Bartlesville, I. T.
O. S. Groner, 1907, Ottawa Univ., Ottawa.
Brice E. Hammers, 1904, chemist, Topeka.
Dr. Eva Harding, 1904, Topeka.
H. J. Harnly, B. S., 1903, McPherson Coll., McPherson.
W. A. Harshbarger, B. S., 1900, Washburn Coll., Topeka.
Frank Hartman, 1905, high school, Wichita.
L. D. Havenhill, 1904, Univ. of Kansas, Lawrence.

T. J. Headlee, 1907, professor of entomology, Manhattan.
Dr. Francis C. Herr, 1905, Ottawa.
W. C. Hoad, 1904, Univ. of Kansas, Lawrence.
Gertrude E. Hole, 1906, Manhattan.
H. A. Horton, 1906, McPherson.
W. F. Hoyt, A. M., 1902, Wesleyan Univ., Salina.
L. C. Hodson, 1905, Univ. of Kansas, Lawrence.
B. C. Hubbell, 1905, Concordia.
Albert K. Hubbard, 1904, Univ. of Kansas, Lawrence.
Thomas M. Iden, 1897, State Norm. Sch., Emporia.
John J. Jewett, 1902, Sawtelle, Cal.
A. W. Jones, B. S., 1894, Wesleyan Univ., Salina.
George F. Kay, 1904, Univ. of Kansas, Lawrence.
W. H. Keller, 1898, teacher high school, Effingham.
Leslie A. Kenoyer, 1906, Independence.
Harry L. Kent, 1904, State Norm. Sch., Hays.
John H. Klopfer, 1904, Topeka.
Pierce Larkin, 1902, high school, Helena, Okla.
M. A. Low, 1906, attorney, Topeka.
L. A. Lowther, 1907, superintendent of schools, Emporia.
F. A. Marlatt, 1907, machinist, Agr. Coll., Manhattan.
R. Matthews, D. D. S., 1898, Wichita.
D. F. McFarland, 1903, Univ. of Kansas, Lawrence.
J. M. McWharf, M. D., 1902, Ottawa.
Grace R. Meeker, 1899, Ottawa.
C. F. Menninger, M. D., 1903, Topeka.
H. L. Miller, 1904, high school, Topeka.
W. L. Moodie, 1906, Univ. of Kansas, Lawrence.
Travis Morse, 1903, Iola.
H. N. Moses, M. D., 1907, Salina.
C. A. Nash, 1907, teacher, Emporia.
J. H. Newby, 1899, Osage City.
N. P. Nielsen, 1906, architect, Topeka.
A. M. Nissen, A. M., 1888, teacher high school, Wetmore.
Henry N. Olson, 1905, Bethany Coll., Lindsborg.
Frank Patrick, 1903, Topeka.
Leslie F. Paull, 1903, manual tr. sch., Kansas City, Mo.
L. M. Peace, 1904, Univ. of Kansas, Lawrence.
Arthur D. Pitcher, 1906, Univ. of Kansas, Lawrence.
Norman Plass, D. D., 1902, president Washburn Coll., Topeka.
M. A. Pond, 1906, teacher, Topeka.
L. M. Powell, M. D., 1906, Topeka.
Charles H. Popenoe, 1903, Washington, D. C.
C. S. Prosser, M. S., 1892, Ohio State Univ., Columbus, Ohio.
W. S. Prout, 1904, Columbia University, N. Y.
Albert B. Reagan, 1904, Indian School, Mora, Wash.
W. B. Robertson, 1905, Univ. of Kansas, Lawrence.
B. R. Rogers, D. V., 1907, Agr. Coll., Manhattan.
W. G. Russell, 1905, Russell.
D. C. Schaffner, 1903, Coll. of Emporia, Emporia.

J. H. Schaffner, A. M., M. S., 1902, Univ. of Ohio, Columbus, Ohio.
Theo. H. Scheffer, 1903, Emporia.
Eva Schley, 1903, teacher high school, Topeka.
C. H. Shattuck, 1899, Washburn Coll., Topeka.
Roscoe H. Shaw, 1904, Univ. of Missouri, Columbia, Mo.
Miriam Sheldon, 1906, University of Chicago, Ill.
E. T. Shelley, M. D., 1902, Atchison.
Claude J. Shirk, 1905, McPherson Coll., McPherson.
J. A. G. Shirk, 1904, Ottawa Univ., Ottawa.
J. O. Short, 1907, electrician, Salina.
Paul L. Shuey, 1905, Univ. of Kansas, Lawrence.
Ralph C. Shuey, 1905, Univ. of Kansas, Lawrence.
Eugene G. Smyth, 1901, Topeka, Kan.
W. N. Speckman, Ph. D., 1903, Wesleyan Univ., Salina.
William O. Starin, 1906, Univ. of Kansas, Lawrence.
B. T. Stauber, D. D., 1903, Salina.
S. G. Stewart, M. D., 1904, Topeka.
Chas. M. Sterling, 1904, Univ. of Kansas, Lawrence.
E. F. Stimpson, 1904, Univ. of Kansas, Lawrence.
Edgar Thomas, 1907, State Normal, Emporia.
F. J. Titt, B. S., 1898, Kingfisher Coll., Kingfisher, Okla.
J. E. Todd, 1907, geologist, Univ. of Kansas, Lawrence.
David Train, 1907, student, Lindsborg.
E. S. Tucker, 1904, Dept. Agr. Asst., Dallas, Tex.
W. A. Van Varis, 1907, State Normal, Emporia.
J. D. Walters, M. S., 1894, Kansas Agr. Coll., Manhattan.
C. D. Weaver, M. D., 1902, McPherson.
Ella Weeks, 1903, Kansas Agr. Coll., Manhattan.
J. E. Welin, 1899, Bethany Coll., Lindsborg.
Archie J. Werth, 1906, Univ. of Kansas, Lawrence.
C. H. Withington, 1903, Kansas Agr. Coll., Manhattan.
H. I. Woods, M. S., 1902, Washburn Coll., Topeka.
L. C. Wooster, Ph. D., 1897, State Norm. Sch., Emporia.
J. A. Yates, M. S., 1897, Ottawa Univ., Ottawa.

Total number of members, January 1, 1908, 167.

MINUTES.

Fortieth Annual Meeting, Kansas Academy of Science, November 28, 29 and 30, 1907, at Emporia, Kan.

ACCORDING to announcement, the Kansas Academy of Science met at Norton Science Hall of the Normal School, Emporia, and was opened at eight P. M. with the president, J. A. Yates, in the chair. About twenty members were present.

The secretary, being called upon for his report, referred to the proceedings of last year, published in the announcement, and was excused from reading these minutes.

He reported at length on the changes made in rooms for the Academy in the state-house, by the Executive Council.

The rooms now occupied are on the fourth floor, and consist of the two northeast rooms and the adjacent corridor. The latter gives abundant space for the museum, only lacking sufficient light, and this deficiency we hope will be supplied. The two rooms on the east make commodious quarters for office and library, and on the whole we are better housed than we were in the basement. The space at our command is larger, and gives a chance for development till a new state building will be erected to accommodate the State Historical Society, the State Horticultural Society, the Goss ornithological museum, and the Academy of Science. Each of these departments has extensive libraries as well as display collections, and it is a considerable advantage to the public, when it is wished to visit and inspect the museums in the statehouse, to have them all on the same floor.

THE LIBRARY.

The library continues its growth through exchanges, and through distribution of the various publications in Washington. From the latter source forty-four bound volumes have come to us during the year, many of them quartos and the rest octavos. From the same source 614 unbound volumes, pamphlets, bulletins, and circulars have been received. From exchanges, during the same period, we have acquired 923 unbound volumes and pamphlets.

All these have been filed away, awaiting the time when volumes will be completed and handed over to the state printer for binding. We have not less than 500 volumes awaiting the binder, and as soon as possible these will be bound and placed on our shelves.

In the cataloguing of books we have, at this date, only been able to arrange our books in sets and by states and countries, and a card catalogue of reference is prepared to facilitate the finding of books. We yet await a much-needed subject card catalogue to which seekers for information may refer. The state-house contains a much larger collection of books than is found in any other place in Kansas. First, there is the state library, originally for law-books only, and so naturally under the management of the supreme court. Subsequently large collections of miscellaneous books have been added to the trust of the same board of directors, with the assistance of subordinate boards. Additions are made by exchanges of the various state publications, and by funds provided for the purchase of books. The Stormont medical library and the "traveling library" are distinct parts of the state library, provided for by statute. These are operated by commissions, of which the state librarian is *ex officio* chairman.

Provision is made by law for the State Historical Society to acquire books, and, acting under the statutes, they have accumulated the next largest number in the state-house. For purposes of exchange they may claim "sixty bound copies each of the several publications of the state, and of its societies and institutions, except the reports of the supreme court."

The State Agricultural and Horticultural Societies as well as the Academy of Science have each considerable libraries, obtained by exchange or purchase of books. Of all these the state library is the only one having made any considerable beginning of a card catalogue on the Dewey system. To do this properly requires expert knowledge as well as much labor. For greatest advantage to the state, such a catalogue should include all the libraries in the capitol building, and all of them ought to be brought under one head.

One of the evils of the present lack of system is the accumulation of duplicate copies of many publications, and this is especially true of government works, printed in Washington. While it is true that duplicates may be convenient in some cases, for the greater part it is simply a waste, and the expense of it could supply other much needed wants. If all these libraries were under one management, with a competent head librarian; there could be departments, each covering a certain field, and not including the books belonging to other departments. Thus, the law library would include those publications needed by the courts and lawyers. The scientific department would include all books such as the proceedings of scientific societies, Smithsonian reports, books on geology, natural history, astronomy, mathematics and medicine. Another department would be devoted to literature and history. Each of these would be distinct from the museum collections. The general office would contain encyclopedias, dictionaries and books of reference, as well as the general catalogue of all books found in these libraries. All exchanges would be directed by a single set of officers. Current periodical literature would be kept on file and be accessible for consultation in the department to which it belongs. Our state library would then be of great educational value and a Mecca for all students who come to Topeka.

On motion, the report of the secretary was adopted.

The president announced his appointment of committees as follows:

On nominations: Messrs. Knaus, Bailey, and Miss Meeker.

On resolutions: Messrs. Dyche, J. G. Shirk, and Deere.

On program: Messrs. Bushong, Wooster, and Mead.

On press: Messrs. A. J. Smith, McWarf, and Sayre.

On necrology: Messrs. Lovewell, Thompson, and Mrs. Smyth.

On membership: Messrs. B. B. Smyth, Sternberg, and Hoyt.

On time and place of next meeting: Messrs. C. J. Shirk, Iden, and Scheffner.

On publication: Messrs. Yates, Lovewell, and Dains.

The last committee is composed of the retiring president, the secretary, and one member from Topeka, and was determined by vote of the Academy, according to the rule adopted last year.

TREASURER'S REPORT.

The treasurer was called upon, and reported as follows:

RECEIPTS.

Received from bank (time deposit)	$250 00
Received interest on time deposit	7 50
Received for Transactions sold	3 85
Received fees and dues	124 00
Total	$385 35

EXPENDITURES.

Paid balance due treasurer	$59 27
Paid for badges for 1906	13 00
Paid for badges for 1907	15 00
Paid express on badges	70
Balance on hand	297 38
Total	$385 35

Referred to A. J. Shirk for audit, who reported that he found it correct. Report of treasurer adopted.

The Academy next proceeded to the reading and discussion of papers, of which the following program was published in the announcement of this meeting, and they will be referred to by the numbers given:

PRESIDENTIAL ADDRESS.

1. The Value of the Work of the Scientist to Humanity, James A. Yates.

CHEMICAL PAPERS.

2. Natural Gas Obtained from Trees, F. W. Bushong and D. F. McFarland.
3. Percentage of Extractives in Certain Drugs and Spices, L. E. Sayre.
4. Public Health and the Quality of Medicinal Preparations, L. E. Sayre.
5. Progress of the Survey of the Waters of Kansas—
   Chemical Work, Professors Bailey and Bushong.
   Bacteriological Work, Professor Barber and Mr. Starin.
   Engineering Problems, Professor Hoad.
   Field-work, H. N. Parker, Asst. Hydrographer, U. S. G. S.
6. Steel-hardening Minerals, J. C. Cooper.
7. Gastric Ferments, Dr. C. F. Menninger.
8. On the Reactions of Formanidines, F. B. Dains and E. W. Brown.

GEOLOGICAL PAPERS.

9. Some Studies in Dakota Fossil Plants, A. W. Jones.
10. Summary of Glacial Literature Relating to Glacial Deposits.
11. Animals, Reptiles and Amphibians of the Rosebud Indian Reservation, South Dakota, Albert B. Reagan.
12. My Expedition to the Kansas Chalk, on my own account, and for the Tubingen University, for 1907, Chas. H. Sternberg.
13. A Fossil Tooth and Other Bones from Phillips County, J. T. Lovewell.

BIOLOGICAL PAPERS.

14. Some Observations on the Food Habits of the Blue Jay (*Cyanocitta cristatus*), L. L. Dyche.

15. A Curious "Impatiens," Grace R. Meeker.

ENTOMOLOGY.

16. Additions to the List of Kansas Coleoptera, W. Knaus.

17. Notes on Coleoptera, W. Knaus.

18. List of Coleoptera Collected in New Mexico in 1907, W. Knaus.

19. Some Photographs of Balsam Mounts of *Phengodes fusciceps* Secured from McPherson, Kan., W. Knaus.

20. List of Noctuidæ, Geometridæ and Microlepidoptera, taken at McPherson, Kan., July and August, 1907, W. Knaus.

21. The Staphylinidæ, Scaphidiidæ, Phalancridæ, Corylophidæ, Coccinellidæ, Endomychidæ and Erotylidæ of Kansas, W. Knaus.

22. A Parasite on Eggs of Mantis, Mrs. Lumina C. R. Smyth.

23. Notes on Protozoa found in Central Park Lake, Topeka, Mrs. Lumina C. R. Smyth.

24. A New Species of Campostoma, F. F. Crevecœur.

25. Observations on Ants of Arizona and Their Auxiliary Captive Beetles, Eugene G. Smyth.

GENERAL BIOLOGY.

26. Antiquity of Man's Body-building Instincts, L. C. Wooster.

MISCELLANEOUS PAPERS.

27. Tuberculosis, B. R. Rogers.

28. Man Abnormal, J. M. McWharf.

29. Anthropology as a Science, A. H. Thompson.

30. Some Scientific Frauds and Fallacies, W. F. Hoyt.

31. The Buried City of the Panhandle, T. L. Eyerly.

32. Climatology in Kansas (second paper), T. P. Jennings.

33. Heredity in Stock-breeding, I. D. Graham.

34. The Election of the Indian Governor at Jemez, New Mexico, December 29, 1900, Albert B. Reagan.

35. Perfect, Zigzag, and Tesselated Squares, and Harmonics and Magic Hexagons, Bernard B. Smyth.

36. Energia as Seen in Bacillaria, A. M. Edwards.*

37. An Adequate Cause for Extremes of Climatic Mutations in Geological Ages, J. J. Jewett.

38. Habits of *Lysiphlebus* sp., C. H. Withington.

39. "Fireless Cooking," J. T. Lovewell.

40. Notes on a Kansas Beaver, taken near Lawrence, November 12, 1907, L. L. Dyche.

41. Chief Noskelzohn's Stove, Albert B. Reagan.

42. The Apache and the Wagon, Albert B. Reagan.

43. A Day in Jemez Pueblo in Harvest Time, Albert B. Reagan.

44. The Birds of the Rosebud Indian Reservation, South Dakota, Albert B. Reagan.

45. Notes on the Habits and Distribution of the Pocket-gopher (*Geomys busarius*), George A. Dean.

46. Coccidæ of Kansas, with a Short Bibliography and Food Plants, George A. Dean.

47. Concerning Some Insects Collected and Bred from Dying Elms, E. S. Tucker.

48. On the Presence of Neon in Natural Gas, H. P. Cady.

49. Quantity of Water Found in Oysters as they are Marketed, J. T. Willard.

50. Occurrence of Copper in Oysters, J. T. Willard.

51. Apparatus for Projections, A. J. Stout.

52. The Nomenclature of the Carboniferous in Kansas, E. Haworth and J. Bennett.

53. A Fossil Tusk Found in the McPherson *Equus* Beds, E. O. Deere.

54. The Use of a Score-card for Natural Waters, E. H. S. Bailey.

55. Preliminary Studies on the Moon, F. A. Marlatt.

56. Collecting in Arkansas, F. A. Hartman.

After the report of the treasurer the Academy listened to the reading and discussion of papers, and the first read was No. 19, by Mr. Knaus—discussed by Mr. Wooster. This paper was illustrated by photographs.

The committee on membership reported applications of the following-named persons, and recommended that they be admitted to membership:

John Bennett, geologist, State University, Lawrence.
L. A. Lowther, superintendent of schools, Emporia.
A. M. Edwards, M. D., physician, Newark, N. J.
F. A. Marlatt, machinist, Agricultural College, Manhattan.
J. E. Todd, professor geology, University of Kansas, Lawrence.
Vance Applebaugh, student, Wesleyan University, Salina.
Edgar Thomas, teacher of biology, Emporia.
W. A. Van Varis, teacher of physics, Emporia.
H. H. Braucher, teacher, Emporia.
C. A. Nash, teacher, Emporia.
David Train, student, Lindsborg.
Julius Brandt, student, Lindsborg.
W. C. Cooke, teacher, Salina.
O. S. Groner, teacher of chemistry, Ottawa.
John Lofty, superintendent of schools, Salina.
Dr. Burton R. Rogers, veterinarian, Agricultural College, Manhattan.
Howard N. Moses, M. D., physician, Salina.
J. O. Short, electrician, Salina.
Roy W. Gragg, laundryman, Bartlesville, I. T.
T. J. Headlee, professor of entomology, Manhattan.

On motion, the rules were suspended and the secretary requested to cast the ballot of the Academy for the persons above named, which was done, and they were declared duly elected and to be enrolled on payment of the usual fee.

On motion, Chas. Sternberg was elected life member, on payment of the balance of dues up to twenty dollars.

Paper No. 28 was read by the author, J. M. McWharf.

On motion, the Academy adjourned, to meet at nine A. M. to-morrow.

FRIDAY, November 29—nine A. M.

The Academy met at the appointed hour, and the minutes of last meeting were read and approved.

All members were asked to report to the committee on necrology if they know of any members of the Academy who have died during the past year.

It was voted that the secretary wire to Doctor Snow, who is prevented by illness from being with us, the greetings of the Academy.

The following message was accordingly sent:

The Kansas Academy of Science, by unanimous vote, sends greetings to Doctor Snow, and expresses earnest wishes for his early restoration to health, and its appreciation of his valuable contributions to science.

The committee on program reported the following papers ready for reading: Nos. 12, 13, 14, 30, 40, 53, and 45. They were read as follows:

No. 12, read by author, C. H. Sternberg.

No. 13, presented by J. T. Lovewell.

No. 14, read by author, L. L. Dyche, and discussed by Bailey, Bushong, and Mead.

No. 30, read by author, W. F. Hoyt.

No. 40, read by author, L. L. Dyche; discussed by Mead.

No. 45, read by author, E. H. S. Bailey.

No. 53, read by author, E. O. Deere.

Voted to take a recess till two P. M.

The Academy resumed session according to vote.

Prof. B. B. Smyth moved the following resolutions:

That copies of the Transactions be sent to all members of the Academy whose initiation fees are paid, and who are not in arrears for dues more than one year.

After discussion the resolution was adopted.

Reading of papers continued.

No. 22, read by author, Mrs. B. B. Smyth.

Nos. 16 and 17, read by author, Warren Knaus.

No. 15, read by author, Grace Meeker. Illustrated by specimens.

No. 7, read by author, Dr. C. F. Menninger; discussed by Bailey and Dyche.

No. 8, read by author, F. B. Dains.

No. 54, read by author, E. H. S. Bailey; discussed by Smyth and Sayre.

No. 2, read by author, F. W. Bushong.

No. 18, read by author, Warren Knaus.

No. 55, read by author, F. A. Marlatt.

No. 48, read by author, H. P. Cady.

No. 47, read by H. H. Braucher, in absence of author, E. S. Tucker.

No. 3, read by author, L. E. Sayre.

No. 31, read by J. R. Mead, in absence of author, T. L. Eyerly.

No. 39, read by author, J. T. Lovewell; discussed by Mrs. Smyth, Bailey, and others.

No. 26, read by title, at request of author, L. C. Wooster.

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

For president, E. Haworth, Lawrence.

For vice-presidents, F. B. Dains, Topeka, and J. M. McWharf, Ottawa.

For treasurer, Alva J. Smith, Emporia.

For secretary, J. T. Lovewell, Topeka.

On motion, the rules were suspended by unanimous consent, and the secretary directed to cast the vote of the Academy for the officers named. This was done and they were declared duly elected as officers of the Academy for 1908.

On invitation of the president of the Normal School, the Academy adjourned to the parlors of the First Christian Church, to partake of a banquet tendered to the Academy by local members and by the Normal faculty. This proved to be a very enjoyable occasion, and after doing full justice to the bountiful and charmingly served repast, the toast-master, T. M. Iden, in a few well-chosen remarks introduced the speakers of the evening.

The first speaker was Hon. William Allen White, who made a graceful speech, and was followed by Mrs. B. B. Smyth, and Dr. L. E. Sayre, with remarks equally felicitous and witty.

Returning to Norton Science Hall, the Academy listened to the address of the retiring president, J. A. Yates, on the subject, "The Value of the Work of Science to Humanity."

The Academy, after this address, voted to take a recess till to-morrow, Saturday, at nine A. M.

SATURDAY, November 30—nine A. M.

The minutes of the two previous sessions were read and approved, and this was followed by an address and paper on "Tuberculosis," by Dr. B. R. Rogers, who gave a full discussion of this vitally interesting theme, and brought out a plan whereby he thought the dreaded and deadly "white plague" might be exterminated.

No. 38, read by author, C. H. Withington.

No. 23, read by author, Mrs. L. R. Smyth.

Papers Nos. 6, 9, 10, 11, 24, 25, 29, 33, 34, 36, 37, 41, 42, 43, 44, 45, 49, 50 and 51, in absence of authors, were read by title.

The secretary called attention to the importance of having all papers typewritten and placed in hands of the publication committee as early as December 15.

The committee on resolutions reported:

Resolved, That the thanks of the Academy be extended to the members of the State Normal faculty, and to the local members, for the sumptuous banquet and the pleasant réception which they extended to the visiting members.

Resolved, That we thank the faculty and the management of the State Normal for the facilities offered us in holding our meetings.

(Signed) L. L. DYCHE,
J. A. G. SHIRK,
EMIL O. DEERE,
Committee.

The committee on time and place of meeting recommended Topeka as the place, and Thanksgiving week the time, subject to change by the executive committee. Report adopted.

On motion, the fortieth annual meeting was adjourned *sine die.*

HISTORICAL SKETCH.

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

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

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

The Academy has increased in membership from the original small body of scientists to over 200. It has held forty annual meetings, of which nineteen have been held in Topeka, six in Lawrence, four in Manhattan, two in Leavenworth, three in Emporia, and one each in Atchison, Baldwin, Iola, McPherson, Ottawa, and Wichita.

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

The Academy is now installed in the north wing of the capitol building, at Topeka, in rooms on the fourth floor. It has two connecting rooms, used for office and library, and the museum is in the adjacent corridor.

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

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.

ADDRESSES DELIVERED

AND PAPERS READ

BEFORE THE

KANSAS ACADEMY OF SCIENCE,

AT

EMPORIA, 1907.

I.—Presidential Address.
II.—Chemical and Physical Papers.
III.—Geological Papers.
IV.—Biological Papers.
V.—Miscellaneous Papers.
VI.—Necrology.
VII.—Announcements and Index.

I.

PRESIDENT'S ADDRESS.

"THE VALUE OF THE WORK OF THE SCIENTIST TO HUMANITY."

By JAMES A. YATES, Normal Training School, Pittsburg.

THE VALUE OF THE WORK OF THE SCIENTIST TO HUMANITY.

By JAMES A. YATES, M. S., Normal Training School, Pittsburg, Kan.

Presidential address, delivered at Emporia, November 29, 1907, before the fortieth annual meeting of the Kansas Academy of Science.

I INFER that the high ideals of the Academy demand that in this address some of the broader questions that agitate general scientific thought shall be discussed, rather than some phase of a particular field of investigation. Therefore, I have chosen to speak on the general theme, "The value of the work of the scientist to humanity."

The true test of the value of anything is its utility; that which conserves, strengthens and continues life and growth in its highest and best relations, while its disuse weeds out and destroys. It is not of the monetary value of science that I wish to speak. That it has this side, I will call attention to the statement of our commissioner of education, whose investigations show that in 1800 the total productive capacity of each man, woman and child in the United States amounted to ten cents a day. During the period from 1830 to 1850 the productive capacity rose to thirty cents a day for each inhabitant, while in 1900 it had risen to fifty-five cents a day for each inhabitant. With this data, a very easy arithmetical calculation will show that in a single year the increased production brought about by scientific investigations has returned in dollars and cents many times the amount expended for scientific work during the whole of the nineteenth century. The examples are numerous that show that money invested in scientific inquiry yields almost fabulous returns.

The question of what use will any new truth or fact be, is one that quickly flashes through the mind of the masses. Let us all fully understand that every scientific fact is useful now, or will be in the near or remote future, at least, in helping us to understand and utilize the manifold stores of nature, and therefore has a bearing, either near or remote, on the welfare of man. As each brick or stone is of service in a building, so a place will be found for every truth wrested from nature. The proper measure of value is that of service, and that thing is of greatest value which will help man most in his struggles upward to attain the goal for which he was created.

What have the scientists wrought, when measured by the standard mentioned, that will encourage us to our highest efforts to push forward with stronger determination and greater zeal the work committed to our hands by those who have labored with much success in the past?

Prophecy and revelation are to-day reserved for the scientist, as shown in his work, which involves the gathering of knowledge through observation, its classification, and the deduction of general principles connecting and explaining all the known facts, with the elimination of self, thus establishing the relation among phenomena. It is this kind of work that gives us the profound difference between the work of the nineteenth century and that of all the preceding ones.

One thing of the greatest value which science has taught humanity is the realization and appreciation of its discoveries. In a word, it has given to man a wide, open mind, ready and willing to learn any and all truth, from any and all sources, and to believe that any truth will be strengthened by submitting it to the most rigid and varied tests. It took centuries to convince mankind of the true form and motion of the heavenly bodies, of the great law of gravitation; but only one generation to make the great law of evolution generally accepted.

No one, who has studied the movements of the last century, can fail to be impressed with the large and ever increasing role that modern science has played. Most every phase of our thought and activity has been modified by the new materials introduced, and especially by its changing our viewpoint and our methods of work. Men have ceased to believe that any one man is good authority in every field of inquiry. We have reached a point in advancement where it is necessary to find out what the workers in any particular field say, and upon their conclusions to found our answers to any questions of inquiry in their special line of work. By the work of the scientists of the nineteenth century, every branch of learning and investigation is placed upon an equal footing, and those who would know all the truth must be content with a little knowledge in some one field of investigation, and a faithful reliance upon the workers in other lines for the truth or falsity of any statement in their particular field of work.

The day is past when any one can successfully deny the truth-seeker the divine right of freedom to investigate, to put to the test any and all puzzling questions, and to publish his results. This retrospective study shows us that the scientific stimulus is the hunger to know, and its reverence and yearning are always picketed along the borders of the unknown, pioneering, peering into that wilderness where no one ever trod before, while the scientific spirit lingers behind, a promotor of the good, a strong ally to all that uplifts humanity, by keeping close to the facts and finding the proper relation of cause and effect, while its mission is to eliminate that which is untrue and hurtful, to augment all that is good and true, and to find all the avenues of service.

We sometimes hear of two classes of scientists: Those who give special attention to the discovery of the theories and laws of nature, the finding and study of truth in all its relations for its own sake and the advancement of knowledge; and those who emphasize the application of these facts in the various arts and industries. In a word, pure and applied science, the difference being that of emphasis. However, pure science is the foundation upon which all of its products are built, and of necessity must precede and blaze out the way whereby its applications may continue their activity in every sphere of life, giving to it increased vigor and power. As we glance over the history of man and study the factors that have contributed to his present advanced condition, we cannot fail to be impressed with the part that the various sciences have played. Thus, by its fruits we may measure its value.

We find science, in its applications, lifting burdens from the oppressed, placing man upon a higher plane of life with a greater control of the forces and materials of nature at his command, that he may use them for the betterment of his fellows. Science dignifies all the avocations of life, broadens the scope of man's influence, that he may come in touch with man wherever he may be, removes sectionalism and binds every race and nationality, as it were, into a single community. Mountains, deserts and oceans are no longer barriers between races, while the products of any single clime are familiar to all climes; also cheap and rapid transportation facilities, combined with quick and convenient means of communication, along with sanitary and architectural discoveries and improvements, are relieving our greater centers of congested population and thus lessening all that train of evils. This scientific conquest of nature is one of the strongest allies of the Christian religion. It takes from man the drudgery of muscular labor and allows him to accomplish that which he desires much more successfully, easily, and safely, through the manipulation of the subtle and mighty forces and materials of nature; thereby giving to man a vastly greater opportunity for mental and moral improvement and enjoyment. It has been estimated that the invention of the steam-engine alone has doubled the productive capacity of the world's labor.

Superstition and tradition are the most implacable enemies of science. The cause of their existence is the simple ignorance of the way in which nature works, while a careful and intelligent study of man and his relations, along his present and past environment, will demonstrate to any one, in an incontrovertible way, the reign of law in the universe. That superstition which has made man its most abject slave and has kept him in the depths of ignorance and folly has been largely conquered by the scientists of the past century. However, each age brings new demands, and through the scientific study of nature every one is better fitted to cope with his environment and successfully solve the problems of life as he finds them. Those of the past centuries are interesting as matters of history; while those of the present and future will be solved by men who have learned to look for all the facts and all the causes, and from these combined to make correct conclusions. We plead that this training is very desirable and essential.

In all the discoveries of the past which have been true insights into the future, man saw the correct explanation from the facts of nature actually recorded, showing the unity and simplicity of the apparently unconnected and unassociated phenomena. We expect this to continue and the generalizations of the future to disclose a greater and closer unity in origin and purpose of the phenomena of the universe. Further researches in the minute structure of matter with its various dissociations and combinations, in the molar and molecular forces with the products of their many and varied transformations, will undoubtedly lead to a closer and more fundamental unity among the many scientific lines. May it not be the same force that gives us stereo-isomerism and that holds the planetary systems in their proper relations to all the other systems and to their many respective units. Thus the word and the works supplement each other, and thereby enable us to understand the Author of nature more completely and to realize that the more we know of the material universe the greater will be our appreciation of the mind that formed it.

Science-study disciplines all the faculties of the mind in a healthy and sane way; trains the brain to plan and the hand to execute; furnishes excellent material for logical and philosophical thoughts; supplies literature with live themes, calling for its wisest and most penetrating expressions; teaches a rigid elimination of self from both its data and conclusions, and as great a love for accuracy in statement as in its records.

The growth of scientific study may be seen from the following charts:

Number 1 shows the increase in our agricultural and mechanical colleges, including students and faculties.

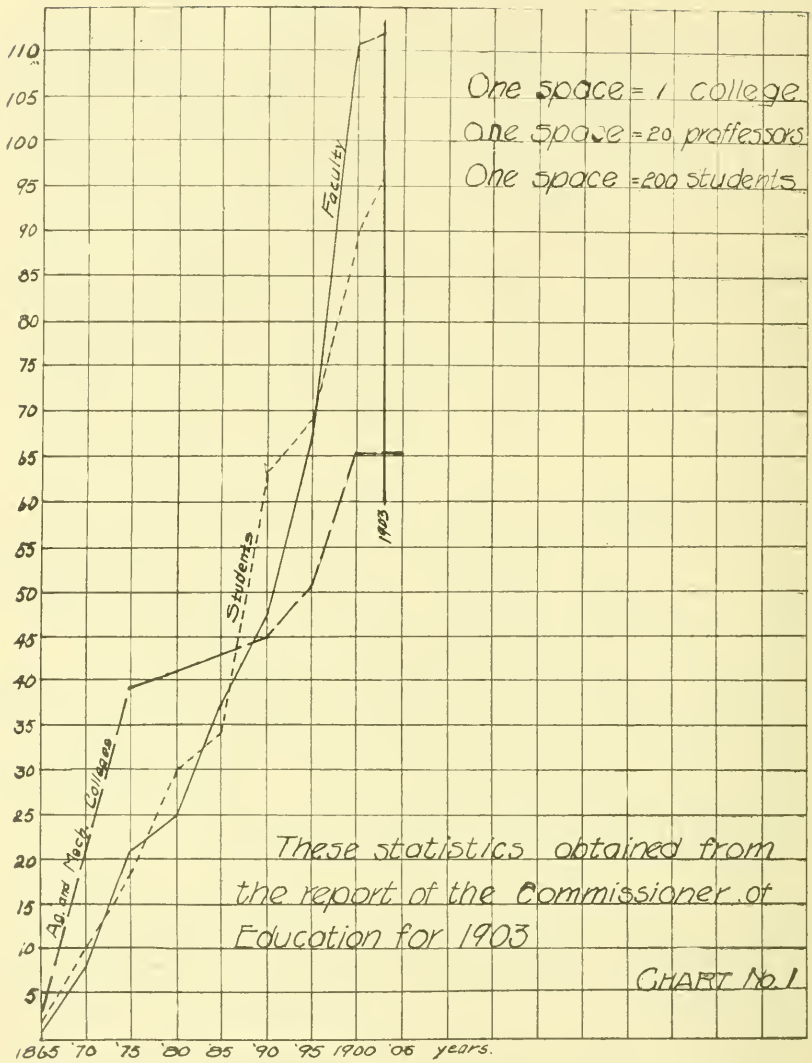
Number 2 shows the increase in the number and the attendance of the manual-training schools of the United States of high-school grade and above. The first school of this character in our country was opened at St. Louis in 1880.

Number 3 shows the growth of all gifts to colleges and universities for endowment, buildings and equipments, also the total gifts which the donor has directed to be used for scientific purposes, including the per cent. of such scientific gifts of all the donations for school purposes. (This data has been obtained from the weekly reports in *Science.*)

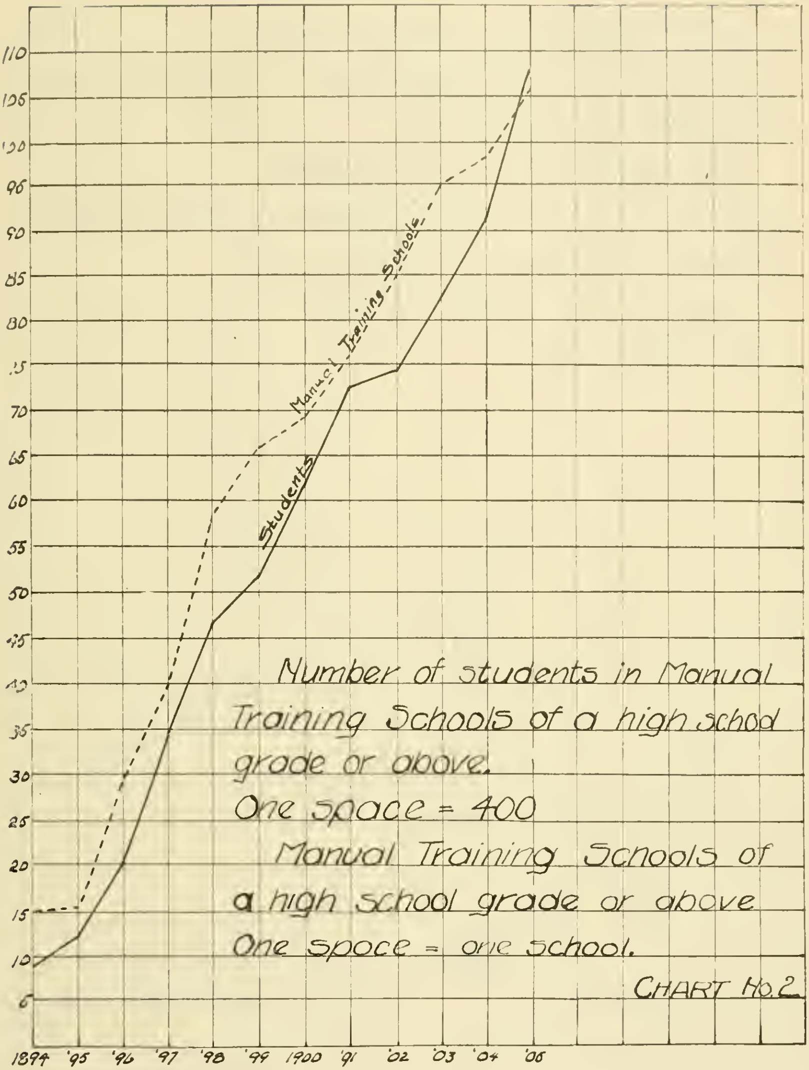
Number 4 shows the per cent. of science teachers of the total faculty of Kansas University and of Ottawa University, the first being a representative state university and the other a representative denominational institution. This shows the average growth of the sciences in the colleges and universities of our country.

During the past nine years, 47.8 per cent. of the total doctorates conferred in our country have been given for work in science. When we call to mind that this represents a measure of the creative scholarship of our country, the value of the work of the scientist is again made evident. The increased appropriations by our government, from $2,038,127, in 1894, to $7,112,690, in 1906, for purely scientific work, shows something of the appreciation in which scientific work is held.

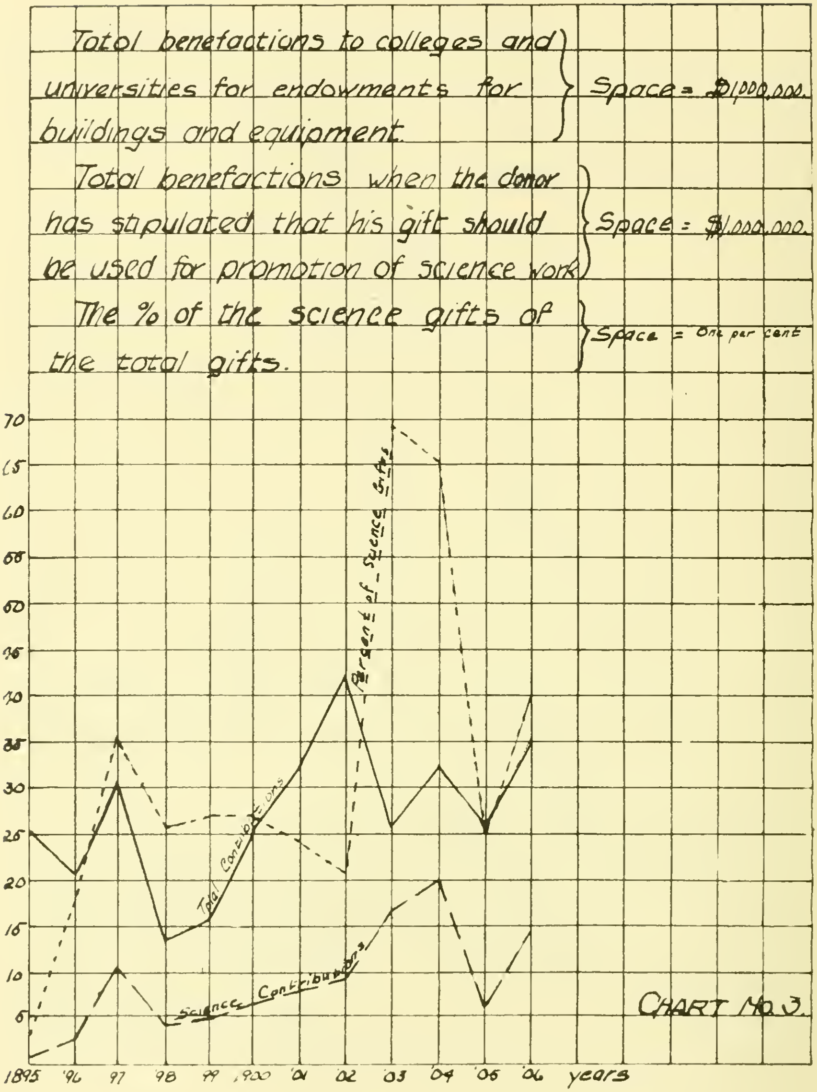
From the reports of the commissioner of education we find



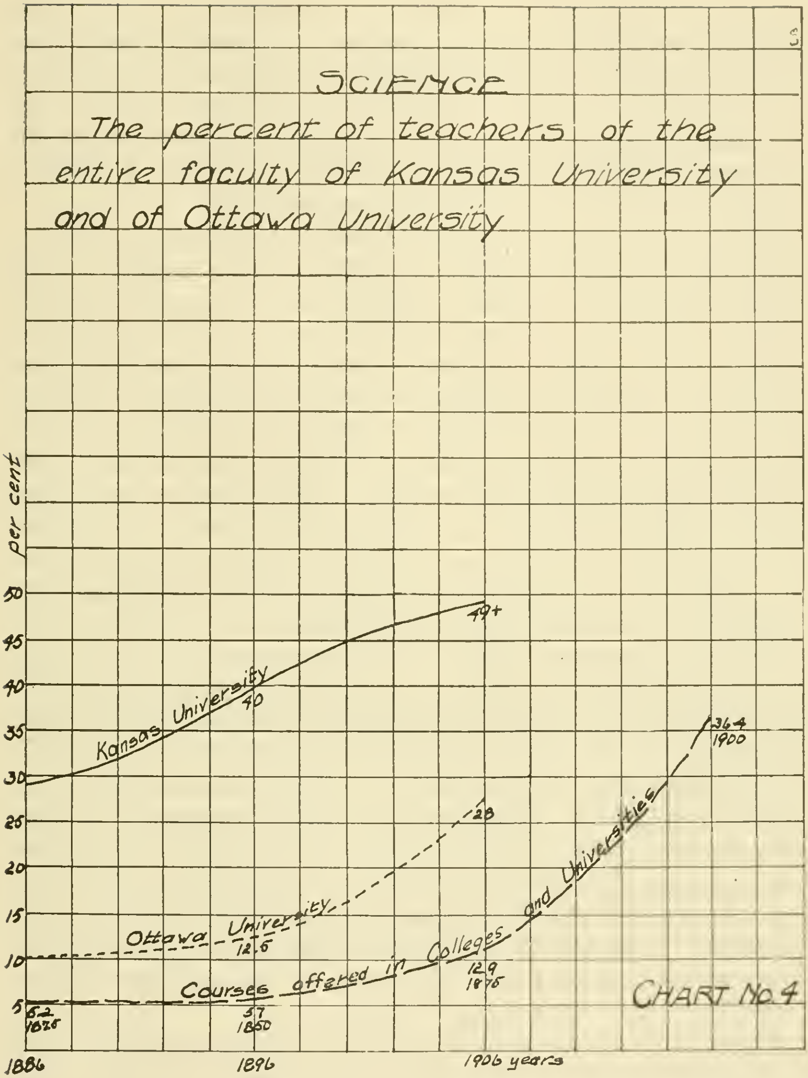
the following ratios between college students and total populations: In 1872, 1 to 1694; in 1902, 1 to 731. Thus, in thirty years the per cent. of those who attend college has more than doubled. Further, we find in all schools of higher education 1 student to every 337 people. Therefore, the percentage of attendance in our higher institutions of learning has increased more than fivefold in the period mentioned. We may partly realize the value of this growth when we call to mind that a college education multiplies by 400 our chances



of really accomplishing something or value over the one who has only a high-school education. In the secondary schools, in 1892, there was 1 student to 161 inhabitants, and in 1902, 1 student to every 106 inhabitants, an average increase of about nine per cent. for each year. As we study these facts in connection with the changes of the curricula and additions thereto, along with the growth of the faculties of our leading colleges and universities, it seems that the high ideal toward



which they are striving is that every upright pursuit in life shall have the highest principles and practices governing it represented in its course of study and taught by the best men it is possible to get, aided by all needed equipment. Further study shows this growth of the sciences has not been in replacing other subjects of the curricula in our various schools. Indeed, every department of all schools has been thereby not only strengthened and increased in efficiency, but it has also



been made possible for a much greater per cent. of the people to obtain a college education by affording a wider scope of work, appealing to all the faculties of the mind, touching every trade and profession of life, and dignifying labor. Believing that the type of mind which designs and builds our various mechanical structures, our magnificent machinery of motive power and labor-saving devices, which serves our every want in such a helpful way, is worthy of the highest cultivation. The true scientist does not seek to replace that which is good, but to make something of service which has not been known or utilized before, as may be seen in many waste products turned into beautiful and useful materials by the magic touch of the chemist. Many barren lands are made to teem, as a great garden, with products to supply a nation's needs, by the skill of the engineer and botanist.

However, let us bear in mind that we have only made a good beginning; that while the past century abounds with brilliant results, the future should grow with increased acceleration; that the facts which are being gathered and recorded will, in the centuries to come, be touched by some genius and thus made to find a place of usefulness. One of the things to be accomplished by the twentieth century, evidently partly realized, is to effectually warn man of the danger of setting any limit to knowledge. When we compare our present with a century ago, and seek for the causes of the great advancement in all our industrial arts, and observe the new and ever widening fields of work, we may get some idea of what the scientists have accomplished.

We may consider some of the important things to be achieved, along with some of the problems yet to be solved. Many of these are of an accumulative character, and broaden as new facts and uses are found. Examples may be given in the changing from a mere hypothesis of one or two of our advanced thinkers to the generally accepted explanation of the many very familiar conceptions of to-day, such as the great age of the earth, the immateriality of heat, the electro-magnetic theory of light, the conservation of energy, and organic evolution. The history of these is sufficient to show how a truth gleaned from facts will widen in its applications and be modified by new facts as it grows.

The way in which scientific discoveries are often made may be illustrated by the discovery of the planet Uranus. The little difference found in the orbit of Neptune, from its calculated orbit at a certain time, enabled the pencil of the mathematician to point within a single degree of the very spot where the planet was found. A similar phenomena enabled Roemer to obtain the velocity of light. One of Jupiter's moons eclipsed a few minutes before, and again a few minutes after its calculated time. This difference, small though it was, enabled the astronomer to show by his calculations that light had a finite velocity. Note these small differences: to any but the scientists a trifle, yet to him whose training has been such as to demand absolute accuracy when his personal equation is accounted for, furnish a line for investigation. The manufacture of nitrogen compounds from the atmosphere by bacteria also illustrates the growth of scientific problems. This one has been attacked by chemists, physicists, and biologists, each with more or less success. Professor Nobbe found that a certain kind of bacteria had the power of causing free nitrogen to combine with other elements, forming nitrates, which compound is a valuable plant-food. Botanists had noticed little tumors on the roots of clover and other leguminous plants, which they had named nodules. It was soon discovered that plants having these nodules would grow in a soil free from nitrogen, while plants devoid of these nodules would not grow in such a soil. This led to an investigation, which found that the nodules were the results of minute bacteria in the soil. Then the problem arose, if these nodules were caused by the soil bacteria, and should not be present in a soil, would it not be possible to supply them, and in this way replenish a worn-out soil and restore it to its original fertility? While this question was pending, Doctor Moore, who had been studying Algæ and had learned something of the properties of these organisms, and who had commenced to apply this knowledge to the purification of polluted water-supplies, was asked by our secretary of agriculture to undertake the solution of the problem of the inoculation of nitrogen in impoverished soil. The problem was finally attacked by the infection of the seed and resulted in some progress, yet the complete solution awaits additional facts, and when all the necessary facts are found the full solution may then be expected.

From the examples mentioned, it may be seen that the methods of planning and conducting a scientific investigation involves finding an exact statement of the problem to be solved, obtaining an accurate knowledge of the work that has been done in this and related fields, and the formation of some definite plan whereby the experimental part is to be faithfully, rigorously and intelligently prosecuted, with the eyes opened and the imagination sharpened to see new relations and applications. When all this is done with the proper foresight in regard to apparatus and material, and the work is pushed vigorously, some results must follow sooner or later.

The value of the work of the scientist may be seen in the changed attitude of the people to-day toward it. In the beginning of the seventeenth century Bruno was burned at the stake for teaching that the earth is not the center of the universe. Early in the eighteenth century Newton was pronounced impious and a heretic for teaching that the law of gravitation extended throughout the universe. In the nineteenth century, how many of our greatest scientists have met much opposition and ridicule. Even to-day, I fear, there are some educators who fail to appreciate its worth, and who ascribe to its workers a lower type of mind, an inferior culture.

Nevertheless, in the study of the history of any of the sciences, we are impressed with the way its truths have grown, though often oppressed by the customary thought of the times. We find in them, as in every historical movement which has had for its purpose the elevation of man, the gradual acceptance of its truths until its acceleration was sufficient to sweep over the errors which opposed it, the opposition only helping to remove the dross which might be clinging to the gold. A further and deeper study reveals the fact that the growth of our knowledge in the truths of the material sphere gives foundation for our political, social and moral improvement. While we contemplate the appropriations of the past years made by our national and state governments, also the philanthropic gifts for stipulated scientific investigations in every line of research, and observe their general appreciation, we cannot fail to be impressed with the fact of their increasingly recognized value.

While the past century has shown wonderful growth, yet when we turn to the future with all our accumulated resources for work, our inheritance of the past, may we not confidently hope that the exercise of the same indomitable energy, courage and intellect that charaterized the scientists of the past will solve, in a much shorter time, the many problems in all the fields of science that bid us a hearty welcome. As we contemplate some of the problems of the future, we find them associated with the past. Charles Darwin's "Origin of Species" gave to biologists the greatest working hypothesis yet suggested. A problem to be completed in the future is the tracing of all the relations of the various classes of animal and plant life; following each of these back to their origin, both in their present and past forms, and from all the facts to complete, in all its parts and details, the tree of life with all its historical relations. Along with this work, our knowledge of the action of certain ions upon the simpler forms of life may be extended, so that we may fully understand all the chemistry of the vital processes, together with the causes of chemical activity in both organic and inorganic substances. The solutions of these problems may give us the full explanation of how the changes in evolution occur, of what necessitates them, and also make clear the laws of heredity. Geologists have mapped in detail, and carefully studied, only a small part of the earth's crust; much basal work of this character remains to be done. The composition of the interior, the mineralogical relations of the rocks, the segregation of the ores, the causes producing great movements of the crust, be they exceedingly slow or rapid, more exact standards for measurement of time, that our conclusions may not be such crude estimates—all these phases of geology present problems which demand solution, both from a theoretical and economical aspect.

We have the vortex ring hypothesis as the explanation of the relation of electricity and magnetism to matter; the conditions of twist in the universal ether for the suspicion by some that all the elements are composed of one primal substance. These are contributions of the nineteenth century, as yet barely a working hypothesis, awaiting the experimental evidence of the twentieth century to confirm, modify, or overthrow them. The nineteenth century gave us the atom, its weight, its laws of combinations, but not its exact form or nature. In fact, the twentieth century has already so far modified our conception of the atom as to leave us only its combining weight.

Experimental evidence proves to us that different ions combine with others in different ratios, but who knows as yet the basal reason for such combinations. Two clear solutions, one of silver nitrate and one of hydrochloric acid, when mixed form a precipitate. A lump of sugar put into a glass of pure water dissolves, a piece of gold does not. A spoonful of salt put into a glass of pure water ionizes, and thus forms an electrolyte; a spoonful of sugar dropped into a similar glass of water goes into solution but does not form an electrolyte

What is the nature of these intermolecular bonds, so easily broken in the one case, so difficult in the other?

By the simple relation of their combining weights, all the elements are arranged in groups composed of those that have similar properties. The twentieth century is awaiting a genius of the type of a Dalton, a Levosier, or a Mendeleeff, to find the fundamental law or laws by which all these facts may be explained. Possibly some light is beginning to appear through the new field of radio-activity, and the electron theory of the structure of matter, which proposes to account for the relation of matter and all forms of energy through whirls and strains in the ether.

Some of the new gaseous elements, as actinium, are said to have a limited life and to change into other substances. Each radio-active product is a transition substance, possessing, while it lasts, definite chemical and physical properties. The electrons that fly off from radium and bombard the air particles around it, and raise the surrounding temperature, are said not to be matter, yet it is found that the mass fluctuates in the presence of the electrical changes. It is further claimed that all the elements possess specific radio-activity in a more or less marked degree. These observations have been made in the last ten years, and would indicate that we may soon fully understand the minute structure of matter and its relation to the ether.

Chemistry as a science is the product of the nineteenth century and has been very fruitful in its service, yet it has many problems of great economic value to solve in such constructive work as the preparation, on a commercial scale, of many compounds, both organic and inorganic.

Physics, with all its brilliant discoveries of the past, presents us machinery of motive power which does not utilize, on the average, more than twenty per cent. of the available energy used. Will the physicist ever be able to turn the latent energy of coal directly into electrical or some other form of kinetic energy without passing through heat, and thus greatly increase the efficiency of our motive machinery? Biologists have shown us how it is possible, by a change in nutrition, to produce aberrant types of life and have demonstrated the transmission of those acquired characters. The investigations of our experimental stations have shown beyond question, how it is possible to add largely to the yield, as well as to the quality, of our manifold farm products. This is accomplished, not by an increase, but by a lessening in the labor involved. Discoveries of incalculable value have been made through the study of the complete life-history of many of our various disease-producing fungi, in both plant and animal life. The means of combatting these injurious parasites has been worked out, in many instances, as well as the prevention and cure of the diseases, in all forms of life, caused from their ravages. However, there are many problems of life yet to be solved, among which may be mentioned the origin of life upon the earth and its many subsequent changes. What are the potentialities of the different primal cells that cause them to develop into widely different organisms? The relation of the chemical and physical changes which take place in the brain and nerves to conscious thought is still incompletely solved.

We trust that the biologists of this century may learn to explain all these difficulties, and that they will give us a basal law governing the vital molecules of the cell and the exact relations in every detail of these molecules to the non-vital ones. We expect the future to reveal the history and present evolutions of man himself; to explain the causes of the different races, their physical characteristics, their mental and moral traits, as are observed in their customs, languages and religion. We hope they will find all the factors that have elevated, also those that have depressed, and show how the one may be augmented and the other retarded: likewise show how the yearning in man for the eternal verities may be increased. The solution of these problems will solve those of our social and governmental evolutions.

Experimental research is adding an increasing accumulation of facts each year in every branch of science. The scope of each is widening and dividing into new fields of investigation. In this way nature is revealing her secrets more rapidly than ever before in the world's history. She is showing her variability and her unity. Therefore, the work is opening new lines of employment and new phases of thought. In this way science is interesting those who supply the sinews of investigation. Yet those who are toiling with all their power that they may find some facts that will aid in the solution of some of the unknown problems of nature are as truly philanthropists as they who contribute of their wealth for the betterment of humanity. Natural laws are inductions from facts and are necessarily successive approximations. They explain the main causes and relations, but many details of all are still to be worked out. The scientists of the nineteenth century have given us these first approximations. No one doubts, in the future investigation of the details and applications, under all conceivable conditions of our present knowledge of nature, but that new truths will be found which will give wider, broader and deeper generalizations.

The trend of the ages, on the whole, has been upward. Our present scientific age is the evolution of the mind which seeks freedom to think, to act for itself, and to be open to the conviction of any truth. Yet it demands facts on which to base its conclusions. The various scientific appliances give the masses time to acquire intellectual and spiritual growth.

A full knowledge and control of nature is man's destiny and one of his greatest needs. To enable our future leaders to comprehend and to perceive perfectly what the knowledge and control of nature is, and how the steps may be increased by which this is gained, is a duty that belongs to each of us. Let our motto be the service of our work to humanity. Let us work shoulder to shoulder with all our powers for greater gifts and larger appropriations, that we may not be hampered for want of means in the investigations of any and all truth, so that we may bequeath to the next century the solution of many of the present unsolved problems, that we may aid in lifting the burdens from the wearied and removing every vestige of prejudice and superstition from the minds of men. This accomplished, and our work will not have been in vain.

II.

CHEMICAL AND PHYSICAL PAPERS.

1. "GASTRIC FERMENTS."
   By C. F. MENNINGER, M. D., Topeka.
2. "ON THE REACTIONS OF FORMANIDINES."
   By F. B. DAINS, Ph. D., and E. W. BROWN, B. S., Washburn College.
3. "NATURAL GAS OBTAINED FROM TREES."
   By F. W. BUSHONG and D. F. MCFARLAND, University of Kansas, Lawrence.
4. "THE RELATION OF PUBLIC HEALTH TO THE QUALITY OF MEDICINE."
   By L. E. SAYRE, University of Kansas, Lawrence.
5. "PERCENTAGE OF EXTRACTIVES IN CERTAIN DRUGS AND SPICES."
   By L. E. SAYRE, University of Kansas, Lawrence.
6. "FIRELESS COOKING."
   By J. T. LOVEWELL, Ph. D., Topeka.
7. "ON THE PRESENCE OF NEON AND ARGON IN NATURAL GAS."
   By H. P. CADY and D. F. MCFARLAND, Lawrence.
8. "SANITARY WATER ANALYSIS."
   By E. H. S. BAILEY, University of Kansas, Lawrence.

GASTRIC FERMENTS.

By Dr. C. F. Menninger, Topeka.

AS FAR back as the beginning of the sixteenth century the phenomena of digestion claimed much attention from students. There was no little diversity of opinion as to how the food was digested. Some held that it was done by pure mechanical action of the stomach, and others explained digestion as due to a dissolving and transforming activity of the juices of the stomach.

Reaumur, who lived from 1683 to 1757, advocated that digestion of food was due to the action of the juices of the stomach. He demonstrated this by causing animals to swallow metallic perforated capsules filled with food. After these had been cast out he examined the contents of the capsules and found that certain substances had been dissolved out while others had not thus been affected. Somewhat later, Spallanzani devoted himself to the investigation of the juice of the stomach and arrived at positive knowledge as to the cause of food digestion in the stomach. He did this by causing birds to swallow small sponges which by means of a string he withdrew, after some delay. In this way he obtained gastric juice and made the first recorded artificial digestion *in vitro.*

For 100 years these conclusive scientific experiments were buried under an avalanche of scientific (?) theories and rubbish, and not until the masterly works of Kirchoff, Eberle, Schwann, Schönbein, Pasteur and Dubrunfaut, within the memory of living man to-day, has science been injected into the study of the ferments.

Ferments were formerly classified into true ferments, this term being applied to bacteria, molds, etc., which caused the decomposition of an organic substance, and false ferments, these being the soluble enzymes of the bacteria, molds, etc. To-day we know, however, that living molds act because they contain the ferment, and the true agent in every case of fermentation is the soluble enzyme, and also that the enzyme will act after the death of the parent cell.

Ferments are also divided by some quite modern investigators into organic and inorganic. The organic ferments are those catalytic agents produced in living cells or tissues or produced by the processes of nutrition of low organisms, which have the property of accelerating the decomposition of complex unstable compounds into simpler substances. The inorganic ferments are those catalytic agents of the mineral world composed of colloidal solutions of the nobler metals, as platinum, silver, iridium, gold, which have the property of accelerating the chemical reactions of two different substances. Here also we deal with chemical reactions which take place even when no ferments are present. Thus far no objection can be safely and permanently maintained against this classification, but to divide the former class, namely, the organic ferments, into two classes or groups, the so-called organized and unorganized, cannot be successfully accomplished. The term organized ferments is applied to those which are connected in some way with the life of the cells in which they are produced and which cannot be extracted from these cells. The unorganized ferments, commonly called enzymes, can, on the other hand, be extracted from the cells in which they are formed, and are able to produce their characteristic actions outside of the cells as well. Those who hold to this classification of organized and unorganized organic ferments, the enzymes, admit that the list of the unorganized ferments is constantly growing at the expense of the organized; that as soon as we will be able to successfully extract the organized from the living cell we will speak of unorganized ferments or enzymes alone. Buchner's successful extraction of zymase from the yeast-cell, which is able to bring about the decomposition of glucose into alcohol and carbon dioxid quite as readily as the yeast-cell itself, is a grand demonstration of the certainty of the coming of such events. Ferments play a most important part in the phenomena of assimilation and of disassimilation of foods. Most of the foods which occur in nature at the disposition of men, lower animals or plants, are not directly assimilable; they require the intervention of a ferment in order to be transformed into substances assimilable and suitable for the formation of new tissues. Pepsin is one of the oldest, if not the oldest, and most thoroughly well known ferment. It was so named by Schwann in 1835, fifty-six years after Spallanzani had shown that the gastric juice can produce chemical changes outside of the body. This ferment, called under the newer nomenclature acid-proteinase, because it acts in acid medium upon protein, gelatin and connective tissues, is present in the stomach of the human being from the time of birth. It is secreted in the fundic, as well as in the pyloric portions of the stomach. Formerly it was quite generally thought that the parietal (delamorphic, oxyntic) cells were the pepsin cells, but since the investigation of Heidenhain and his pupils, Langley, and others, the formation of pepsin has been shifted to the chief cells (adelomorphic, principal of central). Pepsin occurs in the mucous membrane only in the preliminary form of its zymogen, pepsinogen. Pepsin is destroyed by soda. If, however, the mucous membrane be extracted with a weak soda solution and the extract be then acidified with HCl, a pepsin-containing fluid of good digestive properties is obtained. (Langley.) Therefore, there must be in the mucosa a substance which is not destroyed by soda, and which is transformed into pepsin by treatment with acids.

From pure gastric juice of the dog, Nencki and Sieber, also Pekelharing, have prepared by dialysis and precipitation a very pure pepsin. Pekelharing claims to have prepared the purest acid-proteinase thus far obtained, and classes the enzyme among the proteins. His preparation gives the well-known reactions for protein, and on analysis shows the presence of carbon, nitrogen, hydrogen and sulfur in the proportions in which they exist in proteins. It contains no phosphorus, hence is no nucleo-proteid. Chlorin was found to be a constant constituent. Pekelharing's preparation is the most active preparation of this ferment obtained thus far, 0.001 milligram in 6 cc. of a 0.2 per cent. HCl solution dissolved a flake of fibrin in a few hours.

Pepsin splits the proteins into a number of different substances. The farther the cleavage proceeds the simpler will the composition of these substances be. These substances may be separated one from another by fractional precipitation with ammonium sulfate.

The nature of the products formed by this cleavage have been very thoroughly investigated within the past few years. Where we once believed that proteoses and peptones constituted the final products of gastric digestion, ready for absorption and assimilation, we now know that a large number of substances which were formerly looked upon as produced only in pancreatic digestion are also formed. The same substances as those formed in the action of tryptic digestion on protein are formed in gastric digestion, and in consequence we now look upon and ascribe to the gastric juice much greater digestive importance, so far as the proteins are concerned, than heretofore.

Caseinase, rennin, rennet, lab-ferment, are names given to the other important ferment found in the stomach which has the power of curdling milk.

The pepsin of Pekelharing, the purest and most potent ever extracted, is able not only to act on proteins but also curdles milk. Pepsin and rennin seem to be therefore parts of the same molecule. This view was suggested by Nencki and Sieber before him. A number of authors have pointed out the fact that rennin always coexists with a proteolytic ferment. In the human being and in certain other animals rennin accompanies the pepsin of the stomach and the trypsin of the pancreas. Rennin also is found in largest amounts in those portions of the stomach where the most pepsin is found, namely, the fundus.

COMPOSITION OF GAS FROM COTTONWOOD TREES.

By F. W. Bushong.

ABOUT ten years ago, while cutting down some cottonwood trees, the writer observed the formation of bubbles in the sap upon the freshly cut trunk, stump and chips. On applying a lighted match the gas emitted proved to be combustible. In the latter part of July, 1907, gas was collected from a cottonwood tree in the following manner:

An inch hole was bored into the trunk to the heart. A piece of gas-pipe provided with a stopcock was screwed tightly into this hole. A rubber tube conveyed the gas from the stopcock to a bottle previously filled with distilled water and inverted in a dish of distilled water. Two bottles of gas, about four liters, were collected and used for preliminary experiments, but were not used for analysis because they contained the air originally in the gas-pipe, etc. A third bottle of gas was reserved for the analysis, which was made November 27, 1907, with the following average results from two complete and two partial analyses by Professor McFarland:

Oxygen, O_2	1.24
Carbon dioxid, CO_2	7.21
Olefines (ethylene), etc., C_2H_4	0.00
Carbon monoxid, CO (One determination gave 0.5 per cent.)	0.00
Hydrogen, H_2	0.00
Methane (marsh gas), CH_4	60.90
Ethane, etc., C_2H_6	0.00
Nitrogen, etc., by difference, N_2	30.65
Total	100.00
Nitrogen residue as actually determined, N_2	30.01

University of Kansas, Lawrence, November 27, 1907.

THE RELATION OF PUBLIC HEALTH TO THE QUALITY OF MEDICINES.

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

THE early history of medicine shows us that the remedial agents employed were composed mostly of what may be termed simples, consisting of crude herbs, roots, and various parts of the plant; also of various inorganic mineral simple combinations. The medical properties of these were fairly well made out. If we glance at the meteria medica and the therapeutics of these times we are almost inclined to smile at the extreme simplicity and also at the ridiculous absurdities that had survived the superstitious era. One of the remarkable instances of this latter on record is that of the sympathetic powder of Sir Kenelm Digby, Knight of Montpellier. Whenever any wound had been inflicted this powder (composed of calcined green vitriol—ferrous sulfate) was applied to the weapon that had inflicted it, which was, moreover, covered with ointment and dressed two or three times a day. The wound itself, in the meantime, was directed to be brought together and carefully bound up with clean linen rags, but above all to be let alone for seven days; at the end of which period the bandage was removed, when the wound was generally found perfectly united. The triumph of the cure was decreed to the mysterious agency of the sympathetic powder which had been so assiduously applied to the weapon, whereas it is hardly necessary to observe that the promptness of the cure depended upon the total exclusion of the germ-laden air from the wound, and upon the sedative operations of nature not having received any disturbance from officious interference of art. Rational medicine grew out of this superstitious age as chemistry grew out of alchemy, and we find in primitive times the advent of what we might call domestic practice —suited to the sparsely settled country having few physicians. The followers of what we would term domestic practice were self-educated physicians, who devoted themselves to the introduction of family medicines and home medication—those earnest, conscientious persons, who received the sanction of medical practice of the day. The minister and the physician, we are told, were often one.. Domestic medicine was a necessity in those widely separated households. Some of the most conspicuous physicians of those times wrote domestic works for the people and taught them the rudiments of home medication. The lineal descendants of this class are the so-called patent medicines of our day. The old style of domestic medicines has been usurped by the present-day nostrums devised by those who claim the right to dose their fellow man, though themselves ignorant of the elements of pharmacy or medicine. The unfortunate result is that with this practice (controlled entirely by the spirit of commercialism) there has developed an era of self-medication, each one dosing himself with his own ideal nostrum, and his ideal is manufactured for him by the advertisements in the periodicals and in the daily press. This form of medication has grown to such an extent, and the commercial instinct has so cultivated and nourished it, that we are to-day facing a serious problem which has to do with public health. Into the various attractive packages of pills, powders, tablets and liquids have been compounded the synthetics, heart depressants, narcotics and treacherous drugs that may or may not be skilfully compounded—in some cases by irresponsible persons who have little or no pharmaceutical or medical knowledge, but have the money to exploit them. Both physicians and pharmacists are partly to blame for this condition.

We have recently examined some of the medicines of this class in the drug laboratory and find among them another condition which we did not suspect, namely, a deterioration of the material, a disintegration of what was supposed to be a stable compound. The compound may have been, when put up, in good condition, but a lapse of time has broken down its combination.

We would not have it understood that all combinations of this class contain death-dealing drugs, nor that all such medicinal agents are unstable. To be just and fair one must admit that some of the so-called patent medicines have the character of reputable combinations and are as useful as were the domestic remedies of primitive times, and we are not willing to say that if the two professions, pharmacy and medicine, should conscientiously seek to control them they would decide upon a war of their extermination. We do say, however, that for the public good some sort of control should be inaugurated. The food and drug law only partly meets the public demand.

It seems to us that a medicine of this class, before it is allowed to be placed on the open market, its formula and the resulting product should be properly inspected by responsible parties. This could be done without infringing upon the rights of the manufacturers or promoters.

The manufacturers of what are known as official remedial agents are obliged by law to maintain a well-defined standard in producing these agents. These standards are published, and the products put upon the market are at all times subject to chemical examination by authorized officials. This is as it should be. But if the federal government and the state require such rigid surveillance of the medicinal agents of the higher order for the protection of the public, how important is it that these agents of the lower order should be subject to some sort of standardization. These remedies, so artistically concealed from ordinary inspection by attractive wrapper and carton, are none the less liable to deterioration and diversity. It is not probable that this proposed exaction for these domestic remedies would work any hardship or injustice to the manufacturer or the trade. On the contrary, by raising the standard and instituting a judicious surveillance it would help both the manufacturer and the trade. It would discourage and drive out of business, it is true, those who take advantage of the much-abused privilege which men of all classes—trained and untrained—claim of dosing their fellow men on a purely commercial basis.

PERCENTAGE OF AN EXTRACTIVE AS A MEANS OF IDENTIFICATION AND ANALYSIS OF DRUGS AND SPICES.

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

SINCE the food and drug law has come into existence it becomes very necessary for the analysts to adopt methods for the examination of crude drugs and spices that may be considered the preliminary methods. Frequently not more than the preliminary method need be pursued. Such a method must be as simple as possible, and rapid. For ordinary drugs that have no alkaloidal constituency, aside from the microscopical examination, an estimation of the extractive from the drug is quite satisfactory. We have adopted the method of using the solvents of the U. S. P. for the estimation of such extractives. It is well known that the percentage yield of extractives would be proportionate to the quality of solvent, whether it be equal parts of alcohol and water, or 25 parts of alcohol and 75 parts of water, or 75 parts of alcohol and 25 parts of water, or pure alcohol. The yield of extractive would vary according to the amount of starch and inert matter that would be extracted. We have made some estimations of the simple drugs and have compared these with the experiences of other pharmaceutical chemists, and we find it to be safe to give the table on page 58. First, the name of drug, and next the solvents, and finally the percentage of extractives.

The method of preliminary analysis of the spices is somewhat similar to that of the medicinal drugs. The microscope is unquestionably the most valuable means of detecting adulteration in ground spices, as it furnishes direct ocular evidence and frequently discloses the nature of the foreign material, if present, the chemical analysis being mainly confirmatory.

In 1887 Richardson (U. S. Department of Agriculture, Division of Chemistry, Bul. 13, part 2) published a most valuable report on spices and spice adulteration. The report also contains an analysis of forty-two samples of whole spices, ground in the laboratory of the Department of Agriculture, and of numerous samples of ground spices collected in the open market. Modified methods have been devised since then,

Preparation.	Menstruum. (Parts of U. S. P. alcohol to parts of water or other solvents.)	Extractive Gm. per 100 cc., expressed as percentage.
Apocyanum, U. S. P.	3 to 2	29-32
Arnica flowers, N. F.	Dil. alc.	15-17
Arnica root	3 to 1	10-12
Asclepias	Dil. alc.	11-13
Blue cohosh	2 to 1	24-26
Bryonia	U. S. P. alc.	5-6
Columba, U. S. P.	7 to 3	6-8
Cimicifuga, U. S. P.	U. S. P. alc.	9-11
Echinacea	About 5 to 1	10-13
Eucalyptus, U. S. P.	3 to 1	23-26
Gentian, U. S. P.	Dil. alc.	26-31
Geranium, U. S. P.	3 to 2	26-29
Grindelia, U. S. P.	3 to 1	13-16
Phytolacca root, U. S. P.	Dil. alc.	18-21
Quassia, U. S. P.	1 to 2	5
Quillaja, U. S. P.	Dil. alc.	21-26
Rhubarb, U. S. P.	4 to 1	26
Rhus glabra, U. S. P.	Dil. alc.	21-25
Senega, U. S. P.	About 2 to 1	26-29
Senna, U. S. P.	Dil. alc.	17-21
Taraxacum, U. S. P.	Dil. alc.	21-26
Uva ursi, U. S. P.	2 to about 6½	56-61
Viburnum opulus, U. S. P.	3 to 1	16-19
Viburnum prunifolium, U. S. P.	2 to 1	11-13
Xanthoxylum bark, U. S. P.	3 to 1	11-21

and a variation from these has been made apparently necessary. In the Twenty-second Annual Report of Connecticut Agricultural Experiment Station, 1898, a most excellent paper is published, where 125 samples were collected and examined. Numerous other valuable articles have appeared and are frequently consulted.

Since the food and drug law has come into operation it is absolutely necessary that a rapid preliminary method be had for quickly determining whether a quantitative estimation is necessary, and for this purpose we have found good results in the ether and alcoholic extractives.

Two gms. of the powdered material were extracted with absolute ether, the ethereal tinctures evaporated at ordinary temperature, and finally dried over sulfuric acid. The total ether extract is weighed. The extract is then heated to about 110 degrees to constant weight, this latter weight being the non-volatile extract, and the difference between this and the first weight representing the volatile constituents.

We have been endeavoring to obtain through the use of other extractive solvents, such as petroleum ether, acetone, methyl alcohol, carbon tetrachlorid and chloroform, a series of results. The work has not progressed sufficiently to report, as it is somewhat difficult to obtain results which are concordant. This is unquestionably due to the fact that complete extraction is somewhat difficult to obtain. One result seems at present clear to us, namely: For this preliminary analysis, different spices seem to require different treatment. That is, different solvents must be selected for the different classes of spices, and the treatment of the resulting solutions must vary according to the nature of the spice. A statement will be made later when the examinations of solvents and spices have been completed.

FIRELESS COOKING.

By J. T. Lovewell, Ph. D., Topeka.

THE applications of science in the common economies of life are revolutionizing many of our philosophies, as well as methods of doing things. The former is seen very noticeably in the curricula of our schools, in the multiplication of elective courses, and in the laboratory methods of teaching, and in estimating the value of education on a commercial basis. A marked instance of this tendency may be found in the teeming publications of the Department of Agriculture in Washington.

Schools of agriculture and experiment stations are established in all the states, and scientific investigation is instituted in everything relating to utilizing the forces of nature in growing food plants, in winning mineral products, and in the preparation required to bring these things to a condition for the use and service of man. "Breeding to points," both in animal and plant reproduction, is accomplishing results that border on the marvelous. Who can foresee the limits of cross-breeding in the hands of such a skilful manipulator as Burbank?

The discussion of these questions, great and important though they be, is not the object of this paper, but rather another application of science, appealing to our most personal needs in the preparation of food for our tables. This is the criterion by which we classify men as savage, barbarian, half-civilized, civilized and enlightened, according to nomenclature of the old geographies. There is a wide difference between the larder of a savage and a Parisian cafe, and perhaps in neither of these is the right way of living best found. The essential idea of cooking, both etymologically and in common use, is the preparation of food by heat, so as to make it both more palatable and better adapted to nutrition. Heat is usually associated with fire, and therefore when we speak of a "fireless cooker," it seems like the play of Hamlet with Hamlet left out. By heat we bring our viands into a condition so that they are more easily broken up by chewing and made ready for the processes of digestion. Not only this, but the cooking effects other changes.

The carbohydrates, in the form of starch-grains, are broken open and in some cases converted into dextrin, and so rendered soluble by the gastric fluids. The fats, the proteids and many of the mineral constituents are dissolved and made ready for purposes of nutrition. The degree of heat required to effect these objects will vary, and is generally somewhat less for albuminous substances than for starch-grains; but in most cases is several degrees under 212 F. The presence of water greatly aids the reactions and time must be allowed to reach complete results.

The temperature, then, of boiling water, will give us heat enough, and all that is essential to cooking is to conserve this temperature by preventing the escape of heat. This is simply and easily done by enclosing the vessel, that has been brought to the boiling point over the open fire, into a box of some kind, lined with a non-conducting material, and the cooking will then be fully effected without further application of heat and without further care or trouble.

The Norwegian cooker is simply an apparatus of this kind and has been in use for many years. The wonder is that it has not been brought into more general use. Our army posts have lately been experimenting with it on an extensive scale and demonstrating its great convenience and economy. The cheerless, unpalatable ration of the bivouac is greatly improved and the health and spirits of the soldiers correspondingly benefited thereby.

There is an endless variety in these cooking-boxes, and even a small degree of ingenuity and machanical skill will suffice to make an efficient cooker. The essential thing is the lining of the box, and some material must be chosen with abundance of closed air spaces. There is no non-conductor better than confined air, and so our lining should be porous, as we say, just as we find the same kind of material necessary in our refrigerators. In these it is our object to keep the heat out, but in the cooker we must keep it in. The difference between the outside and inside temperatures is commonly much greater in the cooker than in the refrigerator, but the time we find it necessary to maintain this difference is in the latter longer and generally quite indefinite, while in the cooker a few hours is all that is needed. Of the various materials for lining the cooker, loose felt has been much employed, and is perhaps as efficient as anything. Sawdust, excelsior, charcoal, cotton, wool, loose paper, rags, feather cushions, and hay or straw have been used. Whatever is chosen, it should be remembered that many of the conditions inside the cooker are favorable to germ development, and whatever lining we select should be a material capable of easy removal and cleansing. The advisability of a substance like hay may be doubted. which has little to recommend it except cheapness, and of all substances it makes the best culture for bacteria. Among the advantages of the fireless cooker may be enumerated the following:

First. It gives a long and even heat to food like cereals, that require more time than is usually given over an open fire, and the products come out of the cooker better done and more palatable. The same is true of meats, and in these we find the cheaper cuts prepared in the cooker are fully equal to the more expensive ones cooked in the old way. This will often make a saving of one-half on the costliest item on our tables.

Second. The economy of labor is greatly promoted. In the breakfast the housewife anticipates the other meals and will have her viands cooked so that very little further preparation is needed. Her time will then be more free for other occupation than the everlasting drudgery of the kitchen.

Third. There is no danger of burning food on the fireless cooker. The scorched saucepan, the spoiled food, the ruffled feelings, are alike avoided.

Fourth. Economy of fuel is a considerable item. When the food has gone into the cooker the fire in the range may be allowed to go out, and in the summer time it relieves the house of heat introduced by constant fires in the kitchen.

Fifth. In ordinary cooking, with the escaping steam unpleasant odors often pass off, filling the house, and it will certainly be an advantage to have our dinner of cabbage and onions without advertising the fact to our neighbors.

Sixth. The principles of the fireless cooker may be very profitably applied in preparation of food for stock. All that would be needed for this is a sufficiently large vat of wood, or other material, enclosed in a jacket of non-conducting material, and when the vegetables or grains to be cooked are heated to boiling and emptied into the vat this is tightly closed, covered to prevent radiation, and the cooking goes on to completion without further application of heat.

Finally, it may be said that in this very elementary application of science we have an amelioration of labor and expense in one of the commonest and most necessary functions of living.

The fireless cooker will not necessarily make a good cook, nor insure sumptuous viands for our tables. Just as a celebrated painter advised his pupils to mix their colors with brains, so must the kitchen artist use mind as well as muscle.

NEON AND ARGON IN NATURAL GAS.

By Hamilton P. Cady and David F. McFarland, University of Kansas, Lawrence.

AT THE last meeting of the Academy we reported the presence of helium in natural gas. Since that time we have found argon in the Dexter gas and neon in that furnished the University by the Kansas Natural Gas Company.

It is not easy to detect neon in the presence of helium when working with small quantities of gas such as we used in the analyses previously reported, but during the preparation of considerable quantities of helium the neon showed its presence unmistakably.

The method for the isolation of these gases is briefly as follows: The natural gas is largely condensed in a bulb surrounded with liquid air. The uncondensed portion is then passed into bulbs filled with cocoanut charcoal and cooled with liquid air. Here all the gases except hydrogen, neon and helium are completely absorbed. Of these three gases hydrogen is rather freely absorbed, neon somewhat, and helium scarcely at all. In working with small quantities of gas the neon is very largely taken up by the charcoal, while with larger amounts the latter finally becomes saturated and then the lines of neon are plainly visible in the spectrum of the gas. The difference in the absorption of helium and of neon in cocoanut charcoal is great enough so that neon spectroscopically free from helium may be prepared as follows: A charcoal bulb is heated to about 400 degrees and exhausted as completely as possible. It is then cooled with liquid air and the unabsorbed gases from another charcoal bulb are passed in, allowed to stand for a time, and removed with a mercury pump. After a sufficient amount has been passed through the bulb, the helium is removed by pumping until a cathode-ray vacuum is obtained. The bulb is then warmed slightly and some gas removed; after this, by warming the bulb more strongly, neon spectroscopically free from helium is obtained.

The identity of the neon was established by measuring the wave-lengths of the lines in the spectrum and comparing them with those given by Baly (Phil. Trans. 1904, vol. 202, p. 183). Baly photographed something over a hundred lines in the visible portion of the spectrum. About half of these lines are given as very faint. We have measured optically about sixty-five of these lines, including all but the very faintest. The measurements, with one exception, agree with Baly's to within one angström. In this case it is quite evident that there is a misprint in Baly's table, for our measurement agrees well with that given by Living and Dewar (Proc. Roy. Soc. 67, 467, 1901) for this line, while it differs from Baly's by much more than the limit of error.

Besides the lines of neon, the tubes show about fifteen fairly strong lines which do not seem to belong to hydrogen, helium, or any of the familiar gases. These lines are given in a list of lines shown by the more volatile gases of the atmosphere and by the gases from Bath Springs as published by Living and Dewar (loc. cit.). This would seem to show that the lines are not accidental and that it is legitimate to look for a new very volatile gas in this residue.

The argon was identified from its spectrum by measurement of wave-lengths and by direct comparison of the spectrum with that given by a known specimen of argon.

SANITARY WATER ANALYSIS.

By Prof. E. H. S. Bailey, University of Kansas, Lawrence.

NOTWITHSTANDING all the advances that have been made in analytical chemistry within the past twenty-five years, there seems to be little improvement in the methods employed for the sanitary analysis of potable waters. Referring back to the early methods of analysis that were worked out by Wanklyn and by Frankland, we find that there has been little change in these methods, except in the greater accuracy with which they can be carried out. The combustion method suggested by Frankland is so tedious that it is not often followed at present, and the value of the Wanklyn method is seriously questioned, especially by some of the members of the Geological Survey at Washington.

For the analysis of a water to determine whether it is suitable for domestic purposes, the most rational plan so far suggested seems to be to determine the nitrogen in the different forms of free ammonia, albuminoid ammonia, as nitrites and as nitrates. But there is considerable nitrogen in the various vegetable substances that may be dissolved in water, especially if the water flows over a rich or over a peaty soil. How shall we distinguish between the nitrogen from vegetable sources and that from sewage contamination, which might mean animal contamination? The organic bodies existing in the soil extract, or in the "humus," as this soil material is called, are very numerous and complex in structure. The free ammonia as obtained in an ordinary sanitary water analysis, if abundant, is supposed to be largely of animal origin. This is not necessarily true. Some waters are so loaded with organic matter, especially when associated with iron, that they yield a quantity of free ammonia which in other waters would characterize only sewage. This is often the case with artesian waters.

This fact can be best illustrated by referring to the analysis of the water used for supplying the city of Lawrence. These analyses were recently made by Dr. F. W. Bushong. The source of the supply is water obtained from "points" driven in the bottom on the right bank of the Kansas river, a short distance above the city.

N. in—	S. E. point.	Middle point.	New pipe.	City mains.
Free ammonia	2.22	2.35	2.23	0.162
Albuminoid ammonia	0.540	0.452	0.540	0.258
Nitrites	trace	none	none	0.017
Nitrates	none	none	none	0.560
Bacteria *	none	none	trace	present

This water is pumped from the ground to the top of an inclined platform from which it falls over riffles into a basin. After being allowed to settle, it is run into another basin, from which the water is pumped into the city mains.

When first pumped the water is clear, but as soon as it is exposed to the air some of the gases escape, and some oxidation takes place, so that a large quantity of iron is precipitated, and the water becomes very turbid. The process of oxidation continues to some extent in the city mains, but even then the iron is not all precipitated, so that it frequently becomes turbid after being drawn from the faucet.

The organic matter of the soil has evidently yielded ammonia as a product of reduction. This may have been brought about by some vegetable organisms like the well-known Crenothrix, F, which contains iron as one of its necessary constituents. When the water has a chance to become aerated, most of the free ammonia escapes. The albuminoid ammonia retained is also small. There were no nitrates or nitrites in the freshly-drawn water, but it is evident that some of the ammonia has oxidized to these two bodies, hence we find them in the city water. We have noticed that with this particular water the amount of nitrogen as nitrates found can be used an index of the thoroughness of the aeration at the plant.

There were no indications of bacterial contamination except in the case of the city water, and here during the past summer, and possibly at the present time, some river water has been pumped into the pipes, as the ground supply was not abundant enough. Of course it may be possible that the nitrates and nitrites came from the river water, but that is not probable, as the analysis has usually shown but a very small quantity of these in the river.

Water from the points does not show the presence of *Colon* bacillus, while the river water and the city supply do show it,

* Later, the city water when obtained entirely from ground-water was free from bacterial contamination.

so we have concluded that when we get the pipes completely cleared of river water the city supply ought to show practically no bacterial contamination.

The analyses above quoted show the extreme importance of having a full and complete knowledge of the source of the water before passing any judgment on its quality. A decision that would apply to a river water would not apply to a well water, and a decision on the quality of a well water might not apply at all to an artesian-well water. The iron waters in the underflow of the valleys of the Middle West are a class by themselves.

The standards ordinarily applied to shallow-well waters do not apply at all here. Doctor Kinnicutt (*Science*, Vol. XXIII, p. 56) would exclude as suspicious a water that had more than the following quantities of nitrogen in 1,000,000 parts: In free ammonia, 0.05; albuminoid ammonia, 0.08; nitrates, 0.10.

Comparing the waters mentioned above with such a standard would be utterly futile. Then, afterwards the process of aeration entirely changes the character of the water, and it must be compared with surface-waters, in which more albuminoid ammonia would be allowable.

Facts of this kind only emphasize the necessity for more satisfactory chemical methods for water analysis, and a careful study of each water by itself, without too close reliance on standards that are fixed even for that particular class of waters.

III.

GEOLOGICAL PAPERS.

---

1. "Nomenclature of Kansas Coal-measures Employed by the Kansas State Geological Survey."
   By Erasmus Haworth and John Bennett, University of Kansas, Lawrence.
2. "Summary of Glacial Literature Relating to Glacial Deposits."
   By Albert B. Reagan, La Push, Wash.
3. "Animals, Reptiles and Amphibians of the Rosebud Indian Reservation, South Dakota."
   By Albert B. Reagan, La Push, Wash.
4. "My Expedition to the Kansas Chalk in 1907."
   By Charles H. Sternberg, Lawrence.
5. "A Fossil Tusk, Found in the McPherson Equus Beds."
   By Emil O. Deere, Lindsborg.

THE NOMENCLATURE OF KANSAS COAL-MEASURES EMPLOYED BY THE KANSAS STATE GEOLOGICAL SURVEY.

By Erasmus Haworth and John Bennett, University of Kansas, Lawrence.

YEARS ago the Kansas State Geological Survey began a systematic study of the detail stratigraphy of eastern Kansas. Largely because the existence of the Survey depended upon biennial appropriations, preliminary reports were made. Naturally such reports were somewhat defective. Geologists in the neighboring states, Missouri, Iowa, and Nebraska, have taken up the matter in a way largely by criticism of Kansas, rather than by giving details of conditions in their own states, with the result that there is now in print, widely scattered through magazines, state and governmental reports, a comparatively extensive literature of the stratigraphy of the Kansas Coal-measures, practically all of which is partly correct and partly incorrect. This condition has been aggravated, wholly unintentionally, through the labors of the United States Geological Survey. This organization has surveyed the Iola quadrangle and Independence quadrangle. An error in stratigraphy was made and published regarding the southwest corner of the Iola quadrangle. Field-work on the Independence quadrangle was conducted and a preliminary report published before this error in the Iola quadrangle was detected, and as a result its influence caused errors to creep into the Independence sheet reports as well.

In the present paper, the stratigraphy of this part of the state is given in great detail, after years of continued work, and it is confidently believed we have finally succeeded in getting all matters straightened out, so that the presentation here offered is a complete and accurate exposition of positions and relations of all alternating beds of limestones and shales, with included sandstones from the bottom of the Lower Coal-measures up to the Burlingame limestone. Every individual limestone has been traced with greatest detail by a personal examination not only of every mile square, but by a geologist following it across every forty-acre tract of land from the north side of the state to the south. In some instances, where difficulties were greatest, two or more geologists have spent weeks and months tracing such formations a distance of only a few miles.

CHEROKEE STAGE.

The Cherokee stage is not yet subdivided, being composed entirely of the Cherokee shales.

CHEROKEE SHALES.[1]—The name Cherokee shales was given by Haworth and Kirk in 1894 to a heavy bed of shales lying at the base of the Coal-measures in Kansas. The name was chosen on account of their prominence in Cherokee county, the southeastern county of the state.

MARMATON STAGE.[2]

The Marmaton stage is subdivided into eight parts, namely, the Fort Scott limestone, Labette shales, Pawnee limestone, Bandera shales, Altamont limestone, Dudley shales, Coffeyville limestone, Pleasanton shales.

FORT SCOTT LIMESTONE.—The name Fort Scott limestone is here applied to the two limestone beds occurring at Fort Scott, with about seven feet of shale between, which beds have been traced in detail both southwest and northeast to beyond the state line.

In 1894, Haworth and Kirk,[3] in a preliminary description along the Neosho river, named these rocks Oswego limestone, which name was retained in volumes I and III of the State Survey's reports. In his report on Kansas geology, in 1860, Swallow named the lower one Fort Scott cement rock. Since the first publication of the name Oswego, in 1894, it has been learned that the name was previously occupied by Prosser,[4] who used it in connection with a division of the Silurian in the state of New York. As the name Fort Scott is just as appropriate on account of the rocks being so well exposed in the environs of a city by that name, and partly on account of Swallow[5] having proposed the name for the lower bed, the term is here adopted to replace the name Oswego, previously used by this Survey.

LABETTE SHALES.[6]—The name Labette shales is applied to a bed of shale lying immediately above the Fort Scott limestone.

1. Haworth & Kirk, Kan. Univ. Quart., vol. II, p. 105, Lawrence, 1894.
2. Haworth, Prof. E., Kan. Univ. Geol. Surv., vol. III, p. 92, Lawrence, 1898.
3. Haworth & Kirk, Kan. Univ. Quart., vol. II, p. 105, Lawrence, 1894.
4. Prosser, Prof. Chas. S., Bull. Geol. Soc. Amer., vol. IV, pp. 100, 108, 116, 1892.
5. Swallow, Prof. G. C., Geol. of Kan., p. 25, Lawrence, 1866.
6. Adams, Dr. Geo. I., Kan. Univ. Geol. Surv., vol. III, p. 36, Lawrence, 1898.

The term was first used by Adams while the manuscript of volume III was in preparation. Previously Haworth and Kirk[7] had suggested the name Laneville shales in their preliminary report on the geological section along the Neosho river.

PAWNEE LIMESTONE.[8]—The name Pawnee limestone was given by Professor Swallow to the limestone first overlying the Labette shales, largely developed along Pawnee creek, in Bourbon county.

BANDERA SHALES.[9]—The name Bandera shales is here applied to the shale-bed lying above the Pawnee limestone and below the Altamont. It was at one time called the Lower Pleasanton shales, but, as will be explained farther on, this nomenclature was dropped.

ALTAMONT LIMESTONE.[10]—The name Altamont limestone is here applied to the limestone at Altamont, the schoolhouse at that place being built immediately on top of it. This name was first used by Adams in volume I of this series of reports. It is also described by Bennett[11] in volume I, being spoken of as the "eight-foot system" lying within the Pleasanton shales, showing that it is sufficiently persistent to be recognized at that time as dividing the Pleasanton shales.

Later Adams[12] withdrew the name Altamont and substituted the name Parsons for the same formation. In his later description he speaks of it as consisting of two members. Subsequent work by this Survey has shown conclusively that he was in error and that the upper limestone is one so prominent at Coffeyville, which is designated as the Coffeyville limestone. Why he should have changed the name from Altamont to Parsons with no apparent reason is entirely unknown. As Altamont has already appeared in volume I of our geological reports, of course we are under the necessity of retaining the name, and this is particularly desirable on account of its eminent appropriateness.

WALNUT SHALES.—The name Dudley shales was applied by Adams[13] to a bed of shales described as follows: "The name Dudley shales is here applied to the beds occupying the interval

7. Kan. Univ. Quart., vol. II, p. 108, Lawrence, 1896.
8. Swallow, Prof. G. C., Geol. of Kan., p. 24, § 203, Lawrence, 1866.
9. Adams, Dr. Geo. I., U. S. G. S. Bull. 211, Washington, 1903.
10. Adams, Dr. Geo. I., Kan. Univ. Geol. Surv., vol. I, p. 22, Lawrence.
11. Bennett, Rev. John, Kan. Geol. Surv., vol. I, p. 94, Lawrence, 1896.
12. Adams, Dr. Geo. I., U. S. G. S. Bull. 211, p. 33, Washington, 1903.
13. Adams, Dr. Geo. I., U. S. G. S. Bull. 211, p. 34; also Bull. 238, p. 17, Washington, 1903.

between the Parsons limestone and the Hertha limestone, which, as explained above, in the discussion of the synonym, are the equivalent of Haworth's Lower Pleasanton shales." We apply the name Walnut for a portion covered by Adams's name Dudley, for the following reasons: *First.* The town of Dudley does not rest on these shales at all, but on the Ladore shales, named by Adams, which name we adopt, and which lie above the Bethany Falls limestone. *Second.* Adams, under the name Bandera shales, says, page 32: "These shales are the equivalent of the Lower Pleasanton shales of Haworth." This latter statement is correct, making the statement that the Dudley shales correspond to Haworth's Lower Pleasanton shales impossible. *Third.* We want a name for the shale-beds above the Altamont limestone and below the Coffeyville limestone, but Adams did not recognize the Coffeyville limestone, so spread the name from the Altamont to the Bethany Falls limestone, thereby crowding out Haworth's Lower Pleasanton shales, which, by all the laws of priority, should be retained. The name Walnut shales, therefore, is applied by us to the shales above the Altamont limestone and below the Coffeyville limestone.

COFFEYVILLE LIMESTONE.—The name Coffeyville limestone is here used for the first time. It is applied to the limestone so prominent at Coffeyville, from which place it takes its name. It is the limestone spoken of as the Upper Altamont or Parsons by Adams,[14] whose error was due to a lack of detailed information. Since his last publication on the subject, this limestone has been traced with great detail by Bennett, who has been able to determine without question that it is a separate limestone formation extending entirely across the corner of the state. Its independent existence warrants us in giving it a distinct name.

PLEASANTON SHALES.[15]—The term Pleasanton shales was first introduced by Haworth in 1895. At that time it was applied to the entire mass of shales lying above the Pawnee limestone and what was then called the Erie limestone, the lower member of which was called the Bethany Falls limestone, and will so appear in our next volume. The intervening Altamont and Coffeyville limestones were not known at that time.

It should be noted that Professor Swallow, in his report for

14. Adams, Dr. Geo. I., U. S. G. S. Bull. 211, p. 33, Washington, 1903.

15. Haworth, Prof. E., Kan. Univ. Quart., vol. III, p. 274, Lawrence, 1895.

1866, gave no name for either the Bandera, the Dudley or the Pleasanton shales, and, as best we can determine by a careful study of his report, they correspond to the lower part of his Marais des Cygnes coal series, probably from his numbers 178 to 202 inclusive, but we are somewhat in doubt on this subject.

POTTAWATOMIE STAGE.[16]—The Pottawatomie stage is divided into thirteen subdivisions, namely, Bethany Falls limestone, Ladore shales, Mound Valley limestone, Galesburg shales, Dennis limestone, Cherryvale shales, Drum limestone, Chanute shales, Iola limestone, Lane shales, Allen limestone, Vilas shales, Stanton limestone.

BETHANY FALLS LIMESTONE.—The name Bronson Formation was used by Adams[17] to designate the combination or assemblage of three distinct limestone formations which are definitely marked in the southern part of the state, but which come close together on the north by the thinning of the interbedded shales, so that from the middle of eastern Allen county northeastward they appear in the escarpments as one limestone with thin shale-beds between them. These limestones have caused more discussion and confusion than any other formations in the state. In his report in 1866, Swallow confounded them with a number of overlying limestone formations, called them in places Well Rock series, and again the Spring Rock series, and again included them in his Marais des Cygnes coal series.

When the Kansas Survey first began investigations, Bennett ran a geological section west from Fort Scott and encountered these three limestones in the prominent escarpment near Uniontown. He recognized two shale partings and therefore spoke of the limestone as forming a "triple system," which term was used by him provisionally in volume I because exact correlations were not definitely known. Later, Haworth and Kirk named them the Erie limestone, on account of their prominent development northwest of Erie. Still later, Adams gave names to the three individual limestone formations as they occur to the south, and as above stated, suggested the name Bronson formation for their combination on the north, inasmuch as the name Erie was previously occupied.

In 1872,[18] Broadhead gave the name Bethany Falls limestone to a limestone formation which, in his general section, is num-

16. Haworth, Prof. E., Kan. Univ. Geol. Surv., vol. III, p. 93, Lawrence. 1898.
17. Adams, Dr. Geo. I., U. S. G. S. Bull. 238, p. 17, Washington, 1903.
18. Broadhead, Dr. G. C., Mo. Geol. Surv. Rep., 1872, part II, pp. 76-99.

bered 78, and described it as occurring on the south bank of the Missouri river at the end of the Hannibal bridge, Kansas City, and at a number of places in the north part of the state. The abutment on the south end of the Hannibal bridge rests directly on this limestone, and the Missouri Pacific tracks between the bridge abutment and the river also rest upon the upper surface of this limestone.

Recent investigations by this Survey have demonstrated conclusively that the Bethany Falls limestone of Broadhead, his number 78, is the lower member of Adams's Bronson limestone, of the "triple system" of Bennett, and of the Erie limestone of Haworth and Kirk. Priority requires, therefore, that the term Bethany Falls be used to designate this lower limestone formation. It will therefore replace the name Hertha limestone of Adams,[19] which term, by Adams's recommendation, has, in general, been accepted by the United States Geological Survey and used in their Bulletin No. 238, page 18.

LADORE SHALES.[20]—The name Ladore shales is used by Dr. Geo. I. Adams to designate the shales lying between the Bethany Falls limestone below and the Mound Valley limestone above. It is now used with that significance.

MOUND VALLEY LIMESTONE.[21]—The name Mound Valley limestone was used by the Kansas Survey in volume I of their reports at the suggestion of Doctor Adams, who, at that time, was one of the field assistants. Later, Adams[22] abandoned this name and introduced in its stead the name Dennis limestone, without giving any reason for so doing. His writings, however, show that he confounded the Mound Valley limestone with the one first above, or, rather, he recognized only three of the four limestones occurring here, and therefore dropped one name. This Survey still uses the name Mound Valley, as it did originally, to designate the limestone of the hills immediately northwest of Mound Valley.

GALESBURG SHALES.[23]—The name Galesburg shales was proposed by Adams to designate, as he put it, "the rocks occupying the interval between the Hertha limestone and the Dennis limestone." As has already been shown, Adams in some way overlooked the existence of the Mound Valley limestone, which

19. Adams, Dr. Geo. I., U. S. G. S. Bull. 238, p. 35, Washington, 1903.
20. Adams, Dr. Geo. I., U. S. G. S. Bull. 238, pl. II, 1904.
21. Adams, Dr. Geo. I., Kan. Univ. Geol. Surv., vol. I, p. 23, Lawrence, 1896.
22. Adams, Dr. Geo. I., U. S. G. S. Bull. 211, p. 36, Washington, 1903.
23. Adams, Dr. Geo. I., U. S. G. S. Bull. 211, p. 36, Washington, 1903.

separates into two parts the shale-beds he referred to. For the shales below the Mound Valley limestone we have already accepted Adams's name, Ladore shales. It is here proposed to retain the name Galesburg shales for those lying above the Mound Valley limestone and below the Dennis limestone.

DENNIS LIMESTONE.[24]—Adams used the name Dennis limestone to designate a limestone formation immediately underlying the little way station on the railroad between Parsons and Cherryvale.

As explained above, he confounded these with the Mound Valley limestone, so that, so far as his writings are concerned, the name is equally applicable to each formation. As the name Mound Valley had already been used by this Survey, it was retained with its original significance and the term Dennis, out of courtesy to Adams, is now used for the upper one of the two to which he applied it.

CHERRYVALE SHALES.[25]—The name Cherryvale shales is used to designate the shale-bed with the Dennis limestone lying below and the Drum limestone lying above.

DRUM LIMESTONE.[26]—The name Drum limestone was first suggested by Adams to designate the limestone covering the hilltops at Cherryvale and occurring in such abundance in the vicinity of Independence. Previously, Haworth and Piatt[27] had applied the name Independence limestone to this same formation. It appears, however, that the name was previously used by Calvin[28] for a division of the Devonian shales in the vicinity of Independence, Iowa, and its use must, therefore, be abandoned by this Survey. The name Drum limestone is therefore adopted.

CHANUTE SHALES.[29]—The term Chanute shales is used to designate the shale-bed lying first above the Drum limestone and first below the Iola limestone. This name was introduced by Haworth and Kirk in 1894 in a preliminary publication, as already explained, at a time when a number of geological sections were run across the state. In that instance, local names were given to each formation under each section. Later, when a system of correlation was introduced, some of these names

24. Adams, Dr. Geo. I., U. S. G. S. Bull. 211, p. 36, Washington, 1903.
25. Haworth, Prof. E., Kan. Univ. Geol. Surv., vol. III, p. 47, Lawrence, 1898.
26. Adams, Dr. Geo. I., U. S. G. S. Bull. 211, p. 37, Washington, 1903.
27. Haworth & Piatt, Kan. Univ. Quart., vol. II, p. 115, Lawrence, 1894.
28. Calvin, Amer. Jour. Sci., 3d series, vol. XV, pp. 460-462, 1879.
29. Haworth & Kirk, Kan. Univ. Quart., vol. II, p. 109, Lawrence, 1894.

had to be dropped. It was found that the name Chanute shales was applied to the same formation in one section that the name Thayer shales was applied to in another. In volume III of this series of reports, page 49, it was decided to drop the term Chanute shales and retain the term Thayer shales, as it had been introduced at the same time. One of them necessarily had to be dropped, and the question of priority in no way entered into the question.

Subsequently, Adams,[30] in a government publication, restored the name Chanute shales, apparently under the impression that priority demanded it, and the term has been used since then by at least two different governmental publications. At present, therefore, we are forced to decide between the use of the term Chanute as employed by our government upon the advice of Adams, and Thayer, as previously employed by this Survey. As just explained, it is not a question of priority, the two being introduced at the same time and in a similar manner by Haworth and Kirk. The frequency of usage, however, is in favor of the governmental publications, and we bow, therefore, to the greater power and use the name Chanute.

IOLA LIMESTONE.[31]—The name Iola limestone is here used to designate the large and prominent limestone lying first above the Chanute shales. It was first introduced by Haworth and Kirk in 1894, and has been used continuously and without question by every one writing on the geology of this part of the state from that time to the present.

LANE SHALES.[32]—The term Lane shales was applied by Haworth in 1895 to the bed of shales first above the Iola limestone, and is here used with the same significance. In those early days, before positive correlations were possible, there was a little doubt as to its exact limitations. At present such doubt is all removed, and, therefore, its exact position may be given as a shale-bed lying between the Iola limestone below and the Allen limestone above.

Adams[33] has entirely ignored the use of this name, although it had been in good standing for ten years. In his report on the Iola quadrangle, he used in its place the name Concreto, probably in allusion to the manufacture of Portland cement at Iola. Why such disregard for well-established usage he does

---

30. Adams, Dr. Geo. I., U. S. G. S. Bull. 211, p. 38, Washington, 1903.
31. Haworth & Kirk, Kan. Univ. Quart., vol. II, p. 109, Lawrence, 1894.
32. Haworth, Prof. E., Kan. Univ. Quart., vol. III, p. 277, Lawrence, 1895.
33. Adams, Dr. Geo. I., U. S. G. S. Bull. 238, p. 20, Washington, 1903.

not mention, and it is not known by the present writers whether it was his volition or a mandate from the committee on nomenclature of the United States Geological Survey.

Allen Limestone.[34]—The name Allen limestone is here used to designate the limestone first above the Lane shales. There has been a large amount of discussion regarding the names of the two limestones first above the Lane shales. In its early work, this Survey was lead into error a number of times on account of a lack of proper correlation. After Adams[35] joined the United States Geological Survey, he likewise was incorrect in treating this subject. All along it has been known that there were two principal limestone formations, moderately close together and sufficiently persistent to mark a prominent escarpment across the state. In 1894 these two were not differentiated, and in the section of the Neosho river were called the Burlington limestone by Haworth and Kirk. In the same publication, in a section from Coffeyville to Lawrence, Haworth recognized a limestone at Carlisle, which he named Carlisle, and the two limestone masses at Garnett and Ottawa, which he named the Garnett limestone.

In volume II of the State Survey the term Garnett was used, Bennett having previously determined by field-work that the exposure at Carlisle was the lower of these two. In that way the name Carlisle was dropped. Adams decided that the lower member, or possibly both of these, was the limestone mentioned by Swallow as the Stanton limestone. Later, in United States Geological Survey Bulletin No. 238, whether voluntarily or not we do not know, he abandoned the term Stanton and introduced the terms Allen and Piqua for these two limestone-beds.

Our investigations have shown conclusively that the limestone named the Stanton limestone by Swallow in his report for 1866 is the upper one of these two much-discussed limestone formations. Inasmuch as we are now ready to give detailed descriptions and detailed names, we adopt the name Allen for the lower one of the two, because it seems to be the first name suggested for this specific formation, and retain the name Stanton for the upper one, because Swallow suggested it as early as 1866. Our former name, Garnett, may be used, should it be desired, for the combination of the two, as originally understood, but Adams's name, Piqua, for the upper

34. Adams, Dr. Geo. I., U. S. G. S. Bull. 238, p. 20, Washington, 1904.
35. Adams, Dr. Geo. I., U. S. G. S. Bull. 238, p. 20, Washington, 1904.

one of the two must give way to Swallow's Stanton unless priority be entirely ignored.

VILAS SHALES.[36]—The name Vilas shales is used to designate the shales lying just above the Allen limestone and below the Stanton. When it was first named by Adams its exact position was not known, and yet Adams was correct in giving its location. The error consisted in a wrong discussion of the limestones. Adams thought that the Iola limestone extended southwestward, capping the hills at Neodesha, and that, therefore, the Vilas shales lay under the Iola. In this particular area he mistook the Allen for the Iola. This error followed him in all of his publications, even to his latest map of the Iola quadrangle, United States Geological Survey Bulletin No. 238. The shale-bed about Vilas to which he attached the name is now known to lie on top of the Allen limestone, forming a narraw zone extending practically across the state.

STANTON LIMESTONE.[37]—The name Stanton limestone is used to designate the limestone first above the Vilas shales. Swallow gives its locations as follows: "This limestone is well exposed in the eastern bluff of the Marais des Cygnes, in the highest points north of 'The Devil's Backbone,' above Stanton." There can be no doubt, therefore, regarding his exact use of the term at this place. However, he may have been led into error in correlating it with other limestones in other parts of the state. This is the same limestone formation named Piqua by Adams,[38] as has been abundantly proved by the most careful field-work.

DOUGLAS STAGE.[39]

The Douglas stage is divided into the following subdivisions, namely, Le Roy shales, Kickapoo limestone, Lawrence shales, and Oread limestone.

LE ROY SHALES.[40]—The name Le Roy shales is used to designate the shales first above the Stanton limestone and first below the Kickapoo limestone. In 1894 Haworth and Kirk recognized them in their section along the Neosho river. Later they were supposed to be correlated with the Lawrence shales, so well exposed farther north. In those days of imperfect correlation it was difficult to determine just what were their equiva-

---

36. Adams, Dr. Geo. I., Kan. Univ. Geol. Surv., vol. III, p. 51, Lawrence, 1898.
37. Swallow, Dr. G. C., Geol. of Kan., p. 75, Lawrence, 1866.
38. Adams, Dr. Geo. I., U. S. G. S. Bull. 238, p. 20, Washington, 1904.
39. Haworth, Prof. E., Kan. Univ. Geol. Surv., vol. III, p. 93, Lawrence, 1898.
40. Haworth & Kirk, Kan. Univ. Quart., vol. II, p. 110, Lawrence, 1894.

lents north and south. We are now able to say that they have a sufficient existence to warrant a separate name.

KICKAPOO LIMESTONE.[41]—The name Kickapoo limestone is here used to designate a thin limestone found entirely across the state, from the state line in Chautauqua county northward to Doniphan county beyond Atchison. It is not very important, except at the northern outcrop, and had been overlooked in a measure in our earlier field-work. On account of its persistence, however, throughout a distance of 200 miles, its importance is readily recognized. It is the Willow Creek limestone described by Schrader[42] in his description of the Independence quadrangle area.

LAWRENCE SHALES.[43]—The Lawrence shales are so named by Haworth on account of the good exposure at the city of Lawrence, and to the south of that place.

OREAD LIMESTONE.[44]—The name Oread limestone, given by Haworth, is used for the limestone just above the Lawrence shales. The name was given on account of the limestone capping the hill known as Mount Oread, on which the University of Kansas stands, and has been continuously used by this Survey since its introduction. There are three members of this limestone, which, for detailed description, should be separated, but physiographically they appear as one, capping the prominent escarpment stretching entirely across the state.

SHAWNEE STAGE.[45]

The Shawnee stage is divided into eight subdivisions, namely, Kanwaka shales, Lecompton limestone, Tecumseh shales, Deer Creek limestone, Calhoun shales, Topeka limestone, Severy shales, Howard limestone.

KANWAKA SHALES.[46]—These shales are so named by Adams, and they occupy the interval between the Oread and Lecompton limestones. They were named for a township in Douglas county, where they have an outcrop.

LECOMPTON LIMESTONES.[47]—This name was given to these limestones by Bennett. They are named from the town which

41. Bennett, Rev. John, Kan. Univ. Geol. Surv., vol. I, p. 61, Lawrence, 1896.
42. Schrader, Dr. F. C., & Haworth, Prof. E., U. S. G. S. Bull. 296, p. 12, Washington, ———.
43. Haworth, Prof. E., Kan. Univ. Geol. Surv., vol. I, p. 136, Lawrence, 1896.
44. Haworth, Prof. E., Kan. Univ. Quart., vol. II, p. 123, Lawrence, 1894.
45. Haworth, Prof. E., Kan. Univ. Geol. Surv., vol. III, p. 93, Lawrence, 1898.
46. Adams, Dr. Geo. I., U. S. G. S. Bull. 211, p. 45, Washington, 1903.
47. Bennett, Rev. John, Kan. Univ. Geol. Surv., vol. I, p. 116, Lawrence, 1896.

was at one time the territorial capital of what is now the state of Kansas. They lie immediately above the Kanwaka shales.

TECUMSEH SHALES.[48]—The Tecumseh shales are so named by Beede. They fill the interval between the Lecompton and the Deer Creek limestones.

DEER CREEK LIMESTONES.[49]—Bennett named these limestones from their location on Deer Creek, east of Topeka.

CALHOUN SHALES.[50]—This name was introduced by Beede, and is applied to a shale above the Deer Creek and below the Topeka limestones.

TOPEKA LIMESTONES.[51]—The Topeka limestones are so called by Bennett. They are a quadruple series, and have been extensively quarried for building purposes at Topeka, from which place they derive their name. They lie immediately above the Calhoun shales.

SEVERY SHALES.[52]—The name Severy shales was applied by Adams to the outcrop bounded by the Topeka limestone below and the Howard limestone above. The town of Severy, from which the name was taken, rests on these shales. The name Osage City shales was given to this formation, but the name Osage having been preoccupied, Severy will stand.

HOWARD LIMESTONE.[53]—The name Howard limestone was given by Adams. It lies just above the Severy shales and caps an escarpment somewhat persistent from Valley Falls, in Jefferson county, to the south side of the state. It lies a few feet above the coal at Scranton, Carbondale, Osage City, and Topeka.

SCRANTON SHALES.—This name was proposed by Bennett in 1907 to the shale-bed lying between the Howard and the Burlingame limestones. Haworth, Hall and Adams called them the Burlingame shales, but the same name also was given to the Burlingame limestone at the same time, and therefore the name Scranton is now applied to these shales.

WABAUNSEE STAGE.[54]

The Wabaunsee stage is divided into eight subdivisions, namely, Burlingame limestone, Olpe shales, Emporia lime-

48. Beede, Dr. J. W., Trans. Kan. Acad. of Sci., vol. XV, p. 28, 1898.
49. Bennett, Rev. John, Kan. Univ. Geol. Surv., vol. I, p. 117, Lawrence, 1896.
50. Beede, Dr. J. W., Trans. Kan. Acad. of Sci., vol. XV, p. 29, Lawrence, 1896.
51. Bennett, Rev. John, Kan. Univ. Geol. Surv., vol. I, p. 117, Lawrence, 1896.
52. Adams, Dr. Geo. I., Kan. Univ. Geol. Surv., vol. III, p. 66, Lawrence, 1898.
53. Adams, Dr. Geo. I., Kan. Univ. Geol. Surv., vol. III, p. 67, Lawrence, 1898.
54. Prosser, Prof. C. S., Jour. Geol., vol. III, p. 688, Chicago, 1895.

stone, Admire formation, Americus limestone, Elmdale formation, Neva limestone, and Eskridge shales.

BURLINGAME LIMESTONE.[55]—The name Burlingame was given to this limestone by Hall. It caps what is known as the Burlingame escarpment, and lies immediately above the Scranton shales.

OLPE SHALES.[56]—These shales were named by Adams from a little village by that name in the southern part of Lyon county, and is used to designate the shales between the Burlingame and Emporia limestones.

EMPORIA LIMESTONE.[57]—This name is applied by Kirk, and designates the limestone above the Olpe shales. They are described by Smith[58] as follows: "Passing up the bluff 75 feet at Humphrey's ford, we find above the Burlingame limestone 9 feet of yellow and blue shales, 1 foot of limestone, 11 feet of shales, 7 feet friable limestone which is overlaid in places with a mass of excellently preserved specimens of *Streptorhynchus crinistria*, 13½ feet of blue and yellow shale calcareous in places, 3 feet hard blue limestone with a seam 6 inches from the top. This stone I have designated the Emporia Blue. The 6-inch top layer makes a good quality of flagstone, which is extensively used in Emporia. Above this is 4 feet of slaty shale and another hard blue limestone agreeing paleontologically and lithologically with the one below."

ADMIRE FORMATION.[59]—The Admire formation was named by Adams. As before, Prosser[60] quotes from Smith[61] and says of this formation that its thickness is about 300 feet.

AMERICUS LIMESTONE.[62]—Haworth and Kirk named this the Americus limestone on account of its exposure and the quarries in it at that place. It lies just above the Admire formation.

ELMDALE FORMATION.[63]—This is so named by Prosser and Beede. It is exposed east of the town from which it takes its name and occupies the space between the Americus limestone below and the Neva limestone above.

55. Hall, John G., Kan. Univ. Geol. Surv., vol. I, p. 105, Lawrence, 1896.
56. Adams, Dr. Geo. I., U. S. G. S. Bull. 211, p. 52, 1903.
57. Kirk, M. Z., Kan. Univ. Geol. Surv., vol. I, p. 80, 1896.
58. Smith, Alva J., Bull. Lyon Co. Geol., p. 2, 1902.
59. Adams, Dr. Geo. I., U. S. G. S. Bull. 211, p. 53, 1903.
60. Prosser, Dr. C. S., Jour. Geol., vol. X, p. 107.
61. Smith, Alva J., Geol. of Lyon Co., p. 3, 1902.
62. Kirk, M. Z., Kan. Univ. Geol. Surv., vol. I, p. 80, 1896.
63. Prosser, Dr. C. S., & Beede, Dr. J. W., Jour. Geol., vol. X, No. 7, p. 708.

NEVA LIMESTONE.[64]—Prosser and Beede gave this name to this limestone, it being the name of a station of the Atchison, Topeka & Santa Fe railroad. It lies immediately above the Elmdale formation.

ESKRIDGE SHALES.[65]—From large exposure of these shales near Eskridge, the name was given by Prosser and Beede. It fills the interval between the Neva limestone and the Cottonwood limestone.

COUNCIL GROVE STAGE.[66]

The Council Grove stage is subdivided into two parts, namely, the Cottonwood limestone and the Garrison formation.

COTTONWOOD LIMESTONE.[67]—The name Cottonwood limestone or Cottonwood Falls limestone is a commercial term used by the trade for an indefinite period before it was applied to a definite geologic horizon. Extensive stone-quarries were opened up in the vicinity of Cottonwood Falls and stone shipped to many places for erecting costly buildings. In the summer of 1893, Haworth and Kirk made a geologic section up the Neosho and Cottonwood rivers. Their first report was published in January, 1894, and the name Cottonwood Falls limestone formally given to their number 13 of this section. Later, in 1894, Prosser[68] introduced the term "Cottonwood formation," including the Cottonwood Falls limestone and the overlying shale-bed. For the limestone he used the word "Cottonwood" rather than Cottonwood Falls, and in a number of publications since that date has adhered to the name Cottonwood. To simplify matters, therefore, this Survey, in volume III, used the word Cottonwood, which was considered unobjectionable, as the change was so little, and particularly as the commercial name was used indiscriminately, either Cottonwood or Cottonwood Falls. In 1902, Prosser[69] suggested the name Alma limestone instead of Cottonwood limestone, on account of the name Cottonwood being previously used by N. F. Drake in connection with Texas geology. In a letter, however, to Mr. Bennett, in 1907, Professor Prosser states that "Cottonwood or Cottonwood Falls would be the correct nomenclature." We are not informed of the details for Professor Prosser changing

64. Prosser & Beede, Jour. Geol., vol. X, No. 7, p. 709, 1902.
65. Prosser & Beede, Jour. Geol., vol. X, No. 7, p. 709, 1902.
66. Prosser, Dr. C. S., Jour. Geol., vol. X, p. 709, 1902.
67. Haworth & Kirk, Kan. Univ. Quart., vol. II, p. 112, Jan., 1894.
68. Prosser, Dr. Chas. S., Jour. Geol., vol. III, p. 697, 1895.
69. Prosser, Dr. Chas. S., Jour. Geol., vol. X, p. 711, 1902.

his mind as shown by this letter. The commercial use of the name Cottonwood is so extensive this Survey would be entirely powerless in making a change from Cottonwood to Alma were we to attempt it. Therefore we will continue the use of the name Cottonwood.

GARRISON FORMATION.[70]—The Garrison formation, so named by Prosser, fills the interval between the Cottonwood and the Wreford limestone and consists of two members, the Florina shales and the Neosho member.

FLORINA SHALES.[71]—The name Florina was given by Prosser and Beede, and was taken from the exposure over the Cottonwood limestone in the quarries near Florina, in the Big Blue valley.

NEOSHO MEMBER.[72]—This is so called by Prosser. He says: "This member was originally termed the Neosho formation, from the excellent outcrop in the Neosho valley near Council Grove. The Florina shales and the Neosho member are now united to form the Garrison formation, on account of good exposures from Garrison south in the Blue valley.

70. Prosser, Dr. C. S., Jour. Geol., vol. X, No. 7, p. 712, 1902.
71. Prosser, Dr. C. S., Jour. Geol., vol. X, No. 7, p. 712, 1902.
72. Prosser, Dr. C. S., Jour. Geol., vol. III, p. 764, 1895.

SUMMARY OF GLACIAL LITERATURE RELATING TO GLACIAL DEPOSITS.

By Albert B. Reagan, La Push, Wash.

GLACIAL DRIFT.

Definition.—"Glacial drift is an accumulation of earthy materials—clay, sand, gravel, and boulders—which has been transported by moving masses of ice and deposited over portions of the earth's surface, mostly in the higher latitudes."—*Standard Dictionary.*

"This aggregation of surface material which overlies different formations indiscriminately, and which is composed of materials which could not have been derived wholly from the underlying rock, is called drift."—*Rollen B. Salisbury.*

GENETIC CLASSIFICATION.

BASED upon the origin of their formation, glacial deposits are classed as subglacial, englacial, superglacial, and extraglacial.

SUBGLACIAL DEPOSITS.

The subglacial deposits are those deposits which are dragged along beneath the ice or are formed beneath the ice. They are: Lower till, ground-moraine, or boulder-clay. This is the "hard-pan" clay formation found throughout glaciated regions. It is sometimes called boulder-clay because it contains boulders and pebbles. It is the product of abrasion caused by the stones held in the moving ice-sheet grinding the bed-rock into powder, and the bed-rock, in turn, reducing them to the same material. When the great ice-sheet melted its load was dropped, and in this deposit the coarser and finer materials beneath the sheet were indiscriminately mixed; thus the till or rock-flour.

An examination of this till in Wisconsin gave the following results: It is of medium hardness when dry and slakes readily in water, breaking down into a finely pulverulent mass which has a fair degree of hardness. Under the microscope the grains were observed to have diameters ranging from 10 mm. to 0.003 mm. A very small percentage of the individuals are less than 0.0058 mm. in diameter. The larger grains are fairly well rounded, but the smaller ones have angular outlines.

To use the Standard Dictionary definition for this formation, it is "an accumulation of earthy materials—clay, sand, gravel, and boulders—which has been deposited over portions of the earth's surface, mostly in the higher latitudes."

Gumbo.—This formation is the stratified portion of the lower till of the Mississippi valley. It is a granular, adhesive clay, often several feet in thickness. It is not such a continuous deposit as the overlying loess, there being many places where the loess rests directly upon typical till. Like the loess, though, it seems to bè independent of contour lines in its distribution. Its color varies from light gray or ash to nearly black. The black portions are heavily charged with humus and in places present the appearance of swamp muck. It is from this clay that the black soil so often seen at the base of the loess is usually developed. This gumbo clay contains a few pebbles, much less than the typical till or loess. According to Mr. Leverett, these deposits may be of aqueous origin; but such an hypothesis cannot be confidently put forward as a solution.

Drumlins.—A drumlin is a smoothly rounded hill. Mounds or hills of this sort are found all over the glaciated region, from Maine to the Rocky Mountains. Their origin is in doubt. Prof. G. F. Wright[1] and others believe that during the final melting of the ice the surface would melt unequally, since the large boulders and deeper masses of till would partially protect the ice beneath them from melting, and that, consequently, there would be much lateral sliding of till into the depressions thus formed on the ice surface, which, when the glaciers disappeared, would remain as drumlins. But it is difficult to conceive how smoothly rounded hills in such large numbers and such great size could result from this process. Moreover, some of the masses of thoroughly glaciated matter are long ridges parallel with the glaciation, masses still more difficult of explanation as being due to accumulation in surface hollows of the ice.

Prof. N. S. Shaler[2] believes that these hills are the remains of a former sheet of till of which the greater part has been eroded by the sea waves, but to this opinion there are many objections: First, these deep masses of till are sometimes one mile or more from any similar mass. The amount of erosion required is enormous. Second, had a great mass of till been eroded, most of the larger stones would now remain as broad

1. Wright, Ice Age of North America.
2. Bull. Geol. Soc. Am., vol. 10; also Shaler and Davis, Glaciers.

sheets in the valleys or as terraces on the hillsides, a phenomenon which does not exist. Third, had the till been eroded in the manner supposed above, the erosion must have occurred before the deposition of the marine beds; and these beds, in turn, would preserve the beach gravels beneath them from erosion. No such rolled gravels now exist beneath the clays. Fourth, had there been such an erosion of the till, the kames and marine deltas would not have escaped in such a good state of preservation. Fifth, the lenticular sheets of till on the northern slopes of hills must have substantially the same origin as drumlins themselves. Yet there are multitudes of these hillside lenses in regions where no genuine water-washed gravel is to be found.

Another theory is that drumlins are the remains of a former sheet of till irregularly eroded by the glacier. But it is difficult to see how a glacier can deposit till and not at the same time deposit glacial gravel.

In speaking of the drumlins of New Hampshire, Emerson says:[3] "Could one raise the stratum of stony clay which overspreads the valleys, as one lifts a plaster mask from the face, it would be found that its under surface had been exactly molded to every line and curve in the rocky substratum; but its upper surface would have the effect of a comic mask, swelling with unequal thickness over every prominent feature, distorting and concealing its true form, and sending up great protuberances due wholly to a thickening of its own mass and not molded on any projecting ledge below. The protuberances formed thus by local thickening of the sheet appear now as drumlins, massive domed hills, in shape like an inverted canoe, with their long axes pointing in the direction of glacial motion from north to south."

Hitchcock and Wright have thought drumlins to be, perhaps, the material of terminal moraines swept over and massed in these peculiar forms by subsequent farther advances of the ice-sheet.

King and Dana have conjectured that drumlins, at least in some cases, were made by superglacial streams, charged with drift, pouring through crevasses or a moulin to the land surface, there depositing their drift, which afterwards by the outflow of the ice would be subjected to its pressure and sculpturing.

---

3. Monograph 29, p. 545.

Geike, Davis and Salisbury look on drumlins as analogous to the sand-bars of streams.

In speaking of the origin of drumlins, Upham in substance writes:[4] "The till forming drumlins invariably exhibits the characteristic features of subglacial drift or ground-moraine, excepting its superficial portion which was englacial and subglacial when the ice-sheet melted away."

His hypothesis of the drumlin accumulation is somewhat as follows: "In the central area of the ice-sheet the currents of its upper and lower parts probably moved outward with nearly equal rates, the upper movement being slightly faster than at the base. Upon a belt extending many miles back from the margin, however, where the slope of the ice surface had more descent, the upper currents of the ice, unsupported on the outer side, would move faster than its lower currents, which were impeded by friction on land. There would be accordingly in this belt a strong tendency of the ice to flow outward with somewhat curved currents, tending, first, to carry the onwardly moving drift gradually upward into the ice-sheet, and, later, to bear it downward and deposit it partly beneath the edge of the ice and partly along the ice boundary. And as the ice at the time of its melting was making halts and occasionally readvancing, if the ice had nearly a constant position during several years, its border became marked by terminal moraines close to the glacial boundary. Whether it halted and ever readvanced, or merely its retreat was much slackened, the upper part of the ice must have descended over the lower part. This differential and shearing movement gathered the stratum of englacial drift into the great lenticular masses or sometimes longer ridges of the drumlins, thinly underlain by ice and overridden by the upper ice flowing downward to the boundary and bringing with it the formerly higher part of the drift stratum to be added to these ground-drift accumulations. The courses of the glacial currents and their convergencies to the places unoccupied by drumlins were apparently not determined so much by the topography of the underlying land as by the contour of the ice surface, which, under its ablation, had become sculptured into valleys, hills, ridges, and peaks, the isolation of the elevations by deep intervening hollows being doubtless most conspicuous near the ice margin. And again, when the boundary

---

4. See Upham, Glacial Lake, Agassiz, G. S. Monograph xxv, and Ice-sheet Moraine, Geol. Surv. Minn., 1880.

receded the upper currents of the outer belt of the ice, upon a width of probably ten miles, would pour down toward the open land, causing the deposition of much subglacial till; and whenever a stratum of the englacial drift became covered with new ice, it would probably be aggregated englacially or altogether subglacially in drumlins.

"And to conclude, drumlins are the effects of secular vicissitudes of climate on the border of the departing ice-sheet, which seems to have owed its existence to the great altitude of the land at the beginning of the glacial period. This glacier seems to have been atended, when at its maximum extension and volume, by depression of the land on which it lay, and to have witnessed, during the retreat and removal of its load, a progressive reelevation of the same area to its present height."

Remarks on Drumlins.—Drumlins could not have been formed by the tidal or river erosion of a once continuous sheet of drift nor to the excavation and removal of the drift from all intervening areas by the later glaciation mentioned, because, to accord with this view, the terminal moraine of the later ice-sheet must vastly exceed their moderately observed volume. (2) They are not the material of terminal moraines swept over and massed in these peculiar forms by subsequent farther advances of the ice-sheet, because neither the distribution nor the composition of drumlins seems to favor such an hypothesis. (3) They were not made by superglacial streams, charged with drift, pouring through crevasses or a moulin to the land surface, there depositing their drift; because there are no signs of stratification, and because the distribution and composition oppose such a theory. (4) Drumlins are not analogous to the sand-bars of streams, because the areas bearing them are not determined chiefly by the topography and rock structure. (5) They do not seem to have been formed by subglacial drift, leached out from the melting ice by surface-melting and gathered from a large area of the ice surface and concentrated on a smaller one by water action, thus to be transformed into drumlins of true till, for the following reasons: (*a*) The whole mass of the accumulated concentrated surface drift must have been worked over bit by bit by the ice before it could gain the structure of till. This would seem to be a useless concentration, except as affording a possible excessive supply of ready material for ice-dragging. (*b*) The theory as a whole seems to be founded upon special interpretations of phenomena that are difficult to explain. (*c*) The excess of subglacial drift in drumlins opposes the interglacial theory of their accumulation.

The drumlin investigations and arguments given above seem to show that drumlins were formed on the protected side of some projecting hard substance which resisted the wear and erosion of the ice. They seem to have collected in a way similar to the way snow drifts behind a wind obstruction, except that it was closed in at the top and on the sides by ice. Drumlins being more numerous in mountain regions where there would be immovable obstacles to the ice advance, over which the ice must pass, seem to bear out this conclusion. A drumlin may therefore be defined as a lenticular, compact, unstratified mound or hill having its longer axis parallel with the direction of local glacial striation.

DRUMLIN VARIETIES.—Mr. Chamberlin recognizes four sub-varieties of drumlins, as follows:

Lenticular or Elliptical Hills.—These consist of very remarkable aggregations of till in hills of dolphin-back form whose longer axes are two or three, or at most a few times longer than their transverse diameters. Their longer axes lie in the direction of the glacial movement.

Elongated Ridges.—These have the same constitution as the preceding and have similar terminal contours. They differ from the above principally in the fact that they are elongated more, their length often exceeding three miles.

Mammilary Hills.—These have the same constitution as the previous types, but differ from them in the extreme shortness of the axis, the axis often being scarcely longer than the transverse diameter. Though nearly round in form they are always elongated in the direction of glacial movement.

Till Tumuli.—These are low mounds of more than usually stony material, as a rule. They have not generally assumed the drumloidal curves of contour and profile, but their nature is such as to have suggested that they are the immature nuclei of drumlins. Their genesis, however, is in doubt.

DEPOSITS THAT ARE SOMEWHAT DRUMLOIDAL IN FORM.

CRAG AND TAIL.—These embrace the well-known accumulations of till in the lee of rocky crags or embossments.

PRE-CRAG.—These embrace the less well-recognized accumulations of till in the lee of rocky crags.

VENEERED HILLS.—These are hills of rock coated somewhat uniformly with till, the surface conforming approximately to that of the underlying rock. These differ from the last two formations mentioned in that they have a much more uniform distribution over the rock embossments and in the subordination of veneering of the preexistent contour rather than the formation of a new contour.

TILL BILLOWS.—These differ from true drumlins in their want of conformity to axes lying in the direction of the drift movement; and in that they are arranged more closely together, are disposed more irregularly, and are connected with each other by saddles or cols. The type graduates into submarginal moraines. They seem to be intermediate between submarginal moraines and drumlins.

IRREGULAR TILL HILLS.—These hills are aggregations of till that seem to pay no respect to laws of symmetry or systematic principles of growth. Their genesis is wholly in doubt.

SUBGLACIAL STREAMS.

These are streams that run beneath the ice-sheet. Their action is not unlike that of any other stream, except that it may be occasionally dammed with ice or may not keep the center of the valley, as non-glacial streams do. They are crowded from the center by the ice or even compelled to cross the valley from side to side time after time.

DEPOSITS OF SUBGLACIAL STREAMS.

OSARS.—An osar is a long, continuous, serpentine ridge of glacial sand or gravel, sometimes carrying boulders superficially, extending down valleys in the direction of glacial movement. Ridges of this sort are sometimes called serpentine kames. The following are some of the varieties:

SHORT ISOLATED OSARS OR ESKARS.—Ridges of this type are the simplest form of glacial gravel. They have here been called "isolated" because no other glacial gravels are known to be near them. They have the form of a cone, a dome, or often a short ridge, or sometimes several short ridges having a linear arrangement (lengthwise of the ridges), or occasionally a few somewhat parallel ridges inclosing basins They vary in length from a few feet up to a mile or two. A distinguishing feature of the class is that they have no fan-shaped or elongated delta showing assortment of gravel. From the observations it would seem that these osars were formed in one of the following ways: (*a*) A sediment-laden superficial stream may have plunged down a crevasse and deposited the coarser sediment in a cave or pool within the ice that naturally formed near the base of the waterfall. (*b*) They may have collected in an enlargement of pool in the bottom of a channel of a superficial stream, or in a pot-hole or pool in the ice where the tributary streams joined the main channel. (*c*) They may have been formed in the tunnel of a subglacial stream.

Hillside Osars or Eskars.—These ridges are usually not very high—five to twenty feet—and vary in length from fifty feet to one mile. Their direction of extent is nearly the same as that of the ice flow, and, also, must be about the same as the direction of the slope of the ice surface in late glacial times. The sediments composing them are usually gravel and sand; but in some cases there are cobblestones, boulderites, and even a few boulders, all distinctly but not very much water-worn.

Isolated Kames or Short Eskars (Osars) ending in a Marine Delta.—The word "isolated" is here used because no other gravels can be proved to have been deposited by the same glacial streams to which these are due. The field evidence indicates that they were deposited by subglacial streams. The ridges and small hills of these deposits converge into a small plain of horizontally stratified matter, showing clearly a horizontal transition of gravel into sand at the south. They are, in fact, hillside kames.

Isolated Osar-mounds or Massives not ending in a Moraine Delta Proper.—These deposits are mesas rather than ridges. They belong to the region below former sea-level. They are rather level on top, somewhat uneven of surface, but with no reticulated ridges or kettle-holes proper. The smoothness of the surface is, probably, due to wave action. These table-lands consist of sand, gravel and cobblestones mixed in alternating layers, but with no variation in texture from north to south. They were probably laid down in a pool where a superficial stream fell down a crevasse, or where a subglacial stream entered a pool or lake within the ice.

Systems of Discontinuous Osars.—In this class a number of short ridges, often fan-like, have been placed. They have a linear arangement and other relations such that they are regarded as having been deposited by the same glacial river. These systems have nearly the same general directions as the continuous osars. Their topographical relations are, also, substantially the same, except that the gravel deposits of which the system is composed are from a few feet up to a mile or more in length and are separated by intervals varying within the same limits.

GLACIAL GRAVELS OF THE COASTAL REGION.—The glacial gravels of this type are found in three relations to marine clays: (*a*) The gravels have the same level as the clays and pass by degrees directly into them. This is the characteristic relation of the glacial deltas and marks the coarser glacial sediments as being laid down simultaneously with the clays. (*b*) The clays overlie the glacial gravels, either wholly covering them or covering their base. The gravels were first deposited within ice-walls, and subsequently, after the ice melted, the clays were deposited. (*c*) The sand and gravel of the upper parts of the osar gravels overlie the fossiliferous clays which cover the base of the same kames or osars. These can be accounted for in two ways: (1) The ridges were first deposited within the ice-walls; subsequently the ice melted and sea-water covered them. Moraine clay, or in some cases kame or osar boulder-clay, was laid down. (2) The sand and gravel which overlie the clay on the flanks of the osars may have been brought there by glacial streams.

SIMPLE TRACKS OR PATCHES OF DRIFT FORMED BY SUBGLACIAL DRAINAGE.—Thin sheets and lenses of gravel and sand in the midst of subglacial till are common phenomena in glacial regions; and, while in many cases they may have been produced by streams running in tunnels which afterwards shifted their position and left no other mark than these patchy deposits, it seems that many of these drift patches were produced by a diffuse and local drainage developed by one of several combinations of conditions while the ice was still present and continuing its deposit of till.

SUBMARGINAL DEPOSITS.—Submarginal ridges of till parallel with the ice border are often in evidence. These lie along what was the immediate border of the ice at certain stages of its retreat. They are thought to have been formed under the edge of the ice, but it remains to be determined to what extent they were accumulated under the immediate border of the ice and to what extent they were deposited at the distance of one, two or three miles from the precise edge of the glacier. These ridges are from one to a few miles wide, are composed essentially of till, and possess, in the main, a gently flowing contour which distinguishes them from the rougher ridgings and sharper contours of frontal moraines.

LODGE MORAINES.—These moraines are found just under the thin border of the ice-sheet; and constitute a submarginal accumulation.

ENGLACIAL DRIFT.

This drift was borne within the ice-sheet itself, but at the melting of the ice it was so mixed with the superglacial material that it is difficult to separate the two.

ENGLACIAL STREAMS.

An englacial stream is a stream which flows within the glacier itself, a stream inclosed within the ice. The work that they may have performed in glacial times is as follows: (*a*) They may have amassed glacial sediment directly from the ice by melting the ice around the debris and transporting it. (*b*) They were often conduits for streams, otherwise subglacial, their mission being simply to protect the ground-moraine from erosion. Moreover, in them glacial gravels may have been deposited, in which case the stratification of the sediments was generally obliterated by the melting of the subadjacent ice.

SUPERGLACIAL DRIFT.

This drift was borne on the ice or at its margin. It was collected from the cliffs and towering peaks in the vicinity of the ice-sheet or was carried into it by superglacial streams. It may be classified as follows:

DUMP-MORAINES.—These are a variety of terminal moraines. They are formed from material borne on the ice-sheet (or within it) which is dropped at the terminus of the ice. This, when the ice remains stationary for a sufficient period, grows into a bordering ridge.

PUSH-MORAINES.—These are formed by the mechanical thrust of the ice when it advances against any incoherent material that lies in its path.

UPPER TILL.—This till is formed both by englacial and superglacial action. It is material let down over the whole territory of the ice-field, either during its successive stages of retreat or by being let down directly through the melting of the ice when the glacier becomes stagnant. It forms a superglacial sheet quite analogous to the lower till already described. How much of it is englacial and how much is superglacial is still in doubt, but that it was formed both by englacial and superglacial agencies there is an abundance of evidence.

MEDIAL MORAINES.—These merge into dump-moraines at the frontal edge of the ice, and into upper till in cases in which they are let directly down by melting without being carried on to the terminus of the glacier. They are very subordinate elements in the great Pleistocene glacial deposits.

LATERAL MORAINES.—Moraines of this type formed along the sides of the glaciers. They are composed of sands, gravels and boulders, the boulders being the prominent constituent, whence the name "boulder train" which is often applied to this moraine. They are formed by the edges of the ice-sheet rubbing along the sides of the valley through which it travels, forming lateral embankments.

MEDIAL LATERAL MORAINES.—These are moraines formed by the junction and coalescence of two glaciers.

INTERMEDIATE OR INTERLOBATE MORAINES.—These are formed by the front action of two glacial lobes pushing their marginal moraines together and producing a common moraine along their line of contact. They are terminal moraines in character, but intermediate, or interlobate in position.

TERMINAL MORAINES.—Any special aggregation of drift along the margin of a glacier is a terminal moraine.

PERIPHERAL MORAINES.—A peripheral moraine is a moraine of the terminal type which marks only a temporary halt or insignificant advance of the ice-sheet.

Remarks on Morainic Structure and Material.—Considered in respect to its internal constitution, the morainic formation is distinguishable into several distinct portions: The one, usually the uppermost but not occupying the heights of the range where it has its best development, consists almost wholly of assorted and stratified material. The other element of this formation, and the one which constitutes its basal portion and its great core when developed under favorable conditions, consists of a confused commingling of clay, sand, gravel and boulders of the most pronounced type. There is every gradation of material, from boulders of many tons weight down to the finest rock-flour. The corrosion of these boulders is of the glacial type, and examples presenting polished and striated faces abound.

SUPERGLACIAL STREAMS.—These are streams that run over the top of the glacier. They are of importance, because they may carry large amounts of sediment onto the glacier and deposit it.

DEPOSITS OF SUPERGLACIAL STREAMS.

MARGINAL DEPOSITS.—Under this class are embraced all the deposits of glacial streams that were made at the margin of the "mer de glace," and whose forms were dependent upon conditions that obtained at the margin of the ice-field.

SUPERGLACIAL OSARS (ASARS) OR ESKARS (KAMES OF SOME AUTHORS).—These are channel deposits which have retained their original elongated form and become ridges, and hence fall under the Scandinavian type. They were left (dropped) at the melting of the ice.

SUPERGLACIAL KAMES.—These were sheets or pockets of assorted material gathered on the surface of the ice and doubtless subjected to much disturbance and rearrangement in the process of descent at the melting of the ice-sheet. They now constitute undulatory tracts of drift or groups of hillocks scattered here and there over the glaciated region.

KAMES.—Kames are conical hills of discordantly stratified sand and gravel, formed as such by glacial deposition, generally in a system transverse to the glacial movement. They occur chiefly as components of terminal moraines. To use the words of Geikie, "seen from a dominant point . . . an assemblage of kames . . . looks like a tumbled sea." They are irregular heapings of assorted material, found along the border tracts, and also distributed over the entire area abandoned by the ice. They appear to be the products of relatively active, vigorous glaciers. They resemble osars in many respects, but differ from them in that they are transverse to the glacial movement.

OSAR (ESKAR) DELTAS OR FANS.—When the glacial streams reached the border of the ice-sheet and were free from bounding ice-walls, they spread themselves out widely and dropped a large portion of their load in the form of deltas or fans, hence the name overwash aprons.

OVERWASH APRON DEPOSITS.—Glacial overwash is the deposits laid down by glacial streams in the open valley just beyond the ice front. These sediments spread out and filled the valleys not unlike the sediments of Alpine glaciers do to-day. They left a rolling, uneven surface, with shallow hollows, but no deep kettle-holes or conspicuous reticulations. They are often distributed along the moraines for a great distance and constitute a fringe of assorted material to which Shaler has given the apt name "apron." The material varies widely in coarseness, according to the condition of the formation. Classified structurally, they are known as gravel, sand, and silt aprons.

OUTWASH APRON DEPOSITS.—These are tracts of assorted material formed by waters outflowing from the ice where no definite terminal ridging took place. This class is usually made up of sand.

PITTED PLAINS.

Both the osar deltas and the overwash aprons are characterized in certain regions by a surface marked with numerous depressions, sometimes symmetrical (kettles), sometimes irregular, with undulating bottoms and embracing knolls and subbasins, which give the surface an expression resembling kames. A part of these pitted plains seem to be intimately connected in origin with the ice edge and to be due to marginal conditions, of which it has been thought that the incorporation of ice fragments, the grounding of ice blocks, the movement of the ice edge, and the development of underground ice-sheets were among the special agencies.

OSAR PIT.—Another class of pits was found at the terminus of osars. They are probably due to the water's scooping out a hole at the point where the osar waters emerged from the ice. In many cases these holes are now swamps.

EXTRAGLACIAL DEPOSITS.

These deposits are of glacial origin. They, however, were laid down either by wind or water beyond the ice-foot. They are:

GLACIAL RIVER DEPOSITS.—These were laid down by the ice-streams as they issued from the body of the active glacier.

VALLEY DRIFT.—As the glacial streams were greatly overloaded with debris at their outlet they built up their valley bottoms by depositing material from bluff to bluff, forming a valley plain. Out of this, beautiful systems of terraces were often cut. The most notable class of this type head in terminal moraines. Hence this drift affords valuable criteria for determining the altitude at the time of the formation.

Other classes of valley drift are the outwash and overwash apron deposits already described. Loess is also classed under this heading by a majority of the writers on the subject.

LOESS.—To quote Geikie: "This name was given to the deposit in Germany, where the deposit was first studied. It is usually a yellowish, homogeneous clay or loam, unstratified, and presenting a singular uniformity of composition and structure. When carefully examined, its quartz-grains are found to be remarkably angular, and its mica plates, instead of being deposited horizontally, as they are by water, occur depressedly in every possible position and with no definite order. The chief constituent of loess is always hydrate silicate of alumina, in which the scattered grains of quartz and flakes of mica are distributed. . . . Here and there the lime is segregated into concretionary forms by the action of infiltrating water. Though a firm, unstratified mass, it is traversed by innumerable tubes, formed by the descent of rootlets, and mostly incrusted with carbonate of lime. These have generally a vertical position and ramify downwards. These pipe-like lime concretions have a tendency to give a vertical jointing to the mass. The loess contains organic remains, chiefly land shells, sometimes in immense numbers, also bones of various herbiverous and carniverous animals, which are either identical with or closely related to species that abound on steppes and grassy plains to-day. Fresh-water shells are usually rare, and marine forms do not occur. Loess is found at elevations ranging from 5000 to 8000 feet above the sea in China, in which country it ranges in thickness from 500 to 2000 feet. It also occurs in most of the glacial regions of the earth. Various theories have been proposed in explanation of this singular deposit. By some it has been referred to the operation of the sea; by others to the work of lakes and rivers. But its wide extent, its independence of altitude or contours of the ground, its uniform and unstratified character, the unworn condition of its compact particles, and the nature of its organic remains, show that it cannot be assigned to the action of large bodies of water. They, in fact, seem to be due, in the main, to the long-continued drifting and deporting of fine dust by wind over areas more or less covered with grassy vegetation, aided by the washing influence of rain. This opinion is practically substantiated (*a*) by the fact that where rain is distributed somewhat generally throughout the year little dust is formed; but where dry and wet seasons alternate, as in central Asia and in the southwestern part of the United States, vast quantities of dust may be moved during the months of dry weather (Richthofen). When the dust falls on bare dry ground, it is eventually swept away by the wind, but where it settles down on ground covered with vegetation it is in a great measure protected from further transport, and heightens the soil."[5]

Geikie again says, in substance:[6] The origin of the loess is a problem which has given rise to much discussion. It has been regarded by some writers as the deposits of a vast series of lakes; by others as a sediment washed over the surface of the land by abundant rainfall; by others as deposits left by swollen rivers discharged from the melting ice-fields. The remarkable unstratified character of the loess as a whole, its uniformity in fineness of grain, the general absence of coarse fragments, except along the margins, where they might be expected, its singular independence of the underlying contour of the ground, and the almost total absence in it of fluviatile or lacustrine shells, seem to prove conclusively that it cannot have been laid down by rivers or eskars. On the other hand, its internal composition, the thoroughly oxidized condition of its ferruginous constituents, its distribution, and the striking character of its enclosed organic remains, point to its having been accumulated in the open air, probably in circumstances similar to those which now prevail in the dry steppe regions of the globe. It appears to mark some arid interval after the height of the glacial period had passed away, when, whilst the climate remained cold and the Arctic fauna had not entirely retreated to the north, a series of grassy and dusty steppes swept across the heart of Europe and America.

As to the origin of the loess LeConte, in substance, says:[7] Over large areas bordering the Mississippi and its tributaries, and forming conspicuous bluffs of these rivers, there is found

5. Geikie, Text-book of Geology, p. 332. [This last theory is in accord with the writer's observations in the southwestern part of the United States. The adobe clays on top of the basalt northwest of Fort Apache, Ariz., are being added to year by year by dust accumulation.]

6. Loc. cit., p. 1060.

7. Elements of Geology, p. 583.

a peculiar deposit of very fine, even-grained and usually unstratified material, remarkable for forming by river-erosion perpendicular walls—although soft enough to be easily spaded. It is usually destitute of organic remains, but when these are found they consist of fresh-water shells and especially land shells. When fresh-water shells are found, the material is usually obscurely stratified. Similar bluff-materials are found bordering nearly all European rivers, such as the Rhine and Danube, and is there called loess, and referred to the Champlain epoch.

A somewhat similar material, however, is found also spread over wide areas in many countries, especially in arid regions. These have no obvious connection with any rivers. Such is the case in northern China and also in the Basin and Rocky Mountain regions.

The loess of the Mississippi and its tributaries, as also of the European rivers, was probably deposited in flooded lakes and in the slackened water regions of flooded rivers of the latter Glacial and Champlain epochs. It is poor in fossils, because the waters were ice-cold. It is unstratified, because the waters were overloaded with the very finely triturated material left by the retreating ice-sheet.

The loess of northern China is æolian in formation, according to Richthofen. The unstratified superficial soil of the basin region. Russell thinks, is due partly to wind-borne dust, but mainly to rain-wash. The unstratified soil covering the hilly country at the base of the Alps is attributed by Sacco to rain-wash of the base-soil recently left by the retreating ice.

In writing concerning the loess, Mr. Chamberlin says, in substance:[8] While the larger part of the loess found in the glaciated region of North America is believed to be the product of glacial waters, it still remains, in my view, that certain parts of it were produced by winds. This part in general is believed to have been derived from the water-deposited portion, but perhaps this is not universally true. For instance, the loess collected along the leeward side of the Mississippi river seems to have been derived by wind from the flooded flats of the river below. While coinciding with what seems to be the majority opinion of American geologists, that the loess deposits of the glaciated region are chiefly water-lain, it appears to me prudent, if not important, to recognize the

8. Journal of Geology, vol. 2, p. 537.

æolian class, and to search diligently for criteria of discrimination between the two.

On the same subject Leverett says:[9] "The mode of deposition of the loess still remains one of the most puzzling problems of Pleistocene geology. Both the æolian and aqueous hypotheses have strong adherents. Among the students of the Mississippi valley portion, however, all grant that the influence of wind has been important; and probably all would concede that water had been influential. The division of opinion, therefore, is concerned with the relative importance of wind and water in the distribution of the loess. Mr. Udden, after a careful examination, has decided that a large part of the loess may have been deposited through the influence of the atmosphere as an agent of erosion, transportation, and sedimentation. Mr. Chamberlin says, on this point, that the loess of the Mississippi valley was in some way connected with the great streams of the region. The abrupt border of the loess at the edge of the Iowan drift-sheet, both in Illinois and in Iowa, gives it a more or less direct genetic relationship with the ice. The gradation of the loess into glacial clays further tends to conform the association of the loess with glacial action. The influence of glacial action is also shown in the presence of silicates, which are decomposable under prolonged weathering, and of calcium and magnesian carbonates, none of which can be supposed to be from residuary clays. The loess seems to have been formed by glacio-fluvial action, he (Chamberlin) assuming (*a*) the presence of the ice-sheet at the chief stage of deposition; (*b*) a very low slope of land and consequent wide-wandering glacial rivers; (*c*) the development of extensive flats over which the silts were spread; (*d*) great periodic extension of glacial waters caused (1) by periods of warm weather in the melting season, and (2) by warm rains. Upon the retreat of the waters, he concludes, extensive silt-covered flats would become exposed to the sweeping influence of the wind; and when dried the silt would be borne in great quantities over the adjacent uplands. Thus were formed the æolian loess, the aqueous loess having been formed by the first process above mentioned. Again, he says: "While individual types of both deposits (æolian and aqueous) are not difficult to find, a criteria or series of criteria of gen-

9. G. S. Mon. xxxviii, p. 177.

eral applicability which shall distinguish the two and assign to each its appropriate part are wanting."

Mr. Udden says[10] that "the wind has been very important and perhaps more potent and far-reaching in its influence in the forming of the loess than water deposition," his opinion being based upon his study of the wind as a geological agent. "It is necessary," he continues, "to speak of the objections to aqueous deposition based upon topographic relations of the loess. This deposit not only borders valleys, but blankets interfluvial tracts as well, often resting on an eroded surface like snow. It is found on the highest as well as the lowest parts of previously eroded tracts. It is not rare to find it occurring at elevations differing several hundred feet within the distance of a few miles. The occurrence of terrestrial shells in the loess is also a serious objection to the aqueous deposition theory, especially of deposition in a large body of water.

"Adequacy of wind, as shown in the Mississippi valley, to form æolian deposits, is shown as follows: (*a*) The universal presence of mineral dust in the atmosphere, and its constant settling, necessitates its accumulation in places where erosion is at a standstill or where it does not exceed the rate of atmospheric sedimentation. (*b*) Erosion of the flat, loess-covered uplands is at the present time exceedingly slow as compared with the average rate of denudation of the whole Mississippi valley.

"Rain-water on a level surface appears to soak into the ground as rapidly as it falls, even in the heaviest rains. This is especially true where the surface is covered with vegetation. By far the greater part of the land area in the region of the loess consists of such flat land. And where the drainage of the area is so sluggish as not to equal the secular accumulations of atmospheric dust on the land surface, loess dust would of course accumulate.

"In this mechanical composition fine wind-sediments and loess are largely identical. The bulk of each consists of particles 1-16th to 1-64th of a millimeter in diameter, with two nearly symmetrically decreasing series of admixtures above and below their size. No aqueous deposit with such a range of altitude in so few miles could be so uniform in its mechanical composition as the loess is. Again, were the deposits composed of as fine material as it is and laid down by water, it would

10. Bull. Geol. Soc. Amer., vol. IX, p. 6.

show a bedded, laminated structure. Wind action alone can account for its being such a compact substance as it is.

"The multiple age of the loess is as easily accounted for, as with the many climate changes attendant upon the periods of the ice age, conditions may readily at different times have so far favored the work of the wind as to have allowed the accumulation and the preservation of its sediments."

Concerning the loess deposits of Montana, N. S. Shaler says:[11] "The condition of the formation of this loess deposit may be observed at any time when the earth is dry and the wind is strong enough to lift the dust, as is the case for a considerable part of the year. From the surface of the benches of the valleys, as well as from the scantily vegetated lower parts of the mountain ranges, dust is blown to and fro in large quantities. So long as it encounters no closely set vegetation it does not come to rest. It is only when it finds its way amid densely set plants in the limited areas watered by snow-fed streams that it escapes from the controlling winds. In such places it is quickly fixed, to remain so as long as the natural or artificial irrigation continues. The process of wind erosion here, as elsewhere under like conditions, serves to produce and transport a great amount of fine detritus to the position where it may be readily taken up by the rivers and sent on its way to the sea. The result of this action is at once to increase the efficiency of river work, and to overburden the streams with fine sediment. Incidentally it serves to diminish the down-cutting of the upper parts of a river system, the parts just below the true torrents in which arid conditions most occur, by overloading the waters with transporting material. Thus, in an arid mountainous region there is an upper zone of true torrent work, and below it a valley zone where the erosion is of a very contrasted nature, being evenly and widely distributed with and ærial delivery of the detritus of the streams."

Concerning the loess of Minnesota, F. W. Sanderson, in substance, writes:[12] "The loess as a deposit in this region is never more than a thin veneer, seen occasionally on the highest hills. It is therefore scarcely a typical loess, since being near the surface the humic acids have, from time to time, as it was laid down, had ready access to it. It is a wind-borne dust that was

11. Bull. Geol. Soc. Amer., vol. X, pp. 246, 247.

12. Bull. Geol. Soc. Amer., vol. X, p. 349.

not deposited rapidly enough to produce deep and wide beds of loess. Its blanket-like distribution, its evanescent relations to the soil above, and the undoubted water or ice deposits below strongly suggest that the material springs from the finely subdivided glacial debris scattered during the periods following the ice invasions. Touching the further question of evidence that this loess is æolian instead of aqueous in origin, the following points can only be summarily stated: (*a*) The loess of Minnesota does not occur in any one of the 1000 lakes of that state, existing or extinct, whose deposits have been described. (*b*) It does occur on the higher levels of the glacial drift. (*c*) When in relation with dune sands, it is found higher than they; whereas, as a water deposit it would be lower—that is, farther from the shore-line of deposition. (*d*) It is frequently liable to carry loam within it, thus pointing to zones of vegetation."[13]

Concerning the loess of Iowa, Mr. Shimek says:[14] "It will be observed that the proportion of local aquatic shells found in the loess here and elsewhere[15] is comparatively insignificant, and what is true of species applies with even greater force to individuals. The fossil shells of aquatic species occur very sparingly, and even the aquatic fossils found belong to the fauna of small ponds or streamlets, which may, and often do, remain dry during the greater part of the summer, and their presence in nowise proves that large bodies of water existed where the loess was deposited. Indeed, the total absence of species which are truly fluviatile, or which at least prefer large bodies of water, would point to the contrary conclusion. Had large streams or other bodies of water existed where the loess is deposited, thus furnishing conditions favorable to a fluviatile fauna, it is reasonable to suppose that some of these shells would be found fossil to-day to relate the story of the conditions under which they existed; yet no such evidence has ever been found in undoubted, undisturbed loess, and the conclusion that such large bodies of water did not exist where loess is found is irresistible. Indeed the moluscan fauna of the loess points to comparatively dry upland terrestrial conditions, such as exist over the greater part of Iowa to-day. It

13. In this paper paragraphs within quotation marks are usually quoted direct, though not always. In all cases, however, where the quotation marks are used they are in the main the language of the author quoted.

14. Amer. Geol., vol. XXXVIII, 1901.

15. Given on the Identification of Recent and Fossil Molluscas at Iowa City. See Amer. Geol., vol. XXVIII, pp. 345-357.

suggests land surface clothed with vegetation offering shelter and food to snails—a vegetation developed under medium conditions of moisture and temperature, such as exist here (in Iowa) to-day."

Mr. Leverett again says, concerning the loess:[16] "The northern border of the loess, both in western Illinois and in eastern Iowa, appears to have been determined by the ice-sheet. The loess is apparently an apron of silt spread out to the south by water issuing from the ice-sheet. It is loose-textured at the north and is finer textured toward the south, showing a decrease in the strength of the depositing currents. The wide extent of the loess over uplands has led to a consideration of the influence of wind as well as water in its distribution. The wide extent, however, appears to be due to water distribution rather than wind. Wind action apparently came into force subsequent to the water distribution and is minor in importance."

Concerning the loess in Wisconsin, Mr. Salisbury says:[17] "The loess at Devil's lake and at Ableman's, like that in the vicinity of Green lake, was certainly deposited by water, and water associated with the ice of the last glacial epoch. With the loess at Ableman's is to be correlated the clay in the valley of the Balboa and the loams and clays in various other parts of the state. It is distinctly stratified in places, and constitutes, at any rate covers, the valley flats."

Summary of Opinions Concerning the Origin of the Loess.— The adobe clays of the West and the loess of China are undoubtedly and universally accepted to be of æolian formation. But the deposits throughout the Mississippi valley are said by Chamberlin, Leverett and others to be in the main a silt formation derived from the ground-up rock-flour of the glacial drift deposits. They further believe that the deposit was laid down in the slow-moving water in the rivers and smaller streams at the foot of the glacier. To this hypothesis, however, there are many objections, some of which are: (*a*) The loess continued from Wisconsin along the Mississippi to the delta of that stream. (*b*) The composition of the loess of China and the adobe of the southwestern part of the United States is said to be identical with that of the loess of Iowa, which seems to be good evidence that both were formed in the same way. (*c*) The

16. Jour. of Geol., vol. IV, p. 244.

17. Jour. of Geol., vol. IV, p. 929.

loess deposits of the lower Mississippi valley, the loess of China, the Albuquerque loess (Herrick), and many other loess deposits are not within 500 miles of any glacial region. (*d*) The loess of the Mississippi river and tributaries is on the leeward side of the streams, or is at least highest on that side, which seems to be good evidence of wind accumulation. (*e*) The loess varying in altitude from 500 to 1000 feet within a few miles at many places in the central valley of the United States seems to be an unsurmountable obstacle to the water-deposition theory. (*f*) It is difficult to see how sediment of any sort could be deposited in water without being stratified, the loess with few exceptions being unstratified. (*g*) The fossils in the loess of Iowa as well as in that of the Rio Grande region, New Mexico, are, with two exceptions, all land species, and the exceptions belong to the pond type of fossils, thus seeming to indicate that no large body of water ever occupied the region during the formation of the loess. To use the words of Mr. Shimek, above, "had large streams or other large bodies of water existed where the loess is deposited, thus furnishing conditions favorable to a fluviatile fauna, it is reasonable to suppose that some of these shells would be found fossil to-day to relate the story of the conditions under which they were deposited. Yet no such evidence has ever been found." The fossils of the loess, identified by Shimmek and others, are identical with those now found on the steppes of Asia, where that deposit is now in the process of formation. The evidence from this point of view, that taken by Mr. Shimmek, seems to point to the conclusion that the loess was formed by subaerial action which was principally æolian. The ever-blowing winds blew dust from the mountains, table-lands and plains and from the barren areas at the foot of the glacier. This dust collected in grassy regions and in the valleys and canyons, where it was so protected that it was not moved farther by the winds. There it accumulated, the puzzle of the geological world.

Again, to return to the view taken by Messrs. Chamberlin and Leverett (and they are still finding evidence to verify their hypothesis), the loess seems to have been deposited, for the most part, by glacial streams at or near the foot of the ice-sheet. To use the substance of Mr. McGee's conclusion on this subject, (*a*) the loess is commonly fine, homogeneous, free from pebbles or other adventitious matter, and either massive or so obscurely stratified that the bedding plains are usually obscure or inconspicuous. (*b*) It commonly contains unoxidized carbonate of lime in such quantities as to effervesce freely under acids. (*c*) It frequently contains nodules and minute ramifying tubules of carbonate of lime. (*d*) In many regions it contains abundant shells of land and fresh-water mollusca. (*e*) It is commonly so friable that it may be removed with a spade or impressed with the fingers; yet it resists weathering and erosion in a remarkable manner, second only to the more obdurate clastic or crystalline rocks.

In the north of Iowa the loess grades either into water-laid gravel-beds or into stratified sand, and in the middle latitudes it commonly passes into stratified and evidently water-laid sand. At the south it grades either into a peculiarly assorted but variable glacial deposit evidently modified by contemporaneous aqueous action, or into water-laid sand. So the stratigraphic relations, apart from the structural features, ally the formation with water-laid deposits and indicate a certain community of origin between its finely comminuted materials and the coarser aqueo-glacial materials of its base. It is the finer grist of the ice-mill laid down in ice-bound lakes and gorges as the Pleistocene glacier shrunk by surface melting and retreated northward.

Remarks on the Origin of the Loess.—It seems evident that a large part of the loess is æolian in formation; but further investigations and the discovery of criteria by which it can be distinguished from the aqueous type are yet needed to determine how much. It is quite probable that the æolian and aqueous agencies worked simultaneously in the same region, and this accounts for the geological tangle. As the glacier departed the plains of America it must have left a barren strip in its rear many miles in width, an area at its final retreat probably half as large as the United States. In this barren waste the agencies of water and wind vied with each other in moving the lighter material left by the ice-sheet. The streams deposited their sediments in the slackened-water regions, while the wind drifted its deposits everywhere, mixing with the aqueous formation wherever it came in contact with it, otherwise depositing it on the leeward side of obstructions and in the grassy regions to the south, which were gradually advancing northward as the glacier retreated.

GLACIAL MARINE DELTAS.

1. Deltas Deposited in Front of the Ice in the Open Sea.—This class spread outward in round or irregular fan shape when deposited over broad and rather level plains where they were free to expand in all directions; but in narrow valleys their slopes were necessarily determined in part by adjacent hills. They conspicuously show the characteristic horizontal transition of sediments, from coarse at the north to finer material toward the south, that is, away from the mouth of the glacial river. The delta indications are unmistakable.

2. Ice-bordered or Narrow Marine Deltas.—These are usually much longer from north to south than from east to west, having but little of the fan shape. At their southern ends they pass by degrees into clays having the same level, like the delta plains above described. They are found in valleys or level regions much broader than they are, where there is no topographical reason why a delta, if deposited in the open sea, should not have spread outward in fan shape. Evidently the glacial rivers flowed into channels which were open toward the sea, but at the sides were bordered by ice which covered the rest of the valleys and prevented the delta from spreading out.

That these deltas are marine is attested by the marine fossils.

Fringing Lake Sediments.—This class embraces deposits of suspended material brought out from the ice into the bordering lakes by glacial streams and spread over their bottoms. It is a somewhat stratified material of the clayey type, sometimes bearing lacustrine fossils. It is often commingled with stony material dropped by floating ice from the edge of the glacier, but not in noticeable quantities. It is also always commingled with wash from the adjacent land not covered by ice.

Bordering Sea Sediment.—This class differs from the preceding in the fact that the waters were not imponded in ice, and in the fact that the deposits are commingled with oceanic sediments and marine fossils, and impregnated with saline waters, which may or may not have been wholly removed subsequently.

Local Formations Produced by Floating Ice.—These deposits were laid down by fringing glaciers in lakes (lakes usually formed by glacial damming) or in the ocean.

FOREIGN FORMATIONS PRODUCED BY FLOATING ICE.—These are essentially marine deposits, and are due to icebergs derived from distant glaciers. These bear to the point of deposit material wholly of foreign origin.

SHORE RIDGES DUE TO ICE PUSH.—In the northern latitudes the shore action of ice (not including icebergs) is very noticeable, producing shore ridges of unusual strength.

LITTORAL DEPOSITS.—If we confine the above class to those ridges which were pushed upon shore above the reach of the waters, we need also to recognize a class which was deposited beneath the border of the body of the water, since they were deposited by ice action. To this class is given the name "littoral deposits."

OFF-SHORE DEPOSITS.—These embrace the material of the ice action off shore borne back in suspension or by ice-flows into still waters and there deposited. They must, in the nature of the case, simulate the formations produced by floating ice derived from glaciers (Chamberlin).

DUNES.—These are dunes similar to any other class of dunes, except that the material is made up, in part, of grains formed by glacial grinding instead of disintegrated and wave wear, and in their correlation with the ice-border and the glacial waters that issued from the ice, rather than with the sandy shores of lakes and rivers (Chamberlin).

MY EXPEDITION TO THE KANSAS CHALK FOR 1907.

By Charles H. Sternberg, Lawrence.

IT still remains my privilege to tell this Academy of another successful expedition in the Chalk of Kansas during the past season. My oldest son, who has been my chief assistant since he was twelve years old, feeling that he was perfectly capable of carrying on my work in the field without my presence, insisted on my remaining at home in my laboratory. He promised to keep me busy by sending in new material.

I am delighted to tell you that he did all he promised to, and I was well satisfied with the results. I was indeed kept busy opening boxes and preparing the tons of fossils he sent to me, and it was almost as great a pleasure as to find it myself, without the discomforts attending the actual discovery in the field, to open up to the light a finely preserved specimen collected by the second generation of fossil hunters. He sent me the best specimen of the great ram-nosed *Tylosaurus dyspelor* I have ever discovered. The entire column, except a few caudal vertebræ, are present, many continuous. And, strange to tell, for the first time the minute last caudal vertebræ are present, the last six measuring a fraction over an inch in length, and the terminal one a mere nodule of bone, less than three-tenths of an inch in diameter. There are about 126 vertebræ, instead of 116, according to the skeleton described by Doctor Williston. So the number must vary, or the last minute ones had been lost in the University specimen. Further, the caudal vertebræ decreased in all their proportions regularly; each one is a millimeter smaller than the preceding one. Consequently, as I believe, the mounted and restored Bourne specimen, in the American Museum, with a short, crooked tail, is abnormal, and not natural, as Doctor Osborn was led to believe. I have another specimen I will mention later, of the same size, in which the tail turns up in the same way that their specimen turns down. *Tylosaurus* has a long, flexible, eel-like tail.

Another fine specimen sent from the field was a complete skull, with mandibles, of a new species of the Cretaceous sea-tortoise *Toxochelys*. This I believe belongs to the new species of which I sent to Yale a couple of years ago a nearly complete carapace and plastron, described by Doctor Weiland as *Toxo-*

chelys bauri. The skull and mandibles are more robust than the principal species, Cope's *T. latiremus*, wider at the nasal bones, and with round orbits, instead of oblong, as in *latiremus*. The saggital crest is larger and sculptured.

Tylosaurus dyspelor Cope.

Another fine specimen discovered was a magnificent plate of Crinoids, *Uintacrinus socialis* Marsh. This last one went, through the efforts of Mr. Springer, to the National Museum. It contains 150 fine calaces and covers an area of thirty square feet. There is still another fine specimen that I have not seen, but am assured is a complete skeleton, except the head, of *Platecarpus coryphaeus* Cope. I shall be glad to show you some of these specimens of the life of the Cretaceous, at my laboratory, 617 Vermont street, Lawrence, Kan.

I missed the exhilaration and joy of discovery, and longed to find some excuse to take charge of my party, when I received a letter from Dr. E. Koken, of the museum of the University of Tübingen, Germany. He wrote me that he wished me to conduct an expedition to the Kansas Chalk for his museum, and as he accepted by wire my terms, I have spent nearly three months in his employ. We have enjoyed the most delightful fall weather I have ever experienced in the fossil beds, and our success has been remarkable. We discovered a very perfect skull of the large ram-nosed *Tylosaurus dyspelor* Cope. It is four feet in length. I cleaned it so as to show the frontal exposure, and have only seen one skull as large, the one mounted in the Kansas University, discovered by the late Judge West. The one I sold the American Museum is only three feet nine inches long. A singular thing occurs, in connection with this skull, I have never noticed in a Kansas mosasaur before. The end of the ram, or end of the premaxillæ, is missing, and the distal end of the premaxillæ shows the depressions and elevations of one-half the suture, as in the heads of young bones of mammals, and there had evidently been a distinct center of ossification in the ram, that had not yet united firmly with the rest of the bone, and had dropped off. I found fourteen feet of the tail of another individual. There are eighty-six pygal and caudal vertebræ, and a complete pelvic arch with right femur, tibia and fibula, one tarsal and metatarsal. The ischia are directed upward and a little outward; their proximal ends unite with the illia, that lie horizontally with the column; the two pubis bones are out of place, but the right femur and other bones of the limb are in position. This is the first time I have seen these bones in place and they give the height of the illia and ischia, 19 inches; width at the upper ends of the ischia 22 inches, and 20 inches where they join the illia. A great slightly curved basin is thus formed. The ischium is 12 inches long. The illium is 7½ inches long where it joins the ischium. The proximal ends of the two bones are not united, but separated by a space of several inches. The pubis is 8½ inches long, the femur is 9 inches long, and tibia 5½ inches. The length of the preserved limb is 18 inches. The base of the abdomen would have the dimensions of about 20 inches in width and over 30 inches high through the median line—a powerful trunk region, indeed. The tail is a little longer than the body, or about fifteen feet.

To add to our good fortune we discovered a very beautiful skull of *Platecarpus coryphæus* Cope, with one arch and front limb. The teeth are beautifully preserved and all the bones, evidently, of the head present, though slightly disassociated. A very beautiful open mount can be made of this specimen.

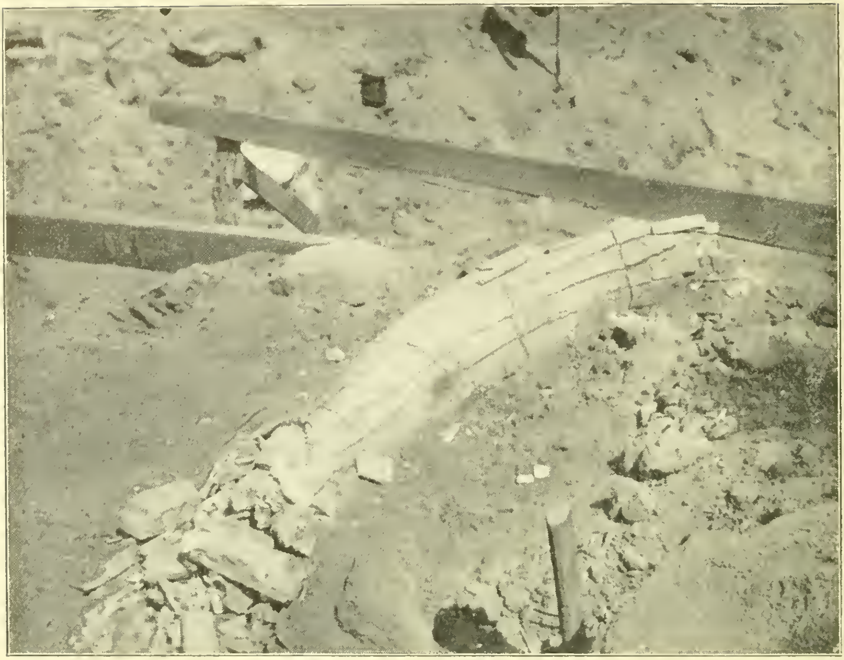
It would occupy too much time to tell of all the material collected within a few miles of Elkader, the center of the richest fossil field in Kansas. But I will close by mentioning the fact that this season I succeeded in securing for Tübingen a complete valve of the huge *Inoceramus* shells whose broken fragments strew the beds of the Upper Niobrara in western Gove and eastern Logan counties. They are so extremely thin and brittle that it is impossible to save them, without covering them with plaster. This I accomplished in the case mentioned. This valve that shows the inside is three feet seven inches long, and three feet four inches high. One graceful elevated curve follows the other, from the hinge to the rim. Think of wandering along the beach and coming across one of these shells traveling your way through the sand. If you measure six feet in height, this shell comes up to your waist. I remember, after years of experience with canned so-called "cove oysters," seeing a tempting sign "Fried Cove Oysters, 40 Cents a Dozen" at a restaurant in Philadelphia, in 1876, and concluded that I would enjoy a dozen for lunch. When in course of time the waiter appeared with a huge platter, loaded as high as possible with my fried oysters, I was very much astonished, and found that three or four satisfied my hunger. But think of a feast requiring two able-bodied men to carry one dainty morsel in, on the half-shell, which would be sufficient for a feast of Titans, for "there were giants in those days."

A FOSSIL TUSK FOUND IN THE EQUUS BEDS IN McPHERSON COUNTY.

By E. O. Deere, A. M., Bethany College, Lindsborg.

LAST May, while digging in a sand-pit near the head of the east branch of Sharp's creek, the workmen found what they at first thought was a large petrified cottonwood root. Upon closer examination it appeared to be petrified and partially decayed ivory. As soon as we heard of it Prof. J. E. Welin and myself drove out to the place and examined the find, which proved to be the right tusk of a mastodon (*M. Americanus?*). When we arrived the fossil had already begun to crumble, being exposed to the sun and wind. Besides, the sand-bank in which it lay had caved in, so that the distal half and part of the base were broken into small pieces, so characteristic of decaying ivory. We at once set at work to gather up all the fragments and place the part yet intact into

View of tusk and bed in which it was found.



View of tusk as seen from above.

a plaster cast. According to measurements taken by the workmen shortly before the sand caved in, the tusk was nine feet eight inches in length and eleven inches in diameter at the base, tapering to a blunt point about one-half inch in diameter; and the concentric layers that compose it vary in thickness from one thirty-second of an inch along the axis to one-half inch in the outer layer.

It rested on the right or outer side, in a bed of sand, which was covered by eight feet of loam. The base of the tusk projected about five inches above the sand into the overlying loam, while the small or distal end was covered by thirty inches of sand. As found, it rested in the sand about thirty feet above the creek bank and about half way up the gently sloping hill on the east side, a distance of about 100 yards from the creek channel.

The sand in the pit where the tusk was found shows considerable cross-bedding and contains many layers of carbonaceous material and coarser sand and fine gravel. It was twenty feet deep on the east or upper border, and has been made by hauling away the sand, which is of an excellent quality for building purposes, being composed of thick alternating layers of both fine and coarser sand. Some of this is hauled for a distance of fifteen miles.

The low hills along the east side of the creek show for miles this same structure of sand and gravel, which is covered by layers of "hardpan" and surface soil of varying thicknesses, from three to fifty feet. In these are found two strata of $CaCo_3$ nodules, so common in this region. At the places I examined they were from eight to twelve inches apart, from one-fourth to one and one-half inches in thickness, and from six to twelve feet below the surface. Much of this material was found in the sand and soil about the tusk.

Last year, in another pit about forty rods north of the tusk, were found most of the bones of a human skeleton, covered by about eight feet of sand and loam. Some other bones were also found, but these had been destroyed, so I have not seen them. According to descriptions given they were bones from the skeleton of an animal of considerable size.

The tusk was found on the north end of the west quarter of section 6, in Jackson township, seven miles west and nine and one-half miles south of Lindsborg, and one and one-half miles west and four and one-half miles north of Conway, which is near the western limit of the McPherson *Equus* beds.

We have now in our museum collection one very valuable fossil from this immediate vicinity. It consists of the greater part of the skull of a *Megalonyx leideyi* Lindh. It was discovered a number of years ago by Prof. J. Udden and described by Dr. J. Lindahl, now of Cincinnati, Ohio. The skull is considered to be of great value, since it is one of the few, and, besides, the most complete of any, ever found.

The tusk has as yet not been reconstructed, but as we have all the pieces it is hoped that we will soon have them replaced and the entire fossil added to the museum collection as a valuable find from the *Equus* beds.

IV.

BIOLOGICAL PAPERS.

1. "Antiquity of Man's Body-building Instincts."
   By L. C. Wooster, Ph. D., Emporia.
2. "Some Observations on the Food Habits of the Blue Jay (*Cyanocitta cristatus*)."
   By Prof. L. L. Dyche, University of Kansas, Lawrence.
3. "Habits of Lysiphlebus, sp."
   By C. H. Withington, Agricultural College, Manhattan.
4. "Tuberculosis: Its Cause and Cure."
   By Dr. Burton H. Rogers, Veterinary Dept., Agricultural Coll., Manhattan.
5. "Additions to the List of Kansas Coleoptera."
   By W. Knaus, McPherson.
6. "Coleoptera of New Mexico."
   By W. Knaus, McPherson.
7. "A New Species of Campostoma."
   By F. F. Crevecœur, Onaga.
8. "Concerning Some Insects Collected and Bred from Dead and Dying Elm."
   By E. S. Tucker, Dallas, Tex.
9. "Animals, Reptiles and Amphibians of the Rosebud Indian Reservation, South Dakota."
   By Albert B. Reagan, La Push, Wash.
10. "A Kansas Beaver (*Castor canadensis* Kuhl)."
    By L. L. Dyche, University of Kansas, Lawrence.
11. "Some Sea Shells from La Push, Wash."
    By Albert B. Reagan, La Push, Wash.
12. "Occurrence of Podagrion Mantis in the Eggs of the Common Mantis."
    By Lumina C. Riddle Smyth, Ph. D., Topeka.
13. "Observations on the Ants of Arizona and their Auxiliary Captive Beetles."
    By Eugene G. Smyth, Topeka.
14. "Notes on Collecting Cicindelidæ—II."
    By Eugene G. Smyth, Topeka.

ANTIQUITY OF MAN'S BODY-BUILDING INSTINCTS.

By L. C. Wooster, Ph. D., Emporia.

LIFE reaches so far back into the dim recesses of the earth's history that the geologist alone is competent to make even an estimate of its antiquity. Furthermore, the geologist is aware that his estimates of the lengths of geological times are merely approximations to the true periods; still, these eras of time are so vast that it is beyond question entirely safe to use these estimates for most scientific purposes. Averaging the opinions of several leading geologists, we may give the lengths of the eras as follows:

Archean	10+	million years.
Proterozoic	17½	" "
Cambrian	6	" "
Ordovician	6	" "
Silurian	2½	" "
Devonian	3½	" "
Carbonic	4½	" "
Jura-Trias	3½	" "
Cretaceous	3½	" "
Tertiary	2	" "
Quaternary	1	" "
Total	60+	million years.

Before giving the times of appearance of the several body-building instincts, it will be necessary to discuss briefly the signification of this new term in biology.

An instinct has been defined as a propensity of each individual to do those things which reason afterwards pronounces to be good, and which were done prior to experience and independent of instruction.

Professor James says that an instinct is usually defined as the faculty of acting in such a way as to produce certain ends, without foresight of the ends, and without previous education in the performance. (Psychology, Brief Course, page 391.) Professor James further says that instincts are functional correlatives of structure, and that with the presence of a certain organ goes almost always a native aptitude for its use. This organ is used in response to a certain stimulus, says Professor James, and this stimulus may be a sensation, as hunger and cold; a perception, as the sight of food or fire at a distance; or an idea stimulus, as the remembrance of a previous dinner or warm place brought to mind by a growl or the sound of a distant whistle. The illustrations of these three kinds of stimuli are in part mine.

Sensations and perceptions are objective stimuli to the use of the organs of the body; ideas are, in some measure, subjective stimuli; but a fourth and very important class of stimuli is purely subjective. Prof. Joseph Baldwin (International Education Series, vol. VI, p. 16) calls this fourth group of stimuli blind impulses implanted by the Creator, and Professor James terms these subjective stimuli native aptitudes for the use of the various parts of the body.

These blind impulses, these native aptitudes, must inhere in the life of the body, for life alone is static as it develops its powers in the midst of the stream of matter passing through the body, and life alone can inherit the capacities and tendencies of ancestral life.

It may be a relief to all psychologists who read this paper to be reminded that the Dictionary of Philosophy and Psychology, edited by Prof. J. Mark Baldwin, defines instinct as an inherited reaction of the sensori-motor type, relatively complex and markedly adaptive in character, and common to a group of individuals. The dictionary further says (page 555) that it is definitely a biological and not a psychological conception; that no adequate psychological definition of instinct is possible, since the psychological states involved are exhausted by the terms sensation (and also perception), instinct feeling, and impulse.

The Dictionary of Philosophy and Psychology's definition of instinct rules out, on the one hand, the application of the term instinct to tendencies and impulses which do not have definite native motor channels of discharge, and, on the other, those reflexes that are simple and not adaptive.

As the term instinct is strictly a biological term, it may be modified in any way to suit the special needs of a study of life activities. It has seemed wise to the writer, therefore, to restrict the term "instincts" to those powers of life by which the several parts of the body are used without instruction to gain appropriate, beneficent ends; and to use the term "body-building instincts" to designate those powers of life by which the several parts of the body were made for some beneficent use in accordance with the practice of a long line of ancestors. Both body-building and body-using instincts are adaptive and mutually reactive, a changing use inducing a changing structure, and a changing structure making possible a more rapidly changing use.

In the developing embryo life begins all the parts of the body and completes several of them before the little organism has any use for these structures. Thus the digestive and respiratory apparatuses are ready for use before food and air can enter them, and the blood-vessels and muscles are begun before they are needed. So use by an ancestor determines structure in a descendant, and not the operation of chance or the effect of an external environment. Where use varies in the parent, the structure and use vary in the descendant, but only to an almost infinitesimal degree, fortunately, in all but a very few of the descendants.

Even a careless observer must have noted that the lower animals possess body-building instincts and instincts proper very much like our own. The evolutionist has inferred, because of this and other reasons, that the higher animals have been evolved from the lower ones, not suddenly, but by the accumulation of infinitesimal variations through long eras of time, many millions of years in duration.

It would not be germane to the purpose of this paper to attempt to prove the correctness of this view of the evolutionist. Indeed, so few now hold the contrary theory such an attempt would scarcely be necessary under any circumstances. It may be well, however, to mention one confirmatory proof which has many interesting bearings on the subject we are considering.

Professor James says that certain instincts in man become habits if the tendencies are used consciously in the performance of work; otherwise these instincts become dormant and may never be fully functional during the lifetime of the individual. In like manner, as has been already stated, the body-building instincts become weakened in the descendant if the part to be made had not been used by its ancestors; and such parts become vestigial in remote succeeding generations if the disuse is persisted in. The eyes of the cave-fish have undoubtedly become vestigial in this way; and man's ancestors have discontinued the use of so many parts that one anatomist, Wiedersheim, declares that he has found 180 parts in man's body which are vestigial. On the other hand, our ancestors have used various parts and organs to an increasingly greater extent than the same parts and organs were used by our still more remote progenitors, with the result, as it is hoped this paper will show, that the parts and organs appear in the following generations down to man of the present time with more and more complex structures and greatly increased functions, all because the life-powers are educable.

The most primitive of all organs in the bodies of animals is the digestive cavity. This statement is supported by the embryologist, the evolutionist, and, in a somewhat indirect way, by the paleontologist.

The embryologist finds that the fertilized eggs of all metazoa become in succession morulas, blastulas, simple gastrulas, and complex gastrulas, as they develop. This in itself would not be especially interesting had not the embryologist discovered that these stages of development of the embryo possess counterparts in a series of adult animals of lower classification. Thus he finds the following corresponding forms:

Fertilized egg	Hematococcus.
Morula	Pandorina and eudorina.
Blastula	Volvox.
Simple gastrula	Fresh-water hydra.
Complex gastrula	Worm, amphibian, reptile (Theriodonts), lower mammal, man.

The evolutionist explains this remarkable series of corresponding structures by calling attention to the fact shown in geology that the lower forms of life appeared on earth first, and then successively higher forms, such as: Protozoa, cœlenterates, worms, fish, amphibians, reptiles, lower mammals, and, lastly, man. The law of development he has found to be such that only one in a million of each species develops structural characteristics of higher importance, while the other 999,999 have remained like their ancestors. The descendants of these stay-behinds remain on earth to-day little changed, except in minor details of structure, and thus serve to show to the evolutionist what his ancestors have been back to the beginning.

In this list of ancestors we find that the sponges and cœlenterates were the first to take the gastrula form, and thus were the first to possess a true digestive cavity. The paleontologist finds by a study of the fossils of the earth's crust that sponges and cœlenterates were common in the Cambrian era, but with much higher forms, such as worms, mollusks, and trilobites. He hence infers that the sponges and cœlenterates, the first animals with digestive chambers, appeared on earth before the Cambrian, in the Proterozoic era, at least forty-five million years ago. It seems possible, then, that the stomach-making instinct has required these forty-five million years to evolve a digestive apparatus as complicated as that possessed by the ox and man.

This digestive chamber was merely a sac with one opening in the cœlenterates; it became a tube with two openings in the worms, if we are to accept as representative of the Proterozoic type of worms the modern, stay-behind examples of these animals; a tube with various enlargements and associated digestive glands in the amphibians thirty-five million years later; and became fully differentiated for animal and vegetable food in the mammals some two million years ago, since which time life has evolved little that is new in the construction and operation of a stomach, unless we add its ability to get out of order in man.

A system of tubes for conveying blood to remote parts of the body is found now in its simplest form among the worms, and worms of the higher types certainly existed twenty-seven million years ago, as shown by fossil worm holes and casts found in the Potsdam sandstone of the Cambrian era. These may have had one-cavity hearts, as earthworms do to-day. Fish with two-cavity hearts existed in the Silurian era, over eight million years later; amphibians with three-cavity hearts were abundant twelve million years ago, in the Carbonic era, and primitive mammals with four-cavity hearts were numerous seven million years ago in the Jura-Trias; since which time the heart-making instinct has not improved much, except in the direction of making larger-hearted individuals.

Ventral nerve-threads to control the food-digesting and distributing organs probably appeared first in the worms twenty-seven million years ago. This ventral nerve-cord producing instinct is certainly so old that man has no conscious control over this system of nerves, the sympathetic system.

The dorsal nerve-cord was originated by an instinct which appeared much later in the development of life. As is now known, the dorsal nerve-cord is formed from a dorsal furrow-invagination of the ectoderm of a worm-like animal, and was made primarily to control an increasingly complex system of muscles in the lower chordates, fish and higher animals. The ventral nerve-cord does this in the arthropods, in addition to managing digestion and circulation; but this double work on the part of the ventral cord in crustaceans and insects has been fatal to their higher development; and vertebrates with two nerve systems and division of labor have far outstripped anthropods in the race to greater complexity. The dorsal cord must have appeared with and in the lower chordates and fish of the Silurian era, twenty million years ago. A special development of this dorsal nerve-cord at its front end and near the organs of special sense, which we call the brain, appeared in fish, so the geologist tells us, in the Silurian era, over twenty million years ago. This instinct for brain-building did not improve much till mammals appeared, twelve or fifteen million years later, in the Jura-Trias. The intricate land life of the true mammals of the Tertiary era induced a rapid development of the brain-building instinct, especially in the production of a larger cerebrum and cerebellum, till it culminated in man after he appeared, 100,000 years ago. The organs of special sense have developed with the brain, as we would naturally expect.

The instinct for building a backbone also appeared with and in the primitive fish; but the first backbone was not at all bony, for it was merely a cartilaginous rod produced from a longitudinal furrow-invagination of the alimentary canal. Millions of years later it became segmented and bony, as we find it in the higher vertebrates, and received its peculiar curves as in man.

The aquatic habits of the early animals permitted the use of the entire ectoderm of the body, increased by evaginations or invaginations in some cases, in oxygenating the blood; but the increasing activity of the more and more complex aquatic animals made it necessary to expose some of the entoderm to water containing oxygen. This was more especially true of those animals which thickened the outer skin for service as an armor to protect them from their foes. Obviously the entire entoderm could not be used for purposes of respiration, so certain anterior portions near the mouth, as we know, were invaginated, forming sacs or pouches which communicated with the exterior through pores or slits. It is true that the gastrula-animals, such as the hydra and sponge, probably did attempt to use the entire entoderm for both digestion and respiration, as they do to-day; but both kinds of work were poorly done, and part of the digestion must have been performed, as now, in the entodermal cells, making digestion in part cellular, as in modern protozoa. We know that recent hydras and fresh-water sponges use algæ, such as the protococcus, to assist in the work of respiration.

The whirlpool method of respiration in pouches used in hydras, polyps, snails, lampreys and hags must have originated in the Proterozoic era in sponges and hydras. Outlet for the water must have been given then, as now, where it entered, or through pores and slits at the bottoms of the pouches.

But when the land habit was acquired, the drying influence of the atmosphere made it necessary to give up using the ectoderm as a respiratory membrane, except incidentally, and to make an increased use of saccules of the entoderm. The mammalian embryo still retains the instinct for making sacs, slit so as to form gills; but these generally close before birth, and deeper-seated invaginations, many times sacculated, serve as respiratory organs or lungs.

The last organ-making instinct which my space will permit me to mention has for its function the preparation of limbs for locomotion. The earlier animals, so we learn from the geologist, either spread themselves over the sea-bottom, or were radially symmetrical with their axes in a vertical position. The equilibrium of such animals was easily maintained, but they were usually poor travelers. Worm-like animals were possibly the first good swimmers. That these long animals might not roll over and over, the body must have been flattened dorsi-ventrally and the sides extended by lobe-evaginations, as we find in the Nereis of modern seas. Eventually certain of these lobes must have become specialized as limbs for locomotion, as in centipedes, insects, fish, salamanders, and mammals.

As the mammals became better and better adapted to the land habit of living, the ends of the subdivisions of these evaginations became covered with hardened scales of the epidermis. These eventually became the hoofs of the herbivorous mammals, the claws of the carnivores, and the nails of man.

As one studies the evolution of the body-building instincts from perhaps a single primitive instinct that made its appearance on earth fifty or sixty million years ago, as one learns that these instincts grew and branched as the parts which were consciously overused within safe limits, or were consciously disused till they dwindled and became vestigial, one's amazement certainly grows that life should have been able in this slow way to have produced such a diversity of parts and organs, all adapted to such a variety of uses and environments.

Where twenty million years could be used by a long series of life-units in the development of a single organ, such as man's brain, and a succession of one million individuals could each use or disuse the developing parts of this wonderful organ and each transmit to his descendant in the tiniest degree the tendency to build the parts used or disused in such a way that they may be used or disused more or less than they had been before, no difficulty should be experienced by any one in understanding how greatly complicated organs are produced and higher types of animals evolved.

A myriad of tiny conscious efforts of the same kind may make a habit, and why may not habits persisted in for thousands of generations, as geology and biology seem to show—why may not such habits become fixed in life and the tendency to form these habits be transmitted to the following generations? These inherited tendencies may well be termed subconscious habits, or semi-instincts, which in millions of years more may become true body-building and body-using instincts independent of direct conscious control. Unfortunate tendencies would be ended by natural or artificial selection, as was abundantly demonstrated by Darwin, and useful variations be strengthened by organic selection plus tiny increments of conscious control continued for millions of years through millions of individuals.

Many advocates of Mendelianism try to explain the inheritance of body-building and body-using instincts from two lines of ancestors, that of the father and of the mother, by imagining that the sperm and egg chromosomes, when they fuse in synapsis, intermingle their biophores and thus give to the embryo which developes from the fertilized egg a mixture of biophore-corpuscles, some dominant and some recessive in their influence.

A simpler form of explanation and therefore a better one, a form based on life and its activities and less largely on matter in its inertness and therefore truer, consists in making the fusion in synapsis one of life-instincts and not chiefly one of corpuscles of matter whose arrangement determines, in some unknown way, the character of their reaction with their environment. When the instincts harmonize they supplement and strengthen one another, as is usually the case when the sperm and egg come from individuals of the same species. When the body-building and body-using instincts cannot harmonize, as is the case when the sperm and egg come from individuals of widely different species, the result is zero, for very obvious and necessary reasons.

SOME OBSERVATIONS ON THE FOOD HABITS OF THE BLUE JAY (*Cyanocitta cristata*).

By L. L. DYCHE, University of Kansas, Lawrence.
Read before the Kansas Academy of Science, at Emporia, November 26, 1907.

IT is not the object of this paper to give a detailed account of the food habits of the blue jay based on the examination of the stomachs. However, more than 150 stomachs have been examined, and a few notes will be given on this phase of the subject.

In 1896 Mr. F. E. L. Beal, assistant biologist, United States Department of Agriculture, made a detailed report on the examination of 292 stomachs which he had carefully studied. The material had been collected in every month of the year and from twenty-two states. At the close of his report, where he sums up the interesting results of his investigations, he says: "The most striking point in the study of the food of the blue jay is the discrepancy between the testimony of field observers concerning the bird's nest-robbing proclivities and the results of stomach examinations. The accusations of eating eggs and young birds are certainly not sustained, and it is futile to attempt to reconcile the conflicting statements on this point, which must be left until more accurate observations have been made. In destroying insects the jay undoubtedly does much good. Most of the predaceous beetles which it eats do not feed on other insects to any great extent. On the other hand, it destroys some grasshoppers and caterpillars, and many noxious beetles, such as scarabæids, click beetles (elaterids), weevils (curculionids), buprestids, chrysomelids, and tenebrionids. The blue jay gathers its fruit from nature's orchard and vineyard, not from man's; corn is the only vegetable food for which the farmer suffers any loss, and here the damage is small. In fact, the examination of nearly 300 stomachs shows that the blue jay certainly does far more good than harm."

I have examined more than half as many stomachs of the blue jay as were examined by Mr. Beal. More than half of my material was collected in the city of Lawrence, and none of it more than ten miles distant. So far as stomach examinations go the results of my investigations were not very different from those of Mr. Beal. The blue jay takes a very great variety of food of both animal and vegetable kinds. The kind of food eaten depends largely upon the kind the locality furnishes during any particular season of the year. The food of July and August, as a rule, is very different from that of January and December. During the summer months the animal food, mostly insects, sometimes reached as high as sixty to seventy-five per cent. of the total food mass. This same per cent. was sometimes reached in case of fruit, especially when blackberries and mulberries were being eaten. In winter time, especially when the ground was frozen and covered with snow, vegetable matter, chiefly corn, constituted the great bulk of the jay's food. Again, the food of the jay birds in and around the city of Lawrence varies considerably from that of the jays that feed in the country districts.

The food of twenty-seven jays killed the third week in September, 1907, some nine miles southwest of Lawrence, in a wild, wooded district, was quite different from that of an equal number of birds taken during the month of September in and around the city of Lawrence. Over sixty per cent. of the mass of the food of the birds taken in the country district was made up of acorns. Only two stomachs contained even a trace of corn. The stomachs of the birds taken in the city showed over fifty per cent. of the food mass to be grain, mostly corn. The birds taken in the country district had eaten thirty per cent. insect food, and about twenty per cent. of this was made up of black ground-beetles, such predacious beetles as carabids being very common. There were also a considerable number of smooth-bodied caterpillars, the larvæ of the common hummingbird, sphinx or hawk moths not being uncommon, some of which measured as much as two and one-half inches in length. Grasshoppers, snails, snout and long-horn beetle, ants, spiders—in fact, almost any insect, even hairy worms, were occasionally found. The insect food of the birds taken in the city was not over fifteen per cent. of the food mass, dark-colored ground-beetles and grasshoppers predominating.

During the winter season the city blue jay takes almost any kind of food that comes handy, feeding in the public roads, the alleys, in back dooryards and in barn-yards. At this season of the year grain, mostly corn chop, makes up the bulk of the food mass. However, such material as cooked meats, potatoes, bread, oatmeal, rice, boiled eggs, apples and bananas are not infrequently found in their stomachs. A considerable amount of mineral matter is always found in the gizzards, such as pieces of stone, glass, various kinds of gravel, and occasionally such articles as beads, buttons and pieces of broken china.

I now desire to speak of some observations on the food habits of the blue jay, made by myself and others, not based on the examination of the contents of stomachs. One day last winter I noticed nearly a pint of walnut hulls at the mouth of a spout that carried the water from the roof of the wash-house. At first I thought it was the work of squirrels. I soon learned that blue jays were taking pieces of walnuts that were left near some stones where the boys had been cracking them. The jays would carry the pieces of walnuts to a tree that overhung the wash-house. The birds would hold the pieces of walnuts on a limb with their feet and pick out the meats. We would crack nuts for them in the evening and watch them perform early next morning. They would take whole acorns, hold them the same as they did the pieces of walnuts, and pick them to pieces. They also tried whole walnuts and hickory-nuts, but failed to get them open. Walnuts are undoubtedly an unnatural food for blue jays. Yet after they got a taste of them they eagerly searched for the broken pieces every morning. When food is plenty the jays eat what they like best; when it is scarce they eat almost anything in the shape of food that they can find. They are fond of mulberries; I have seen them eat them many times in my own yard. I have also seen them eat blackberries, apples and green corn.

On July 21, 1907, I saw three working in a sweet-corn patch. One of these birds picked open an ear that had not been injured by other birds and began vigorously to pick at the grains of corn.

The above observations are such as might be made by any one willing to give a little time to the study of the blue jay in his natural haunts.

There are other observations not so easily made, and more to the point of this paper, which I now desire to give. My two small boys, George and Lindsay, ages eight and twelve respectively, aided me very materially in making these observations. They were usually in the yard a great deal of the time and had many opportunities as well as a keen interest in any disturbances that might take place in bird society. Two pairs of blue jays built their nests in my yard during the past summer. The birds were very shy and very quiet about their nesting quarters, and unless one understood something of their nesting habits he would never even suspect that there was a nest anywhere in the neighborhood. My present home place has five and one-half acres in it and is partly covered with forest and fruit trees. The boys kept the English sparrows exterminated by the use of a small gun. The result was that at one time we counted as many as twenty wild native bird's nests that were being used on our own grounds.

One morning in May I saw a jay picking at something on a fence-post, and threw a stone so as to frighten the bird suddenly. When I reached the spot I found half of the shell and about one-third of the contents of a turtle-dove's egg. A few mornings later I saw a jay picking at something on a dead limb of a fallen apple tree. I frightened the bird by throwing a hammer at it, which I happened to have in my hand. On the limb I found part of the remains of a robin's egg. The very next morning, near the same spot, I saw a jay flying with something in its mouth. It lit high up in an elm tree, just over the roadway. After the jay began to pick at the object I approached and found small pieces of a speckled egg-shell which I could not determine for a certainty; by comparison it was that of a brown thrasher or cardinal redbird. In May, 1906, just a year before the above observations were made, a robin built her nest in a small tree that grew not more than ten feet from our house. The tree was beside the pump and near the kitchen door. We naturally took unusual interest in the bird, as the nest was so low that by standing on a chair placed on the sidewalk it could be touched by the hand. My boys saw nearly every movement the birds made while the nest was being constructed. Only a few days had passed when they informed me that five little blue eggs were in the nest. Immediately the old robin began her duties of incubation, and everything looked favorable for a fine brood of semidomesticated robins right in front of our door. Quite early one morning I heard, through an open window, a great commotion among the birds out of doors. I ran to a window and saw robins and catbirds flying at a blue jay. I hurried down-stairs and was out of doors just in time to see the jay fly to a tree some distance away, the robins and catbirds still pursuing. On the sidewalk, under the little tree where the robins had their nest, was part of the shell of a robin's egg and a mangled embryo bird that had been torn out of it. I examined the robin's nest and found nothing in it except part of a broken egg-shell.

The catbirds above mentioned had their nest in a small catalpa tree about thirty yards from the house. There were four young birds in the nest. They were not disturbed at this time. A few days later, just at noon time, the boys came running to the house shouting that the jays were fighting the catbirds. We hastened to the scene of disturbance just in time to see a jay fly from a spot several yards beyond the catalpa tree. When we reached the place we found one of the young catbirds, nearly full grown, with its head and back so badly picked that it soon died. An examination of the nest showed only two birds remaining, which went to show that this was not the first attack that had been made on the young in the nest. A few days later, while I was at the University, the small boys saw a jay on a limb of the catalpa tree picking one of the young catbirds. Lindsay took a gun and killed the jay, a thing he had begged me to let him do on the occasion of the first robbery and murder we had witnessed in the catbird family. On my return home I examined the catbird's nest. It had but one bird left in it and that one was so badly picked that it was dead the next morning.

June 18, 1905, Lindsay and George saw a jay bird fighting a young catbird that was large enough to fly from one bush to another. Lindsay ran after his gun and returned as soon as possible, to find, however, that the jay had the catbird killed. He shot the jay. I dissected the bird and found feathers and mulberries in its stomach.

May 19, 1907, the boys, who were playing in the yard, called to me that a jay was fighting the robins in an old apple tree near the wood-house. I hastened to the spot. The jay did not leave the tree until I threw a stone at it. I found a half-grown robin on the ground under the tree with a gash an inch long in its side and neck. George, my youngest boy, climbed the tree and put the wounded robin in the nest with its three brothers and sisters.

May 21, George brought me a young dead robin with its head picked and a hole in its side, that he found under the old apple tree. I went to the tree to examine the nest and found that it had been robbed of all its young birds.

July 5, 1907, Lindsay saw a turtle-dove trying to fight a jay from its nest in an elm tree near our house. The jay got one of the dove's eggs and flew to a near-by fence. Most of the contents of the egg spilled out before the jay reached the fence. The boy begged me to let him take the gun and kill the jay. I told him if we killed the jay that we would not get any more observations. He said he had all the observations he wanted on jays robbing nests and killing young birds and that what he wanted when he saw a jay was a gun.

BLUE JAYS KILL YOUNG CHICKENS.

June 18, 1905, about eight A. M., as I walked back of the barn, I saw a blue jay picking at something on a low shed roof. It was a young chicken, less than a week old. The jay flew into a near-by tree, leaving the chicken dead, with one eye picked out and the skin torn from its neck and breast. A few days before I had placed a hen and chickens under an old peach tree in a box coop fixed up with a rat-proof wire door; so I was somewhat puzzled when four or five of the chickens had disappeared. I thought of cats and rats, but the day before I caught the real thief I found the mangled body of a young chicken on the end of an old peach-tree stump. This really put me to watching the jays, as I had noticed them a number of times flying about when I went to feed the chickens. It was not an uncommon thing for the jays, in winter season, to light on the troughs where the chickens were fed and help themselves. I watched for the jays every morning but did not see them with another chicken, though all the young chickens disappeared except three. I might say that I did not try to protect the young chickens after I found that the jays were taking them. When I let the little birds out in the morning I would watch a while with the hope of seeing a jay take one, as I wanted to see how the attack was made.

On June 23, 1906, Dr. L. B. Powell, a neighbor of mine, and an intelligent gentleman, reported to me that he had lost about a dozen young chickens, less than a week old, that had been killed by a pair of blue jays that had a nest in a tree in his yard. After he saw the jays kill some of the young chickens and pick their brains out, he shot the old blue jays and took the young ones from their nest and pulled their heads off.

Mr. C. D. Bunker, my assistant in the museum at the University, reported to me that the blue jays killed a number of young chickens for him two years ago. The bodies of the young chickens were more or less torn to pieces and partly eaten up. He also reported two canary birds killed by blue jays. The bird-cages were left on the porch. The jays caught the little birds and pulled them out through the spaces between the wires of the cage. Miss Alice Lichfield, a classmate of mine at the University, told me a number of years ago that the blue jays had killed a number of young chickens for her, but she failed to notice how the bodies had been mutilated.

Mr. Will Bullene, who lives a few blocks southeast of me, and who, from his general knowledge of birds, is abundantly able to make correct observations, told me of a neighbor of his that had lost quite a number of young chickens, due to blue jays. In this case there was a flock of about seventy-five young chickens. They were kept in a coop and allowed to run, after being fed, in quite a large runway enclosed by wire screening. A number of the little birds had been found dead in the runway, with their bodies mutilated. The owner was puzzled to make out what it was that was doing the mischief. Mr. Bullene suggested that some one be put to watch. It was not long before a jay was seen to pounce upon a chicken and pick it to death. After a few more chickens was killed, Mr. Bullene set steel traps on the fence posts where the jays were accustomed to light and caught a number of them. In this particular case the jays picked the crops of the chickens open and ate the feed, mostly corn chop.

A number of other cases have been reported to me concerning the jay's habit of robbing nests and killing young birds. I will give but one more illustration of the jay's wickedness in this line, and that came under my personal observation. It was in August, 1887. A pair of house wrens had built their nest in a little cubby-hole in the corner of our porch. One afternoon, about five o'clock, while Mrs. Dyche and myself were sitting on the porch, a little wren flew down from the nest. It was a young bird, and that was the first time it had ever tried its wings. While we were admiring the little midget hopping about on the porch, a blue jay darted from somewhere and with a great flutter and commotion of its wings grabbed the little wren and flew to a fence not more than fifteen feet away. I made a few hurried steps into the house and secured a small shotgun that happened to be handy. When I returned the jay flew a rod farther along on the fence. However, it was not more than two rods away, an easy shot, and I killed the bird. Mrs. Dyche, who was watching, had meantime noticed the little wren fall by the side of the fence from the spot where the jay first lit. I picked up the little dead wren and on examination found a small cut under one wing. There was no other cut or bruise on its body that I could find. I now picked up the blue jay. It had a little bloody heart in its beak. I dissected the wren and found that its little heart had been pulled out through the small cut that the jay had made under its wing. I dissected the jay and found two hearts in its stomach, quite a little larger in size than the one that had been pulled from the unfortunate little wren.

The very next evening I saw a jay dart after a little young wren, perhaps one of the same brood. My presence made it possible for the little wren to get under cover of some small bushes. The jay lit on the fence to watch. I secured my gun and shot at the jay, crippling it so that it flew to a neighbor's yard and died. I was reported to the city attorney, Mr. W. C. Spangler, for shooting poor innocent birds.

After recording such observations I cannot help but feel somewhat like my small boy, who, after he had seen the jay with his own eyes commit a number of robberies and murders, said that "he had all the observations he wanted on jays robbing nests and killing young birds, and that what he wanted when he saw a jay was a gun."

HABITS OF LYSIPHLEBUS sp.

By C. H. WITHINGTON, Kansas State Agricultural College, Manhattan.

DURING the past summer I noticed that some of the corn-fields about Lawrence, Kan., were badly infested with the corn-leaf louse, *Aphis maidis* Fetch. At this time I was greatly interested in insect parasitism, and so watched closely for any evidence of it in this species. On the afternoon of August 10 my search was rewarded by the finding of seven parasitized specimens of *Aphis maidis* sticking to the tassel of a corn-stalk. These were taken to my room, where I could easily watch the emergence and secure the parasites. On August 12 two specimens of the genus *Lysiphlebus* emerged and were promptly mounted for study. Nothing came from the remaining five. Thenceforward I watched the fields closely for further parasitism, but saw no more until September 20, when, while collecting on the college farm at Manhattan, Kan., I found a female of *Lysiphlebus* sp. on volunteer corn, with some specimens of *Aphis maidis* that clearly showed evidence of parasitism, and on the following day I found hundreds of parasitized lice dead and dying on the under sides of the leaves and on the inner husks of the corn-stalk. At Lawrence the parasitized individuals were found only on the young tassels and the two upper leaves, while at Manhattan, six weeks later, they were confined to the leaves and husks. As the season advanced the lice left the leaves and the infestation came to be limited to the inner husks about the ear, becoming so great here that these were frequently entirely covered with aphids. By the first of October winged individuals were very plentiful, and from this time forward the infestation decreased until, with the coming of the first frosts, about the 1st of November, it disappeared from here as well. At this stage I became very anxious to know where the lice had gone and what the parasite was going to do for a host, but, in spite of close watching, am unable to answer either of these questions satisfactorily.

I found wingless *Aphis maidis* on well-grown volunteer wheat as late as November 24, but from November 9 the specimens under observation have been torpid. The majority of the embryo parasites inhabiting the lice on the 1st of November have not emerged, but also appear to be dormant.

After carefully comparing this species with the seventeen described by Ashmead in the Proceedings of the United States National Museum, volume II, 1888, page 662, I am convinced that we are dealing with a species that is not identical with any described in that work, and I therefore append the following description, written from fully fifty males and females of *Lysiphlebus* sp. that had been bred from *Aphis maidis:*

The male of the *Lysiphlebus* sp. has fifteen-jointed antennæ, the first and second coxæ yellowish-brown to honey-yellow, third coxæ being yellowish-brown to darker basally; head and thorax entirely black; petiole yellowish-brown, terminal antennal joint equal to the preceding; antennæ uniformly brown-black, basal joint of hind tarsi not equal to the following. It differs from all other species described by Ashmead (in the above reference) in that the terminal antennæ joint is equal to the preceding.

The female *Lysiphlebus* sp. has thirteen-jointed antennæ; head and thorax entirely black; first and second coxæ yellowish-brown, third yellowish-brown to darker basally; petiole yellowish-brown; hind joint of tarsi not equal to the following joint, from 1-10th to 4-10ths longer than the following, antennæ brown-black; joints of flagellum about twice as long as thick.

Soon after my discovery of parasitized *Aphis maidis* at Manhattan, the entomological department undertook the study of this parasite, and it is by the courtesy of Doctor Headlee that I have the privilege of using data from the experiments performed for the college.

Soon after emerging the parasites copulate, occupying an average of fifty-two seconds, and in some cases unite after the female has deposited several of her eggs. The female runs nervously about among the aphids, and when she finds one not parasitized throws the tip of her abdomen underneath her body between her legs, and with a quick "spring-like motion" thrusts her ovipositor into the body of the aphid, leaving there an egg. We then set about the determination of the length of life cycle of *Lysiphlebus* sp., and the number of aphids a single female would destroy. Twenty-five cages were set, each consisting of a flower-pot containing a stalk of corn or sorghum covered by a cloth-capped common lantern globe. From 100 to 200 fully grown *Aphis maidis* were placed on each plant and a single pair of parasites introduced among them. During the entire experiment reliable maximum and minimum thermometer records were kept. Seventeen of the cages came through without accident. At a mean daily temperature of 62.6 degrees F. the parasite passed from egg to adult in an average of 16.8 days, with 13 to 23 days as extremes. A single female successfully parasitized from 1 to 147 individuals, with an average of 34.

We then made an effort to determine what other hosts this species of *Lysiphlebus* could use. We tried fertilized females on *Hyalopterus arundinis* Fab., *Siphocoryne avenæ* Thomas, *Aphis cucumeris* Thomas, *Nectarophora calendulæ* Morrell, *Nectarophora prunicola* Ashmead, *Chaitophorus negundinis* Kalt., *Nectarophora chrysanthemi* Oestl., and *Toxoptera graminum* Rond., but found they worked readily only on *Aphis cucumeris, Siphocoryne avenæ,* and *Toxoptera graminum.* In case of the last, under a mean daily temperature of 60 degrees F. the parasite passed from egg to adult in an average of 17.5 days.

When we consider that this *Lysiphlebus* sp. lives readily at the expense of *Toxoptera graminum,* which has so lately shown its ability to destroy wheat and oats of immense areas, besides being able to subsist on other hosts that are seriously injurious to human welfare, it is clear that this species is worthy of careful study from a purely economic view-point, to say nothing of its scientific interest.

TUBERCULOSIS.

By Dr. Burton R. Rogers, Agricultural College, Manhattan.

IN all civilized countries there is a preventable disease which has been and is the cause, and the only cause, of the death of ten per cent. of our people. If we knew no more concerning the white man's plague to-day than we did prior to 1880, nine million of the ninety million people living in this country to-day would die of this disease. If we do not grasp and profit by the facts we know to-day the same will be true in the future.

But the most magnificent and most beautiful star in the medical and scientific firmament of to-day is that this disease is preventable and largely curable.

The only direct cause of tuberculosis is the entrance of the tuberculosis germ into a living body. Tuberculosis is absolutely impossible without the germ, as a corn-field is impossible without seeds of corn. Therefore the proposition is, where do the germs come from, and how may they be exterminated?

More than ninety-five per cent. of them come from two sources, namely, from the undestroyed sputum of tuberculous people and the unprepared food products of tuberculous animals. There are many varied opinions as to which of these two sources produces the larger per cent., the majority having held for a long time that the bulk of human tuberculosis is due to the dried sputum of careless or ignorant tuberculous people being inhaled.

Conscientiously I cannot concur in this, for I believe Nature has so constructed the air-passages that very few diseases can be produced by inhalation, for it contains moist angles that make a winding, rather than a direct, course for the inspired and expired air. The beautiful result is that, while the volume of air itself may follow a curved course, deflected here and there till it reaches the air-cells of the lungs, the particles, including germ life of all kinds, strike the moist angles, to which they adhere. It is similar to fanning dust into two curved stovepipes, one dry, the other lined by a moist cloth.

The cilia of the cells of the respiratory mucous membrane then convey them to channels through which they can be expelled to the exterior. Foreign material thus reaching the pharynx produces the reaction of either expectoration or swallowing. For this reason germs going in or out strike the most pronounced moist curve at the pharynx, producing that extraordinarily fortunate impossibility of germs being passed out to the exterior in ordinary expiration. Otherwise nearly every public room and public gathering would be unsafe. Because of this simple fact alone, it is within the will-power of properly educated tuberculous persons to collect practically every tuberculous germ which they give off, and, by destroying them, prevent the spread of the disease from one person to another. The cough, the sneeze and the expectoration are abnormally forcible and accelerated forms of expiration that carry out the germs, and while indoors the handkerchief at the nose and mouth collects practically all of them, so he can destroy them. Thus constant association with the educated tuberculous person is safe—but it is a positive menace with the one who does not know this fact.

But I am not here to discuss the intertransmissibility of human tuberculosis between man and man.

During a recent summer, while a federal meat inspector in the only packing-house in a city of 18,000, and to which the farmers for fifteen miles around hauled their hogs direct to this packer, I tagged 3430 of these hogs before the farmer had unloaded them from his wagon. As a result, when slaughtered I was able to trace back to the owner all tuberculous hogs and thus get a history and opportunity for an investigation of contributory causes.

Of about 600 different hog raisers, only 39 brought in all of the tuberculous hogs, and of these I only wish to mention two as pertinent and serious examples.

Every time a certain man brought in hogs, every single one of them was badly affected with intestinal and generalized tuberculosis. The filter system of the alimentary tract was so over-distended that it was positive evidence the food of the animal was mixed with tuberculous germs. Mesenteric lymphatic glands that should be as small as peas were as large as one's fist.

He informed me, and I confirmed it in several ways, that he was hauling to his farm the surplus milk from a milk store located in the same block in which I lived. Being milk too old for sale, it could be used for no other purpose than for feeding to hogs.

Gentlemen, the milk of cows that would produce this condition in hogs was sold for human consumption. We know that hogs can eat that which man cannot.

The other instance was that of the local country butcher having no inspection in an adjacent village, and who fed the lungs and other offal of the few animals he slaughtered to his omnivorous hogs. One hundred per cent. of his hogs showed equally bad intestinal tuberculosis. Several other dairymen and local slaughter-houses revealed the same conditions, to a lesser degree. Unless conditions are positively known to be otherwise, the very same conditions may exist in any community in the United States.

It is an actual and indisputable fact that if every tuberculous germ that has been given off or will be given off from the tuberculous people and animals living at the present time could be secured and effectually destroyed, or be merely prevented from entering a living body, the last death that would occur from tuberculosis would be in a person or animal in the present generation. I have shown it to be within the will-power of educated tuberculous persons to prevent infecting other persons and be their brother's keeper rather than destroyer.

Since domestic food-animals have very little mental power, it follows that the disease must be completely eradicated from them. Cattle do not expectorate—they slobber and swallow instead. The germs thus coughed up from the lungs are swallowed and those that are not again reabsorbed are passed out with the fæces. Farmers have found it economical to have hogs secure a portion of their nutrition from the fæces of the cattle.

When the cattle are tuberculous the hogs also acquire the disease. Thus tuberculous hogs are an index to dangerous tuberculous cattle and other tuberculous hogs.

It has been claimed recently that when the manure of tuberculous cattle dries within the stable it becomes dust, and portions of it, together with tuberculous germs, drop into the milk, which, if still retained at the temperature of the cow, offers the finest of opportunities for the tuberculous germs to grow, live, and multiply. A few germs at the time of milking may become several hundred at time of drinking.

The methods by which tuberculosis is transmitted from one animal to another or from one species to another can be reduced to three sources: *First,* animals living beneath the same roof can acquire it of each other. Cattle very seldom acquire the disease from other cattle in the pasture or even in the open feed-lot. Therefore, it is positively true that the disease is never carried through the air from one farm to another. However, by a *second* method, hogs may acquire the disease from tuberculous cattle by being turned into the feed-lot and eating the manure. Manure is an organic nutritive substance which, when first dropped, equals the body temperature and is favorable to the growth of the tuberculous germs. By a *third* method, hogs may acquire tuberculosis from the milk of tuberculous cows on the same premises. Therefore, if hogs never received any food, milk or manure, except that from the animals on the farm of the owner of the hogs, we would have an index at the packing-houses slaughtering hogs to practically every farm in this country having the tuberculous animals upon them. Manure is seldom hauled from one farm to another except for fertilizer.

Now, here is the important point: An exceedingly good animal husbandman can prepare a hog ready for market at six months of age; and nearly every hog, except parents, going to market is less than one year of age. Therefore, practically every farm in this country, before one year from to-day, will have sent one or more hogs to market.

The beauty of these facts is that the bulk of hogs are slaughtered in packing-houses where government veterinarians make two thorough examinations for tuberculosis of every hog killed.

The natural result would be that if they knew the farm from which every tuberculous hog came, we would, inside of one short year, know every farm having dangerous tuberculous animals upon it. The results would almost equal the tuberculin test applied on every farm in the country.

Human physicians advocate the registration of every tuberculous person and their place of habitation. Very recently I publicly proposed a detailed plan for accomplishing this much-desired result in animals.

But does tuberculosis exist in many animals?

The public animal reports of the government show that just in packing-houses alone having United States inspection, 15,546 tuberculous animals were detected in 1901, 27,752 were detected in 1902, and 81,179 were detected in 1903; and most certainly a like proportionate increase in the subsequent years, especially since the new law by which the inspection has been extended, and since nothing has been done to eradicate the disease.

The total number slaughtered during the three years was 113,630,682, thus making a smaller percentage than in any other country.

As many as 72,000 hogs have come into the Chicago stock-yards in a single day and been offered for sale. A tuberculous hog looks absolutely no different from a healthful animal. After these hogs have been bought, individual packers sometimes purchasing more than 15,000 on a single day; no farmer would be able to pick out his own hogs after they have been mixed together, let alone picking them out after they have been slaughtered and their hair removed. Packers thus buy tuberculous animals unconsciously, and if conditions are not changed they will continue to so do.

At the present time the general per cent. for the entire country is less than three in the hogs slaughtered where government inspection exists. A conservative estimate, based upon these facts and upon the experiment which I carried out, is that less than six per cent. of the farms of this country are sending all the tuberculous animals to market. Less than six per cent. of the farms are thus likewise responsible for all the tuberculous dairy products.

One simple thing will be the means of ascertaining the location of all of the small yet dangerous six per cent. of farms having tuberculous animals upon them—and that is to securely tag all hogs sent to market with tags that will remain until they have been inspected by the federal inspector.

I propose a letter from each state suffixing or prefixing a number for each county in each state, the combination being the numerator of a fraction; the denominator being a number given to the individual farmers in each state, as

$$\frac{a\ 26}{833}, \frac{27\ d}{1005}, \text{etc.}$$

But what shall be done after discovering the location of the tuberculous farms?

In the past irrational and radical people, so-called scientists, too, have advocated going to the farm and slaughtering all of the tuberculous animals, if need be, at the owner's expense, for they are a menace to the public health and he has no business owning them. Gentlemen, I know of no single factor which has been a greater hindrance to the eradication of animal tuberculosis than this. Many times the carrying out of such an edict would financially ruin the small accumulation of a hard-working man.

You will, no doubt, believe that it would be to the packers' benefit to completely eradicate tuberculosis from domestic food animals, and it must seem reasonable to you that he would want to cooperate with the farmer and do all in his power to reach such an end.

All the tuberculous animals coming to market this year came from farms on which the conditions continue to be favorable for acquiring tuberculosis by the hogs that are still on those farms and those that will be there next year and next year and next year and next year. Some of the tuberculous animals marketed this year caused it in the younger animals on the same farm that will be marketed next year. In fact, unless something is done, all coming from those farms will be tied to the same string forever.

So next year the packers will buy unconsciously, at the same price and at the same loss, animals that they could buy consciously at the same price and certainly without greater loss.

If the farmers of this country could sell all of their present tuberculous animals at full market values, and thus without one cent of loss, and the packers could buy them consciously with no greater loss than if bought unconsciously, the putting of two and two together is that animal tuberculosis could be totally eradicated from this country within a space of two years and without one cent of loss or cost.

Can you conceive of anything more remarkable, when all along every one has contended that it would take years and an immense sum of money to accomplish this result?

Indeed, I can prove to you that it would be at a profit to the packer, to the farmer, to the consumer, to the entire country, and to the whole world.

The eradication or the control of the animals that are at present tuberculous means the eradication of the animal tuberculous germ manufacturing establishments. This, together with the will-power of the educated tuberculous person, means the complete eradication of the disease. Not only is it eradicated without loss or cost on the part of the packer, farmer, consumer and the entire country, but it likewise yields an immense profit to all.

Tuberculosis seldom dies out spontaneously from a farm. It is only by the act of man that such a thing occurs. If all other present conditions remain the same and nothing is done concerning tuberculosis, the present less than six per cent. will soon become more than seven per cent., and then eight per cent., and so on, for tuberculosis spreads from tuberculous animals on one farm to the previously healthful animals on another farm by two methods only. First, either at public auction or private sale tuberculous animals are bought consciously, or, more frequently, unconsciously, and placed in previously healthful quarters and among previously healthful animals, and with the very same disastrous results from the association explained heretofore. Secondly, by the food products, especially milk of tuberculous cows on one or more farms being taken to the local creamery and mixed with the entire skim-milk product of the creamery. Thus all the farmers hauling back this skim-milk carry infection to their own hogs, the majority of which were previously healthful. Thus new source-centers are started, and just as a few years ago we could probably say less than four per cent. of the farms had tuberculous animals upon them, in a few more years we cannot even say less than six per cent. Each of the present six per cent. of farms will become more saturated with the disease. Thus the percentage of tuberculous animals on the farms will increase above six per cent. and the per cent. of farms will increase.

Let me relate what we have suffered and lost in not adopting my plan June 30, 1906, seventeen months ago, when the famous meat-inspection bill became a law.

Since that time nearly, and probably, every farmer in the country has marketed one or more hogs, several hundred thousand of them being tuberculous. Had the hogs been tagged we would to-day know where practically every tuberculous animal in the country is now located. Conversely we would know nearly every animal that was free from tuberculosis.

Since that time, tuberculous animals that would be either dead or under control to-day have been bought, are being bought, and will be bought at private and public sales, and have been taken to healthful farms and among healthy cattle.

Since that time, tuberculous animals that would be either dead or under control to-day have supplied, are supplying and will continue to supply creameries with milk that when skimmed has gone, is going and will go to other farms and infect other animals.

Since that time, tuberculous animals that would have gone to the larger packing-houses and been properly disposed of have been, are being, and will continue to be slaughtered in local country and town slaughtering-houses and be eaten by man.

Since that time, tuberculous cows that would now be dead or under control have been, are, and will continue, supplying the milk to the creamery, and thus contaminate the entire product of that creamery.

Since that time, tuberculous cows that would now be dead or under control have been, are, and will continue, supplying raw, uncooked milk to adults, children, invalids and infants, much of it under the physician's directions.

Since that time, individuals have taken into their system the germs that will cause them to be a part of a per cent. that we do not know of the 100,000 that died last year, a share of the 100,000 that will die next year, and an unknown portion of the 2,500,000 that will die within the next twenty-five years. Every day's delay means the sacrifice of human life.

And what would the plan have accomplished and gained for us had it been accepted and adopted June 30, 1906?

It would have practically eradicated animal tuberculosis from this country. It would have been a monumental achievement for America. It would give a reputation to American meat and dairy products unequaled by any country in the world, and thus increased instead of decreased our exports.

In 1901 Robert Koch made the startling statement that man could not acquire tuberculosis from animals, and the whole scientific world took up the subject and much time and money has since been expended in attempting to solve the problem.

The plan I propose, while eradicating the disease from animals would make the problem immaterial, and therefore eradicate both the disease and the problem.

At one stroke the problem of the milk-supply of towns and cities would be solved as far as tuberculosis is concerned.

At one stroke the problem of municipal and country slaughter-house inspection would be solved, as far as tuberculosis is concerned. Over ninety-five per cent. of condemnations in packing-houses having federal inspection is for tuberculosis.

Gentlemen! Several years ago the meat loss estimated by Dr. Salmon from condemned tuberculous animals was over one million dollars annually.

Since June 30, 1906, much more than a million has been lost, and before another year has passed an additional million will be at a dead loss, and nothing is accomplished by it.

I believe in making scientific, harmless, economic use of the meat for a short period, and thus convert this dead loss into a working power for the eradication of the disease forever.

This would result in making every single pound of meat and dairy produce forever in the future come from animals absolutely free from tuberculosis.

Without egotism I claim a hearing for these views, and firmly and sincerely believe that no proposition has ever been made so far-reaching as this in behalf of the wealth, health and happiness of the people. It is radically simple, radically rapid, and radically economical, and is not antagonistic to a single soul on earth.

I want you to study it thoroughly and improve on it where you can.

ADDITIONS TO THE LIST OF KANSAS COLEOPTERA FOR 1907.

By W. KNAUS, McPherson.

THE following seventy-one species and varieties of Coleoptera are, so far as I know, new to the Kansas list. Two or three, possibly, have been listed previously under other names owing to erroneous determinations.

Of the number listed about eighteen have been taken by myself at McPherson and in Pratt and Reno counties. Eleven are in the State University collection, Lawrence. One was taken at Topeka and one at Grantville, near Topeka, and two at Onaga. The others are from the monographic works of Horn, Leng & Hamilton, Casey, and Fall. Mr. H. C. Fall has passed upon the identity of all the species other than those from monographs as above, and from Douglas county.

1—678	Amara remotestriata Dej. (Horn.)
2—945	Cymindis cribrata Lec. (Horn.)
3—1879	Tychus minor Lec. One specimen at light, McPherson.
4—2023	Homolata lividipennis Mann. Douglas county.
5—	Baryodma verna Say. McPherson and Onaga.
6—	Thiasophila sp. Douglas county.
7—2064	Oxypoda minuta Sachse. McPherson and Onaga.
8—	Oxypoda perexilis Csy. March and April, Onaga.
9—2080	Gyrophæna corruscula Er. One specimen, Onaga.
10—2098	Quedius explanatus Lec. One specimen, Douglas county.
11—2165	Philonthus basalis Horn. Douglas county.
12—2199	Philonthus aequallis Horn. (Horn.)
13—2203	Philonthus quediinus Horn. (Horn.)
14—2205	Philonthus cephalotes Grav. Douglas county.
15—2522	Lathrobium armatum Say. Douglas county.
15*a*—	Lathrobium debilehire. One specimen at light, McPherson.
16—2540	Lathrobium anale Lec. Two specimens at light, McPherson.
17—	Lathrobium puncticolle Kirby. Douglas county.
18—	Scopæus sp. One specimen at light, McPherson.
19—2592	Palaminus testaceus Er. Douglas county.
20—2635	Tachyporus chrysomelinus Linn. Douglas county.
21—2637	Tachyporus nanus Er. Douglas county.
21*a*—	Bledins. One specimen at light, McPherson.
22—	Trogophlœus, sp. At light, McPherson.
23—3014	Sacium amabile Lec. Douglas county.
24—3035	Anisosticta episcopalis Kirby. (Leng.)
25—3053	Hippodamia americana Cr. (Leng.)
26—3055*a*	Neoharmonia, var. venusta Melsh. (Leng.)
27—2061	Coccinella transversoguttata, var. prolonga Cr. (Leng.)

28—3062 Coccinella tricuspis Kirby. (Leng.)
29—3066 Adalia frigida Schn. (Leng.)
30— Brachycantha socialis Csy. (Casey.)
31— Scymnus rubricauda Csy. (Casey.)
32— Scymnus Kansanus Csy. (Casey.)
33— Scymnus dulcis Csy. (Casey.)
34—3146 Scymnus hæmorrhous Lec., var. devisus Csy. (Casey.)
35—3147 Scymnus brullei Melsh. Onaga.
36—3189 Aphorista testacea Ziegl. Douglas county.
37—3545 Ulkeus intricatus Horn. (Horn.)
38—3974 Eurypogon niger Melsh. (Horn.)
39—4135 Cardiophorus fenestratus Lec. (Blanchard.)
40—4182 Monocrepidius aversus Lec. One specimen at light, August, McPherson.
41—4627 Anthaxia salicis Fab. Two specimens, Smoky Hill river, H. A. Brous.
42—4854 Phengodes fusciceps Lec. July, McPherson.
43— Trichochrous modestus Csy. (Casey.)
44—5168 Clerus ocreatus Horn. (Horn.)
45— Clerus corallinus Fall. (Fall.) Gove county.
46— Catorama grave Fall. One specimen at light, McPherson.
47— Amphicerus gracilis Csy. (Casey.)
48— Ochodæus kansanus Fall. (Ms.) elec. light, July and August, McPherson.
49—5634 Glaresis inducta Horn. One specimen at light, July, McPherson.
50—5813 Listrochelus obtusa Lec. (Horn.)
51—5817 Listrochelus falsus Lec. (Horn.)
52—6373 Monilema lævigatum Blanch. (Leng & Hamilton.)
53—6417 Leptostylus parvus Lec. (Horn.)
54—6446 Acanthocinus obliquus Lec. (Horn.)
55—6468 Oncideres texana Horn. (Leng & Hamilton.)
56—6479 Saperda mutica Say. (Leng & Hamilton.)
57—6487 Saperda puncticollis Say. (Leng & Hamilton.)
58—6539 Donacia æqualis Say. Several specimens, Grantville, Smith.
59— Charistena, n. sp., near ariadne Newm. Three specimens from willows, June, Medora.
60—7145 Bruchus perforatus Horn. Three specimens, Topeka.
61— Lobometopon cribricollæ Csy. (Casey.)
62— Lobometopon jucundum Csy. (Casey.)
63— Lobometopon obscurus Csy. July and August, Wallace and Pratt counties.
64— Bothrotes insitus Csy. (Casey.)
65— Bothrotes knausii Csy. Epitragus acutus. Pratt and Reno counties.
66—7811 Mordellistena, n. sp. One specimen at light, McPherson.
67— Mordellistena, n. sp. Three specimens at light, McPherson.
68—7917 Notoxus nuperus Horn. (Horn.)
69—7924 Notoxus serratus Lec. (Horn.)
70—8379 Apion melanarium Gerst. (Fall.)
71— Smicronyx sp. At light, McPherson.

COLEOPTERA OF NEW MEXICO.

By W. Knaus, McPherson.

IN the Transactions of the American Entomological Society, volume 33, 1907, T. D. A. Cockerell and H. C. Fall published a list of the Coleoptera of New Mexico with descriptions of many new species. The number of species listed totaled 2148. These were from the records of the author and from the recorded captures of Dr. F. H. Snow, C. H. T. Townsend, H. F. Wickham, E. A. Schwarz, H. L. Viereck, Dr. A. Fenyes, Doctors Leconte and Horn, the Wheeler survey, as reported by Henry Ulke, Hubbard and Schwarz, Schwarx and Barber, by the writer, and by a few others. Since the publication of this list, I spent two days last June at Santa Rosa, Alamogordo, Cloudcroft and Deming, and the present list of eighty-two species are either new to the New Mexican list or are new localities for species already listed. Mr. H. C. Fall and Dr. A. Fenyes have passed upon doubtful species.

1— Cicindela, var. knausii Leng. Alkali flats, near Santa Rosa, June and July, with C. sperata Lec. and C. tenus insignata Lec. The variety not before listed from New Mexico.

2—668 Amara polita Lec. Cloudcroft.
2*a*—1672

3— Actium, n. sp. One specimen under pine bark, Cloudcroft. First record of the genus in New Mexico.

4— Euplectus, n. sp. Fairly common under bark of dead pines, Cloudcroft.

5— Baryodma, near afflœns Csy. Two specimens, Cloudcroft. New to New Mexico.

6— Platandria species near mormonica Csy. Common in flower catkins of shrubs, Cloudcroft. Genus and species new to New Mexico.

7— Stenus, n. sp. One specimen, Cloudcroft. New to New Mexico.

8—2747 Platystethus americanus Er. Four specimens, Alamogordo.

9—2971 Ptinella pini Lec. Common under pine bark at Cloudcroft. Genus and species new to New Mexico.

10—3101 Hyperaspis fimbriolata Melsh. Deming.

11—3102 Hyperaspis lateralis Mels., var. omissa Csy. One specimen, Santa Rosa. New to New Mexico.

12—3105 Hyperaspis undulata Say. On young pines, Santa Rosa.

13—3111 Hyperaspis osculans Lec. Deming.

14— Scymnus, sp., Mountain Park (below Cloudcroft).

15—	Scymnus virginalis Wick. Deming.
16—	Sylvanus, n. sp. Under pine bark, Cloudcroft. New to New Mexico.
17—	Cryptorhopalum reversum Csy. Alamogordo.
17*a*—	Atomara, sp., Cloudcroft. New to New Mexico.
18—3490	Hister abbreviatus Fab. Deming.
18*a*—3539	Epierus nasutus Horn. Cloudcroft.
19—3569	Anapleus marginatus Lec. One specimen, Santa Rosa. New to New Mexico.
20—3607	Saprinus vitiosus Lec. Two specimens, Deming.
21—3610	Saprinus fimbriolatus Lec. Deming.
22—3625	Saprinus patruelis Lec. Deming.
22*a*—	Cercus, n. sp. Cloudcroft. New to New Mexico.
23—3710	Epurea planulata Er. One specimen, Cloudcroft. New to New Mexico.
24—3805	Corticaria serrata Payk. Two specimens, Cloudcroft.
24*a*—	Corticaria tenuipes. One specimen, Cloudcroft. New to New Mexico.
25—4202	Elater rhodopus Lec. One specimen under pine bark, Cloudcroft.
26—4623	Chrysobothris debilis Lec. Several specimens on Prosopis. Deming.
27—	Acmæodera lucia Fall, var. One specimen, Alamogordo. New to New Mexico.
28—4705	Acmæodera guttifera Lec., var. One specimen on Prosopis. Deming. New to New Mexico.
29—5055	Attalus morulus Lec. Several specimens, Cloudcroft.
30—	Trichochrous erythropus Lec. One specimen, Mountain Park. New to New Mexico.
31—5168	Clerus ocreatus Horn. Several specimens on decaying pine branches, Cloudcroft. New to New Mexico.
32—	Catorama gibbulum Fall. Common on Prosopis, Deming. New to New Mexico.
33—	Ptilinus lobatus Csy. Common boring in dead quaking-asp, Cloudcroft.
34—5358	Sinoxylon simplex Horn. One specimen, Deming. New to New Mexico.
35—10161	Lyctus californicus Csy. One specimen, Deming. New to New Mexico.
36—5452	Phanæus carnifex Linn. Santa Rosa.
37—	Diplotaxis, sp. Common, Deming.
38—6002	Phymatodes dimidiatus Kirby. A unicolored variety; one specimen, Cloudcroft.
39—6158	Sphænothecus suturalis Lec. Deming.
40—6387	Monohammus scutellatus Say. One specimen, Cloudcroft.
40*a*—6600	Urodera crucifera Lec. Two specimens, Mountain Park.
41—10365	Luperodes morrisoni Jac. One specimen, Cloudcroft.
42—	Monoxia, near debilis Lec. Fairly common at Mountain Park.
43—6932c	Œdionychis concinna Fab. One specimen, Cloudcroft. New to New Mexico.

44—6962 Haltica carinata Germ. Beaten from pines, Cloudcroft.
45— Systena tæniata Say. Mountain Park.
46—7118 Glypitna cyanipennis Cr. Cloudcroft.
47—7102 Coptocycla aurichalcea Fab. Mountain Park.
48—7134 Bruchus desertorum Lec. On Prosopis, Deming.
49—7137 Bruchus prosopis Lec. On Prosopis, Deming.
50— Bruchus, n. sp. Mountain Park.
51— Metaponium anceps Csy. Two specimens, Deming. New to New Mexico.
52— Metopoloba densiventris Csy. Common on Prosopis, at Deming. New to New Mexican list.
53— Cistelid, n. sp. One specimen, Deming. New to New Mexican list.
54—7701 Lacconotus pinicolus Horn. One specimen, Cloudcroft.
55—7752 Asclera ruficollis Say. One specimen, Wootens. New to New Mexico.
56—7843 Mordellistena morula Lec. Cloudcroft.
57—8043 Nemognatha lutea Lec. Cloudcroft.
58—8092 Epicauta maculata Say. Deming.
59—8315 Pandeletejus cinereus Horn. Deming.
60— Apion occidentale Fall. Alamogordo.
61—8515 Cleonus (Aplæneus) pulvereus Lec. One specimen, Deming.
62— Smicronyx, n. sp. Mountain Park.
63— Smicronyx, sp. Mountain Park.
64—10907 Smicronyx profusus Csy. Deming. New to New Mexico.
65—10923 Smicronyx, near spretus Deitz. Deming.
66—10926 Smicronyx quadrifer Csy. Two specimens, Deming. New to New Mexico.
67— Bagous, sp. One specimen, Santa Rosa.
68— Anthonomus, near hirtus Lec. One specimen, Mountain Park. New to New Mexico.
69—8700 Tychius setosus Lec. Common on Prosopis, at Deming.
70—8701 Sibynes fulvus Lec. Two specimens, Deming. New to New Mexico.
71—8745 Rhyssematus pruinosus Boh. Common on Prosopis at Deming.
72— Baris, sp. One specimen, Mountain Park.
73—8883 Trichobaris texana Lec. Alamogordo.
74—11133 Onychobaris mystica Csy. Deming.
75— Centrinus, n. sp. One specimen, Mountain Park. New to New Mexico.
76— Barilepton, n. sp. Two specimens, Santa Rosa. New to New Mexico.
77— Chramesus, n. sp. One specimen on Prosopis, Deming.

A NEW SPECIES OF CAMPOSTOMA?

By F. F. Crevecœur, Onaga.

WHAT the writer thinks will prove to be undoubtedly a new species of fish of the genus *Campostoma* was taken last spring in a small pool just above a gravelly riffle on Mound creek, six miles northeast of Onaga.

In the early years of the settlement by the white man the fish was abundant every spring at riffles, where it was busily engaged in the task of nest-building and spawning, but on the streams filling up with soil washed down from cultivated fields the fish disappeared from observation for about twenty-five or thirty years. Last March, while approaching the creek on a high bank overlooking the riffle in question, a great commotion was seen in the water at the riffle. On closer examination it was seen the turmoil was caused by a school of fishes composed of the species mentioned above and of the minnow *Semotilus atromaculatus.* The fishes were busy spawning, or preparing nests in which to spawn. A few specimens of each species were procured and sent to the National Museum, where they were pronounced by Mr. B. A. Bean as *Campostoma anomalum* for the first species mentioned, and the other the minnow as given above. Upon comparing the description of *Campostoma anomalum,* as given in Bulletin No. 47 of the United States National Museum, with our specimens of *Campostoma,* it was found our fish differs from *C. anomalum* in several important particulars, chief of which are size and color. The size of *C. anomalum* as given in the bulletin mentioned is from six to eight inches. Of many specimens of our fish seen, both in early days and those seen and taken last spring, none exceeded four and one-half inches. The coloration of *C. anomalum* as given in the bulletin is as follows: "Color brownish, with a brassy luster above, the scales more or less mottled with dark; a dusky vertical bar behind the opercle; dorsal and anal fins each with a dusky cross-bar about half way up, the rest of the fin olivaceous in the females, fiery red in the males in the spring; iris orange in males. Males in spring with the head and often the whole body covered with large rounded tubercles."

The color of our fish is a grayish-brown, with the scales mottled with dark, the mottling being more prominent posterior to the dorsal fin; sides tinged with brassy; under side silvery-white. Base of dorsal fin orange for about one-eighth inch in height, then dusky to about one-half height of fin; the rest of the fin colorless except the last (posterior) four rays, which are yellowish-white. Bases of pectoral fins yellowish-white, the rest of the fin colorless except the branched portion of the rays, which is yellowish-white. Ventral fins yellowish-white, with a dusky bar through the middle. Anal fins have an orange band at the base, which band is broader anteriorly than posteriorly; branches of rays yellowish-white. Caudal fin with a dusky spot at the base, which is surrounded more or less with a little orange; the rest of the fin colorless. The colors as here given apply only to breeding males, the females being plain-colored, that is, with the fins colorless. The males have the head covered with prominent tubercles; the whole upper portion of the body is also covered with tubercles, but they are more perceptible to the touch than to the eye.

Perhaps a few notes on the fish's breeding habits will prove interesting. From about the middle of the month of March (it must be remembered last March was an abnormally warm month) to about the middle of April the fishes could be daily seen at their task of nest-building. They had selected a gravelly riffle just below a small pool, to which they retreated on the approach of danger. When they left the pool to go to their work they naturally faced downstream, but on arriving at the riffle they would turn about, facing upstream, and immediately commence operations by picking up the gravel in the spot selected for their nest in their mouth, when they would advance a few inches upstream and expel the grain of gravel with a motion of the lips not unlike those made by a person in blowing a particle to some distance; the fish would then drop back tail first to its position over its nest and go through the same performance again. The nests consisted of pits in the gravel and sand, some of them to a depth of nearly two inches and a breadth of five or six inches. When digging out the gravel in the deeper portions of the pits the fish would assume a nearly vertical position and force its lips over the grains of gravel with a vigorous convulsive motion of the body and much and vigorous lateral movement of the tail. When a fish had to remove a pebble too large to take into its mouth it would take hold of it as best it could and roll it along, but always upstream. When they had a nest dug out to suit their requirements they would lie down in the excavation quite still for quite a while.

Just below the riffle used for nest-building there was another pool only two or three feet across, below which was another gravelly riffle, but our fish did not resort to these portions of the stream so far as was observed; but a few darters, *Etheostoma arcuscelestis,* were seen here. This latter species of fish seems to confine itself in spawning to riffles having a smooth clay bottom covered more or less with sand and gravel.

CONCERNING SOME INSECTS COLLECTED AND BRED FROM DEAD AND DYING ELM.

By E. S. Tucker, Dallas, Tex.

IN response to a request written by a citizen of Lawrence, Kan., under date of September 23, 1904, and desiring information in regard to means of checking the attacks of insects boring in elm trees, I was led to make a personal inspection of the affected trees in order to ascertain the species and prevalence of the pests and extent of injuries committed by them. During the course of my observations a number of associated insects, including useful parasites, were found, and a report of them is herewith presented in connection with my remarks upon the destructive borers. The place which I visited comprised several acres of lawn and grounds in a residential section of the city. A dozen or perhaps fifteen fine shade elms were found stricken, some of them being already dead and others showing the yellow leaf a month or more too early. The case was not isolated, as other elm trees in the neighborhood were suffering in the same manner. The trees ranged in age from growths of ten years up to probably twenty years, and, on account of the long time required for elm trees to grow into prime condition, the owner was particularly desirous of saving them, if possible, or at least to prevent further loss among his healthy trees.

The larvæ of two kinds of borers, *Saperda tridentata* and *Magdalis armicollis,* were the principal enemies found attacking such trees as were almost dead. After an elm tree is once attacked by these borers, all efforts to save it appear useless on account of the difficulty in detecting and removing the grubs at work in the trunk and branches, and if the tree is not cut and burned clear to the roots in proper time it becomes a favorite breeding-place for the pests, which mature as beetles and emerge in the spring months, then endangering other trees in the vicinity, where the insects are liable to spread. The most practical method of combating elm-borers, then, is to follow Prof. S. A. Forbes's advice, as given in his third report on the injurious insects of Illinois, in which publication he says, with reference to *Saperda tridentata:* "The only remedy available is unquestionably the destruction of afflicted trees in autumn and winter before the beetles have a chance to emerge from the trunks."

There seems to be no indication or evidence whatever that the above-mentioned borers had attacked perfectly healthy trees, but rather those which had begun to die from some unknown cause. An examination of several trees which exhibited the first signs of dying, denoted by a premature shedding of the leaves, proved them to be entirely sound, and, with one exception, failed to reveal the least trace of any insect at work in them. This one exception pertained to an older tree from which *Tremex columba* and a larva of *Chrysobothris femorata* were removed, but the presence of these specimens could only be regarded as an incidental matter having nothing to do with the primary cause of the tree's failure in health. In no instance could the responsibility for the original trouble be charged to the elm-borer, *Saperda tridentata,* or its companion, *Magdalis armicollis,* both of which, however, infested diseased trees of long standing. That the first stages in the dying of the trees, in whole or in part, as shown by the wilting and falling of the leaves before the usual time, were due to some disease, was consequently inferred. If such trees are allowed to stand in this enfeebled condition, they invite the attacks of borers as mentioned, and their complete death would eventually result. Nevertheless, the claim is made by eminent authorities that the elm *Saperda* will attack healthy trees.

The particulars concerning the different species of insects secured from dead and dying elm during the progress of my investigation as stated are herewith embodied, with a list of determinations.

ATTACKING THE TRUNK.

Saperda tridentata Olivier. (The common elm-tree borer.) Numerous larvæ collected September 26, 1904; adults emerged May 9 and 12, 1905, from section of tree kept in breeding cage.

Chrysobothris femorata LeConte. (Commonly known as the flat-headed apple-tree borer.) One larva in its burrow between bark and sapwood, at a distance of about one foot above ground, October 6, 1904; one adult emerged May 23, 1905, from section of tree kept in breeding-cage. Although elm has been mentioned in literature as a food-plant of this species, the authority for such a record appeared to be un-certain, according to Mr. F. H. Chittenden, in his account of the insect published in Circular No. 32, Division of Entomology, United States Department of Agriculture. My records can now establish this fact concerning elm as food-plant beyond doubt.

Tremex columba Linne. (The pigeon *Tremex.*) One female found dead with ovipositor stuck fast in bark, September 26, 1904.

ATTACKING THE BRANCHES PREFERABLY, OCCASIONALLY THE TRUNK.

Magdalis armicollis Say. Numerous larvæ taken from their channels under bark, September 26, 1904; adults emerged April 5 to May 29, 1905, from sections of branches and trunk kept in breeding-cage. The tree from which the sections were cut for breeding purposes was so badly attacked by the grubs of this species that they had become established some distance down on the trunk below the branches, where they encroached on the regions tunneled by *Saperda tridentata.*

PARASITES.

Melanobracon ulmicola Viereck. Males and females flying about and alighting on bark of infested portions of tree later cut into sections for breeding purposes, September 26, 1904, the females probing with the ovipositor into cracks of the bark and holes of *Magdalis armicollis,* whose larvæ abounded beneath the bark; other specimens emerged during the following May from sections of the tree kept in breeding-cage. Regarding the naming of these parasites, Mr. H. L. Viereck, to whom a pair of specimens was submitted for study, wrote as follows: "This appears to be a new species and one that has been confused with *simplex.* I propose to call it *ulmicola.*"

Brachistes rotundiceps Cresson. In company with *Melanobracon ulmicola,* September 26. Other specimens emerged during the following spring from April 13 to May 24, from sections of tree kept in breeding-cage.

Spathius simillimus Ashmead. Specimens emerged April 3 to May 29, 1905, from sections of tree kept in breeding-cage. Doctor Ashmead, who determined the species, added the following remark: "All *Spathius* are parasitic on Coleoptera."

Haltichella ovatus Walker. Specimen emerged in May, 1905, from section of tree kept in breeding-cage. The specimen was identified by Doctor Ashmead, who referred to it as follows: "The legs are missing from your specimen, but the thorax, etc., resemble the *Hockeria ovatus* Walker in my collection obtained many years ago in Florida."

PREDACEOUS ENEMY.

Chariessa pilosa Forster. (The hairy *Clerid.*) One adult emerged May 9, 1905, from section of tree kept in breeding-cage.

TAKEN FROM DEAD STANDING TRUNK.

The danger of leaving any dead or dying elm standing, as well as any portion lying on the ground, from one season to another, was forcibly exemplified by the riddled condition of an old standing trunk of a large elm tree. This trunk stood about fifteen feet high, the upper part of the original tree having been cut off and destroyed several years previously. As a support for climbing plants, the owner of the property had utilized the trunk for ornamental effect, but had overlooked the fact that it offered a harbor for borers and other insects of a more or less objectionable nature. In spots where the bark had fallen off or was stripped off from this trunk, the characteristic openings to the tunnels bored by larvæ of *Saperda tridentata* appeared in great number, thus giving evidence that the trunk had been a dangerous center for prolific breeding of the enemy. Although no borers nor fresh signs of their work were detected, the wood evidently being too far advanced in age to induce further attacks of borers, other species of insects, as indicated by the following names, were found under the loose bark or in crevices of decaying wood.

Cremastogaster lineola Say, subspecies *læviuscula* Mayr. Numbers of females and workers of this kind of ant, October 6, 1904.

Ischnoptera pennsylvanica De Geer. One immature female of this kind of roach, October 6.

Scarites subterraneus Fabricius, variety *substriatus* Haldeman. Adult, October 6.

Brontes clubius Fabricius. Numerous adults, October 6.

Tenebrioides sinuata LeConte. Adults, October 6.

Tenebrioides castanea Melsheimer, variety *nigrita* Horn. Two adults, October 6.

Elater manipularis Candeze. One adult, October 6; determined by Mr. H. S. Barber, of the United States National Museum. One elaterid larva also taken may perhaps belong to this species.

Parandra brunnea Fabricius. One dead adult, October 6.

Nyctobates pennsylvanica De Geer. Adults, October 6.

Pyrochroid. Larvæ, October 6; nearly mature, but difficult to identify the species positively.

ANIMALS, REPTILES AND AMPHIBIANS OF THE ROSEBUD INDIAN RESERVATION, SOUTH DAKOTA.

By Albert B. Reagan, La Push, Wash.

BELOW is given a list of the animals, reptiles and amphibians seen on the Rosebud Indian reservation, South Dakota, from January 7, 1904, to March 20, 1905.

AMPHIBIANS AND REPTILES.

1.—Bufo lentiginosus Shaw. Not common.
2.—Rana pipens Schreber. Common frog. Very abundant.
3.—Rana clamitans Linn. Seldom seen.
4.—Tammophis sirtalis Linn.
5.—Licopellis vernalis Linn. Green snake. Rare.
6.—Pituophis sayi Schegel. Only one individual of this species was seen.
7.—Sistrurus catenatus Rafinesque. Prairie rattlesnake.
8.—Crotalus horridus?
(The last two species are found everywhere. They have dens in the Rattlesnake buttes. There on warm days they come out and bask in the sun by thousands.)
9.—Chelydra serpentina?

ANIMALS.

1.—Lepus nuttalli imallurus, subspecies mearnsi Allen. This rabbit is not very abundant on the reservation, except in the cultivated areas and in the little patches of timber along the streams.
2.—Lepus campestris Bauchmann. Jack-rabbit. This rabbit lives principally in the "Mauvaises Terres" and in places remote from the settlements.
3.—Zapus hudsonius Zimm. Spring mouse. Of this species only one individual was seen.
4.—Thomomys talpoides Maxim.
5.—Fiber xibethicus Linn. Muskrat. Very plentiful along water-courses.
6.—Microtus hydeni Baird.
7.—Microtus austerus LeConte.
8.—Arvicola riparious. Ord.
(The last three species are quite abundant.)
9.—Castor canadensis Kuhl. Rare.
10.—Spermophilus tridecemlineatus Mitchel. Abundant.
11.—Sorex personatus Isadore Geoffrey St. Hilaire. Only one individual of this species was seen.
12.—Scalops aquaticus, subpecies machrinus Rafin. Prairie mole. Not abundant.
13.—Vespertilio fuscus Beauv.
14.—Odocoileus americanus, subspecies macrourus Rafin. Very rare; found only in the "bad lands."

15.—Antilocapra americana Ord. Only a few of these animals remain on the reservation. Five were seen on Antelope creek near Turtle Butte, in August, 1904.

16.—Procyon lotor Linn.

17.—Mephitis hudsonica Richardson. The Great North American skunk.

18.—Taxidea americana Linn. American badger. These animals are very numerous on the reservation. They live principally in the vicinity of prairie-dog towns.

19.—Mustela pennatii Erxleben. These animals are migrating southward. They made their first appearance on the Rosebud lands in 1903. They live principally in prairie-dog towns; and their food is the prairie-dog. Whole prairie-dog towns have been destroyed by them.

20.—Lutreola vison Schreber. Mink. Not numerous.

21.—Putorius longicauda Bonaparte. A stuffed specimen of this species is to be seen in Mr. E. Jourdan's store at Butte creek, on the reservation. This weasel is not abundant.

22.—Putorius cicognani Bonaparte. The little brown weasel. Not numerous.

23.—Canis latrans Say. Coyote. A numerous pest. They even come in the barn-yards in the middle of the day and kill chickens.

24.—Canis nubilus Say. Gray wolf. Found principally in the "bad lands."

25.—Cynomys ludovicianus. Prairie-dog. Towns of these little animals are numerous over the whole region.

26.—Lynx canadensis Desm. Canada lynx. Not numerous.

A KANSAS BEAVER.

(*Castor canadensis* Kuhl.)

By L. L. Dyche, Lawrence.

THE beaver in Kansas is a rare animal, and it will not be many years until it will be placed on the list with the deer, buffalo, bear, and other animals that have become extinct. There is no law to protect them, and the old beaver trappers will travel miles and miles to get just one more, each trapper making the excuse that if he does not catch the beaver the other fellow will. Not many years ago it was a very common animal on most of the larger streams in Kansas. The first winter (1877 and 1878) I spent at Lawrence there were a number of beavers living within a mile of the city. They had their homes on the banks of the Kansas river and some of its small islands. During the winter of 1882 and 1883 I secured some for specimens that were taken near Lawrence. However, I have not heard of a beaver being taken anywhere near Lawrence since the winter of 1888 and 1889, until November of this year, when one was taken within a few miles of Lawrence. This animal was an old male. It was trapped by J. C. Saunders, an old beaver trapper, the same person who trapped beavers for me in 1882 and 1883. This last beaver, that we have any record of, was taken November 12, 1907, two and one-half miles east of Lecompton and about nine miles up the river, or west, from Lawrence. The animal has been known to have been in existence in that locality for some months.

I have heard at different times during the past few years of a family or two of beavers that were still living on some of the western branches of the Kansas river. This animal probably came down the river and was perhaps the sole survivor of some exterminated family, as he was living as an old bachelor. The animal was a very fine specimen, being a large old male that weighed forty-nine and one-half pounds, after it had been out of the water twenty-four hours and after, as dissection showed, it had lost all its blood. It was said to have weighed fifty-four pounds when it was first caught. Mr. Saunders tells me that the largest beaver he ever caught weighed sixty pounds.

To indicate the size of this animal, and to preserve a record of a large Kansas beaver, I will give some of the most important measurements, and some general notes, that I made of the animal while it was still in the flesh.

The measurements were made in inches and hundredths, and were taken from the animal's body while it was stretched out flat upon the floor:

Length from end of nose to end of tail (not stretched)	42.00
Length from end of nose to end of tail (moderately stretched)	45.00
Length from end of nose to end of outstretched hind foot	35.50
Length of hind foot from heel to end of longest (middle) toe	7.00
Greatest width of hind foot (web stretched)	6.75
Greatest width of web between toes (web stretched)	2.00
Length of front foot to end of longest toe	3.25
Distance from end of nose to end of ear (stretched back)	6.50
Distance from tip of ear to tip of ear (moderately stretched)	5.25
Natural height of ear	1.25
Natural width of ear	1.00
Width of ear when spread out flat	1.75
Distance from end of nose to center of eye (eyeball)	3.00
Distance between eyes (center of eyeball to center of eyeball)	2.90

TAIL.

Total length of tail vertebræ	18.25
Length of scaly portion of tail	11.00
Greatest width of scaly portion of tail	5.75
Thickest place in scaly portion of tail	1.50
Thickest place in middle of scaly tail	.75
Circumference at root of scaly portion of tail	10.65
Circumference of middle of scaly portion of tail	11.90

Body measurements, taken while the animal's body was lying flat upon its belly upon the floor:

Natural distance from head of femur bone to head of humerus	17.00
Natural distance from head of femur back to where scaly portion of tail begins	10.00
Natural width of body behind shoulders	9.75
Natural width of middle (abdomen) of animal	12.25
Natural depth of middle (abdomen) of animal	5.25
Circumference behind the shoulder	26.00
Circumference of middle of abdomen	31.00
Circumference of neck	16.50

DIGESTIVE TRACT.

The entire length of digestive tract was 35 feet 1 inch, made up as follows: Esophagus, 11 inches; stomach, 13 inches; cæcum, 22 inches; small intestine 25 feet; large intestine, 42 inches; rectum, 34 inches.

The average width of the stomach was about four inches. The stomach was contracted to almost half its natural width about one-third of the distance from the pyloric end. This was due to a sort of a valve or partition on the inside.

A reddish-looking gland three inches long and one inch thick was apparently spliced onto the stomach at the cardiac end where the esophagus enters. It had about a dozen little mouth-like openings into the stomach. Each opening and its surrounding lips was about as large as the end of a lead-pencil.

The cæcum was twenty-two inches long measured through the center portion, and twenty-five inches measured on the outside, and three and one-half inches wide at its larger or attached end; a foot from this end it was three inches wide. It would hold about three quarts, or nearly twice as much as the stomach.

The liver had six principal lobes and one or two smaller pieces, due to fissures in the lobes. The three larger lobes were each about seven inches long and from three to three and a half inches wide. The smaller lobes ranged from three to five inches long. In a general way the gall was one by two inches in size. The kidneys were shaped very much like a short Lima bean, and in size were three inches long, two and one-half inches wide and about an inch thick in the center. The spleen was four inches long by three-eighths of an inch in diameter, was round, and was dark red in appearance. The heart was about three inches long and two and one-half inches in diameter at its large end.

We laid the animal on its back and dissected out the castoreum or bark glands and the oil-glands or sacks. The glands occupy a position between the pubis and the scaly part of the tail. This space is seven or eight inches long and nearly as wide, and covered with hair the same as the rest of the body. The bark glands were of a yellowish or light-brownish tinge in color. They were about five inches long and three in width. They were under the skin and some fat and muscular fascia and rested just back of the pubis. Just back of these bark glands and connected with them are the two oil-glands or sacks. They were about as long as the bark glands, but not much over an inch in diameter. Trappers prize the bark glands very highly for making a scent-bait for trapping other beavers. The oil-glands are also used in making a bait for trapping otters. The testicles were situated in front of the bark glands and rested one on either side and about two and one-half inches from the union of the pubic bones. In size they were about two by one inches.

SOME SEA SHELLS FROM LA PUSH, WASH.

By Albert B. Reagan, La Push, Wash.

IN a picturesque little spot on the Pacific coast about thirty-six miles southeast of Cape Flattery, Washington, is the Indian village of La Push. To the northwest of the village, extending up the coast for many miles, are series of islets, reefs and shallow ocean patches. Facing the village to the southwest and south is Quileute bay, partly inclosed on the southeast by a series of islands, called the Giants' Graveyard, and on the northwest by James island. This bay is small and is exposed to the southwest storms in winter. It was along the shores of this bay and the shore extending northwestward from James island that most of the shells listed below were collected.

The collecting of the shells extended over a period of two years, 1905-'07, but most of the specimens were collected in 1906. The severe weather of January, 1907, killed many of the species; so but few shells were found on the beach this year (1907).

An examination of the shells shows that they are very variable, both in color, shape, size and sculpture, and seem to occupy an intermediate position between the shells of the Alaskan coast and those of the California coast to the south. This variable condition is probably due to the exposed condition of the coast, to the winter storms, and to the fact that the Japan current washes the shore-line here.

The shells were collected by the writer and his wife. Prof. Trevor Kincaid, of the University of Washington, classified them, and the drawings from 1 to 71 were made by Messrs. Gordon B. Hobucket and Frank L. Bennett. The remaining drawings were made by the writer and his wife.

The number of each drawing here given is the number of that respective shell in the writer's collection.

Duplicate specimens of the shells given below are to be found in the museum of the Kansas Academy of Science.

Echinarachinus excentricus. Sea biscuit.
Plate IV, fig. 15.

This species is not found in the waters at La Push, but on the sandy beaches towards Neah bay and Cape Flattery. The specimen here figured was presented to the writer by Policeman Hobucket (Ind.), who found it on the beach near the mouth of the Suez river, seven miles southeast of Cape Flattery.

Strongylocentratus drobachensis. Sea-egg, Sea-urchin.
Plate IV, fig. 93.

This species is very plentiful. It is one of the sea species used as food by the Indians. It grows to be quite large.

Terebratella (Terebratalia) transversa Somerby.
Plate IV, figs. 19*a* and *b*.

This species is not numerous.

Glycimeris (Panopæa) generose Gould.
Plate II, fig. 87.

This is a Neah bay shell from the strait of Juan de Fuca. The writer has not seen it on the Pacific coast.

Pecten hericeus Gould.
Plate III, fig. 80.

This species is quite abundant.

Hinnites giganteus Gray.
Plate II, figs. 59*a*, *b*, *c*.

The shell of this species is very variable. It is an abundant species.

Placunenomia macroschisma Deshayes.
Plate III, fig. 75.

This species is quite general along the coast.

Mytilus californicus Conrad.
Plate I, figs. 13*a*, *b*.

This species is the most abundant shell-fish on the coast. It lives on the rocks at tide-line, and the rocks are completely covered with its representatives. They stick to the rocks so tightly that it is with difficulty that they are pulled from their lodgement. It is this "mussel" that the Indians are so fond of. They gather them by the basketful, put them, shell and all, into a pot and boil them. Then the "mussel" meat is scraped from the shell and eaten. They also eat them raw; also, bake them—that is, they dig a pit, throw hot rocks into it, then put the clams on the heated rocks, and cover the rocks and "mussels" up with dirt. These they leave till the next day. The "mussels" are then dug up and make excellent eating.

Pholadidea ovoidea Gould.
Plate I, figs. 5*a*, *b*.

The shell of this species is very frail and easily broken. Only one whole valve was seen. The species is not numerous.

PLATE I.

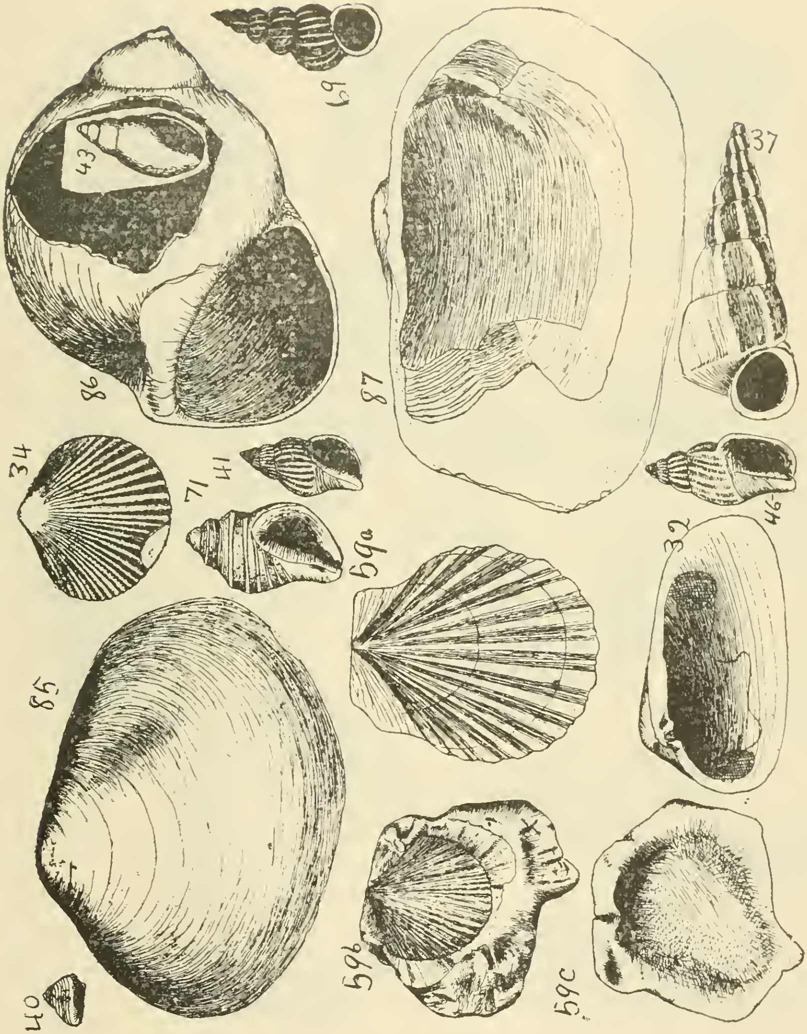


PLATE II.

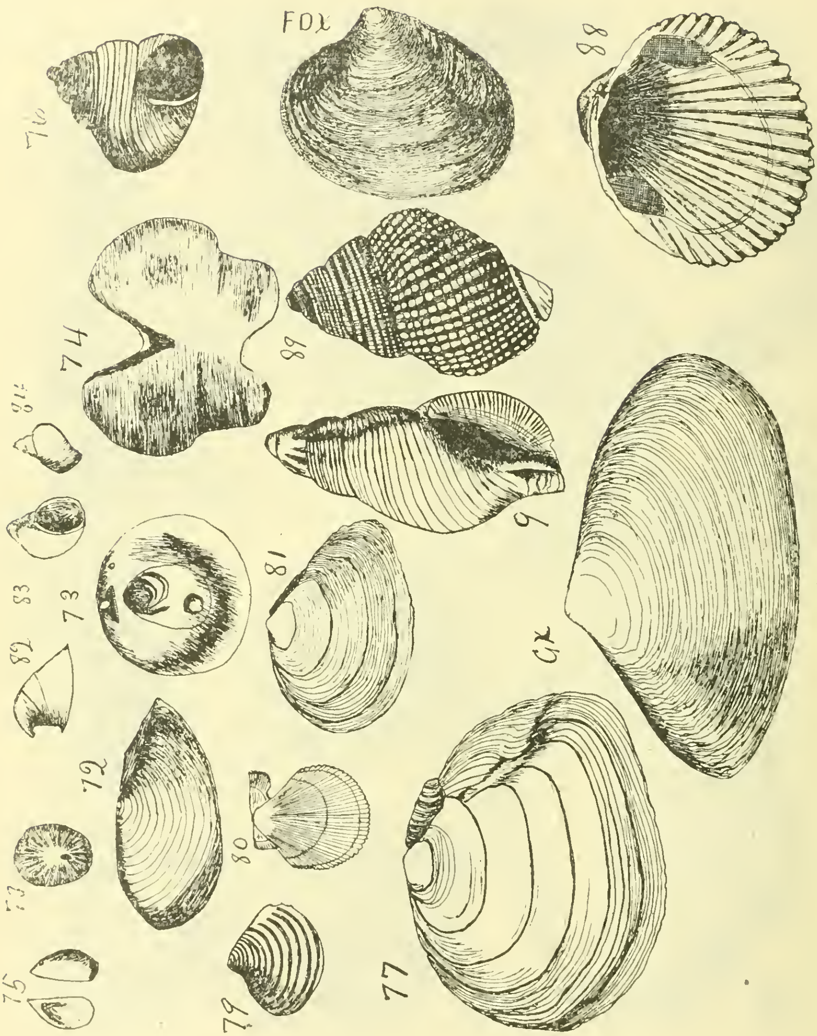


PLATE III.

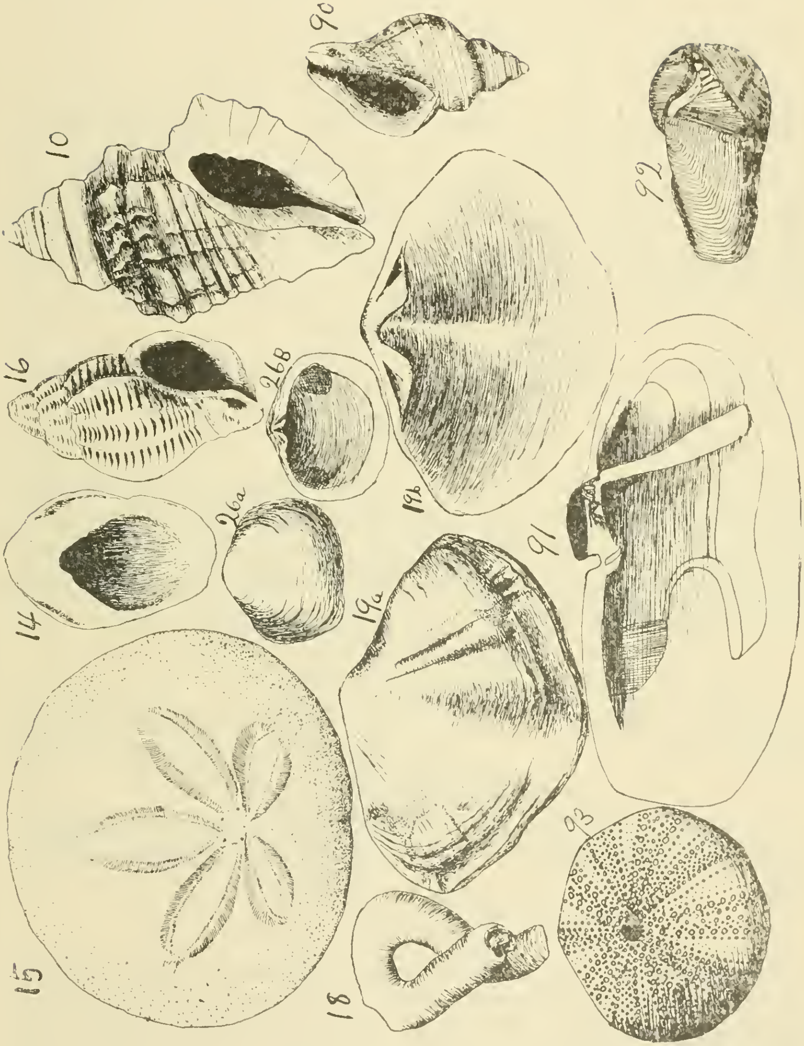


PLATE IV.

Astarte compacta.
Plate III, fig. 79.

Only one specimen of this species was obtained.

Cardium nuttallii Mart.
Plate II, fig. 34.

Not an abundant species.

Tapes staminea Conrad. Clam.
Plate I, figs. 8*a*, *b*.

This is an abundant species and is one of the principal shell-fish used for food. The natives dig them out of the seaweed and gravel with a sharp stick or a pointed iron rod. In eating them they smash the shell with a hammer or a rock and then eat the meat raw. They often make a whole meal on this shell-fish alone.

Tellina bodegensis Hinds.
Plate III, fig. GX.

The shell of this species is one of the prettiest of the beach here.

Macoma inquinata Deshayes. Common clam.
Plate I, figs. 24*a*, *b*.

This is another one of the principal food clams of the region. The Indians dig them out of the sand with a stick at low tide. In preparing them for eating, they are either scraped out of the shell and boiled, or they are baked in the same manner as the "mussels" above. They are excellent eating.

Macoma nasuta Conrad.
Plate III, fig. 81.

A very common shell. It is much used as food by the natives.

Macoma, sp.
Plate III, fig. 77.

This shell was picked up on the strait of Juan de Fuca near Neah bay, Washington. The species does not occur at La Push.

Siliqua patula Dixon. Razor clam.
Plate IV, fig. 91.

This species is very common down the coast toward Grandville and Gray's Harbor; but at La Push it is rare, and to the northwest of it, to Cape Flattery, it does not exist. It is said to be the most delicious clam on the coast.

Schizothærus nuttallii Conrad. Horse clam.
Plate II, fig. 85.

This is a very common clam. It is coarse-meated, and consequently is not hunted much by the natives. When used it is usually dried for winter use.

Cryptochiton stellere Middleton. Giant chiton.
Plate III, fig. 74. (Showing plate only.)

This "Chinese slipper" is very common. It is pulled off of the rocks by the natives, boiled whole, then the meat is dug out and eaten. The natives relish it very much.

Acmæa pelta Eschscholtz.
Plate I, fig. 28.

Very common on rocks at tide-line. It is used as food by the natives. It is not likely that white people would relish it.

Glyphis (Fissuridea) aspera Eschscholtz.
Plate I, fig. 6.

This is a very common species and is much sought by both the natives and the whites. The former pull them off of the rocks, where they adhere in great numbers at tide-line, and use them as food; the latter string the shells on strings and use them for ornamentation and decoration.

Calliostoma costatum Martyn.
Plate III, fig. 76.

Very common in the seaweed among the rocks of the tide flats.

Margarita pupilla.
Plate II, fig. 40.

This shell, colored in purple or pink, is very pretty. It is quite abundant. It is found principally among the seaweed of the rocky coast. The shells are used for ornamentation.

Chlorostomum funebrale.
Plate I, fig. 25.

This is a very common species. It is to be found principally among the seaweed of the tide flats.

(Litorina) Nassa fossata Gould.
Plate III, fig. 89.

Only a broken specimen of this species was obtained.

Litorina scutulata Gould.
Plate III, fig. 84.

Litorina sitkana Philippi.
Plate III, fig. 83.

The last two species are found everywhere sticking to the rocks at tide-line. They are also to be found in the shallow pools left by the receding tide. The former species is black in color; the latter of a lighter hue.

Scalaria indianorum Carpenter.
Plate II, fig. 69.

This species is very rare.

Scalaria, sp.
Plate II, fig. 37.

Only one specimen of this species was secured.

Parapholus californicus Conrad.
Plate IV, fig. 92.

The specimen here drawn was found at the mouth of Jackson creek, eight miles southeast of La Push. No other specimen was seen.

Hipponyx, sp.
Plate I, fig. 3.

This species is not very plentiful.

Crepidula adunca Somerby.
Plate III, fig. 82.

Only two specimens were seen.

Crepidula adunca Somerby.
Plate IV, fig. 14.

This species is well represented along the coast.

Lunatia lewisii Gould.
Plate II, fig. 86.

Only two specimens of this species were secured, one at Neah bay, the other at La Push. The specimen from La Push, the one figured, is much broken.

Puncturella cucullata Gould.
Plate III, fig. 78.

This species is not abundant.

Nassa mendica Gould.
Plate II, fig. 41.

This is one of the numerous small shells of the rocky coast patches.

Chrysodomus dicus (*Euthria dira*) Reene.
Plate III, fig. 9.

This is a very common species in the vicinity of James island.

Murex foliatum Gmelin.
Plate I, fig. 63.

This is a rather common species.

Ocinebra lurida Middleton.
Plate IV, fig. 16.

A common and very variable species.

Ocila lyalli.
(Not drawn.)

The shell representing this species was secured at Neah bay on the strait of Juan de Fuca.

Purpura lapillus Linuæus.
Plate II, fig. 71.

Purpura crispata Chemnitz.
Plate I, fig. F9; plate IV, figs. 10 and 90.

Purpura saxicola Valenciennes.
Plate I, fig. 7.

Purpura saxicola, var.
(Not drawn.)

The *Purpura* species are the most abundant of the gastropoda, a common pailful of them has been picked off of one small rock at low tide. They are the most variable of any of the shells in sculpture and color. The *Purpura crispata* species is the most variable, especially in color. White, colorless, pink, purple, yellow and brown specimens have been picked off of the same small rock at La Push at one tide.

Olivella biplicata Somerby.
Plate I, fig. 27.

This is not an abundant species.

Amphyssa corrugata Reene.
Plate I, fig. 58.

Very common.

Tube of worm.

Plate IV, fig. 18.

Saxidomus squalidus.
Plate III, fig. FDX.

This is a very common clam.

Amycla gausapata Gould.
Plate II, fig. 43.

Not common.

Yoldia limitula Say.
Plate III, fig. 72.

This is a Puget Sound shell.

OCCURRENCE OF PODAGRION MANTIS IN THE EGGS OF THE COMMON MANTIS.

By Lumina C. Riddle Smyth, Ph. D., Topeka.

DURING the fall of 1906 I found numerous packets of the eggs of the common mantis, *Stagmomantis carolina,* attached here and there to the branches in a small orchard. On leaving the place early in April, 1907, one of these packets was collected, twig and all. The twig was stuck into the earth in a flower-pot, where it remained for some time in the temperature of the living-room. The eggs were not collected early enough to escape the influence of the summer-like heat of March, 1907, but did escape the return to winter conditions that followed in April and even May.

In early May I chanced to read an article in volume IV of *Insect Life* concerning the occurrence of a chalcid parasite in mantis eggs; so, although the packets looked perfectly normal, I placed them in a bottle to prevent the loss of anything that might emerge from them. On June 8 a single parasite had emerged. The long ovipositor, enlarged posterior femora and wing venation all indicated its relationship to the chalcids, and it was evidently identical with *Podagrion mantis* Ashm. By June 10 all the parasites had emerged by gnawing their way out through the sides of the packet. They were removed to another bottle and counted. There were fifty-four females and only four males. All had emerged through less than a dozen holes. The egg-case remained in the original bottle, and on June 24 there were again signs of life. About sixty young mantids had been uninjured and had issued through the usual openings.

The genus *Podagrion* was named by Spinola in 1811, and later the same genus was described under other generic titles by other authors. This particular species has been known since 1854, and was reared by Prof. C. V. Riley, in Missouri, in 1868, but was not named until 1885, by Ashmead. Practically all of the species of Mantidæ thus far studied have been found to have some egg parasite, but while nearly every collection has some representatives of the genus *Podagrion,* comparatively few have been studied and named. The dates of the appearance of the parasite, so far as I am able to learn, is usually much earlier than the time given in this instance. Those reared in Missouri in 1870 came out on May 9, followed five days later by the young mantids. For a packet of eggs from which parasites issued in 1881 the date of the appearance of the parasite is recorded as May 12 and the young mantids hatched May 24, while from eggs collected in Arizona in 1892 the parasite emerged April 16 and the young mantids remained in the egg until May 12. The great disparity in the relative number of male and female issuing from a single packet seems a matter worthy of further study and record.

NOTES ON COLLECTING CICINDELIDÆ.—II.

By Eugene G. Smyth, Topeka.

THE four years that have elapsed since the presentation of the author's first Notes on Collecting *Cicindelidæ* have afforded introduction to several rare and very unusual western forms, and have given ample opportunity for a more thorough study of the habits of local species.

Visits to the deep clay gullies in the high prairie southeast of Topeka are each year more richly rewarded than the previous year. On April 2, 1904, over sixty specimens of *splendida* and *amœna* were taken, and with them a specimen each of *purpurea* and *limbalis*, and several *12-guttata*. On March 24, 1905, in the same locality, were taken eighty-eight specimens of *splendida* and *amœna*, three *limbalis*, one *transversa*, and six *12-guttata;* and on March 28, seventy-eight *splendida* and *amœna*, one *limbalis*, one *transversa*, and a dozen *12-guttata*. On other days specimens of *purpurea* and *graminea* were taken, grading closely into each other in color, and with them a single *audubonii*. Two others of the last species were seen, but flew high with the wind and took refuge in the prairie-grass some distance away.

Several visits were made in 1904 and 1905 to the sand-dunes by the river east of town, where *lepida* was taken commonly in 1902; but either the big June flood of 1903 or the frequent turning over of the sand by the negroes in their attempts to cultivate the soil had apparently forced the delicate creatures to abandon their home. Not a single *lepida* has been seen since 1902, though the *formosa* varieties are as plentiful there as ever.

The annual Kansas University scientific expeditions to Arizona, under charge of Dr. F. H. Snow, which I have had the good fortune to accompany for the past five years, have offered exceptional opportunity for studying the *Cicindelidæ* of the territory. Our camping place in 1904 was about twenty miles south of Flagstaff, in Oak Creek canyon, a branch of the Verde river. Though a charming place to camp it proved a poor locality for tiger-beetles, the precipitous walls of the canyon acting as a barrier against their encroachment. But a single species was found, *Cicindela maricopa*, a variety of *oregona*, recently described by Mr. Charles W. Leng from specimens taken on the Salt river at Phoenix. The species had undoubtedly come up the canyon from below, as it is abundant along the Verde river. Mature larvæ, probably of *maricopa*, were observed in their burrows in a sandy field eight or ten feet above stream-level during the latter part of July. The first imago appeared on August 31, and the beetles increased rapidly in numbers during the few remaining days of our stay in the canyon. They occurred all along the stream on areas of damp soil or mud left by a recent flood. The color of the specimens varied through all shades of bright green or blue, the females alone exhibiting the deep purple coloration of the elytra. The variety and luxuriance of color involved in the transition from brown, green or blue to rich purple, in the elytra, was remarkable. An occasional specimen had purplish-brown elytra, with head and thorax only slightly tinged with green, being not far removed from ordinary *oregona*. The markings were broad and very constant. A single *punctulata* was taken at Flagstaff, July 13.

A number of species were taken on the return trip during a stop-over of a day at Albuquerque, N. M., September 5. Most interesting was a variety of *hæmorrhagica*, similar in size to *16-punctata*, and probably the same beetle previously taken at Albuquerque by Professor Wickham and determined as *16-punctata*. It differs from *16-punctata* of the Rockies (1) in being dull blue-black instead of brown; (2) in usually lacking the brassy iridescence of the under side and legs, and the bright red and green coloration of the pleura; (3) in the color of the trochanters, which are pale rufous and not polished on the surface; and (4) in having the humeral lunule frequently entire, and the post-marginal (supplementary) and anteapical dots often lacking, never true of *16-punctata*. The two characters, however, that set it apart from any affinity to the *rufiventris* varieties are (1) the sinuate median band, and (2) the fact that the female elytral apices are separately rounded or squared, the apical lunule at the same time receding somewhat from the apical margin. Of the hundreds of *16-punctata* that I have taken the median band is invariably interrupted, or at least reduced to a very narrow line, in the middle, while the elytral apices are always in the female conjointly rounded as in the male. These two characters would at once set apart my specimens of *Cicindela arizonæ*

Wickham from St. George, Utah, as a variety of *hæmorrhagica,* or, better, of *carthagena,* and not of *rufiventris.*

The specimens of *hæmorrhagica* were found on the muddy margins of pools along roads near the river, in company with brown *sperata* and an occasional *micans.* On bare spots in pastures, where the ground was slightly saline and the grass short, *fulgida* occurred sparingly, and on sand-bars in the Rio Grande were found *sperata, ponderosa, repanda,* and *vulgaris.* With the last were taken several fine examples of the variety *obliquata,* which were decidedly cupreous in color, and the markings so broad as to in some cases very much resemble those of *venusta.*

On April 1, 1905, I went to St. Louis to accept a scholarship in the Shaw School of Botany, which is connected with the Missouri Botanical Garden. Sunday being my only day of leisure there, I took advantage of the chance to make short suburban detours in quest of the game of my passion—the tiger-beetles.

On April 9, while following a dry, rocky ravine down from the lightly timbered hills at Meramec Highlands, I ran across several specimens of *sexguttata* sunning on the flat rocks and dry leaves. When disturbed they flew either up or down the ravine, or circled back to the same spot. Their occurrence seemed unusual as I had never found the species earlier than May 25 at Topeka. They had evidently hibernated under the rocks and leaves, and the unusually warm weather had brought them to activity. They were all smaller than the same species taken at Topeka, and all 8-dotted. One specimen was a rich blue in color. A single *transversa* was seen while following a road back up the hill. On the following Sunday, which was cold and dismal, specimens of *sexguttata* were found torpid under stones and the bark of logs in timber.

On April 23 a careful search was made for *limbalis* and *transversa* on banks of railroad cuts and gullies. Only two specimens were taken, one a typical *transversa,* the other almost immaculate, with head and thorax scarcely bronzed.

On May 7, two weeks later, while walking carelessly along a road entering the wooded bluffs at Fern Glen, a few miles west of St. Louis, my attention was called to a tiger-beetle that arose from the road before me. In the net it proved to be a beautiful *transversa.* A few steps further on another fell prey to the net, and as I advanced higher into the bluffs and the timber they seemed to grow more numerous. Presently a pair was found in copula, and then another pair, and soon I realized that here at last I had found the home of *Cicindela transversa.* Not a single *limbalis* was found with them, and only one *transversa* sustained the humeral and posthumeral dots to show any affinity to *limbalis.* On the other hand, a number of the specimens had green or blue head and thorax, agreeing exactly with our eastern forms of *splendida.* Specimens of this last were frequently found in copula with typical *transversa,* thus establishing *splendida* as a variety of *transversa,* and so of *purpurea.* But why had these two species, in this particular locality, abandoned the sun-baked clay-banks and retired to the woods? And why were there no signs here present of the closely associated forms *limbalis* and *amœna?* These two questions remain a puzzle to me.

May 14 was devoted to the capture of *transversa* and *splendida* at Kimmswick, south of St. Louis, and over thirty specimens were taken. They were found along a shady, winding road that ran among the wooded hills, and were more abundant at high elevations. The proportion of the two species was about eight *transversa* to one *splendida.* Fewer pairs were found copulating than on the previous week. *Sexguttata* associated with them, but was much less plentiful. A single *purpurea* was taken along the open road, and several *vulgaris* and *12-guttata* on the banks of a shallow stream. Another trip to the same locality was made on May 28, but the best time for finding *transversa* had apparently passed, as only a few were taken, and those largely imperfect.

The following table attempts to affiliate the numerous varieties of *purpurea.* Forms numbered consecutively are closely related, and each form is derived from the preceding form of higher notation. *C. denverensis* occurs in two forms, corresponding to *splendida* and *amœna* in markings, which have not received distinctive names. *C. cimarrona* has resulted from a fusion of *graminea* and *audubonii,* together with a change of markings, in the high table-lands east of the Rocky Mountains, as shown by a series taken by Doctor Snow in South Park, Colo., which exhibits every possible stage of transition from *graminea* and *audubonii* to *cimarrona.*

I. *Cicindela purpurea* Oliv.
  1. *graminea* sch.
    a. graminea, var. (Utah, Or., etc.)
    b. lanta Casey.
    c. cimarrona Lec. (green).
  2. *audubonii* Lec.
    c. cimarrona Lec. (black).
    d. plutonica Casey.
II. *C. limbalis* Klug.
  1. *amœna* Lec.
    a. spreta Lec. (?)
    b. denverensis var. (markings complete).
III. *C. transversa* Leng.
  2. *splendida* Hentz.
    c. ludoviciana Leng.
    d. denverensis Casey.

A careful search was made on May 21 for *scutellaris* and *generosa* in sandy fields along the Missouri river, opposite St. Charles; but while *vulgaris* and *repanda* were abundant, no sign could be found of the two species sought. The only possible explanation is that it was too late in season for the one and too early for the other, although the two occur together under like circumstances in May at Topeka.

The most exciting experience of the season was the taking of a series of *unipunctata,* while collecting with my father at Crevecœur lake, just west of St. Louis, June 6. Arriving rather early in the morning we descended the steep bluff through timber to the edge of the lake, taking a number of *sexguttata* as we did so. I spent most of the forenoon in an aggravating attempt to scoop up a few of the *cuprascens* that ran tantalizingly over the wet mud, without both sinking to the shoulders in the mire and engulfing each specimen in a net full of it when I chanced to sweep half an inch too low. Having by sheer stratagem accomplished the capture of a few of the "critters," and fewer still of *hirticollis,* I was ready and glad to retire to the woods for the noon repast, and to incidentally disencumber myself from the mud.

From the spring we ascended the bluff by a narrow footpath bordered by herbs and creepers. Half way up I engaged in hasty pursuit of a "tiger" that ran across a wide place in the path. I naturally supposed it to be *punctulata,* but in my fingers the peculiar appearance arrested me, and with a flash of consciousness I recognized the insect whose biography I had read many times. Shouting "*unipunctata! unipunctata!*"

I thrust it before the spectacles of my father, whose seeming lack of enthusiasm provoked me. A hundred feet farther on the rest of the party sat down to lunch under a tree, while I with careful scrutiny patrolled the entire length of the path some dozen odd times, proclaiming each capture of a *unipunctata* with a loud shout. After lunch the search was continued by both of us until late in the day and the beetles had apparently all "gone to roost." Ten specimens rewarded the afternoon's vigilance. The rapidity with which the species can run, and the suddenness with which it can stop under a leaf, are truly amazing. It was noticed that not a single specimen even attempted to fly, and, while I have never seen the statement, I doubt very much if *unipunctata* possesses the power of flight. One specimen did not move until picked up, and a crushed one in the path indicated a similar cause for its fate beneath some foot. How abundant they might have been under cover of the vegetation I cannot tell, for no amount of frequency over the same path seemed to lessen the possibility of finding one on the next round. The thought of overtaking so agile an insect in a dense mat of vegetation kept me closely to the path.

The Kansas University expedition of 1905, located in the valley of San Bernardino creek, twenty miles east of Douglas, Ariz., was productive of unusual results. Twelve species of *Cicindelidæ* were taken—the best representation of any trip since the one to Clark county, Kansas, mentioned in my first paper (vol. XIX, Trans. Kan. Acad. Sci., 1904, p. 429).

Several species were taken during stop-over on the way out at El Paso, Tex., July 28. On the fine clay soil, in an arroyo that washes down from the gravel-hills north of town, *lemniscata* was abundant, and from the number of pairs copulating it appeared to be their mating season. Around mud pools in the streets the ordinary brown form of *sperata* fairly swarmed. On mud and sand-bars in the Rio Grande *sperata* and *tenuisignata* were both frequent, with an occasional specimen of *rectilatera*, somewhat smaller and more cupreous than the eastern Texas form, and with only the tip segments of the abdomen rufous, in all respects intermediate between true *rectilatera* and the Mexican *flavopunctata*.

At Douglas we saw *16-punctata* about mud-holes, and while crossing the Perilla mountains found it in untold numbers about the so-called tanks, or watering-holes—cavities in the great flat masses of rock in which rain-water collects, and where the teamsters water their horses and fill their canteens, in the absence of better water.

Our camp was but a few yards north of the Mexican boundary in a broad, very flat, green, almost treeless valley, bordered by bluffs covered with dense chaparral, beyond which was the parched, limitless mesa—a veritable oasis in the desert. Beside us a noisy artesian well belched forth from an eight-inch pipe clear, warm water, that loitered off through the salt-grass to a pond half a mile below, making the low vegetation doubly green along its path. While pitching the tents I noticed with feverish anxiety an occasional bright green tiger-beetle arise from the bare spots to evade our footsteps, and I could scarcely wait till camp was made to put the net into play; for the ground seemed fairly strewn with them. I mistook the species for *unicolor*. Starting early next morning I returned at noon with over sixty of them. Little did I realize that instead of *unicolor* I had a nice catch of the rare *pimeriana*, known to science by a single specimen taken by the Mexican Boundary Survey years before, possibly in the same valley. The habit of flight was identical with *scutellaris*, and the ground on which they occurred was mostly bare and somewhat sandy. Their remarkable tameness came to be a matter of no little comment, as they ran about the dinner-table devouring the ants that came for crumbs, and we often amused ourselves throwing pebbles at them. On particularly "lazy" days our ambitions would actually degenerate to such a level that we would bottle a few of them to make the catch look bigger. Up and down the valley, however, they were not found, but were confined to a limited area in the vicinity of the artesian well.

The species differs from *unicolor* principally in (1) the highly polished surface; (2) the deep-blue reflections toward the apex; (3) the brassy reflections of head and thorax; (4) the deep, uniform punctuation of the elytra over the entire surface; (5) the minute serrulation of elytral apices; (6) the equal robustness and equal hairiness of the front in the two sexes; (7) the white color of the female labrum; and (8) the light color of all but the tip segments of the palpi. The color is often entirely blue, with the brassy reflections lacking. Most specimens are immaculate, though the median and humeral dots are often present. The species is a little more slender and less robust than the *scutellaris* varieties.

On damp ground, in freshly irrigated alfalfa and corn-fields, *nigrocærulea* was quite common. It varied from green or brassy-green to deep blue, or even black. It is a rather wary species in bright sunshine, but on cloudy days could be found running amongst the alfalfa. Along the narrow ditch that carried the artesian water *16-punctata* was frequent, but was far outnumbered by *hæmorrhagica.* The latter grew more and more abundant each day after August 1, until by the middle of the month the damp, level ground covered with salt-grass fairly swarmed with them. One could by sweeping his net a few times over the top of the grass as he walked get enough of the "red-ended" fellows to half fill a cyanide bottle. They were nearly all dull black, though an occasional small one had bright cupreous head and thorax, pleura, suture and legs, resembling *16-punctata* except for the markings, the sinuate median band being constantly preserved. Under cow-chips on the same damp soil several *Tetracha carolina* were found.

One of the collectors, while searching for *Carabidæ* along the creek, hit upon a colony of the tiny *Cicindela arizonensis,* at the base of a high and steep east bank of the creek. Further search revealed another colony on a similar strip of bank. When frequent visits to these colonies had nearly exhausted them, a large colony was found in a distant part of the valley, where the grass was short and sparse, and a number of depressions caused by washing water after heavy rains left a series of low, sloping banks, in the shelter and on the sides of which the insects gathered. A few days later specimens were found along irrigating ditches with *lemniscata,* though ordinarily the two species were not found together.

Arizonensis flies less readily than *lemniscata,* but is nevertheless quick in its movements. At first sight it somewhat resembles *celeripes.* It is the smallest *cicindelid* of our fauna, and probably the smallest in the world, being yet smaller than *lemniscata* or *celeripes.* The markings consist of apical lunule and median band, often reduced to a dot and, rarely, even lacking. I can see little to separate it from the Mexican *viridisticta,* since Bates's description of the latter says "median marginal dot and very narrow apical lunule white." I should at least place it as a variety of *viridisticta.*

In certain limited areas in dry arroyos entering the valley from the mesa, on other bare areas scattered over the valley, and along certain irrigating ditches, *lemniscata* was quite common. In company with it I took one day a single small tiger-beetle that thrilled me with excitement. The head and thorax were brown and quite pubescent on the sides, while the elytra were dull red with markings somewhat prolonged, but not fused to form a vitta. The under side was less pubescent than in *lemniscata,* but much more so than in *viridisticta,* so that the insect was in many respects an ideal intermediate between the two species. I at once presumed it to be a hybrid, and on reaching camp announced the capture of a rare "*Cicindela lemnisticta.*" The following days were devoted to a careful search for more of the hybrids, and as a result a very few more found their way to the boxes. Two or three were also taken at lamplight in the evening along with a lot of *lemniscata.* The cherished hybrids on our return home turned out to be *wickhami,* but were none the less valuable. The markings consist of apical lunule, produced in front, median band set in from the margin and almost parallel to it; and before the band a single dot to indicate the posterior extremity of the humeral lunule. The affinities tend as much toward *lemniscata* as toward *viridisticta,* for the legs show a strong tendency to be pale, in addition to the characters cited above.

A blue specimen of *hornii* was brought to camp by a cowboy who had found it on the mesa. A search was made for them, and two were seen on a damp, sloping stretch of the mesa where the gravel had been covered by a thin soil washed over it by recent rains. Several green *santaclaræ* were taken there, one pair in copula. A few days later, in the latter part of August, a few more green *santaclaræ* and black *vulturina* were taken in the rolling grass-land on the east side of the valley. They were extremely wary, and flew far when alarmed. A day or so before our departure, on September 2, two specimens of *pulchra,* of the unusual western form, with complete markings, were taken near camp in company with the still common *pimeriana.*

V.

MISCELLANEOUS PAPERS.

1. "Man Abnormal."
   By J. M. McWharf, Ottawa.
2. "Anthropology as a Science."
   By A. H. Thompson, D. D. S., Topeka.
3. "Sketches of Indian Life and Character."
   1. "Chief Noskelzohn's Stove."
   2. "A Day in Jemez Pueblo, New Mexico."
   3. "The Apache and the Wagon."
   4. "Election of the Indian Governor at Jemez, N. M."
   5. "The Apache and the Camera."

   By Albert B. Reagan, La Push, Wash.
4. "Collecting in Arkansas."
   By F. A. Hartman, Wichita.
5. "The Buried City of the Panhandle."
   By T. L. Eyerly, Canadian, Tex.
6. "Scientific Frauds and Fallacies."
   By Prof. W. F. Hoyt, Salina.
7. "Harmonic Forms" (Second Paper.—Perfect Squares.)
   By B. B. Smyth, Topeka.
8. "Preliminary Studies on the Moon."
   By F. A. Marlatt, Manhattan.
9. "Heredity in Stock Breeding."
   By I. D. Graham, Topeka.

MAN ABNORMAL.

By J. M. McWharf, Ottawa.

IN the presentation of this subject, it will be necessary to consider heredity, insanity and imbecility. A question more vital, in so far as it relates to our well-being, could not be brought forward. When we take into consideration the thought that Jesus Christ, as he entered the arena of moral darkness, dispelled the superstition of the ages; that by this act he gave birth to a new era, which quickened the consciences of men and created in them a new life, a life filled with the light of science; that this life is penetrating or transforming many of the hidden mysteries into living truths, all things must be brought to a plane of natural laws.

The twentieth century evidently will be classed as the century of science. To-day we are confronted with the demand for definite knowledge, plain facts and demonstrable truths. Rapid progress was made along this line in the last half of the nineteenth century. Anthropology is no longer a dead letter of the past, and archeology has given us very many relics of a prehistoric character, while ethnology is pushing to the forefront; we also have sociology, at one time the dream of the idealist, but to-day a practical science—a science that demands more than a passing notice.

The new psychology is opening up the secrets and mysteries of the philosophy of ancient Egypt. It furnishes a definite science of mind, and, its methods being reliable, gives not only brain-building but soul-growth. To-day heredity is not considered as a myth but as a fact, a science; when, if applied in the light of the new psychology, it will serve as a potent factor in solving the problem of human progress. Heredity and psychology must of necessity revolutionize all methods. Heredity is universally admitted; it is a self-evident truth. To deny this would be entering a plea against existence. I am firmly of the opinion that all of our possibilities in life are inborn. A writer makes this statement: "The result of all recent research points to the conclusion that human beings are born into the world with a distinct bent of temperament and character which will always manifest itself in some form, no matter what process of training the individual is called upon the undergo." Another says: "Every man is the outcome and product of his ancestry; this is true not only of the broad fundamental characteristics by which he is animal, by which he is human, by which he is natural, by which he betrays the country and family from which he proceeds, but extends to the trivial and minutely trivial characteristics by which he is distinguished from other individuals of his own race, country and family." Do we not find physical and mental peculiarities strongly manifested in very young children, even at an age when environment could not have produced any material effects upon them, and does not this suggest that they were inborn? If environments are the same, children will manifest widely different dispositions as to tastes, talents, etc. We must therefore conclude that inborn traits in a degree surpass environment; but you are not to infer from this that environment plays no part in the life of the child. Variation of child intellect of a necessity is inborn, hence not attributable to environment. If this be true as regards the intellectual powers of the child, is it not equally true of the physical? Heredity would therefore determine the natural trend of every one. Does not profane and sacred history confirm this statement? Instincts that are abnormal, as well as those that are normal, run through families and are classed under the head of hereditary transmission. The same law prevails when applied to plant or animal life. Flowers, fruits and vegetables are improved not only as to quality but quantity and variety. This is also true in the domestic animals. Man is denied, or, rather, does not apply, these laws of heredity to himself or succeeding generations, hence the offspring is a product of blind chance. We must not thus close our eyes and ears, refusing to listen to the voice of wisdom or our better judgment.

A child has an inherent right to be well born, and yet the per cent. that should be classed under this head is numerically very small. Nature's laws are ignorantly and, may I not add, wilfully set at naught, thus dumping upon society an increase of vice and crime. A knowledge of the laws of heredity and a compliance with them is the foundation of reform. Miss Willard once said: "If man is to overcome the evils of intemperance, children must be better born." What is true here is also an axiom in regard to all mental, moral and physical defects. Education, of necessity, is a factor in brain-building; it should therefore begin during or while the brain is forming, that it may become a part of it. Evil impressions, evidently, are made upon the mature mind; how much more susceptible, then, is the plastic and forming brain to impressions?

There are many factors which enter into this question of heredity that serve to unpopularize it; they are factors well understood by all. Man is the outgrowth of influences which begin in embryonic life; they are therefore prenatal and post-natal. Every factor in life is potential, and yet this degree of influence, by the very nature of things, must be varying, and hence cannot be absolute. The elements which enter into the formation of man's life can with propriety be divided into three separate and distinct divisions—generation, education, and regeneration, each one of which plays its part in the development of a well-rounded life, and man's character requires their uniform strength.

Every man is morally responsible for his acts, but cannot be equally so. Three conditions are essential in man's ability to do right—knowledge, desire for right, and self-control. The moral responsibility of each individual must depend upon these conditions. We must consider man as a creature of heredity and environment. This suggests the question of moral responsibility considered from a legal, a psychological and an ethical standpoint. Are we, then, responsible for errors of opinion? If so, to what extent or degree? Responsibility is denied by some, who claim that belief is controlled by rigid necessity; that there is a fixed and inexorable law that is or may be born in man which does control him. If this proposition be true, man is not only powerless but blameless. In contradistinction we have those who hold that all error involves guilt. With this class there is no exception to the general rule. A suggestive question is, Are either of these views correct; and, if not, to what degree are we amenable to a just law? Sin is the transgression of law and law is a decree. There is not a field but what is crowded with mistakes, hence we have widely different ideas suggested, each type being viewed from different standpoints. This diversity suggests intellectual error. If by occupation a man's mind becomes diseased this evil will be handed down to his children.

The nutrition of the whole body may be so interfered with that all the plastic material formed by the blood is vitiated and incapable of forming sound nervous tissue. When these abnormal conditions of the mind exist there will be a want of perfect nerve energy, which creates a consciousness that there is something wrong. This may be classed as a want of coordination of the mental faculties. If this be true there will be false reasoning and erroneous conclusions. Should there exist a morbid condition of the emotions, then the whole mental life of the individual is changed, and we have what may be termed a form of insanity or partial derangement of reason. Insanity consists of a derangement of the intellect and will, hence mental weakness. Is it not a truism that a large per cent. of the people are to a greater or less extent monomaniacs? The sin of some far-back time may so impair our faculties and conditions as to make it impossible, for our best efforts of to-day, that we may escape a given error. This error of necessity is criminal; and yet, what is plainer than the fact that the error is not culpable, it being one which we neither could avoid—in fact, could not have been avoided consistently with a discharge of duty? This perhaps is too general, and yet I can but feel that we are not worthy of blame for all mistakes and errors of opinion.

Will a perfectly moral man be exempt, and that absolutely, from all mistakes? Moral perfection, doubtless, would aid him in arriving at a more perfect conclusion, yet a morally perfect man could not avoid all mistakes; being governed by his limited faculties, such a man must of necessity judge from that which comes within his range of observation, having only appearances and probabilities to guide him. His range of observation, being limited to a greater or less extent, must be erroneous. Man is a finite being, having finite faculties, hence, a finite vision. Facts lying beyond his field of vision may be necessary to avoid a wrong conclusion. In the very nature of things our faculties are limited, therefore our understanding must be superficial; being superficial makes it a product of error. We are confronted with the promises of God to keep and guide the righteous. But are we to understand that this implies a perfect immunity from mistakes? I think not; it is shown by facts that such immunity has never been vouchsafed to man. Good men are often poor thinkers upon the ordinary things pertaining to life, and devout

Christians frequently manage their worldly affairs with less judgment than those of lower moral integrity. This being true, we are compelled to say that under God's correctness of opinion there is not a proportion to moral goodness alone; therefore, a good man might be perfect without immunity from mistakes. Hence we conclude that man is not responsible for all errors of judgment; that the extent to which he may be held responsible must be governed largely by the knowledge he possesses of secular and divine things. We should receive credit or condemnation, not for what we do or fail to do, but, rather, upon the plan of doing or failing to do our best. Divine law is in perfect accord with this statement.

The old idea that has been rung down through the ages for centuries, that God sends the children of all conditions, preordaining their lives, to me is not consistent with reason or divine law. It is a malicious idea, born of selfishness, and the father of many who are unfortunately born. Parents are responsible for the physical, mental and moral character of the child. The better element of society recognizes this truth and does not longer grope in darkness. It has been said that: "In science and law, ethics and religion, turn whichever way we may, man is bound by ignorance, fettered by prejudice and imprisoned by sin. Only as he knows the truth is he able to break the chains of ignorance, burst the shackles of prejudice, unlock the prison doors of sin and stand forth a free man." From the creation of man, down to the present moment, we find him through all the ages struggling for freedom. This condition can only be reached in a degree, and that through brain-building and soul-growth. This work must be persistent and long-continued that we may reach the desired results. Correct brain-building cannot be reached at a single bound. We must study that we may secure definite thinking, as this will produce a close observer and a more perfect thinker. Experience, if it develops a higher sentiment, must be conducive to character-building, and the converse is true when applied to vice or crime. We must continually keep before the child pure thoughts, high ideals and noble aspirations; when character is established under such a training these things become the governing factors of the life. Doctor DeMotte says: "The physical basis of a virtuous life is a network of trunk lines where the incoming waves of stimulation, on reaching the cerebral hemispheres of the brain, find their well-worn tracks, with switches already set, leading to the God-given higher possessions of the soul-holy memories, pure imaginations, concentrated ambition, righteous judgments, and a will whose nerve connection with these higher faculties is so perfect that at once, unless the line of duty present complications requiring consideration, the commands for right conduct are flashed out through the outgoing nerve-tracks and instantly obeyed." General Wheeler, while in command at Santiago, beautifully illustrated this thought. When he saw the Spaniards fleeing before his forces he shouted, "Forward, boys, the Yankees are running." A brain-path had been established and the expression ran along that line. We find three essentials necessary in special training of the muscular system—definite purpose, vigorous and normal action, and regularity, stopping short of exhaustion. This method applied to the brain will develop and strengthen it. The same is true of character-building. (It would be interesting to continue these illustrations, but I feel that it is not necessary.)

Heredity includes all laws, factors and forces which enter into the origin and determine the character of the new life. Insanity, of necessity, comes under this head. What is it? Shakespeare said: "To define true madness, what is it but to be mad." This is not a definition; many attempts have been made to define insanity, but failure has crowned each effort. Perhaps we could say that insanity is but a manifestation of impaired and disabled brain mechanism in its relation to mental functions. I think the trend of medical progress is steadily in this direction. Scientific knowledge which enables one to generalize fundamental principles of universal applicability is comparatively a new phase of human development. I care not what our conclusion may be, it is evident that when the insane taint becomes established it is transmitted from generation to generation; that this condition exists until the family degenerate or are extinct. Doubtless a large per cent. of those who become mentally unbalanced are a product of neurotic, drunken, insane, feeble-minded, scrofulitic or consumptive parentage. If time would permit, we could enter into minute detail and establish, as we believe, the above hypothesis. Lambroso, a reliable authority, states that "insanity is frequently transmitted; that even in succeeding generations it appears in greater intensity, and that these cases are very numerous."

We are confronted with the fact that insanity is on the increase, and to an alarming extent. In A. D. 1880 there was 1 insane person to every 1200 people; in 1900 we find 1 to every 460—an increase of nearly three to one in twenty years. Insanity and imbecility give us to-day not far from 400,000 people in the United States, and it is shown that this number, through heredity, is rapidly on the increase. Is it not time, then, to call a halt and take an account of stock in trade? To ask ourselves this question—Whither are we drifting? To cast about us for a remedy? How can we stop this increase of the abnormal man? is the greatest problem which is before the people to-day. Health, virtue and honor must enter into and form a component part of our mental and moral nature, that the nations yet unborn may profit thereby. This problem stands out in bold relief, and it can be solved only through the channel of education. Make the people feel not only their individuality but their responsibility.

We have learned somewhat of the intensity of life but lack a knowledge of our responsibility. It is an axiom that the rights of every one are circumscribed by the welfare of others. This might be shown by the many and varied relations which morphine, tobacco, alcohol and numerous drugs sustain to feeble-mindedness or imbecility, if farther investigation along this line were desired.

Before closing this paper, it would be well to look just for a moment upon the abnormal man from a statistical standpoint. From 50 to 75 per cent. of all crime is the result of intemperance; 70 per cent. of all cases of insanity are charged directly or indirectly to narcotics; 80 per cent. of all criminals are habitual malefactors, and 40 per cent. of hereditary criminals are the result of bad maternal impressions—mother-made criminals. We see, therefore, that heredity, bad whisky and bad environments vie with each other for the trophy of crime.

Change is written on all things human; we have the springtime of youth, followed by the hot summer of manhood, and the mellow autumn and dreary winter of old age and death. We are actors upon a stage; one generation plays its part, the scene changes and gives place to the next. Man is indeed a poor philosopher if he does not take into account this ceaseless law. Habit, thought and customs of the people are ever changing. We must of necessity keep step to the march of progress. We must not become morbid and link ourselves to the dry bones of a dead past. Nor are we to live as though the future had no change in store for us. Plan for the future, prepare for it, and then, when new conditions arise, we will be able to adjust ourselves to them.

There are many ideas brought into the field of vision at this time, yet not admissible for our discussion. In this brief paper the desire has been to excite an interest along the line of farther and more complete investigation. To study the ideas suggested is but to be convinced. After a thorough investigation, should failure take the place of success, you can only "wait until the evening bells of time have ceased tolling and the morning bells of eternity break the intervening silence with their clarion notes. Then mount the great white throne, stand beside the Recording Angel, and, as the unending day of eternity sweeps on, observe the consequences. Watch that debauched, debased, pauper, idiotic, insane and criminal throng as it passes the Judge of Nations to receive its reward; there where the deformed limp; where the feeble-minded chuckle in silly mirth; where the epileptics froth in periocditic fits; where the insane rave with madness; where drunkards stand face to face with heaven's gate and see those awful words flashing from flaming swords, "No drunkard shall enter the kingdom of heaven"; there where scarlet women are cursing the mother that gave them birth, and hardened criminals stand shuddering on the crumbling cliff that o'erhangs the dark valley of death and despair; there where family ties are being severed forever and loved ones are parting to meet no more; there where heart-broken mothers, choked with sobs, plead against fate; there where cruel justice, blinding her eyes, closes the day of probation and places the seal of death upon every impenitent soul; there where angels weep and the pitying, pleading Christ begs to drink once more the cup of death and endure the passion of Golgotha's cross that erring man may be forgiven; there, in scenes like this, reckon the consequences and settle the plea for personal liberty." Settle, and forever, the great question of man abnormal.

ANTHROPOLOGY AS A SCIENCE.

By Alton Howard Thompson, Topeka.

THE study of anthropology has become so fraught with interest in contemplating the progress of the human race in all ages that its tremendous importance is acknowledged nowadays by the most casual observer. As the pursuit of this science is undergoing a marked revival throughout the world, a glance at some of its salient features may not be without interest to the specialist as well as to the general student. It is well to study the bearings of any science, not only as regards its economic value but also with reference to the influence it may have upon the general progress of humanity and the various benefits it confers.

As a preliminary, let us take a glance at the history of anthropology, which is quite interesting and exhibits the vicissitudes of the evolution of a specialty under different conditions. M. Broca has given an account of its development, in an address before the Anthropological Society of Paris (Jl. Anthrop. Inst. N. Y., vol. 1, p. 25). He says: "In the year 1800 the Society of the Observers of Men was founded in Paris, and was devoted mainly to the natural history of man with the special object of directing the observations of travelers among the different races of men, and the hearing and discussing of such observations. But the long and general continental wars put an embargo on travel, and the society devoted its attention to questions of general ethnology. It drifted into politics, philosophy, and philanthropy, and when the oppression of Greece became the absorbing topic of the day it was the resort of the Philhellenes. After three years of languishing existence it was absorbed by the Philanthropic Society and left little trace of its influence upon the science, but it was the first organization having an anthropological aspect.

"This experiment had long been forgotten when some English philanthropists founded in London, in 1838, the Society for the Protection of the Aborigines, which was political and social rather than scientific. The question of slavery was beginning to be discussed, and hotly so, by the abolitionists and proslavery men the world over. England had solved the question for herself by the gradual emancipation of the negroes in her colonies, and it had begun to occupy the attention of the French government. The London society, to influence France favorably toward abolition, sent some of its members over to Paris to establish a society for the agitation of the question of the emancipation of the negroes in the French colonies. Although not successful in this, their efforts were not without fruits for the benefit of science, for M. Milne Edwards and his friends resolved to found a scientific organization, and thus brought into existence the celebrated Ethnological Society of Paris, which was authorized by the minister of public instruction August 20, 1839. Since the failure of the Society of the Observers of Men, anthropology had made marked progress, and possessed a large mass of material. Museums of craniology, archeology, ethnology, etc., had been formed; valuable publications had appeared; numbers of savants devoted their attention to the science; and, taken altogether, anthropology needed only organization and a home, and this the first ethnological society gave. It began under favorable conditions and accomplished much; its work was good and its publications were valuable additions to the literature of the science."

It was followed by the Ethnological Society of London in 1844, and a few years later by one in New York. The Parisian society was in the lead, but its field was too narrow, for it studied only racial distinctions and excluded the important basis of anatomy and physiology," so that it was not strictly and comprehensively anthropological in its work. "The society was like a ship without ballast, when deprived of the invaluable guidance of natural science, and sailed well enough, perhaps, in calm seas, but was not prepared for storms, if any should arise. Unfortunately one did arise when the society began to be agitated by the question of slavery. The first thing was to determine the distinctive characteristics of the white and black races. But it was in vain that the naturalists and anatomists, too few in number, tried to confine the discussions within the limits of natural history. The friends and foes of emancipation looked at it as a question of social politics and dragged the society after them into the passionate arena." The polygenists declared for the independent origin of each race, the natural inferiority of the black race and its consequent destiny to be the slave of the superior or white races; while the monogenists declared for the unity of origin of the whole human race and a community of destiny, the consequent equality of all men and the absence of any moral right whatever for one race to enslave another." This was in 1847. The debates became more animated at each meeting, the speeches found their way into the public press, and the outside world became interested and willingly believed that ethnology, of which it heard for the first time, was not a science, but a something between politics and philanthropy. This absorbing question lasted nearly a year, and would have dragged out longer if the provisional government of February had not ended it by abolishing slavery itself. This question had so absorbed the society that with the abolition of its subject, slavery, it seemed to have nothing else to live for and gradually sank out of existence, leaving a blank in the science in Paris that was only filled up eleven years later.

There remained the Ethnological Societies of London and New York, which had had neither equally brilliant careers nor similar misfortunes. They passed quiet lives, collecting material and publishing proceedings and memoirs of value. But they too made the mistake of separating ethnology from natural history and thus losing the influence and assistance of men accustomed to vigorous methods of observation. It was not through these then that the chief work of the next few years in anthropology was carried forward. "The science was aided by individuals and museums in all lands, essays were read before other societies and scientific bodies, and, by the publication of many valuable works, the science advanced toward exactness."

In America there was about this time increasing activity and interest in the subject, but the study of the races of men became involved in the inevitable slavery question. Dr. Samuel George Morton, of Philadelphia, had amassed a collection of skulls that for many years was unrivaled in the world. He had published his incomparable *Crania egyptiaca* and *Crania americana* when envious death called him from a place that has never yet been filled. "He perfected methods of craniometry, and he and his disciples understood better than his predecessors the indispensable value of scientific methods and of the mutual value of geology, archeology and zoölogy in relation to the science of man." Says M. Broca, significantly: "All that was lacking to the American school was that calm philosophy which places scientific investigation above and beyond political and religious animosities." Morton died in

1851, and the abolition question was warming to the terrible crisis of ten years later. Vehement discussions arose, theology furnished weapons to both sides from the first, and science was at length dragged into the strife. Proslavery was coupled with polygenistic ideas and emancipation with the monogenistic faith, but this association was arbitrary. Slavery had been sanctioned and practiced by monogenistic peoples for centuries, and *vice versa.* But what mattered the past? The religious societies of England had carried emancipation by the cry of the brotherhood of man and the idea of the common origin of all the races with Adam. This cry was echoed by the abolitionists of the United States. The slavery party were, in a manner, crowded into the polygenistic theory, and for a time the controversy seemed limited to a scientific basis. The fate of the negro in this country seemed to hang upon the opinion of legislators as to the effect of an African sun upon human integuments, and the differences between the sections of the hair of the white and black races. The disciples of Morton were attacked fiercely by some and unduly praised by others, they being polygenists but not all slavery men. The question brought out essays and memoirs from the hands of Morton and his followers that have remained as interesting writings to us.

Nott and Gliddon's Types of Mankind and Indigenous Races are good examples of the ethnological books that were written during those times, which were devoted to the defense of the theory of the diversity of the origin of mankind and incidentally of slavery. A curious anecdote they relate will illustrate this idea. In the introduction of the Types of Mankind, the authors say: "The proposition of the diversity of the origin of mankind was long known to the master mind of Jno. C. Calhoun, secretary of state. In an interview with Mr. Gliddon he complained that England pertinaciously continued to interfere with our inherited institution of negro slavery, in a manner that rendered it necessary to indict strong protestations through our ambassador. So he sent for Mr. Gliddon, who was then United States consul to Egypt, on account of his knowledge of African ethnology and his writings on the subject, for information. Mr. Gliddon referred the great statesman to Doctor Morton, with whom a correspondence ensued and whose books he read. Mr. Calhoun was confirmed in his opinion, from his study of history, of the doctrine of the diversity of origin of the white and black races and of the physical inferiority of the latter and consequent right of the white to enslave the black man. These ideas were embodied in the formal letter of protest to our ambassador to the court of St. James, with the result that the English prime minister complained of dragging ethnology into diplomatic correspondence, but accepted the protest against England's interference with our pet institution and refrained from it ever afterwards."

M. Broca observes "that with an excellent beginning, the sceptre of anthropology might easily have passed to the American school, if the political events which followed had not very shortly clogged its career. The tempest which had long been gathering soon burst with violence; a nation rushed to arms and the question of slavery was solved—washed out in the blood of patriots!" Science was lost sight of amid the clash of arms, and anthropology in America suffered an eclipse from which it did not recover for ten years.

But the savants of Europe were, in the meantime, pushing their researches, with steps slow by sure. "But their isolated labors received little attention, and that only when discredit was thrown upon their work, for their discoveries and opinions ran counter to popularly received opinions. It was then that the Anthropological Society of Paris formed a tribunal before which opposing sciences might appear and obtain a hearing, where anthropology in its broadest sense might claim the aid of all the sciences." This event marked the beginning of the present era in anthropology. "It began its career coincident with two important and significant events: (1) M. Boucher de Perthe's discoveries of the evidences of paleontological man, and the publication of Darwin's Origin of Species. These two great events gave the impetus to the study of anthropology which has marked the progress of recent years. Other cities followed the example of Paris and organized anthropological societies, viz.: London in 1863; St. Petersburg, Moscow and New York in 1865; Berlin in 1869; Vienna in 1870; Stockholm in 1874; and others have followed, both in America and Europe."

Anthropology to-day is defined as the study of the natural history of man. As Prof. E. B. Tylor says: "In the general classification of knowledge anthropology stands for the science of man, the highest section of zoölogy, which is the science of animals. Zoölogy in its turn stands as the highest section of the science of biology, which is the science of life." Anthropology is therefore the highest department of the science of life. Simple and truthful as this definition is, it is not grasped by the generality of workers in the science who do not acknowledge the oneness of all life and the interrelationship of all living things. Like all specialists, there is too much narrow exclusiveness, and too little of the grasping of great principles, in the study of anthropology. The science is divided into two great divisions: The first is physical anthropology, which considers man as a biological unit, an animal; races and varieties; general and special anatomy; physiology, pathology, and all the phenomena of his physical being. The second is called cultural anthropology, which embraces the vast range of human achievements, the products of his hand and brain. As Prof. W. H. Holmes says, "If the physical qualities of man include all that connects him *with* the brute, his cultural products, the work of his hands, includes all that distinguishes him *from* the brute. If we wish to realize more fully the scope of the latter division of the subject, which includes the objective evidences of culture, we have only to sweep away in imagination all the myriads of things that it has brought into the world; destroy every city, town and dwelling; set aside the use of fire and cooked food; banish all language, government and social organization—in short, destroy all that is the product of human hand or brain, and when this has been done, we may behold the real man standing in his original nakedness among his fellows of the brute world."

It is becoming more and more apparent that anthropology is the science of the future. Its value to all departments of life is becoming better recognized and the science has more followers than ever before. Fifty years ago it was biology that occupied the attention of thinking mankind. It was the time of the battles of the giants, when the great questions of evolution and Darwinism, the origin of life and the antiquity of man, were hotly discussed. But those questions were fought out, and biology retired from the public stage to make way for the reign of physics. The public mind was amazed and entertained by the marvelous discoveries in this science next, as it had been by the discussions in biology of the previous decades. These marvelous discoveries laid the foundations of the wonderful material advancement of the last quarter of the nineteenth century and were of absorbing interest. But now the popular interest in physics is passing and anthropology is coming to the fore to occupy the arena for the next era. There is undoubtedly an increasing scientific and popular interest in all branches of anthropology, as is indicated by the increased number of books and magazines and popular magazine and newspaper articles appearing on the subject, the increasing number of visitors to this department in the museums, and the greater number of public and private collections that have a real scientific value. It is to be noted also that the science is being taught more in our colleges, which are establishing special chairs that are devoted to the science, the classes of which are well attended. The value of anthropology to the general purposes of life is thus coming to be recognized and it is at last coming into its own.

Anthropology is said to be the newest of the sciences, as astronomy is the oldest, and it is not a little curious that the oldest of the sciences, that deals with the things furthest away from us, should be the most exact of the sciences, while anthropology, the newest of the sciences, that deals with the things of ourselves, should be the most inexact. In fact, anthropology is yet in its infancy—a sturdy infant, it is true, but still young when compared with other and more exact sciences. We know less of our own species than we do of most animals, but the deficiency is being very rapidly remedied by the tremendously rapid accumulation of data that characterizes our day.

It is only since the establishment of evolution as a philosophical principle that anthropology has had a scientific basis. It is only since its liberation from the thralldom of teleological and prejudiced theories that it has been able to advance as a science. Anthropology, more than any other science, has been hampered and handicapped in its growth by superstition and prejudice. It has but just stepped out from the darkness in which it has lain for centuries and is yet bewildered and blinded by the fierce light that is thrown upon it by modern research. Data and material are accumulating so rapidly and in such quantities that it is yet quite impossible to classify it and formulate even the beginning of a philosophy, such as our sister sciences have accomplished. The elucidation of the great problems of the science that bear upon the past and future of our species seems further away to-day than it did fifty years ago, when the facts bearing upon them were within easy comprehension. Theories were easy and plentiful in those days, for the facts were for and easily marshalled, but he would be daring, indeed, who philosophized to-day with the mass of knowledge to classify that demands attention. A great many books were written upon ethnology before the advent of evolution, filled with self-satisfied theories, which are of no value now except as curiosities. What a contrast with the spirit of to-day, when vast and sweeping generalizations are unheard of. We are impressed more and more, as the mountain of facts continues to grow, that the time for that is far away.

We are convinced that anthropology is filled with vast possibilities that involve the future well-being of the race. Great problems are to be solved and anthropology is to solve them. The stupendous questions, Whence came we? and Whither are we going? have rung down the ages and are yet unanswered. Can anthropology contribute to their solution? The beautiful laws of evolution have opened to us the laboratories of God, where all things will in time be revealed. Let us therefore stand with unsandaled feet, thankful for what we have been allowed to learn, but deeply humble for the ignorance that still oppresses us.

SKETCHES OF INDIAN LIFE AND CHARACTER.

By Albert B. Reagan, La Push, Wash.

CHIEF NOSKELZOHN'S STOVE.

SEVERAL years ago, when the government first began to issue things to the Apache Indians of Arizona, the agent at Fort Apache received a stove to be issued to one of the chiefs of the reservtion. After some deliberation the agent decided to give the stove to Chief Noskelzohn of the Cibicu division. So he dispatched an Indian police to Cibicu for the chief, and in due time Noskelzohn came to the agency for his stove. Before the agent gave it to him, however, he took him over to his house and showed him a stove in use and explained to him how to cook many things on it. Then he had him take dinner with him, that he might see how much better things tasted that were prepared on the white man's stove than in the ashes or on the bottom of an inverted skillet.

After the repast the chief packed his stove on a *burro* and started home with it. But when he got to Cibicu—having stopped at a *tiswin*—drunk on the way, he had forgotten all about what to do with it. So he placed it in his yard near his teepee, and there it remained rusting for nearly two years. At last one day an Indian scout came along on his way from the fort to Canyon creek, and noticing the stove, remarked: "That is one of those things on which the agent's wife cooks so many nice things. I have also seen the soldiers cook on one of them at the fort. It is a good thing. Why don't you use it, Noskelzohn?"

"Put it up for us, brother, and show us how to use it," replied the chief. "We know nothing about it."

"All right," rejoined the scout. "Let 's put it up at once."

Instantly the whole band of aborigines was interested; all was excitement. Some of the Indians stood around the scout with open mouths. Others carried the stove into the teepee and set it up as the scout directed. Others rushed to the nearby forest and gathered wood. Then when the stove was filled with wood and everything was ready, the scout proceeded to kindle the fire in it. "Now you 'll see her go," he remarked, as he lighted a match on the sole of his moccasin and touched it to the shavings. Breathlessly all stood around and looked on—till the stove smoked them out of the teepee. The Indian scout had kindled the fire in the oven.

The stove stands in Noskelzohn's yard rusting to this day.

A DAY IN JEMEZ PUEBLO, NEW MEXICO.

IT IS August 14. The great orb of day, the fond object of Pueblo worship, is raising his burning eye above the wooded landmarks on the eastern horizon. The violet-blue sky is clear. The wind from the northwest has lulled, and a sultry calm sets in.

We are in Jemez pueblo. The Jemez Indians, who are industrious when the work interests them personally, have been busy since the first streak of light began to encroach upon the regions of darkness on their eastern horizon. The men are dressed in white tunic and pantaloons; each has an *aleh,* about an inch wide and made of red-colored cotton cloth, tied around his head to keep his hair in place; his feet are covered with moccasins; and his hair is tied up in a *chungo* (cue). Thus attired they are all at work in their fields. Some are hoeing their maize; they never cultivate it. Some are irrigating their fields; others are cutting their wheat with a hand sickle. Others are hoeing their *chille.* The women are dressed in a black skirt and a red or white waist; each has a shawl or Navajo blanket over her head; her feet are covered with buckskin moccasins; her legs to the knee are protected with leggings made from the same material; and each woman has a beautifully embroidered *panya* (apron) suspended at her back by a cord which passes over the shoulders and is clasped under the chin. Thus attired, the women are also at work. Some are milking their cows. Some are carrying water in water-jars from the river; the water-jars are carried on their heads. Others are preparing the morning meal.

At about nine o'clock the men return from their work and partake of the morning repast. It consists principally of chille-stew (green corn and green red peppers boiled together) ; some meat roasted on the coals before the fire; some *tortea,* a sort of pancake made from Graham flour; and some *wyava,* a paper bread made from corn-meal This meal, ground by hand by rubbing one millstone over another, so that it is much finer than the meal used by European descendants, is made into a paste. This paste is spread in a very thin layer upon a flat rock over the fire, where it bakes rapidly. When done, it is taken off and a new layer is spread. These papers, as fast as baked, are laid one on top of another till the thickness of the combined layers is a little less than an inch. This bread is dipped in water to moisten it when eaten. Coffee is the usual Jemez drink. While eating, the family are usually seated on the earth floor in a circle surrounding the water-jars and baskets which contain the eatables.

After the meal is completed, the governor, having been informed that the left bank of the irrigating ditch west of the river has been broken by an overplus of water during the night, starts out on his tour around the village ordering the men out to fix the ditch, his harangue sounding like that of a show manager when announcing the parts of a circus to be acted. The governor has not been in the street long till he is followed by the two lieutenant-governors and finally by the *fiscal* (ditch commissioner), each one delivering in like manner a harangue to the people. At last, after an immense amount of persuasion—there is not the interest shown in public works that there is in private affairs—the men turn out and fix the ditch. Then they return to their own work.

Threshing wheat is the order of the day now. The wheat in the straw is hauled from the field in just the wagon-bed, the ponies being too small to haul a larger load. It is then piled on the threshing-floor, which usually consists of a level circular spot of earth. After a sufficient amount of the grain has been hauled, the wheat is tramped out of the straw with horses. Then comes the tedious cleaning process, which is only accomplished by shaking the tramped product in the wind, thus allowing the wheat to drop to the ground and the lighter particles, such as straw and chaff, to blow away. The particles of earth, however, which have accumulated in the tramping, are not removed in this process but must be washed out. This last act is accomplished by the women at a later time.

Suddenly there comes a lull. The meridian-hour has been reached, and the people quit their work to partake of the noonday meal; and for one hour the village is wrapped in silence.

After the siesta, the people return to their work, hauling, threshing and cleaning wheat as before. It is much pleasanter now, however, than it was in the ante-meridian hours. The wind, which veered to the southwest at about ten o'clock in the forenoon, is now blowing quite briskly, while intervening clouds shut out the rays of the sun, which rode radiant and undimmed in his splendor during the forenoon hours. Under these more favorable conditions the work progresses faster than before the midday hour.

As night advances, and as the sun begins to color the evening sky with golden and crimson paints, the work ceases, and the governor gives his orders for the work to be done on the following day.

THE APACHE AND THE WAGON.

When the Apache Indians first saw a wagon, they shot it full of holes and then burned it. At a later date wagons were issued to them by the government. These they tried to use, instead of destroying, but, as they had had but little experience in using the white man's things, several accidents occurred.

In hitching a team to a wagon, they hitched the traces first; then took down the lines; and, as a finish to his hitching up, put up the neck-yoke last. As a result of this backward way of procedure the teams, when only the tugs were hitched, often ran away and smashed up the wagon.

An accident of another sort occurred several times as the result of their not knowing how to lock a wagon. When they would come to a hill that they were compelled to descend, instead of using the lock to hold the wagon from running on the team, they would "pile" as many Indians as possible into the wagon to hold it down and keep it from running on the team as it went down hill. The lassoing of another team was the usual result, if nothing worse. When this mode of keeping the wagon from running too fast down hill failed, they resorted to another scheme. They had seen the cowboys, when mounted, hold a cow with a lariat rope; so they tried the same plan in holding the wagon from running down hill too fast in its descent. This scheme would, probably, have worked better if the rope had not been left slack till the wagon got under headway. A mounted Indian, at the top of the hill, held a rope around the pommel of the saddle, the other end being tied to the hind axletree of the wagon. With this rope the simple-hearted aborigine supposed that he and his horse could stop the wagon; but when all the slack in the rope was taken up, the result need not be mentioned.

The Apache has learned more about a wagon since then; but to this day, when hitching to it he hooks the tugs first and puts up the neck-yoke last.

THE ELECTION OF THE INDIAN GOVERNOR AT JEMEZ, NEW MEXICO, DECEMBER 29, 1900.

[Read by title before Section H at the Philadelphia meeting of the American Association for the Advancement of Science, 1904.]

AT about three o'clock in the morning of December 29, 1900, Victoriana Gachupine, the Indian who chored for me, woke me and said: "They have built the fires of the gods." I went to the house roof, and sure enough a huge fire was burning just without the pueblo in each of the cardinal directions, one to each of their deities. The one to the south represented the sun, the one to the north the moon, the one to the east the morning star, the one to the west the evening star.

"To-day is election day," broke in Mr. Gachupine, as he joined me on the housetop. "Last night," he continued, "the cacique and chief religious men and medicine men met and cast corn (cast lots) to see who would be a suitable man for governor (this is the Jemez mode of nominating a candidate). To-day we will vote for the governor and other officers."

At that instant the heavy, guttural, basic command of the governor and his aids, who just then entered the plaza on their commanding tour, broke the stillness of the early morning with: "O-wah bah kwal-la-shoo ka-whee pang-a-oong-hung"—go to the south estufa to vote for governor to-day. This they repeated time after time as they made the circuit of the entire village.

After this commanding tour was completed nothing farther of interest was noticeable till about ten o'clock in the forenoon, except that guards were put out on every side of the village to prevent any of the male Indians above twenty years of age from leaving the place. At ten o'clock the governor and his aids again appeared in the public square, and, as they walked around and around the streets of the village, they gave the command: "Bah ka-whee pang-oo"—go to the election. This order was not obeyed. The Jemez never care to attend an election. If there they stand a chance of being elected to some office; and, if elected, they must serve, whether they want to or not.

At noon the governor and his aids again appeared, and, in gruff, coarse, emphatic, basic voices, gave the following and last command of the day: "Sho yosch-shee tang-a ka-whee pang-oo"—we command you (in the name of) all the gods of our fathers, go to the election. This order likewise was not obeyed. So the Indian constables were compelled to force attendance; some of the Indians were dragged from their dark rooms and carried, struggling, to the estufa.

When all were within the secret religious hall, the cacique, standing with his back against the post which separates the north wall of that edifice into the two rainbow sections—the section of the Rainbow in the West and that of the Rainbow in the East, lifted his hands to heaven and out toward the symbolic paintings of the house as he prayed long and earnestly to his deities. After his prayer was completed, the retiring governor, Augustine Pecos, gave his farewell address in the form of a prayer, as follows: "O Sun, O Moon, O Evening Star, O Morning Star, O Montezuma, etc., O all the gods of our fathers, we indeed and in truth thank you for all things. We thank you for the infants, we thank you for the young women, we thank you for the young men, we thank you for the middle-aged and old women, we thank you for the old men, we thank you for the horses, we thank you for the mules, we thank you for the cattle, we thank you for the corn, we thank you for the wheat, . . . we thank you for our kind neighbors (kyaba), we indeed and in truth thank you for all things."

Then turning to his associates in office he said: "In the name of the God of Day, of the God of Night, of the God of the Morning, of the God of the Evening, of the Great Water Snake, of the Power-producing Flash Lightning, of Montezuma, . . . and of all the gods of our fathers, I thank you all for your faithful work. I thank you, cacique, I thank you, first assistant cacique. I thank you, second assistant cacique. I thank you, my first lieutenant-governor. I thank you, my second assistant lieutenant-governor. I thank you, war captain. I thank you, assistant war captain. I thank you, our east-side ditch commissioner. . . . I indeed and in truth thank you all for your faithful work."

Then, as he turned his face heavenward, he continued: "In the year to come, as in the past, O God of the Rain, give us water. As in this year, O God of Bloom, give us flowers in abundance. Oh, may the gods of our fathers give us a bountiful harvest, . . . and O God of Day, O God of Night, . . . O gods of all our fathers, give us for the year to come a good governor.

Then, with one official cane raised toward the heavens, the other official rod of authority suspended over his visible hearers, he said: "I indeed and in truth thank you all, both those present and those above."*

After the farewell address was finished, nominations were in order. The result of the casting lots the night before was supposed to be secret and not known to the populace. Mr. Jose Reyes Gallena was the candidate for governor. As soon as his nomination was announced, the vote was taken by acclamation, all rising and saying "nop." It was unanimous. Had it not been unanimous, a new candidate would have had to be proposed; everything must be by unanimous consent with the Jemez.

As soon as declared elected, the governor elect went to the cacique and got down on his knees before him. Then that august person, the cacique, as he bent over the man at his feet, first prayed to his deities; second, he gave the new governor instructions as to the duties of his office; and, third, he gave him the two gold-headed canes of authority, which go with the office of governor. The now inaugurated governor rose from his humbled position and seated himself at the right side of the cacique beneath the section of the Rainbow in the West.

---

* Pä-ta-gā′tza, A-tä-wat′-za, Shō′-bä Wang′-hō, hōm-wa Wang′-hō, Montezuma,......āx shō-yō′-shē tŏng′-ā, shō muts′-ā nēns, shō muts′-ā nēns, shō muts-ā nēns. Kū muts′-ā, ŭm′-pĭ-kū muts-ā, a′′-kū muts′-ā, ō′-wa muts′-ā, väla muts′-ā, kā-wī-lu muts′-ā, wag′-ga-shē muts′-ā, mul′a muts′-ā, pō-′hō muts′-ā, dunt′-chu-nō muts′ā......Kya′-ba muts′-ā, shō muts′-ā, shō- muts′-ā, shō muts′-ā.

Whan′′-ĭ-kī-yan′-ha Pät-a-gāt′-za, A-tä-wat′-za, Shō′-bä Wahng′-hō, Hōm′-wa Wang′-hō, Wan-a-kūn′-tō, Hō′stō-ō-lu-sä-lā, Montezuma, shō-yōsch-shē tŏng-ā, shō ŭn′-wa muts′-ā nē. Wä-kyĕm-bā muts′-ā, wa-ä′-da muts′-ā, Shan-tō-tū′-ū muts′-ā, Da′-ha-wag′-gē muts′-ā, Un′-shŭng muts′-ā, Sōn′-a-pā′ muts′-ā, Wä-ham′-pā′′ muts′-ā Pal′-lu muts′-ā,......Shō muts′-ā, shō muts′-ā, shō muts′-ā.

Sā-dal′-lē- pĭsch kwal′-lē-pĭsch, Wan-a-kūn′-tō, p'ba ma′- la. Kwal′-la-pĭsch, sā-dal′-le-pĭsch Hōs′-tō-ō-lu′-sā-lā pa ma′-la. Yōsch′-shē shō tŏng′-ā hä′-ba-da′ ma′-la......Pä-ta-gāt′-za, A-tä-wat-za......yōsc′-shē shō tŏng′-ā sā-dal′-lē-pĭsch whēēsch Shō′-bä Wang′-hō mala.

Shō muts′-a, shō muts′-ā, shō muts′-ā.

The election of the other officers immediately followed. The election of each remaining officer was somewhat similar to that of governor, except in the case of the minor officers. Each of these was nominated by the retiring officer; and, as soon as elected, the retiring officer turned his rod of authority over to him without any ceremony. In all, thirty-one officers were elected.

When all the officers had been elected, the cacique again prayed long and earnestly to his gods and to their symbolic paintings on the estufa walls. With his prayer the election closed.

THE APACHE INDIAN AND THE CAMERA.

The Apache has an abhorrence for a camera. He peoples everything with spirits or ghosts. He believes the camera to be a box in which the white man has legions of evil spirits to turn on his red brother. He believes these spirits are to harm him in some way or other while he is here as a living being.

He furthermore peoples each thing with its counterpart spirit; consequently, when he dies he destroys everything which belonged to him of earth, that the spirit of his effects may accompany him to the Beyond. He wants no white man to have his picture after his death; because everything of his would not be with him in spirit then; and he would be one most miserable there, though surrounded by all the enjoyable things of the happy hunting-grounds.* He therefore will have no picture taken, if he knows it, provided he is not paid for it. He will sell his chances for happiness in the land of bliss for immediate gain, as his white brother sometimes does.

* The traders used to threaten to take a picture of an Apache short in his accounts to induce him to "pay up"; and as a result the debt was usually promptly paid.

COLLECTING IN ARKANSAS.

By F. A. Hartman, Wichita High School.

DURING July one finds collecting in Arkansas more enjoyable than on the Kansas plains. At Siloam Springs there is shade—the kind of shade that is refreshing. This, together with plenty of good, healthy water, makes the hot sun more endurable.

If you go an hour's walk from Siloam Springs to the southwest, your path will be through orchards on rising ground. This rise loses itself abruptly in deep ravines so that you will be surprised to be so suddenly transported from the bright and noisy orchards to the shady solitude of the woods. Some of the ravines are sparsely covered with trees, others are neatly clothed to the bottom, where there may be a spring feeding a merry rivulet or, in place of this, a densely crowded undergrowth. The ravines will lead you into the river valley. To the west of town you will find the prairie, with its farms and groves.

It is in such a place as this that one may expect to find a great variety of life.

The purpose of this paper is to give the observations of a week's exploration of this region.

As to the general distribution of the fauna, we find insects most plentiful on or bordering cultivated ground. The same may be said of the birds, but the reptiles are perhaps more common in the woods. There is very little life in the densely growing woods.

One of the things that attracted my attention was the great number of beetles called fig-eaters (*Allorhina nitida*), which go darting like mad through the orchards with the noise of the bumblebees. They stop a few seconds on some tree, but are off again with as much hurry-scurry as before. There was a large box-elder tree in front of the farmhouse where I stayed that was a favorite place for these insects. From a little after sunup the top of this tree would swarm with these beetles, which were coming and going incessantly. At all times they would not come close enough to the ground while on the tree to be caught with a net. Toward sundown they would begin to disappear until all became quiet.

Of other insects noticeable along the roadside and in the orchards the striking bird grasshopper (*Schistocerca americana*) was quite common.

Occasionally one of the spiny lizards (*Sceloporus u. undulatus*) might be surprised in the road. He would run along the smooth surface for a distance, then scamper into the bushes. It is interesting to see how close they will allow you to get if you move quietly and slowly. I found a specimen one morning on a post, sunning himself. As I carelessly moved toward him he climbed around on the opposite side. Then very quietly I reached a position where I could get a full view of him. I extended my hand cautiously toward him. While doing this he would tilt his head up at me and blink his eyes. If I made a slight irregular movement, he would go a few inches down the post. Finally my hand was close enough so that by a sudden thrust I caught him. Lizards seem to think that anything which is apparently motionless is harmless.

The orchards abound in bird life—doves, thrushes and finches. The mocking-bird loves to build its nest in a thickly leaved tree, while the dove, as usual, scrapes a few sticks together almost anywhere. Where the orchard meets the wood you may rarely see one of those beautiful blue finches (*Guiraca cœrulea*) perched on a tree-top.

The chipmunk makes his home in the clearings.

I wish now to take you down a favorite hollow. Here the undergrowth has been burnt out so that you can see to the top of the ridge on either side. The birds are scarce and, as they are everywhere in the woods about, very shy and difficult of approach. The woodpecker is a-tapping away, while the vireo with his plaintive notes entices you on.

Soon you will come to a spring which goes gliding away for a few rods, then disappears in a rocky bed. In the spring, which is as clear as a crystal, upon stooping to drink, I saw what appeared to be a minnow. I dipped him up with my net, and what did I have but a pretty little salamander scarcely two inches long. He had surely chosen a pleasant place to live in the summer-time.

As we move along, capturing an insect here and there, our ear catches a slight sound of rustling leaves. If we watch close, at the next rustle we may see a tiny lizard dart under the leaves. By dashing to the spot and clapping your hands onto the leaves where we saw the sprite disappear, then with one hand moving the leaves away, we will find Mr. Lizard pinioned. I caught twelve of these fellows by this method in the course of an hour. Upon identification they proved to be *Liolepisma laterale.* The dry leaves seem to be their favorite haunt. I never saw one in any other place.

The little brook continually plays hide and seek until it dashes over a waterfall into a little canyon around which is a cluster of small trees. This is a rendezvous of birds. Conceal youself and you will think that you have come to a woodland paradise. The birds are singing to the tune of the rippling water, trim little forms flit about—all fills your heart with a love of nature.

Wherever you may be in the woods the hornet, *Vespa carolina,* may be found buzzing along among the weeds and bushes about a foot from the ground. His noise is very attractive, but you find that he is not the only insect which hovers close to the ground with the same buzz. There are two flies which can scarcely be distinguished from him by sound. One is of about the same size and color, so that he imitates the hornet perfectly. The other fly mimics him only in sound, being of a green color.

That interesting snout-beetle, *Upsalis minuta,* is found under the bark of old logs along the river valley. The slender proboscis of the female contrasts oddly with the large head and jaws of the male. One of the large bumblebee-like *asilids* is a rare visitant of the dry timber.

Perhaps the prettiest denizens of the wood are the butterflies and humming-birds. They are certainly in keeping with the surroundings, conveying the idea of beauty without a sound.

Snakes do not seem to be very common. Rattlesnakes are reported from the more unsettled parts; copperheads live in the shady localities, while the blacksnake seems to be rare. A lizard which I have neglected to mention is comparatively common under logs. It is *Eumeces quinque-lineatus.* I found one of these in the stomach of a copperhead.

If you visit the woods many times you will carry a lasting memory of the ticks and jiggers. The tick is a wood-tick whose favorite habit is crawling up the back of the neck into the hair.

The birds in the valley are different than those in the hills. It is here that the larger hawks find their prey. These hawks may be found any day in the river-bottom perched on some lone tree.

One day while following a hollow to its head an interesting sight greeted my eye. In an old nest about forty feet from the ground stood a spectre of a bird. At first I thought it was a young owl, it stood so silent and watchful. By tossing stones into the surrounding branches I caused it to move, then another smaller one appeared. I could see then that it was a brood of hawks. Anxious to obtain one of the old birds for identification, I lay in wait for half an hour when the mother swooped down and perched on a neighboring tree. A charge of shot wounded her in the wing, bringing her to the ground.

I started to climb the tree, when one of the young ones flew from the nest into another tree. Fearing lest it should escape, I quickly killed it. I climbed the tree again; but this time, as I was about to reach the nest, the other one tried to fly, but succeeded only in skimming its way like an aeroplane to some branches near by, where it clung head down until I relieved it some ten minutes later. The nest was built very much after the fashion of a crow's nest, being made of coarse sticks. It was placed forty feet from the ground, in a tree which stood at the base of a ridge where two hollows met. Within a radius of seventy feet were four old nests, apparently having been used by this same pair on previous years. This was certainly an excellent nesting site, being concealed on all sides but one by trees growing close together. I had passed this place at least three times before but had not seen the nest. The position was in the center of their hunting-ground, with the hills and valleys on one hand and the clearings on the other.

Examination of the stomachs showed that the old bird had eaten a number of fig-eaters while the young bird contained parts of a blacksnake. This hawk is *Buteo latissimus.*

The fauna of this region is very diverse. The winters are so mild that hibernating animals live in the most favorable conditions. This is on the borderland of the South, and likewise shares in the fauna of both the Northern and Southern states. It is an excellent place for the study of animal distribution. We need to know more of regions of this kind.

THE BURIED CITY OF THE PANHANDLE.

By T. L. Eyerly, Canadian, Tex.

IN Ochiltree county, Texas, on the south bank of Wolf creek, is a group of stone ruins which has aroused the interest and curiosity of all who have visited them, and caused much speculation among those who have tried to formulate a theory to account for their existence. It is a firmly established opinion of many who live in the vicinity that the place where these ruins are was at one time the site of a prehistoric town. This opinion was deduced largely from the fact that the remains resemble to a marked degree foundations of large buildings. So prevalent has this idea been that some of them have received names, such as "The Temple," "The Watchtower" and others, from some fanciful suggestion as to the location or form that would render them fit to serve the purpose of the structure named. The place has been known as "The Buried City" so long that the appellation is retained above, although recent researches have proved the remains to be of a different nature from that generally supposed.

The place has been visited by a number of scientists, and a superficial examination of the ruins made a number of times; but so far as known, no report of the work has ever been published, nor has any sufficient argument been produced to support any of the various theories that have been advanced to explain their origin. It has been an object of such interest to the people of the Panhandle that it was considered by Canadian Academy to be of sufficient importance to demand a more careful examination. With this end in view an expedition consisting of twelve members was equipped and sent out by the scientific department during March of 1907 for the purpose of excavating among the ruins, and the material for this article secured.

The place is situated twelve miles southeast from Ochiltree, the county seat, on section 525, block 43, which section is part of the large ranch owned by Mr. James Fryer. The ruins stand on a level stretch of land covered by native grass, and at the base of a high escarpment caused by a limestone caprock in the Tertiary formation. The immediate surroundings are very picturesque and pleasing to the eye. Situated in a

Expedition encamped on Wolf creek.

bend of Wolf creek, with its abundant supply of crystal waters, and covered at this place with plenty of timber, the site was well fitted to attract with its beauty the hearts of whatever people may have constructed these walls which now lay in ruins. This creek forms the north and partially the eastern boundary. The western boundary is a deep ravine fringed with cedars, and the southern the high walls and buttes of the cliff before mentioned. Thus surrounded it would appeal either to the instincts and superstition of the savage or to the culture and esthetic sense of the Aztec.

Among those who still live in the community, the first to take notice of these remains was Mr. Thomas Connell, who resides at present in Canadian. In 1877 he settled on Wolf creek, on a ranch which he still owns, a few miles from the ruins. The place was at that time known to the old buffalo-hunters who maintained their camps in this region, but of its origin they could tell nothing. The same fall Mr. Connell came he took with him Spotted Wolf, chief of the Arrapahoes, to the site. This chief was at that time near eighty years of age, and he declared that the ruins were never the work of Indians and were placed there long before he was born. Spotted Wolf had more than the ordinary intelligence of the Indian and could understand English well. He attributed the ruins to the work of white men.

Butte with Indian mound and grave excavated by expedition.

The field containing the remains forms an almost exact equilateral triangle, with its apex to the west and with sides one-half mile in length. This makes the area approximately seventy acres. Within this area are situated twelve mounds, some quite noticeable, others so low that their presence is not discovered except on close approach. Some of these mounds are about two feet above the surface of the surrounding plain and are quite regular in their form On each of these it is easy to distinguish the outline of an enclosure made of stone, which bears a strong suggestion, if not resemblance, to the foundation walls of a building. With the exception of one or two, these outlines are rectangular in shape and vary from a few feet to over sixty in their length, and have proportional widths. The stones, however, are not laid as for a foundation or wall of a building, but are set on edge in much the same fashion as the borders of a walk made of unhewn stones would be. The stones vary in size, from a few inches in diameter up to a foot or more. None of them show the least trace of a tool ever having been used on them. They are of the same appearance and character as the stone in the ledge of the escarpment adjoining the field, and doubtless were obtained from the debris of the talus-slopes, which come within a short distance of the mounds. Excavation revealed the fact that there is more than this surface row of stones. They extend down for a depth of two or three feet, or a little lower than the bottom of the mounds. Throughout this distance they appear to have been placed in a similar manner as on the surface and no indication was found to suggest that a solid wall had ever been made of them.

So far as could be ascertained, these mounds were not arranged in the field in any regular order; but there are certain characteristics common to all which are extremely interesting. The state of the remains prevents an exact measurement of the stone outlines, but in general their dimensions are in an even number of feet. With one exception they all face due east and west, with the greatest length in this direction. Instrumental determination found the walls of one to be at exact right angles and appearance indicates this to be true of all of them. In most of them the width of the outline is to the length as three is to four. They all appear to have had an opening in the center of their east wall. From this last fact some have referred this work to sun-worshipers of remote antiquity. The mounds may all be seen from a high butte marked in the map, and this contains remains to be described later. All excavations have yielded remains of human bones, flint chips, pottery and charcoal. The finding of the latter has suggested to some the idea that the stone remains were covered with wooden structures which were all burned. The finding of the human bones impresses some with the belief that the inhabitants were all massacred. The discovery of a broken arrow-head in one of the bones, and the position in which the imperfect remains of a skeleton were found, has strengthened this belief. Over the entire field are scattered flint chips and small pieces of mussel-shells. A number of fragments of pottery and some mutat stones—mills used for grinding corn—have also been found on the field.

By reference to the map the location of the different mounds, and their position with respect to one another and to the surrounding territory, may be ascertained. A detailed description of each one will be given in the order in which it is numbered on the map.

Mound No. 1 has, with the exception of the temple, been of more interest than any other. More excavation was made here and more remains uncovered. It was here that the most perfect skeleton was found. A large mutat stone, a quantity of pottery, and other materials such as this, were discovered in this mound. The space enclosed by the stone remains measures 38 x 28 feet. It was on this one that the instrumental measurements were made which resulted in determining the

Map of Section 565, Block 43, Ochiltree County, Texas, containing Site of "Buried City."

fact that it was laid out with exactness in regard to the cardinal points.

No. 2 measures 44 x 32.

No. 3 is 50 x 25. This ratio of one to two in the dimensions of this one varies from the ratio existing in most of the others.

No. 4 consists of two small enclosures, each a few feet in its dimensions. Both of these yielded traces of bones.

No. 5 is 30 x 23; No. 6 measures 32 x 26. These are both prominent elevations, but little excavation has been done in either of them, and nothing of especial interest has ever been taken from them. These two lie close to the base of the cliff and the stone borders are quite perfect.

No. 7 is also close to the talus slope and the elevation prom-

Mound No. 1, Buried City.

inent. The irregularity in the dimensions here is greater than in any of the others, unless it be the temple. The best measurements which could be determined were, in length, forty-seven feet, and in width, thirty-two feet at the west wall and thirty-seven at the east wall. But this difference could easily be accounted for here by the scattered condition of the stones.

No. 8 is small, measuring but 7 x 6. A number of fragments of skull and rib bones were taken from here at a depth of a foot and one-half or less.

No. 9 shows the stone outline indistinctly and has but slight elevation above the surrounding surface. No remains were taken from this one.

No. 10, referred to as the temple, somewhat irregular in its dimensions, measuring approximately 60 x 20, is the single exception of the entire group in not facing the cardinal points; but instead it stands with its length due southwest and northeast, facing the butte before mentioned, and with indications of an opening in the center of the wall nearest it. A skull was found here, and fragments of the materials before mentioned.

No. 11 has yielded no remains of especial importance. It is 37 x 28, with the mound prominent but the stone outline rather indistinct.

No. 12 is a circular mound ten feet in diameter. From here a number of fragments of bones, pottery and flint chips were taken; and with these was found a smoothed stone of granite resembling an Indian hammer, which is similar to the ones used with the stone mills for crushing corn.

A brief description of the region contiguous to this field is of importance, as it will furnish additional proofs for the support of the theory that will be given as to the origin and antiquity of the remains. On the high butte which is marked on the map, and of which mention has been made, is a circular mound of slight elevation, about twenty-five feet in diameter. It is by all who visit the place connected with the rest of the ruins. There is nothing to confirm this opinion except its close proximity to the field, and the flint chips and arrow-heads, similar to those found in the field, which were taken from this mound. Numerous Indian graves are found on the prominences and buttes which border Wolf creek for some distance up and down and on both sides. These graves are of recent origin, in some cases at least, and the mound in question may be one of these.

In addition to these Indian graves, which are so frequently found on the high buttes bordering Wolf creek, some four miles down from the "buried city," on land owned by a Mr. Jackson, is situated a burying-ground. Excavations here yielded the same class of relics as found in the fields of this description. In one grave was found a small iron hammer badly oxidized. In another a string of glass beads.

To the west of the field containing the mounds, and separated from it by a deep ravine, are to be found remains of a similar nature. This place is designated on the map by *C*. The mounds found here are not so prominent nor are the stone borders so well marked. For a distance of two miles up the creek and on the same side are indications of a like nature. One of these, with large dimensions, is on the bank and has been cut half in two by the stream, exposing to view remains of the same character as those described, and. in addition, a number of buffalo bones and a rib of a small child were taken from here. At this place there is at a depth of from three to four feet a layer of soil in which is mixed small pieces of charcoal. On the creek bank, at the place marked in the map with a cross, there occurs the same layer at about the same depth.

In the northwest corner of the section, and on the north side of the stream, marked on the map as *D*, there are indications of an Indian village having been there at one time, and the adjacent ground cultivated. Scattered over this field are found remains of pottery, flint chips and shells very similar in character to the specimens of the material taken from the ruins on the south side of the creek. A crushing-stone for a stone mill, almost an exact counterpart of the one found in mound No. 12 and described in the details of that place, was picked up here. Parts of teepee-poles, in a state of fair preservation, lie about the field. This space occupies about twenty acres of ground.

As in the case of other remains found in this country whose exact origin is unknown, the prevailing opinion has been to ascribe to the "buried city" a greater age than the evidences will warrant, and to relegate them to the works of antiquity. As yet nothing has been discovered to indicate an age greater than a few centuries, and the probable age is much less. This estimate is based on the character of the remains, their state of preservation and the depth at which they were found. The pottery and flints can with certainty be identified as those of the Plains Indians. The bones found in the mounds, while badly decayed for the most part, in some cases are fairly well preserved. Making all allowance possible for the climatic conditions in this section, which tend to prevent decay, their age could not be greater than that assigned. The depth at which they are found, generally from one to two feet below the surface, indicates but little deposit of material on these ruins. The erosion in this section of the country is very rapid, and the situation of the mounds at the very base of the talus slope renders the site exposed to the deposition of the soil from this source.

Either of two theories has generally been accepted to account for the origin of the ruins. According to one they are considered the work of prehistoric Aztecs; the other holds them to be the remains of camps left by early Spanish explorers. In considering the first enough has been said concerning the age to prove the impossibility of the antiquity that it ascribes. But as some will insist that the Indian remains found may not have any connection with the stone ruins, additional argument will be given. This region is farther east than the remains of the Pueblos, the nearest of living tribes allied to the Aztec, although it must be admitted that it is the borderland between these on the west and the Plains Indians on the east. But the strongest proof against this theory is the fact mentioned in the beginning of the article, that the stone outlines remaining could never have been foundations to houses, much less remnants of walls of structures; the amount of stone present is not sufficient for this, and there is no reason to believe any has ever been removed. The supposition that the Spanish explorers left these remains is as unfounded as the former theory. As far as we know from historical accounts, Coronado in his march from Mexico up into the region now comprising Kansas, passed nearer to this place than any other of these Spaniards. Cabeza de Vaca, in 1528, marched from the present site of Galveston northwest to the Rio Grande, and from thence toward the Pacific coast. But this region, far from the path of either, is too remote from the Spanish settlements to admit of its being an outpost, even if the remains indicated the site of a town, while the exposed position they occupy would preclude the possibility of their having been built for fortifications.

That the Plains Indians were the builders of these mounds there can be no doubt. The pottery and flints found here are the culture of these tribes and can be found all over the plains region northward and eastward from this section. The Wolf creek valley was for years the trail over which the migration to and fro of these tribes from the Indian Territory and adjacent country to Mexico and Arizona took place. Their remains are scattered along the entire way; but these remains of recent times are not to be confounded with those of the "buried city," which certainly antedated them by many years and form a distinct subject for ethnological research.

The use for which these mounds were intended was, we believe, solely for burial purposes. Every one of them that has been excavated has yielded human bones, but not in greater quantity than to indicate that each one was the grave of a single person. In more than one place in the Iowa reservation in northeastern Kansas we have seen the graveyards of the Indians of recent times laid out in a crude way, and each grave edged with wooden pickets in much the same way that these mounds are set with stone.

There are certain peculiarities in the remains of the "buried city" that deserve careful attention and are worthy of future research. The size of the enclosures, the marked regularity of the walls in respect to dimensions, directions and openings toward the east, indicate the work of a tribe more advanced in civilization than were the majority of the Plains Indians. As their remains are meagre and their history unwritten, an air of the mysterious and the unknown will always cling about this place, "The Buried City of the Panhandle."

SCIENTIFIC FALLACIES AND FRAUDS.

By W. F. Hoyt, Wesleyan University, Salina.

WHETHER the Darwinian theories have played the chief part in the development of living beings is being questioned by Hugo DeVries and other present-day investigators; but that scientific theories themselves are subjected to the most rigid application of the principle of the "survival of the fittest" cannot be doubted. The pathway of human progress is strewn with the debris of cast-off theories of natural phenomena. The student is often perplexed by the facility with which science molts her outgrown coverings, but this same facility is an evidence of abounding life and vigorous growth. Each discarded theory, however, if based upon careful observation and rational deduction, served its purpose of aiding science in its search after truth, just as the varying tacks of a sailing-vessel brings it nearer its destination, though few of them were in the direct line of port.

In order to claim the serious consideration of scientists, a theory concerning natural phenomena must stand the following tests: (1) It must accord with the facts of nature, and should be based upon painstaking investigation. (2) It should furnish rational explanation of certain phenomena, without conflicting with other well-known facts. Nature is not contradictory. (3) It should be simple and ought not assume greater causes than are necessary to explain the phenomena under consideration. Nature is direct and economical in her operations. She rarely invokes an earthquake to overturn an anthill.

There have been in all ages, including the present one, ill-informed theorists who believe that the fancies and phantasms that course through their disordered craniums have the same stamp of divine authenticity as a prophetic vision, especially if they misquote and misapply the Scriptures in support of their theories. They have their uses, perhaps, in adding to the hilarity of thinking people, but hardly add to the sum total of human knowledge. These misconceived theories fail in one or all of the above tests. They are usually not in accord with the facts of nature, they do not furnish rational explanation for natural phenomena, nor are they based upon accurate and adequate observation. That branch of science known as theology has its full share of freaks and frauds and fallacies, as shown by the numberless creeds that afflict the human race. The crazier the founder, and the more foolish the dogma, the more devoted are its followers in many cases. The concrete sciences, too, have their quota of fakes and fakirs. Only the sublime may have its antipode in the ridiculous.

There are two kinds of fallacies: First, those promulgated by scientific investigators, whose hypotheses have missed the true cause for the well-attested effects; and second, mere fancies which have no rational basis in natural phenomena. In the first class are a goodly list of distinguished names. Darwin's hypothesis of pangenesis to explain the facts of heredity is a typical case. Darwin was an investigator and philosopher par excellence, and his theory was somewhat less absurd than its predecessor, which predicates germ within germ within germ, *ad infinitum*. The theory of abiogenesis, or spontaneous generation, seems as tenacious of life as the fabled hydra. Every one of its multiple heads has been cut off, time and again, and by all the laws of bionomy it should have died the death long ago, but it persistently bobs up now and then, with such notables as Professors Haeckel and Loeb as sponsors, not to mention the interminable list of cranks and semi-cranks seeking notoriety. Newton's corpuscular theory of light died hard, but it died, despite the efforts of Wilford Hall *et al.* to galvanize it into life. It had a sort of *post-mortem* vindication, however, in the phenomena of radio-activity. Dalton's theory of the indivisible atom received a rude shock from the same source.

But it is with the second class of fallacies that this paper is chiefly concerned. Two or three years ago I received a pamphlet from some unknown individual in Delaware, Ohio, claiming to disprove the law of gravitation. His assumptions were not based on facts, and in closing he naively said he had not yet tested his theories, but he promised to do so as soon as he got sufficient leisure. A gentleman came into the office of Simon Newcomb, on the third floor of the Smithsonian Institution, Washington, D. C. "You astronomers are all wrong," he declared; "I can prove that there is no such thing as gravitation." "Yes, you can," replied Newcomb. "If you will jump out of that window and not fall to the ground, you will prove your statement." "Well, Mr. Newcomb, gravitation may act near the earth's surface, but it does not extend above the atmosphere, and does not reach to the moon at all." "How do you know?" retorted Newcomb. "Have you been up there to see?"

Cosmogony is another of the favorite topics of scientific freaks. I received an ungrammatical, misspelled mimeograph letter recently, from which I quote literally: "Our Moon is a skeleton of a former planet, rising too near the sun, she lost her gaseous belt through combustion, being now without lifting power, she plunged into space; her naked body ignited being exposed to friction against universal matter, her interior gradually burned out, and as the lava oozed out of her volcanoes, being unrestrained by atmospheric pressure, flowed unhindered into space forming gigantic talcs, as she swepped majestically through space. Through eruptions a multitude of chambers formed in her interior, which gradually filled up with gaseous matter, by which means the former planet, transformed into a comet maintained her position and finally collided with our planet, penetrated her gaseous belt, sank deep into our atmosphere and revolutionized the whole of our planetary surface, continents disappeared and reappeared from ocean beds, mountains slided into oceans, and ocean beds raised up gigantic peaks, confusion and terror prevailed among animals, new species were created through fright and the human race became possible." There you have the whole story—astronomical, geological and biological in two stupendous sentences, for, "swepped" on by the irresistible current of his phantasmagoria, he stops but once to breathe. No doubt the above explains the statement that "We are fearfully and wonderfully made!" The author further on asserts that Mars and Uranus consist of hydrogen, Saturn of oxygen, and Jupiter and Neptune of nitrogen, and that as these heavenly bodies sweep through our atmosphere these gases mix, and combine to form rain. The rings of Saturn, it seems, are gigantic rainbows! There is not a hint of hesitation or doubt throughout the paper. One is reminded of the caustic criticism of a similar dogmatist, "Every time he opens his mouth he subtracts from the sum total of human knowledge!"

The above is only one of the worst of the phantasms which the freaks perpetrate upon the long-suffering public. I have in my possession a bound pamphlet from an "M. D.," of

Evansville, Ind., who makes electricity the "Open Sesame" to the universe. It causes gravitation, planetary motions, the heat of the sun, glaciers, earthquakes, the rings of Saturn (and of Jupiter also, according to his pamphlet), sun-spots, etc. Many of his so-called facts are figments, and others are badly garbled facts. A college education, including an elementary course in electricity and astronomy, would increase his store of knowledge, and incidentally his respect for natural phenomena.

A few years ago I received postpaid a sample copy of a cloth-bound book of some 200 pages of as rich, unconscious humor as I ever read. As a sample, the author insisted that the stratified rocks of the earth were wound upon our globe as a revolving spindle, from the cometary visitants to the solar system. A comet coming near the earth would get its tail tangled on the rapidly revolving earth and be wound upon it, forming a particular geological layer. A proof of this theory is the regular geological formations of differing materials, that must have come from different comets—if not, from what source could they come, pray tell me that? I sat up to the wee hours one night to complete this book, and I felt like Henry Ward Beecher after finishing Uncle Tom's Cabin under similar circumstances—"If Harriet should write another such book, it would be the death of me!"

A similar publication, that comes geographically nearer home, contains some interesting modifications of the above theories, and some startling information to the humdrum scientist. The author modestly promises to revolutionize science and "place it on a higher plane." He begins by explaining that the original earth was a perfect sphere, but that its present spheroidal shape is due to the loose "originary" matter wound upon it in much the same way as explained above. The original earth was made up of globular masses of this same "originary" matter, the interspaces of which were filled up with water, which was decomposed by the heat generated by pressure, and its elements, uniting with carbon, formed petroleum and natural gas. Gravity, too, is due to electricity, and like it may be reversed and become a force of repulsion rather than attraction. He proves this by the phenomena attending cyclonic disturbances, a theory that simplifies the terrible lifting power of tornadoes. He forestalls Nikola Tesla by announcing that the Martians have been bombarding us with messages in the form of meteorites propelled by reversed gravity, lo, these many years. A meteorite that fell near Rochester, N. Y., several years ago, by the indubitable testimony of a public school teacher of that city, and the New York *Sun*, has some cuneiform writing that must be a celestial message, from Mars in all probability. One thing to be regretted is that the author failed to translate this "coelogram," a feat much less tiring to the imagination than the formation of many of his truly original hypotheses. Bodily nutrition and growth are very simple phenomena, identical, in fact, with electroplating, with the "tissue atoms" as the ions. Space he proves in three short sentences, without any of the usual preliminary investigation so necessary to the ordinary clumsy intellect, to be the "originary" matter from which all other matter is derived, and incidentally to be unlimited in extent. The famous whirlpool nebula he calls "Cane's Venatici," but fails to identify the Mr. Cane after whom it was probably named. He has a much more intimate knowledge of the moon than any other scientist, as is clearly shown by a cut which he insists is a photograph, but which bears some of the earmarks of a woodcut. The photograph, if authentic, must have been exposed somewhere on our satellite's surface.

But it is in connection with the polar regions his volume is most replete with original information. As one sails due northward, at about eighty degrees latitude the polar star rapidly approaches the zenith and drifts to the rear of the vessel. One wonders if his data for this interesting piece of information is not the nautical yarn concerning the apprentice pilot whom the captain left in charge of the wheel with the injunction to steer straight for the north star. A few minutes later the captain was aroused by a call to come up and pick out another star, as the vessel had passed the other one. The regions about the poles, contrary to the usual belief, are the hottest places on the globe during their long day, and, of course, the coldest during their long night. He darkly hints that Andre certainly perished from excessive heat, if he ever succeeded in approaching the pole. During the arctic night the temperature frequently falls so low that liquid air falls as a gentle rain. This is stated on the testimony of "many explorers." Glaciers consist of alternate layers of ice and liquid air. There are several polar islands that consist wholly of the carcases of mammoths and other giant vertebrates, piled upon one another from the sea bottom to the surface, and so well preserved that their flesh is eaten by Esquimaux and arctic carnivora. Really, our friends Sternberg, Henry, Fairfield, Osburn, and other paleontologists should be informed by wire of these inexhaustible deposits, so they will not waste any more time on the barren deserts of Africa and our own West. The change of climate in polar regions, from tropic heat to arctic cold, was so sudden that many of these huge beasts were "frozen while peacefully grazing on the previously unfrosted vegetation." One is reminded of the naive remark of a four-year-old boy, after gazing on some good specimens of taxidermal skill—"How did they get them dead standing?"

The laws of the conservation of matter and force are points for attack upon prevailing theories. Inventions have been multiplied to secure perpetual motion, or to do work without the expenditure of an equivalent amount of energy. For twenty odd years a man by the name of Keeley induced the public, including many capitalists, to believe he had discovered an occult force hitherto unknown, that was utilized in his laboratories to run a machine, called after him the Keeley motor. He was constantly on the point of perfecting it so it could be put to practical use. For a quarter of a century hard-headed business men of New York, after a look into his laboratory at the motor buzzing away without any apparent expenditure of energy, invested thousands of dollars to enable him to complete his invention. After his death, an investigation of the laboratory revealed that the occult force was plain compressed air contained in tubes concealed beneath the floor, and Keeley slipped into his place among the fakirs.

Last year the papers of the state contained descriptions of an application of a windmill to secure locomotion. Its inventor, a Kansan, gravely claimed his machine would run faster against the wind than with it, because the windmill would turn faster in such case. Mr. Chas. Trippler, of New York, the first man to manufacture liquid air in large quantities in this country, in an article in the McClure, several years ago, claimed he could run his machine with liquid air and at the same time produce more liquid air than he used for motive power. He has probably reread and meditated upon the law of conservation since that date.

Radio-activity is sometimes referred to as violating the law of conservation, because radium and other radio-active elements seem to give off energy and emanations without loss of matter or force. This is only an apparent contravention, however, because radium and all other radio-active substances do lose both matter and energy through their emanations, but so slowly as not to be easily detected. Radio-activity is now known to consist in a slow disintegration, a breaking up into less complex elemental substances of lower density.

There are other scientific pretensions which ought not to be euphemistically considered fallacies, because their promulgators are not self-deceived, except in so far as they think they can deceive all the scientific world all the time, for fraud, like murder, will out, sometime, somewhere. The less-pleasing term, fake or fraud, is more accurate and apt. The famous Cardiff giant is sufficiently distant, in scientific time at least, to excite only a reminiscent smile. It has had many successors, but none so successful. The widely-advertised Calaveras skull is not so ancient as not to cause a wry face and nausea even as "Poor Yorick's." That the cranium of a Digger Indian should have been accepted as that of Tertiary man, even by the elect, is not a pleasant thought. A most amusing instance of attempted fraud fell under my observation a few years ago. Stepping into a clothing establishment, my attention was called to a very fine display of sea life in a large wall case. There were seaweed, sponges, coral, flying-fish, etc.; and last, but not least by any means, a perfectly preserved specimen of a mermaid. There it was before my wondering eyes as plain as it ever manifested itself to the gaze of any mediæval seafaring man—half scaly fish, and half anthropoid ape. The mermaid thus was rescued from the castle of myths and handed over to the taxonomist for classification as best he may. The proprietor, in answer to my questions, very glibly and with seeming pride informed me those specimens came from near Los Angeles, and asserted that he had caught the mermaid himself.

From repeated deception the scientist is learning extreme caution concerning alleged discoveries and revolutionary theories. There are many mysteries which science has never explained, and may never solve, but thanks to the patient investigator and the keen philosopher, there are some things we do know, even if seen as "through a glass darkly." One of these certainties is that if the established facts and principles of modern science are ever overthrown it will be by the trained scientist with microscope, telescope and spectroscope, not by the ignoramus with a divining-rod. Russia, the typical military power, was defeated, not by the undisciplined hordes of Asia, but by Japan, with all the enginery of militarism, together with trained and disciplined men behind the guns. In like manner, scientific tenets can be disproved only by the rigid laboratory methods of present-day science.

HARMONIC FORMS.

(SECOND PAPER.)

By BERNARD B. SMYTH, Topeka.

Read in abstract before the Academy, at Emporia, Kan., November 30, 1907.

CHAPTER I.—PERFECT SQUARES.

THE requirements of a *magic square* are that all the columns, horizontal lines and two main diagonals of the proposed square should add equally.

In a *harmonic square* not only do the rectilineal lines and diagonals add equally, but the sum of the vertices of all possible regular quadrilateral figures, as squares, rectangles, rhombs, and rhomboids, add equally. Harmonic squares are possible only when the root of the square, or number of cells on a side, is divisible by 4.

The term *perfect square* is applied to a square which adds equally not only in all the rectilineal lines but also in all the diagonal lines, thus making in straight lines a number of sums equal to four times the number of cells on one side of the given square. Thus a square of 4 should give 16 equal sums; a square of 5 should give 20 equal sums; a square of 6 should give 24 equal sums, etc. But the perfect squares here shown are of a superior character, and not only add equally in the many ways shown, but also add equally in all possible quadrilateral figures in any part of the square when as many cells are included in the quadrilateral as the number of cells on a side of the square.

Perfect squares are now constructed of any number of cells on a side above 3. A perfect square of 3 is impossible, for the reason that the number of sums necessary to entitle a square of 3 to be called "perfect" is twelve, while the greatest number of equal sums that can be obtained from any three numbers of a regular series of nine numbers is eight, as shown in part I of this paper, published in volume XIV of these Transactions (1894), pages 47, 48.

To form any sort of a magic square the given series must be divided into as many sets as there are cells on one side of the square. Whatever arrangement be given to the first set must be followed absolutely by each of the other sets The members of the first set need not be taken consecutively from the series, but may be taken in any order whatsoever. An unused number of one set may be taken as a member of another set.

In odd squares all sets must be placed parallel to the first. In even squares compensatory arrangements must be observed so as to preserve a rhythmic or balanced effect. The initial members of the several sets in a perfect square need not be equidistant mathematically. It is only necessary in odd squares that the initials of the several sets bear the same relation to each other in position as the second does to the first, and in even squares be opposed, so as to balance.

SECTION 1.—Perfect Square of Four.

Perfect squares of four cells on each side may be formed, as are harmonic squares, according to certain schemes which are here shown. They may be formed without the aid of a visible scheme; but human ability to see a mental picture of all numbers in position before writing any is not great and the visible scheme is a great help in that direction.

Before showing any of the schemes a few definitions would seem to be desirable.

DEFINITIONS.

An *adjacent* number, line or column is the one next to it in the same half square, as first and second are adjacent to each other; third and fourth are adjacent. Second and third, though contiguous, are not adjacent. An adjacent quarter is one on the same side, whether vertically or horizontally.

An *alternate* number, cell, line or column is the second removed, or with one intervening, as first and third are alternate; second and fourth are alternate.

An *opposite* line or column is the one in the opposite part of the square that would come against it if we fold the square along its middle line, as first and fourth are opposite; second and third, though contiguous, are opposite. An opposite cell or quarter is the one diagonally or diametrically opposite.

A *couplet* is two numbers in succession in a series, consisting, in a series whose first term is 1 and whose common difference is 1, of an odd and an even number; and in any other series consists of two numbers side by side when the entire series is arranged in pairs from the beginning. The first member of each couplet may be called the antecedent or leader and the second the consequent or follower.

A *pair* is two numbers standing side by side in the same quarter of the square. A columnar pair are those in the same vertical line; a linear pair are in the same horizontal line. A couplet should never be a pair.

A *complement* of a number in any square is the difference between that number and half the sum of a line in that square.

SCHEDULE OF SCHEMES.

SCHEME I (fig. 17).—*Coupling-arrows joining alternate columns and opposite lines.* Numbers of trial arrangements govern two upper lines. This places 15 adjacent to 1 in same column.

In order to produce a perfect square from scheme 1, the eight coupling-arrows of the scheme are numbered at their upper ends in such a way that each of the two rows of arrow numbers adds 18 horizontally and 9 vertically. There are six possible combinations, each of which will produce a perfect square differing from every other. From these trial arrangements the following six model perfect squares are produced, strictly according to the scheme:

FIRST ARRANGEMENT.

1	7	6	4
8	2	3	5

1	14	11	8
15	4	5	10
6	9	16	3
12	7	2	13

No. 1.

SECOND ARRANGEMENT.

1	7	4	6
8	2	5	3

1	14	7	12
15	4	9	6
10	5	16	3
8	11	2	13

No. 2.

THIRD ARRANGEMENT.

1	6	7	4
8	3	2	5

1	12	13	8
15	6	3	10
4	9	16	5
14	7	2	11

No. 3.

FOURTH ARRANGEMENT.

1	6	4	7
8	3	5	2

1	12	7	14
15	6	9	4
10	3	16	5
8	13	2	11

No. 4.

FIFTH ARRANGEMENT.

1	4	7	6
8	5	2	3

1	8	13	12
15	10	3	6
4	5	16	9
14	11	2	7

No. 5.

SIXTH ARRANGEMENT.

1	4	6	7
8	5	3	2

1	8	11	14
15	10	5	4
6	3	16	9
12	13	2	7

No. 6.

Equal sums are obtained from this square by adding together four numbers in each of the following regular ways:

	Ways.
1.—By lines—	
Each of the columns (fig. 1)	4
Each of the lines (fig. 2)	4
Every diagonal line, entire or broken (figs. 3, 4)	8
2.—By squares—	
The four corners and the four centrals (fig. 5)	2
Any four contiguous numbers in a square (figs. 5, 6, 7)	8
Corresponding corners of quarters (fig. 8)	4
3.—By rectangles—	
Linear pairs opposite lines (figs. 9, 10, 12)	3
Columnar pairs in opposite columns (figs. 9, 11)	3
4.—By rhomboids and trapezoids—	
Columnar pairs at opposite ends of alternate columns (fig. 13),	4
Linear pairs at opposite ends of alternate lines (fig. 14)	4
Opposite numbers in alternate lines (fig. 15)	4
Opposite numbers in alternate columns (fig. 16)	4
Total regular ways of adding 34	52

Each of these squares yields the equal sum of 34 in 52 regular ways, as here shown, taking the first one as an example:

RIGHT LINES.

1 + 14 + 11 + 5 = 34
15 + 4 + 5 + 10 = 34
6 + 9 + 16 + 3 = 34
12 + 7 + 2 + 13 = 34
1 + 15 + 6 + 12 = 34
14 + 4 + 9 + 7 = 34
11 + 5 + 16 + 2 = 34
8 + 10 + 3 + 13 = 34

DIAGONAL LINES.

1 + 4 + 16 + 13 = 34
14 + 5 + 3 + 12 = 34
11 + 10 + 6 + 7 = 34
8 + 15 + 9 + 2 = 34
1 + 10 + 16 + 7 = 34
14 + 15 + 3 + 2 = 34
11 + 4 + 6 + 13 = 34
8 + 5 + 9 + 12 = 34

RECTANGLES.

1 + 14 + 15 + 4 = 4
14 + 11 + 4 + 5 = 34
11 + 8 + 5 + 10 = 34
1 + 15 + 8 + 10 = 34
15 + 4 + 6 + 9 = 34
4 + 5 + 9 + 16 = 34
5 + 10 + 16 + 3 = 34
15 + 6 + 10 + 3 = 34
6 + 9 + 12 + 7 = 34
9 + 16 + 7 + 2 = 34
16 + 3 + 2 + 13 = 34
6 + 12 + 3 + 13 = 34
1 + 14 + 12 + 7 = 34
14 + 11 + 7 + 2 = 34
11 + 8 + 2 + 13 = 34
1 + 11 + 6 + 16 = 34
14 + 8 + 9 + 3 = 34
15 + 5 + 12 + 2 = 34
4 + 10 + 7 + 13 = 34
1 + 8 + 12 + 13 = 34

RHOMBOIDS.

1 + 15 + 16 + 2 = 34
14 + 4 + 3 + 13 = 34
11 + 5 + 6 + 12 = 34
8 + 10 + 9 + 7 = 34
1 + 14 + 16 + 3 = 34
15 + 4 + 2 + 13 = 34
6 + 9 + 11 + 8 = 34
12 + 7 + 5 + 10 = 34

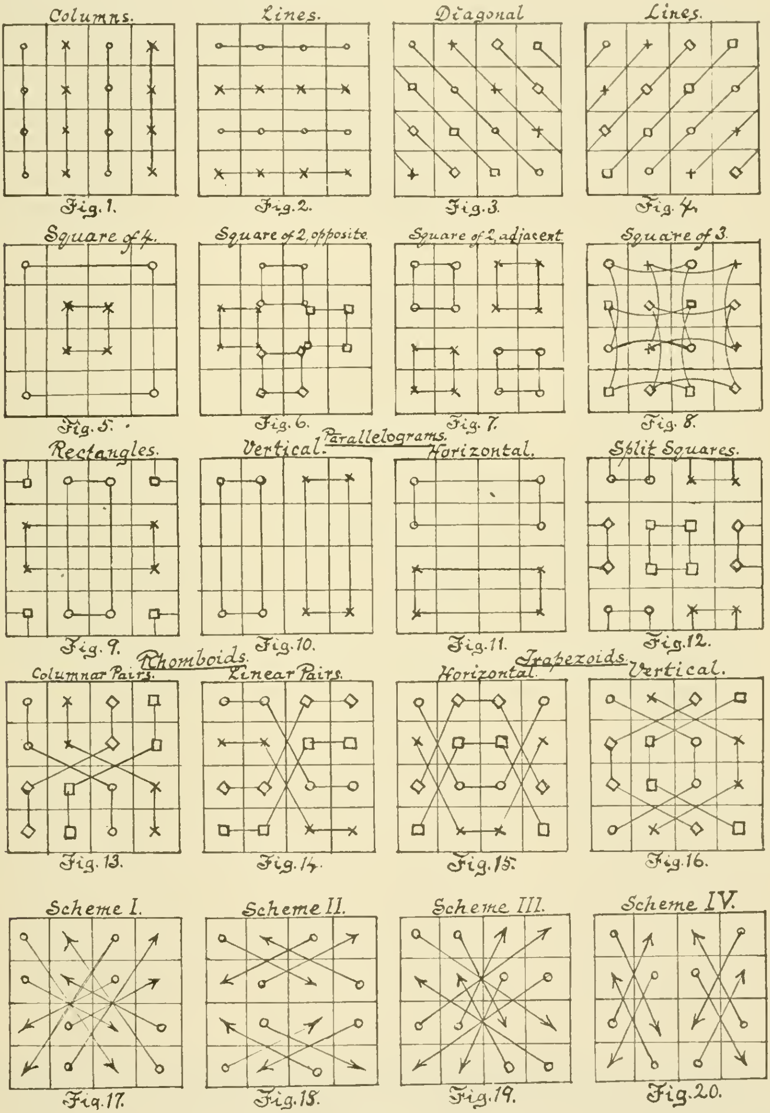
TRAPEZOIDS.

1 + 8 + 9 + 16 = 34
15 + 10 + 7 + 2 = 34
6 + 3 + 14 + 11 = 34
12 + 13 + 4 + 5 = 34
1 + 12 + 5 + 16 = 34
14 + 7 + 10 + 3 = 34
11 + 2 + 15 + 6 = 34
8 + 13 + 4 + 9 = 34

Total sums of 34 = 52

RULE.—To fill a square according to this scheme consider the eight numbers in one of the trial arrangements to represent the eight couplets of the series; apply the numbers in consecutive order to the upper ends of the coupling-arrows in the scheme; double each number in turn and place the product in the cell corresponding with the point of the arrow; subtract 1 from that product and place in the cell corresponding to the tail of the arrow (represented by a circle). The result will be a perfect square.

From each of these six squares fifteen other squares apparently different may be formed by simply transposing one or more lines from any one side of the square to the opposite side, without in any degree changing the perfection of the square. This makes ninety-six perfect squares that can be made from that one scheme.



The construction of schemes for perfect squares is hedged by the necessity of having not more than two arrow-points in any line, column, or diagonal, whether whole or broken. And besides, an arrow cannot begin and end in the same line, either vertically, horizontally, or diagonally. Only four schemes for perfect squares have so far been constructed.

SCHEME II (fig. 18).—*Coupling-arrows joining alternate columns and adjacent lines.* This scheme is readily transformable from scheme I. It is only necessary to transpose the second and fourth lines. The numbers of the coupling-arrows in the trial arrangements are placed as before; but, instead of governing adjacent lines as before, they are to be applied to the top and bottom lines. This puts 15 in the lower left-hand corner. The model squares resulting from the six arrangements are as follow:

FIRST ARRANGEMENT.

1	7	6	4
8	2	3	5

1	14	11	8
12	7	2	13
6	9	16	3
15	4	5	10

No. 7.

SECOND ARRANGEMENT.

1	7	4	6
8	2	5	3

1	14	7	12
8	11	2	13
10	5	16	3
15	4	9	6

No. 8.

THIRD ARRANGEMENT.

1	6	7	4
8	3	2	5

1	12	13	8
14	7	2	11
4	9	16	5
15	6	3	10

No. 9.

FOURTH ARRANGEMENT.

1	6	4	7
8	3	5	2

1	12	7	14
8	13	2	11
10	3	16	5
15	6	9	4

No. 10.

FIFTH ARRANGEMENT.

1	4	7	6
8	5	2	3

1	8	13	12
14	11	2	7
4	5	16	9
15	10	3	6

No. 11.

SIXTH ARRANGEMENT.

1	4	6	7
8	5	3	2

1	8	11	14
12	13	2	7
6	3	16	9
15	10	5	4

No. 12.

Ninety-six additional perfect squares, in every respect equal with the original ninety-six, can be made from these six arrangements.

SCHEME III (fig. 19).—*Coupling-arrows joining alternate* *lines and opposite columns.* This scheme is the same as scheme I turned over on its direct central diagonal. The numbers of the coupling-arrows in the trial arrangements are to be placed in two columns so that they add 18 vertically and 9 horizontally, and are to be applied to the left-hand ends of the arrows, which fall in the first and second columns. That puts 15 at the top of the second column adjacent to 1. The resulting model squares here follow:

FIRST ARRANGEMENT.

1	8
7	2
6	3
4	5

1	15	6	12
14	4	9	7
11	5	16	2
8	10	3	13

No. 13.

SECOND ARRANGEMENT.

1	8
7	2
4	5
6	3

1	15	10	8
14	4	5	11
7	9	16	2
12	6	3	13

No. 14.

THIRD ARRANGEMENT.

1	8
6	3
7	2
4	5

1	15	4	14
12	6	9	7
13	3	16	2
8	10	5	11

No. 15.

FOURTH ARRANGEMENT.

1	8
6	3
4	5
7	2

1	15	10	8
12	6	3	13
7	9	16	2
14	4	5	11

No. 16.

FIFTH ARRANGEMENT.

1	8
4	5
7	2
6	3

1	15	4	14
8	10	5	11
13	3	16	2
12	6	9	7

No. 17.

SIXTH ARRANGEMENT.

1	8
4	5
6	3
7	2

1	15	6	12
8	10	3	13
11	5	16	2
14	4	9	7

No. 18.

Remark.—It is to be noted that the celebrated square of the Greek Moschopulus, first published, so far as known, in the sixteenth century, translated into Latin by Delahire and read by him before the French Academy of Sciences in 1691, is really a harmonic square and fits nicely into my harmonic system as square No. 41, under scheme II, published on page 58 of volume XIV, Transactions Kansas Academy of Science (1893-'94), and by an easy transposition of the fourth column for the third, and the fourth line for the third, it becomes a perfect square like No. 15 above.

SCHEME IV (fig. 20).—*Coupling-arrows joining alternate lines and adjacent columns.* This is the same as scheme III, with the second and fourth columns transposed. The numbers in the trial arrangements are therefore to be applied to the first and fourth columns. This puts 15 in the upper right-hand corner. The six model squares here follow:

FIRST ARRANGEMENT.

1	8
7	2
6	3
4	5

1	12	6	15
14	7	9	4
11	2	16	5
8	13	3	10

No. 19.

SECOND ARRANGEMENT.

1	8
7	2
4	5
6	3

1	8	10	15
14	11	5	4
7	2	16	9
12	13	3	6

No. 20.

THIRD ARRANGEMENT.

1	8
6	3
7	2
4	5

1	14	4	15
12	7	9	6
13	2	16	3
8	11	5	10

No. 21.

FOURTH ARRANGEMENT.

1	8
6	3
4	5
7	2

1	8	10	15
12	13	3	6
7	2	16	9
14	11	5	4

No. 22.

FIFTH ARRANGEMENT.

1	8
4	5
7	2
6	3

1	14	4	15
8	11	5	10
13	2	16	3
12	7	9	6

No. 23.

SIXTH ARRANGEMENT.

1	8
4	5
6	3
7	2

1	12	6	15
8	13	3	10
11	2	16	5
14	7	9	4

No. 24.

Remark.—One of the most conspicuous objects in an old copper engraving, entitled "Melancholia" and executed by Albrecht Dürer in Nuremberg, Bavaria, in 1514, is a well-prepared magic square. It appears to be a modification of the square of Moschopulus, by *reinversion,* or reversing and inverting, and transposition of the second and third columns. The date, 1514, however, would seem to antedate or be cotemporary with Moschopulus. The square is perfectly harmonic; and on reinversion is exactly the same as my No. 47, scheme IV, harmonic system, page 59 of volume XIV, Transactions Kansas Academy of Science, 1894. On transposing the third and fourth columns and the third and fourth lines it becomes "perfect" and is No. 21 above. A comparison of Nos. 21 and 15 above will show the similarity of those two old magic squares when reduced to a primary condition. They are both probably modifications of some still older magic square.

As each of the above twenty-four primary squares can be transposed into fifteen other squares, it follows that 24×16, or 384, different perfect squares can be constructed from these four schemes. No other schemes for perfect squares of 4 are possible.

A SIMPLE METHOD.

A simple method of forming perfect squares of 4 without the aid of a scheme or prearranged plan has been evolved by Mr. D. H. Davison, of Minonk, Ill.; and as still further simplified and modified by the present author is here presented:

1			15
	2	16	

FIRST STEP.

1			15
14			4
	2	16	
	13	3	

SECOND STEP.

1	12	6	15
14			4
11	2	16	5
	13	3	

THIRD STEP.

1	12	6	15
14	7	9	4
11	2	16	5
8	13	3	10

COMPLETE SQUARE.

No. 19.

1.—(*a*) Place 1 in the upper left-hand corner and (*b*) its complement, 16, in the alternate or second cell diagonally from it; (*c*) place 2 in either one of the four cells next to 16, above, below, or on either side, and (*d*) its complement, 15, in the alternate cell diagonally from it.

2.—(*a*) Place 3 in one of the three remaining cells next to 16, and (*b*) its mate, 4, in a cell relatively from 3 as 2 is from 1. For instance, if 2 is in an alternate line and adjacent column from 1, then 4 must be placed in an adjacent column and alternate line from 3. Thus the harmony of the square is preserved. (*c* and *d*) Their complements, 14 and 13, are to be placed in the alternate diagonal cells from each of them respectively.

3.—(*a*) Place 5 in either one of the two remaining cells beside 16, and (*b*) its mate, 6, in the same position relatively to 5 as 2 is to 1; that is to say, in an alternate line and adjacent column. (*c* and *d*) Their complements, 12 and 11, are to be placed, as before, in the alternate diagonal cells from each of them.

4.—(*a*) Place 9 in the only remaining cell next to 16, and (*b*) its mate, 10, in the same relative position to it as 2 is to 1. (*c* and *d*) Their complements, 8 and 7, are to be placed as before in the alternate cells diagonally from them.

The numbers 2, 3, 5 and 9 are always to be laid around 16. The reason for this is that these four places are just a "knight-step" or paladin step from 1; all other cells in the square are in the same line with 1, either vertically, horizontally, or diagonally; 16 is at the intersection of the two diagonals. The four numbers mentioned must occupy those four cells and no other. They may be laid in any order. The number 9 may be placed first if preferred, and may be placed in any of the four vacant cells next to 16. It is immaterial what order these four numbers are placed in; it *is* material where their mates are placed.

Once an antecedent number is placed in a cell there is only one place for its mate, according to the scheme, and one place for each of their complements. There are really four places in either of which a consequent of a couplet may be placed; but there are four schemes; and whatever scheme is adopted for the first couplet must be followed for all the rest, in order to preserve the unity and harmony of the square.

So the placing of 2 immediately predetermines the position of seven other numbers; for the position of every consequent of a couplet must bear the same relation to its antecedent that 2 bears to 1. Mates are always a paladin step apart, that is, two cells in one direction and one cell at right angles to the two; for while they may appear otherwise, the one is a paladin step from the other across the margin of the square, as though the other were in its proper position in an adjoining square. The real position of the consequents, however, depends upon the positions occupied by 3 and 5, in the placing of each of which there is some latitude.

Similarly, the placing of 3 predetermines the position of three other numbers which are the leaders of the second couplet of the three following sets, as 3 is the leader of the second couplet of the first set.

The placing of any number immediately determines the position of its complement; and this complement can and should be laid at once, thus simplifying the construction of the square.

The first number laid around 16 has a choice of four positions; the second number has a choice of three; the third number has a choice of two positions and may be laid in either; the fourth number has only one place left for it. Multiplying together these factors, 4, 3, 2, and 1, we obtain 24 as the possible ways of arranging the sixteen numbers into a perfect square, with 1 placed in a certain definite place, as, for example, in the upper left-hand corner.

VARYING SERIES AND SPECIAL SUMS.

It is by no means necessary in order to produce a perfect square that a series shall be absolutely uniform; it is only necessary that the common differences shall be harmonic, rhythmic, or concordant. There are four kinds of differences in a series of sixteen terms, namely:

1. The difference between the antecedent and consequent in each couplet. There are eight couplets in a series and therefore eight of these differences ($=d$).

2. The differences between the leading couplet and the following couplet of each set, thus coming in the middle of each of the four sets. There are four of these in any series of sixteen numbers. For the purpose of distinction these differences will be called *notches* ($=n$).

3. The differences between adjacent sets of four in each half of the series. There are two such differences, one coming in the middle of each half. These will be called *side gaps* ($=g$).

4. The difference between the two halves of a series. There is but one of this. It is the *main gap* (=G).

Some other terms may be represented by letters for convenience. For example, let a represent the first term, q the last term, and S the sum of all the numbers in one row of the square, whether columnar, linear or diagonal.

On arranging the terms of a series of sixteen numbers in a row by number, the differences will appear thus:

a 1 d 2 n 3 d 4 g 5 d 6 n 7 d 8 G 9 d 10 n 11 d 12 g 13 d 14 n 15 d 16 a

It will be evident that in a square of 4, since four numbers are included in each equal sum, the sum of any line should equal twice the sum of the extremes (a and q); and the last term should equal the first term plus all the differences between the extremes. Written out in the form of equations these statements would appear thus:

$$S = 2(q+a) \quad \text{or} \quad S = 2q + 2a,$$
$$q - a = 8d + 4n + 2g + G, \quad \text{and}$$
$$q = a + 8d + 4n + 2g + G; \quad \text{whence,}$$
$$S = 4a + 16d + 8n + 4g + 2G$$

A few examples will show how to use these formulæ:

PROBLEM.—Let it be required to write a square of 4 from a varying series which will give sums of 64.

SOLUTION.—There are eighty-three series of integral numbers, without resorting to fractions, which will yield sums of 64 in a square of 4. Three such series will be selected as examples:

(1)	1	2	5	6	9	10	13	14	18	19	22	23	26	27	30	31
(2)	3	5	6	8	10	12	13	15	17	19	20	22	24	26	27	29
(3)	4	5	7	8	9	10	12	13	19	20	22	23	24	25	27	28

In the first selection it will be seen that $a = 1$, $d = 1$, $n = 3$, $g = 3$, and $G \doteq 4$; whence $2a = 2$, $8d = 8$, $4n = 12$, $2g = 6$, and $G = 4$. Total = 32.

In the second selection $a = 3$, $d = 2$, $n = 1$, $g = 2$, and $G = 2$; whence $2a = 6$, $8d = 16$, $4n = 4$, $2g = 4$, and $G = 2$. Total = 32, as before.

In the third selection $a = 4$, $d = 1$, $n = 2$, $g = 1$, and $G = 6$; whence $2a = 8$, $8d = 8$, $4n = 8$, $2g = 2$, and $G = 6$. Total = 32, half of 64.

Putting these series into squares of 4 it will be seen that they are just as perfect with these varying series as any regular series would make.

(1)

$a=1$, $d=2$, $n=3$, $g=3$, $G=4$.

				64
1	27	22	14	64
23	13	2	26	64
10	18	31	5	64
30	6	9	19	64
64	64	64	64	64

No. 25.

(2)

$a=3$, $d=2$, $n=1$, $g=2$, $G=3$.

				64
3	27	12	22	64
26	8	17	13	64
20	10	29	5	64
15	9	6	24	64
64	64	64	64	64

No. 26.

(3)

$a=4$, $d=1$, $n=2$, $g=1$, $G=6$.

				64
4	23	10	27	64
25	12	19	8	64
22	5	28	9	64
13	24	7	20	64
64	64	64	64	64

No. 27.

PROBLEM.—Write perfect squares of 4 from varying series, beginning with 1, 2, 5, and 10, in which the differences shall in no case exceed 5, and in which every row and quadrilateral shall sum up 100.

SOLUTIONS.—There are 895 series of integral numbers, any one of which when placed in a perfect square will equal 100 in all its parts. A very large percentage of these have differences not exceeding 5. Here are four:

(1)	1	6	10	12	15	17	21	24	26	29	33	35	38	40	44	49
(2)	2	6	9	13	15	19	22	24	26	28	31	35	37	41	44	48
(3)	5	10	14	15	19	20	21	24	26	29	30	31	35	36	40	45
(4)	10	11	14	15	19	20	23	24	26	27	30	31	35	36	39	40

In order to make it easier we arrange the series each into four sets, thus:

(1)				(2)				(3)				(4)			
1	6	10	15	2	6	9	13	5	10	15	20	10	11	14	15
12	17	21	26	15	19	22	26	14	19	24	29	19	20	23	24
24	29	33	38	24	28	31	35	21	26	31	36	26	27	30	31
35	40	44	49	37	41	44	48	30	35	40	45	35	36	39	40

In the first selection $a = 1$, $d = 5$, $n = 4$, $g = —3$, $G = —2$; whence $2a = 2$, $8d = 40$, $4n = 16$, $2g = —6$, $G = —2$; total, 50.

In the second selection $a = 2$, $d = 4$, $n = 3$, $g = 2$, $G = —2$; whence $2a = 4$, $8d = 32$, $4n = 12$, $2g = 4$, $G = 2$; total, 50.

In the third selection $a = 5$, $d = 5$, $n = 5$, $g = —6$, $G = —8$; whence $2a = 10$, $8d = 40$, $4n = 20$, $2g = —12$, $G = —8$; total, 50.

In the fourth selection $a = 10$, $d = 1$, $n = 3$, $g = 4$, $G = 2$; wherefore $2a = 20$, $8d = 8$, $4n = 12$, $2g = 8$, $G = 2$; total, 50.

Arranging these series in squares according to one or another of the twenty-four model squares already given, we have the following:

(1)

$a=1$, $d=5$, $n=4$, $g=-3$, $G=-2$.

				100
1	40	15	44	100
38	21	24	17	100
35	6	49	10	100
26	33	12	29	100
100	100	100	100	100

No. 29.

(2)

$a=2$, $d=4$, $n=3$, $g=2$, $G=-2$.

				100
2	41	31	26	100
35	22	6	37	100
19	24	48	9	100
44	13	15	28	100
100	100	100	100	100

No. 30.

(3)

$a=5$, $d=5$, $n=5$, $g=-6$, $G=-8$.

				100
5	40	26	29	100
35	20	14	31	100
24	21	45	10	100
36	14	15	30	100
100	100	100	100	100

No. 31.

(4)

$a=10$. $d=1$, $n=3$, $g=4$, $G=4$.

				100
10	36	30	24	100
31	23	11	35	100
20	26	40	14	100
39	15	19	27	100
100	100	100	100	100

No. 32.

ODD SUMS.

Perfect squares yielding odd sums cannot be constructed of integral numbers. A half-unit must be added to at least half of the numbers. This can be done in various ways, as (1) by inserting a half-unit in the main gap; (2) by inserting a half-unit in each of the side gaps and main gap; (3) by inserting a half-unit in each of the four notches and main gap; (4) by inserting a half-unit in each of the four notches, two side gaps and main gap; (5) by inserting a half-unit in each of the eight differences and main gap; (6) by inserting a half-unit in each of the eight differences, two side gaps and main gap; (7) by inserting a half-unit in each of the eight differences, four notches and main gap; and (8) by inserting a half-unit in each of the eight differences, four notches, two side gaps and main gap. In either case half the terms will be integral and half of them fractional. This principle is clearly seen in the three following examples, where irregular series beginning with 7 are arranged to add 77 in every direction.

(1)	7	8	10	11	14	15	17	18	20.5	21.5	23.5	24.5	27.5	28.5	30.5	31.5
(2)	7	9	10	12	13.5	15.5	16.5	18.5	20	22	23	25	26.5	28.5	29.5	31.5
(3)	7	8.5	10	11.5	14	15.5	17	18.5	20	21.5	23	24.5	27	28.5	30	31.5
(4)	7	8.5	10	11.5	14	15	17	18.5	20	21.5	23	24.5	27	28.5	30	31.5

In order to facilitate inspection of the series and the placing of the several terms in a square the series should be arranged each in four sets, thus:

(1)				(2)				(3)				(4)			
7	8	10	11	7	9	10	12	7	8.5	10	11.5	7	10	14	17
14	15	17	18	13.5	15.5	16.5	18.5	14	15.5	17	18.5	8.5	11.5	15.5	18.5
20.5	21.5	23.5	24.5	20	22	23	25	20	21.5	23	24.5	20	23	27	30
27.5	28.5	30.5	31.5	26.5	28.5	29.5	31.5	27	28.5	30	31.5	21.5	24.5	28.5	31.5

No. 4 is the same series as No. 3 but differently arranged.

In the first series $a = 7$, $d = 1$, $n = 2$, $g = 3$, $G = 2.5$; which makes $2a = 14$, $8d = 8$, $4n = 8$, $2g = 6$, $G = 2.5$; total, 38.5, which is one-half of 77.

In the second series $a = 7$, $d = 2$, $n = 1$, $g = 1.5$, $G = 1.5$; therefore $2a = 14$, $8d = 16$, $4n = 4$, $2g = 3$, $G = 1.5$; total, 38.5.

In the third series $a = 7$, $d = 1.5$, $n = 1.5$, $g = 2.5$, $G = 1.5$; from which $2a = 14$, $8d = 12$, $4n = 6$, $2g = 5$, $G = 1.5$; total, 38.5, as before.

In another arrangement (4) of the third series $a = 7$, $d = 3$, $n = 4$, $g = -8.5$, $G = 1.5$; which gives $2a = 14$, $8d = 24$, $4n = 16$, $2g = -17$, $G = 1.5$.

From these series are constructed the following perfect squares:

(1)
$a=7$, $d=1$, $n=2$, $g=3$, $G=2.5$.

				77
7	30.5	15	24.5	77
28.5	11	20.5	17	77
23.5	14	31.5	8	77
18	21.5	10	27.5	77
77	77	77	77	77

No. 33.

(2)
$a=7$, $d=2$, $n=1$, $g=1.5$, $G=1.5$.

				77
7	25	16.5	28.5	77
18.5	26.5	9	23	77
22	10	31.5	13.5	77
29.5	15.5	20	12	77
77	77	77	77	77

No. 34.

(3 and 4)
$a=7$, $d=1.5$, $n=1.5$, $g=2.5$, $G=1.5$.

				77
7	30	11.5	28.5	77
24.5	15.5	20	17	77
27	10	31.5	8.5	77
18.5	21.5	14	23	77
77	77	77	77	77

Nos. 35 and 36.

Two arrangements are shown for the third series. One (3) is laid according to model square No. 15, *ante,* and the other (4) is laid according to model square No. 19. Both are precisely alike; the only difference is in the order that the terms are taken. Some of the others may also be taken in different orders.

As shown in the preceding pages every sum of a row in any square of 4 is equal to twice the continued sum of double the first term of the series plus eight times the difference between the first and second terms, plus four times the difference between the second and third terms, plus twice the difference between the fourth and fifth terms, plus the difference between the eighth and ninth terms. Using the same letters as before to represent these several differences, the formula becomes, as already shown,

$$S = 2(2a + 8d + 4n + 2g + G).$$

To obtain 111 as the sum in a perfect square, as for any other number, we take half the amount, in this case 55.5, divide it up to suit fancy or convenience by making the several

				111
1	48	23	39	111
25	37	3	46	111
32.5	16.5	54.5	7.5	111
52.5	9.5	30.5	18.5	111
111	111	111	111	111

No. 37.

DIFFERENCES.

$2a=2$	$a=1$
$8d=16$	$d=2$
$4n=18$	$n=4.5$
$2g=14$	$g=7$
$G=5.5$	$G=5.5$
55.5	

SERIES.

1	3	7.5	9.5
16.5	18.5	23	25
30.5	32.5	37	39
46	48	52.5	54.5

quantities used as differences represent any amount advisable or available, add the values of the several quantities, then proceed to lay out the series in strict accordance with the formula. The square may then be built up according to any one of the twenty-four model squares already shown. In the first example shown above, if we make $2a = 2$, $8d = 16$, $4n = 18$, $2g = 14$, and $G = 5.5$, then will $a = 1$, $d = 2$, $n = 4.5$, $g = 7$, and $G = 5.5$; total, 55.5.

				111
20	34.5	25	31.5	111
33.5	23	28.5	26	111
30.5	24	35.5	21	111
27	29.5	22	32.5	111
111	111	111	111	111

No. 38.

DIFFERENCES.

$a=20$	$2a=40$
$d=1$	$8d=8$
$n=1$	$4n=4$
$g=1$	$2g=2$
$G=1.5$	$G=1.5$
	55.5

SERIES.

20	21	22	23
24	25	26	27
28.5	29.5	30.5	31.5
32.5	33.5	34.5	35.5

In the second example, in order to differ materially from the other, take 20 for the first term and let each of the other differences be 1 except the difference in the main gap (G), which will be 1.5. From these we obtain $2a = 40$, $8d = 8$, $4n = 4$, $2g = 2$, and $G = 1.5$. A series of sixteen terms prepared from these differences give the numbers as above, from which a perfect square adding 111 in all its parts may readily be constructed.

THE CIRCLE SQUARED.

Shall we essay the problem that has engaged the most eminent mathematicians for thousands of years, that of squaring the circle? But we perform the operation in an entirely new way, by a method that has never before been tried. No claim is here made that the problem is solved. It is entirely a play upon words. But if taking the diameter and circumference of a circle and placing the divisions in the form of a square, so that by addition of the parts in any direction the same circumference is obtained, if that is not squaring the circle it certainly is not circling the square. In other words, if it is not a circular square or a square circle it must be a circle squared, so it amounts to the same thing.

Take the figures that represent the circumference when the diameter is 1.0000, or as near that amount as four decimal places will give us, namely, 3.1416; though any other number of decimal places might as well be taken, except that the farther the decimal is extended the more time and space it will take.

First we take half of our number, namely, 1.5708, and divide it up as we please according to the formula, being careful to make our several numbers sum up exactly our required number. Then, if we have taken $2a$, $8d$, $4n$, etc., to make our numbers correspond with, we should select numbers that are divisible by 2, 8, etc., in order to avoid fractional numbers when not necessary, as in the case where the sum of a line is odd.

Here are two examples. In the first one the series begins with the decimal surplus above 3 included in the circumference of the circle; the sum of the eight minor differences ($8d$ =

THE CIRCLE SQUARED.

				3.1416
1.0000	.7345	.9345	.4726	3.1416
1.2655	.1416	1.3310	.4035	3.1416
.6363	1.0982	.5708	.8363	3.1416
.2398	1.1673	.3053	1.4292	3,1416
3.1416	3.1416	3.1416	3.1416	3.1416

No. 39.

DIFFERENCES.

$2a$ = .2832	a = .1416
$8d$ = .7854	d = .0982
$4n$ = .2618	n = .0655
$2g$ = .1384	g = .0692
G = .1020	G = .1020
1.5708	

SERIES.

.1416	.2398	.3053	.4035
.4726	.5708	.6363	.7345
.8363	.9345	1.0000	1.0982
1.1673	1.2655	1.3310	1.4292

.7854) represents the area of a circle whose diameter is 1: the sum of the four differences next greater ($4n$ = .2618) is equal to one-third of that amount; the term in the upper left-hand corner of the square (1.0000) represents the diameter of the circle; and, as should be expected, the sum of every line in any direction and the sum of the four corners of every quadrilateral, whether rectangular or rhomboid, equals 3.1416, the circumference of the circle.

The second example is more complex because it represents more. The sum of the two differences in the middle of each

SQUARE OF THE CIRCLE.

				3.1416
1.0000	.0193	1.5740	.5483	3.1416
1.4377	.6846	.8637	.1555	3.1416
−.0032	1.0225	.5708	1.5515	3.1416
.7071	1.4152	.1331	.8862	3.1416
3.1416	3.1416	3.1416	3.1416	3.1416

No. 40.

DIFFERENCES.

$2a$ = −.0064	a = −.0032
$8d$ = .1800	d = .0025
$4n$ = .4552	n = .1138
$2g$ = .7854	g = .3927
G = .1566	G = .1566
1.5708	

SERIES.

−.0032	.0193	.1331	.1556
.5483	.5708	.6846	.7071
.8637	.8862	1.0000	1.0225
1.4152	1.4377	1.5515	1.5740

half of the series (2*g*) equals .7854, the area of a circle whose diameter is 1; no other difference is significant, except that the first term (a = —.0032) is less than zero, and being a minus quantity must be subtracted instead of added whenever included in any sum. But in the square no less than three of the terms are significant: The number in the upper left-hand corner (1.0000) represents the diameter of a circle, as before; the opposite number (the one in the lower right-hand corner, .8862) represents an equivalent square, that is to say the side of a square equivalent in area to a circle whose diameter is 1; the lower left-hand corner (.7071) represents the side of the greatest square that can be inscribed in that same circle; and finally, the sum of every line and quadrilateral equals 3.1416, the circumference of the circle.

SMYTH'S THEOREM.

This paper will be closed with a theorem which, while it may not be new, is not taught in the schools as one of the interesting and instructive features of mathematics. It is a principle that upon careful inspection must be acknowledged as a truth; yet it is not sufficiently self-evident to be called an axiom. The proposition is this:

THEOREM.—*The sum of any number of terms (quantities) is equal to the sum of the products of the several terms diminished each by the preceding term and multiplied by the number of terms following that difference.*

The principle is not only true of any line of any perfect square but of any number of numbers whatever, taken in any order, and the numbers may be above zero or below, or mixed in any manner. Before presenting a working formula a few illustrations will be presented by way of demonstration.

The sum of any set of four numbers is equal to four times the first number, plus three times the second minus the first, plus twice the third minus the second, plus the fourth minus the third. When the number to be subtracted is greater than the minuend, then the product of the difference between the two numbers is to be subtracted in the addition. If the numbers be taken in numerical order, the smallest first, then the sum of a series of four numbers is equal to four times the first, plus three times the difference between the first and second, plus twice the difference between the second and third, plus the difference between the third and the fourth.

1×4=	4
13×3=	39
8×2=	16
5×1=	5
27	64

For example, take the numbers 1, 14, 22, 27, as in the first line of square No. 25. The first and lowest number in the line is 1; four times that is 4. The next number is 14; the difference between that and 1 is 13; three times 13 is 39. The next difference is 8; twice that is 16. Finally, the difference between 22 and 27 is 5; once that is 5. The sum of these differences equals 27, the last number taken; the sum of the products equals 64, equal to the sum of the numbers.

SQUARE.

10	36	30	24
31	23	11	35
20	26	40	14
39	15	19	27

10×4=	40
26×3=	78
−6×2=	−12
−6×1=	−6
24	100

Again, take the numbers 10, 36, 30, 24, as in the above square, in the order in which they occur in the line. The first is 10, which, multiplied by 4 equals 40; the difference between 10 and 36 is 26, which multiplied by 3 equals 78; the next difference is 6 minus, which multiplied by 2 gives 12 to be subtracted; the final difference is 6, also to be subtracted. The sum of the differences is 24, the last number taken; the sum of the products is 100, equal to the sum of the numbers in the line.

Several other examples are here given of the same problem performed in various ways, but always ending in the same result, namely: The sum of the differences is always equal to the last number taken in the operation; the sum of the products is always equal to the total of all the numbers taken. The examples above given can undoubtedly be understood by inspection without further elucidation.

10− 0=10	10×4= 40	36− 0= 36	36×4= 144
24−10=14	14×3= 42	30−36= −6	−6×3=−18
30−24= 6	6×2= 12	24−30= −6	−6×2=−12
36−30= 6	6×1= 6	10−24=−14	−14×1=−14
	36 100		10 100

24− 0= 24	24×4= 96	36− 0= 36	36×4= 144
30−24= 6	6×3= 18	10−36=−26	−26×3=−78
36−30= 6	6×2= 12	24−10= 14	14×2= 28
10−36=−36	−36×1=−36	30−24= 6	6×1= 6
	10 100		30 100

If, after arranging a series of numbers in four sets preparatory to constructing a magic square, we take the successive differences in the first set and multiply them in order by 4, 3, 2, and 1, respectively, and to the products add the differences between the initials of the sets multiplied in consecutive order by 3, 2, and 1, we obtain as sum of the differences the highest

	10− 0=10	1×4= 40
	11−10= 1	1×3= 3
10 11 14 15	14−11= 3	3×2= 6
19 20 23 24	15−14= 1	1×1= 1
26 27 30 31	19−10= 9	9×3= 27
35 36 39 40	26−19= 7	7×2= 14
	35−26= 9	9×1= 9
		40 100

number of the entire series, and as sum of the products the sum of any line or subsquare in a square made from that series. This is true of any series and of a square of any size.

One more illustration ought to suffice: Let it be required to add according to the theorem some numbers of which we know the sum, say 15, 11, —8.5, 19, 26.5, 37, no matter what the numbers are or the order in which they occur. The first

15 − 0 = 15	15 ×6= 90
11 −15 =− 4	− 4 ×5=−20
− 8.5−11 =−19.5	−19.5×4=−78
19−− 8.5= 27.5	27.5×3= 82.5
26.5−19 = 7.5	7.5×2= 15
37 −26.5= 10.5	10.5×1= 10.5
	37 100

difference (which is the first number, the difference being the difference between itself and 0) is to be multiplied by 6, as there are six numbers to be added; the next difference, minus 4 (11—15), is to be multiplied by 5 and subtracted; the next difference is minus 19.5, which is to be multiplied by 4 and subtracted; the other differences, 27.5, 7.5, and 10.5, are to be multiplied in their order by 3, 2, and 1, and added. The entire sum of the products equals 100, as the numbers do; and the differences sum up 37, which is equal to the last number taken.

The foregoing principle may be stated as follows: The sum of any number of terms is equal to the lowest or smallest term multiplied by the number of terms, plus the difference between the lowest term and the second in order multiplied by the number of terms less 1, plus the difference between the second and third multiplied by the number of terms less 2, plus the next difference multiplied by the number of terms less 3, and so on to the end or highest term. The sum of the differences will be equal to the highest term and the sum of the products will be equal to the sum of all the terms.

Again, when a series of numbers is arranged in sets of equal length, the sum of the several differences in the first set, each multiplied in order by the number of terms between that difference and the end, plus the differences between the initials of the several sets multiplied by the number of the difference in order beginning with the last, equals the sum of an average set of that series; and the sum of the several differences taken equals the highest term of that series.

We may put these principles into intelligible working formulæ by adopting symbols for the several quantities expressed. For the first, let a, b, c, etc., to p, q, represent the several terms of a series, p and q being the last two; let n be the number of terms in the series and let S be the total sum. Then a general formula will be:

$$S = an + (b-a)(n-1) + (c-b)(n-2) + (d-c)(n-3) \; . \; . \; . \; (q-p)(n - (n-1).$$

Expanding,

$$S = an + bn - an - b + a + cn - bn - 2c + 2b + dn - cn - 3d + 3c \; . \; . \; . + q.$$

Canceling and collecting,

$$S = a + b + c + d \; . \; . \; . + q.$$

q. e. d.

Again, in a series for a magic square, when it becomes necessary to write the series in n sets of n terms each, let Aa, Ab, Ac, to Aq, represent the first set; let Ba, Bb, Bc, etc., represent the second set; Ca, Cb, Cc, etc., represent the third set, and so on; let n be the number of terms in a line and S equal the sum of the numbers in a line; then the formula will be:

$$\begin{aligned} S = Sn = \; & Aan + (Ab - Aa)(n-1) + (Ac - Ab)(n-2) \ldots + (Aq - Ap)(n - (n-1) + \\ & Ban + (Bb - Ba)(n-1) + (Bc - Bb)(n-2) \ldots + (Bq - Bp)(n - (n-1) + \\ & Can + (Cb - Ca)(n-1) + (Cc - Cb)(n-2) \ldots + (Cq - Cp)(n - (n-1) + \\ & \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ & Qan + (Qb - Qa)(n-1) + (Qc - Qb)(n-2) \ldots + (Qq - Qp)(n - (n-1) \end{aligned}$$

Expanding, the equation will be:

$$S = Aan + Bbn - Aan - Bb + Aa + Ccn - Bbn - 2Cc + 2Bb \; . \; . \; . + Qq.$$

Simplifying,

$$S = Aa + Bb + Cc \; . \; . \; . + Qq,$$

which is a self-evident fact.

An apparently simpler formula, though not so explicit unless well understood, would be to let d°, d′, d″, etc., to d^n, represent the differences between the successive terms of any set (d° being the first term or the difference between itself and zero; and let D′, D″, etc., to D^n, represent the differences between the initials of the several sets; then the formula will be:

$$S = d^{\circ} n \pm (D' + d')(n-1) \pm (D'' + d'')(n-2) \; . \; . \; . \pm (D^n + d^n)(n - (n-1).$$

Nothing, however, is gained by this formula as it is irreducible. It must be known and expressed in the formula whether any term is greater or less than the preceding term, and, therefore, whether that difference when increased by its proper multiplier is to be added or subtracted. The formula does not specify this. It must be understood that every term is a minuend from which the preceding term is to be subtracted. When the preceding term is the greater, then the difference becomes a minus quantity and is to be subtracted in the general addition instead of added. When no term precedes, as in the case of the first term, then 0 is to be subtracted and the term itself becomes a difference.

PRELIMINARY STUDIES ON THE MOON.

By F. A. Marlatt, Manhattan, Kan.

WHILE the moon has been a favorite field of study not only for the astronomer but for every lover of nature for centuries, the history that is written all over her surface has been misread by all, if my interpretation of it be the correct one; and as to that I will leave the Academy to judge.

Let us look for a moment at a brief outline of the present theory of the formation of our solar system.

Without going into details, it is supposed that two immense dead suns wandering through space met in such a way that either one or both of them were reduced to fragments, and that these fragments filled the space now occupied by our present solar system.

In time, by the law of attraction, the larger bodies attracted the smaller ones and the largest became our sun, and the other larger fragments developed according to the laws of momentum and attraction into the planets as we now know them.

By this coming together heat was produced, the larger masses becoming very much hotter than the smaller ones, by reason of the mass, and in time this heat was and is radiated into space, till we have the system in its present condition.

That this chaotic condition did exist at the first, and that our system was made up from these fragments of former suns, is clearly enough proven by the meteors that are seen to plunge into our atmosphere every night, many of them to be consumed by frictional heat before reaching the earth, and the few that do reach the earth are found to be of the same elemental composition as that of our planet, thus showing a common origin.

So far we may agree with the theory, as it certainly is in harmony with all of the records that are about us so far as we have been able to read them, and exactly coincides with the deductions that called forth this paper.

According to the present theory, the landscape as we know it is the result of cooling, shrinking and wrinkling, and thus producing oceans, valleys and mountains, and volcanoes are supposed by some to be vents from the molten interior.

According to this theory, the larger the mass the rougher will be the surface; and the converse, the smaller the mass the smoother the surface. Thus the earth should be very rough, and the moon should present a surface as smooth as a ball.

The facts, however, are almost the reverse.

That I may make no mistake in presenting the present theory, I will quote Dr. Percival Lowell, of the Lowell Observatory, Flagstaff, Ariz., from his article in the November *Century.*

"Turning now to the moon, the first thing that strikes us on observation is the glaring exception to the order of smoothness, earth, Mars, moon, seemingly made by the latter. The lunar surface is conspicuously rough, pitted with what are evidently volcanic cones of enormous girth and of great height, and seamed by ridges more than the equal of the earth's in elevation. Many lunar craters have ramparts 17,000 feet high, and some exceed in diameter 100 miles; while the Leibnitz range of mountains, seen in profile on the lunar limb, rise nearly 30,000 feet in the air, or rather into space, as the moon has no atmosphere.

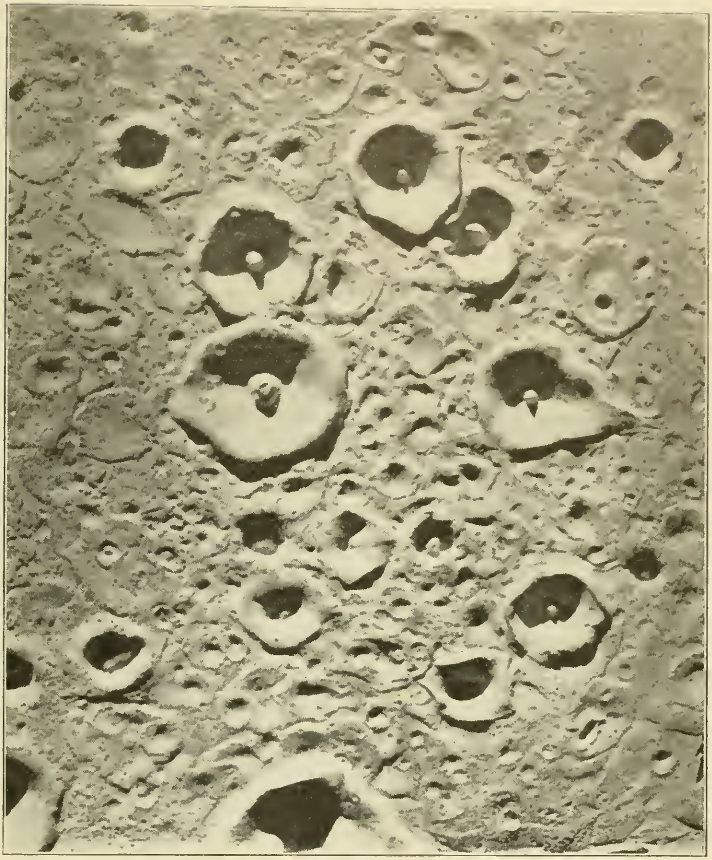
"On the principle that the internal heat to cause contraction was as the body's mass—and no physical deduction is sounder—this state of things on the surface of our satellite is unaccountable. The moon should have a surface like a frozen sea, and it shows one that surpasses the earth's in shagginess."

It is right here that my deductions conflict with all of the present theories as to the cause of the roughness of the moon's surface.

I claim that the moon has no mountains or volcanoes such as we know here on the earth—that is, produced by internal force—but that its present roughened surface was produced by external forces and by these alone.

The law of liquids obtains throughout the universe, so what we may see and demonstrate in them here and now must have occurred under like conditions when the moon was formed.

Whatever the origin of the moon may have been, it is evident that it was at one time a molten mass, else it could not have assumed the globular form; and also it must have attained this shape and started to cool before all the fragments that made its present mass were finally attracted to it, just



Photograph of semi-fluid plaster on which pebbles were thrown just prior to its setting.

as some of the yet remaining fragments are still coming to us in meteors and meteorites.

Now, everyone has noticed that a pebble dropped into a pool of water will produce a series of concentric waves, and, as the displaced water returns over the pebble, a little cone is raised, which subsides again, as do also the waves. Now, if this experiment be tried in a semiliquid, the first wave will go but a short distance and retain its wave shape, and the central cone will rise but not subside as in water, and the less fluid the substance, the more marked will be the result.

This, I claim, is just what happened on the moon. As it began to cool, the belated fragments came plunging into it and produced the markings that we can see even with the unaided eye, as well as all the others that are revealed by the aid of the telescope.

The larger fragments, plunging in earlier in the stage of cooling, produced the large, uneven lower areas called sea bottoms, and later the smaller ones entering the less fluid mass produced the so-called craters which are seen to overlap each other just as they would do if produced in the manner described.

If we take plaster of paris and mix it so that it will not set too quickly, and then throw in various-sized shot or marbles just before and during the time of setting, we can make a very good map of any portion of the moon's surface.

Some may ask why the earth does not present the same features as the moon, for certainly it was subjected to a like bombardment of these fragments while it was cooling, and should show an even rougher surface than the moon.

In answer to this it may be said that the moon, having no air and being devoid of water, has retained all of its original features just as they were when finally cooled. The earth, on the other hand, has been subjected to the combined action of water and climatic changes, so that for thousands of feet below the present surface, all that we know of it, in fact, has been worked over and over again, and so leveled down till all of the original features have been obliterated.

HEREDITY IN STOCK BREEDING.

By I. D. Graham, Topeka, Kan.

MY purpose in this paper is not to call attention to any fact that is new to science, nor to any new discoveries along scientific lines. The aim is rather to direct brief attention to the practical application in a commercial way of certain well-established scientific laws. The scientist is too often credited with being a dreamer and his work is frequently looked down upon by his fellow man who delights to style himself "practical." In spite of the attitude assumed by the self-styled "practical man," the fact remains that a vast deal of the material prosperity to which he has attained is due directly to the previous work done by the scientist in his study of nature's laws.

None has been better established among the laws of nature than that "like produces like." Nothing is better established than the added fact that the law of variation is just as well founded. In applying these laws to his own purposes, the breeder of pure-bred live stock has done so, not because of the value which his work might prove to science, but because he saw the only means by which he could attain the object of his labors and supply the demands of his market.

With the emergence of our race from barbarism began the taming and the ultimate improvement of the wild animals of forest and plain. With his increase in intelligence and his daily handling of the animals which he had tamed to his own uses, earlier man came to notice that certain types were more valuable to him for certain purposes, and that the mating of animals of similar type increased or strengthened these valuable points in the progeny. Of course, it is understood that these facts only came to be realized after ages of handling the animals. The development of knowledge along this line was gradual, but it was found to be real knowledge and to have a financial value. Upon this, and accompanied by the increased demands of our civilization, has grown up the business of stock breeding which is now one of our largest industries and which rests for its success upon the knowledge and practical application of the laws before mentioned.

The oldest breed of pure-bred live stock, the Shorthorn cattle, which is so important in the commercial life of to-day, is but little more than one hundred years of age. Beginning with the wild cattle with which he was surrounded, the breeder, by selection and proper mating, has developed the wonderful special-purpose types which we have to-day. The observer who looks at the 600-pound cow of the cattle range, and compares her with the 2400-pound cow of the show ring, can see at a glance the wonderful advance that has been made in the development of beef animals, though he may not understand how it has been accomplished nor the time required for the development of this pride of the American breeder. Nor is the average observer aware of the fact that the great beef animals and the splendidly-developed dairy cattle are not only the results of a judicial control of the laws of heredity, but the animals on exhibition are select specimens taken from among those of their kind which have required a century to produce.

I am firmly convinced that the breeder who produces the great beef animals or the special-purpose dairy animals that are now so common at our exhibitions is worthy of great credit. In fact, he has been termed an artist who is just as much entitled to a niche in the temple of fame as is the man who produces a great painting or he who creates a musical masterpiece. He certainly is entitled to credit, and the animals obtained by his labors are due to his careful observance of the laws of heredity and his careful selection of types whose union will produce what he needs.

The cattle-breeder of to-day finds that his market demands animals of a certain size with extra or perhaps abnormal development in certain parts. As no two animals are exactly alike and as no one is perfect, it becomes his duty to select animals for mating purposes each of which is the complement of the other. For instance, the part known as the loin in a beef animal contains the highest-priced cuts of meat, and it is the ambition of the breeder to produce an animal that will have the largest amount of fleshy deposit in this region. In doing this he must not only select animals which are strong in this feature, but those which will possess other valuable qualities as well. Both parent animals must be of large vitality. They must be of the type known as "easy feeders," and this necessitates large abdominal regions with great digestive powers. Their vitality is indicated by large heart girth and great "spring of rib." Coupled with these must be the bright eyes which at once indicate health and intelligence, because these are two of the important foundation stones upon which he must build.

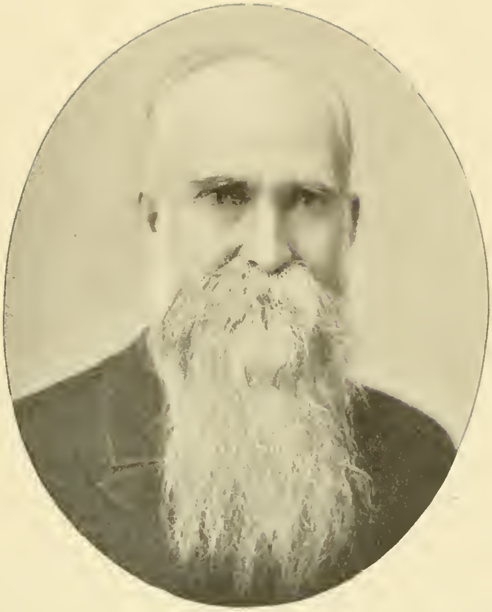
If the breeder finds that he has a cow that is practically perfect in all respects save one quality, he mates this animal with one that is exceptionally strong in that quality and by this process of natural selection he ultimately produces the wonders of the bovine world which record his triumph over his ancestors and over the law of variation which constantly tends to undo his work.

I have in my office a picture of a cow whose maternal qualities have been developed to such an extent that her product of milk and butter has reached an abnormal point, and she is credited with a little over 1000 pounds of butter in one year. I have also the portrait of a hog that is so near perfection and so desirable a type of herd header that he recently sold for more than $5000 and proved a good investment to the purchaser. I have numerous portraits of beef breeds of cattle which have been so developed through selection and breeding that they produce the "baby beef" so much in demand at present and for which such ready sale is found. Formerly it was true that our beef animals had to be fed, or at least grown, to three or four years old before they were in marketable condition. Now eighteen months is about the limit. Our official statistics for the year 1907 show that the total value of live stock in Kansas was $197,250,857, and from this one fact alone, to which we may add the other fact that Kansas is rapidly becoming one of the best-known pure-bred states in the Union, it will be seen that a knowledge of heredity in stock breeding is of vast importance to our people. It is estimated that eighty per cent. of the pure-bred Hereford cattle of the United States are to be found in the territory of which Kansas City is the center. Facts show that other breeds are equally well represented in this region, while northern Kansas and southern Nebraska have become one of the greatest swine-breeding sections of the entire country, and this in spite of the fact that the corn belt was supposed to be the only home of the hog and that its western limits had long been passed by the settlers of that country.

Within the writer's knowledge there is no scientific fact the application of which to the affairs of daily life has brought more direct or valuable results than those of heredity in live-stock breeding.

VI.

NECROLOGY.



D. M. VALENTINE, LL. D.

JUDGE DANIEL M. VALENTINE died at his home in Topeka August 5, 1907. He was seventy-seven years old, and death ensued from a general breakdown, incident to age. He was for nearly twenty-five years a justice of the supreme court, and was admitted to our Academy in 1878.

As one of the pioneers in Kansas he had much to do with its early history, and as a justice of the supreme court was one of the guiding spirits in the construction and interpretation of the state constitution. His reputation as a jurist of ability and integrity is attested by his long term of service. His interest in scientific pursuits was shown by his support of the Academy and he was elected a life-member in 1904. He is survived by his widow and nine children, five sons and four daughters, all of whom worthily represent one of our earliest and most useful citizens.

VII.

APPENDIX.

ANNOUNCEMENTS.

THERE are three objects to be pursued by the Academy which will increase its usefulness and give it strength. The first of these pertains to the library, the second to the museum, and the third to scientific investigation.

THE LIBRARY.

By a system of exchanges we have secured about 5000 volumes of scientific literature—much of it consisting of the transactions of scientific societies in all parts of the world where such organizations exist. Much of this matter is of great value and can be found in no other publications. It represents the front wave of progress and is of highest interest to investigators, only needing such cataloguing and classification as will make it available for ready consultation. There is in the state-house a large collection of books, and considerable scientific literature, outside of the collection of the Academy. All these books belong to the state, inasmuch as they have been bound and cared for through state appropriation, and it is expected that they will still be sustained by public funds. The state library was originally simply a law library, in charge of the supreme court, who directed its management and appointed the librarian. Later this library came to include many miscellaneous books, departmental reports, Smithsonian publications, dictionaries, encyclopedias, books of reference, as well as some sets of valuable scientific and literary journals. At a later date the state accepted the donation of $5000 to maintain the Stormont medical library, and a large collection of medical books from the library of Doctor Stormont became the nucleus of this department, which was also placed in charge of the officers of the state library, but the Kansas Medical Society, through a committee, recommends the volumes to be purchased with this fund.

In 1899 the Traveling Libraries Commission went into operation, in charge of the state librarian, the president of the federated clubs, and three other persons, appointed by the state library directors. This library includes books of a more popular character given to or purchased for the commission or sent out by the librarian from the state library. This department has about 20,000 volumes in its rooms, in the west wing of the basement.

The most considerable collection of books, outside of those under direct management of the state librarian, is the library of the State Historical Society. By its act of incorporation this society is directed to procure by gift or exchange not only material illustrative of history, but books, maps, etc., of every description, which will "facilitate the investigation of historical, scientific, social, educational and literary subjects." To enable the society to augment its collection, the law has given to it "sixty bound copies each of the several publications of the state and of its societies and institutions," except supreme court reports. Besides these collections, every department in the state-house has its own more or less considerable library, which may be regarded as tools of these offices.

It will thus be seen that the capitol contains large sources of possible information in books, but if one seeks here for any particular article or book the quest is often not easy and may be fruitless. Our Academy is on record, more than once, as favoring such a consolidation of all the book interests of the state-house as will insure a separation into departments and a complete cataloguing, by the Dewey system, of all the books found here.

One way of doing this is to extend the authority of the state librarian so that he may divide the collections into departments and have his cataloguers include them all. By such an arrangement the duplication of books would be avoided, which is now a common occurrence.

The individuality of the Academy library and that of the Historical Society would be modified from what it now is, but not destroyed, and each organization would go on adding to its collection, only each would be restricted to its own field. The main thought would be not to glorify this or that department, but to build up the library as a whole.

THE MUSEUM.

It has always been a function of the Academy to foster collections of natural history, especially those which have a distinct educational or economic value. Our membership has always embraced quite a percentage of botanists, entomologists, mineralogists, etc., and it has been customary for them to bring specimens to the Academy. These used to be displayed in the rooms of the State Board of Agriculture, and

MUSEUM (looking east).

no very distinct line existed between them and agricultural products, just os our "Transactions" was a supplement to the agricultural report. In the Centennial at Philadelphia, and in the Columbian Eposition at Chicago, the displays were made together, but in the Purchase Exposition at St. Louis our secretary having been appointed to have charge of the Kansas mineral exhibits, worked in conjunction with the Labor Bureau commissioner, and at the close was fortunate in having the Kansas exhibit turned over to our Academy. In the meantime the Goss collection had been moved to new quarters, and it was thought best to have the mammals and insects go with the birds and so make the Academy museum represent only the economic mineral products of the state. Such a museum might be made of great commercial value in showing the location of our clays suited for brick and pottery as well as cement material, building stone, glass sand, shales for mineral paint and brick, salt deposits, and, most important of all, point to the location of coal, oil and gas deposits.

This plan would bring us into cooperation with the Geological Survey of the state, and it is certainly proper for the Academy to have a share in that great enterprise. There is no place in the state so convenient and useful as the capitol building for the display of these economic products. Our present nucleus is a good beginning, and it is time to unite the varied interests that should be contributory to the desired result. The work already done by the University Geological Survey has prepared the way, and now is the time to enlarge the structure on a broader foundation, so that all geologists of the state may feel that they have a part and interest in the State Geological Survey. In the not distant future there will be need of a new state building to properly house the various departments that are even now clamoring for more room, and this will leave the present capitol for legislative chambers and executive offices. In that new structure plans should be laid for offices, display rooms and libraries; but, in the meantime, our present quarters permit considerable development of the proposed economic museum. It should be the place where people may come for accurate information respecting the mineral resources of the state, and the display samples of these minerals might be accompanied by chemical analyses, showing their adaptability to proposed uses. From present showing, the mineral wealth of Kansas will compare favorably with that of any state, even though we have no direct resources in gold, silver and copper. The substitution of stone, brick and cement for wood is bound to become general, and no country is better supplied than Kansas with the raw material for these products. Our museum will call attention to and tend to develop this mineral wealth.

THE ADVANCEMENT OF SCIENCE.

The third object to be aimed at by the Academy of Science should be, as stated in the original draft of the constitution, "to increase and diffuse a knowledge of the natural sciences."

This may be done by encouraging scientific investigation, and by making our Transactions the organ through which to publish to the world of science the contributions of our members. At an earlier day it was the custom to have commissions appointed for the investigation of special problems, and grants were made from the society's funds to aid in this work. There is at present in our treasury a small sum that could be used for such purposes, and the regular dues of members will continue to supply such resources, to say nothing of bequests for the advancement of science that may be entrusted to the Academy. The various universities and colleges are developing rapidly, and each, in its own way, is a center of scientific activity; but the Academy should be the place where scientific workers can meet on a common ground and gain the inspiration that comes from numbers and fellowship. We are at present able to publish annual volumes, but may expect to replace these annual volumes by quarterly bulletins, and perhaps have more frequent meetings.

So the Academy may become the common publishing bureau for all the schools of the state, as well as for individual scientists, and each will thus gain the encouragement that comes from approval and friendly criticism.

J. T. LOVEWELL, *Secretary.*

PRINTED TRANSACTIONS OF THE ACADEMY.

Original volumes I, II, III, were published as parts of the State Agricultural Reports for 1872, 1873, 1874. (Out of print now.)

	PRICE.
Reprint of volumes I to III (1896), 135 pages, 4 figures	$0 60
Volume IV, 1875, 63 pages. (Reprinted.)	40
Volume V, 1876, 75 pages, 1 figure. (Reprinted.)	40
Volume VI, 1878, 94 pages, 6 figures, 1 plate. (Reprinted.)	60
Volume VII, 1881, 136 pages, 1 plate. (Reprinted.)	1 00
Volume VIII, 1883, 85 pages, 5 plates	60
Volume IX, 1885, 145 pages, 9 plates .... paper, 75 cts.; cloth,	1 25
Volume X, 1887, 155 pages, 19 figures, 6 plates	1 00
Volume XI, 1889, 128 pages, 4 figures, 1 plate	75
Volume XII, 1891, 189 pp., 9 fig., 7 pl .... paper, 75 cts.; cloth,	1 25
Volume XIII, 1893, 175 pp., 55 fig., 7 pl .... paper, 60 cts.; cloth,	1 00
Volume XIV, 1896, 370 pages, 96 figures, 8 plates .... paper,	1 25
Volume XV, 1898, 226 pages, 2 figures, 7 plates	1 50
Volume XVI, 1899, 320 pp., 12 fig., 9 pl .... paper, $1; cloth,	1 50
Volume XVII, 1901, 248 pp., 15 fig., 13 pl .... paper, $1; cloth,	1 50
Volume XVIII, 1903, 287 pp., 35 fig., 15 pl .... paper, $1; cloth,	1 50
Volume XIX, 1905, 461 pp., 13 fig., 33 pl .... paper, $1; cloth,	1 50
Volume XX, part 1, 1906, 272 pp., 3 fig., 4 pl.... paper, 75 cts.; cloth,	1 00
Volume XX, part 2, 1907, 316 pp., 4 maps, 9 pl ..... paper, $1; cloth,	1 25
Volume XXI, part 1, 1908, — pp., 5 fig., 8 pl .... paper, $1; cloth,	1 25

Members can complete their sets at one-half above rates, prepaid.

Requests for the purchase or exchange of these publications, and all correspondence, should be addressed to the

SECRETARY KANSAS ACADEMY OF SCIENCE,
Topeka, Kan., U. S. A.

INDEX.

Date Due