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TRANSACTIONS

OF THE

KANSAS ACADEMY OF SCIENCE.

VOLUME XXV.

CONTAINS

LIST OF OFFICERS AND PAST PRESIDENTS; MEMBERSHIP LIST JANUARY 1, 1913; MINUTES OF FORTY-FOURTH AND FORTY-FIFTH ANNUAL MEETINGS; PRESIDENTS' ADDRESSES; SOME PAPERS READ.

December 23 and 24, 1912.

STATE PRINTING OFFICE:
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OFFICERS OF THE ACADEMY, 1913.

President, A. J. SMITH .... Emporia.
Vice President, W. A. HARSHBARGER .... Topeka.
Vice President, J. A G. SHIRK .... Pittsburg.
Treasurer, L. D. HAVENHILL .... Lawrence.
Secretary, J. T. LOVEWELL .... Topeka.

EXECUTIVE COUNCIL.

Ex officio the PRESIDENT, TREASURER and SECRETARY.

Elective for 1913.

E. H. S. BAILEY. S. J. CRUMBINE.
F. B. DAINS. J. T. WILLARD.

MEMBERSHIP OF THE ACADEMY.

January 1, 1913.

Dates signify date of election to membership in the Academy.

HONORARY MEMBERS.

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

ASSOCIATE MEMBER.

Mr. R. J. Brown, 1903, Leavenworth.

LIFE MEMBERS.

E. H. S. Bailey, Ph. D., 1883, Univ. of Kansas, Lawrence.
Edward Bartow, Ph. D., 1898, director of water survey, Urbana, Ill.
Joshua William Beede, Ph. D., 1894, associate professor of geology, Bloomington, Ind.
F. W. Bushong, Sc. D., 1896, Mellon Institute, Univ. of Pittsburg, Pa.
F. W. Cragin, Ph. D., 1880, economic, geologic and historical research, Colorado Springs, Colo.
Lewis Lindsay Dyche, M. S., 1881, professor of systematic zoölogy and curator of birds, mammals and fishes, state fish and game warden, Univ. of Kansas, Lawrence.
Geo. H. Failyer, M. Sc., 1879, Manhattan.
E. C. Franklin, Ph. D., 1884, Stanford Univ., Palo Alto, Cal.
I. D. Graham, 1879, Live Stock Com., Panama Ex., San Francisco, Cal.
Wm Ashbrook Harshbarger, B. S. 1900, professor of mathematics, Washburn Coll., Topeka.
Erasmus Haworth, Ph. D., 1882, state geologist, Univ. of Kansas, Lawrence.

Warren Knaus, M. Sc., 1884, entomologist, editor and publisher, McPherson.
D. E. Lantz, M. Sc., 1887, biological survey, Washington, D. C.
J. T. Lovewell, Ph. D., 1878, chemist, Topeka.
F. O. Marvin, A. M., 1884, Univ. of Kansas, Lawrence.
Ephraim Miller, A. B., A. M., Ph. D., 1873, Pasadena, Cal.
E. A. Popenoe, A. M., 1872, entomologist, Topeka.
L. E Sayre, Ph. M., 1885, Univ. of Kansas, Lawrence.
Alva J. Smith, 1903, city engineer, Emporia.
*B. B. Smyth, 1880, curator Goss Orinthological Collection, Topeka.
Mrs. L. C. R. Smyth, M. S., Ph. D., 1902, curator of Goss Ornithological Collection, Topeka.
C. H. Sternberg, 1896, explorer and collector, Lawrence.
A. H. Thompson, D. D. S., 1873, Topeka.
M. L. Ward, D. D., 1880, Ottawa Univ., Ottawa.
J. T. Willard, M. S., 1883, Kansas Agr. Coll., Manhattan.

ANNUAL MEMBERS.

Frank G. Agrelius, A. M., 1905, State Normal School, Emporia.
H. C. Allen, 1904, Univ. of Kansas, Lawrence.
John J. Arthur, 1904, Topeka.
Wm. R. Arthur, B. A., 1903, dean of law school, Washburn Coll., Topeka.
W. M. Bailey, 1906, teacher, Holton.
Harvey W. Baker, 1902, florist, White Church.
Benj. P. Baker, 1909, student Agr. Coll., Manhattan.
Elam Bartholemew, M. S., 1905, mycologist, Stockton.
W. J. Baumgartner, 1904, professor of zoölogy and histology, Univ. of Kansas, Lawrence.
Frank G Bedell, 1904, Dodge City.
F. H. Billings, Ph. D., 1909, Univ. of Kansas, Lawrence.
Julius Brandt, 1907, Bethany Coll , Lindsborg.
H. H. Braucher, 1907, teacher, K. S. N , Emporia.
Frank. P. Brock, 1911, ind. research, Univ. of Kansas, Lawrence.
E. W. Brown, B. S., 1909, Chehalis, Wash.
Edw. Bumgardner, M. D., Univ. of Kansas, Lawrence.
L. D. Bushnell, 1909, professor of bacteriology, Agr. Coll., Manhattan.
H. P. Cady, Ph. D., 1904, professor chemistry, Univ. of Kansas, Lawrence.
M. E Canty, 1903, Buffalo, Kan.
I. D. Cardiff, Ph. D., 1909, professor of botany, State Agr. Coll., Pullman, Wash.
V. B. Caris, 1911, professor mathematics, M. T. S., Pittsburg.
F. P. Clark, M. D., 1909, Univ. Hospital, Kansas City, Kan.
W. A. Cook, M. S., 1907, Baker Univ., Baldwin.
R. A. Cooley, 1910, Ag. Expt. Station, Bozeman, Mont.
Rev. John T. Copley, 1903, clergyman, Manhattan.
E. G. Corwine, 1905, Mulvane.
E. F. Crevecœur, 1899, entomologist, Onaga.
S. J. Cru bine, M. D., 1909, secretary State Board of Health, Topeka.
B. J. Dalton, C. E., 1909, Univ. of Kansas, Lawrence.
Geo. A. Dean, M. S., 1912, professor entomology, Manhattan.
O. P. Dellinger, professor biology, M. T. S., Pittsburg.

*Deceased.

Frank Burnett Dains Ph. D., 1902, professor of chemistry, Univ. of Kansas, Lawrence.
Emil O. Deere, A. M., 1905, Bethany Coll., Lindsborg.
James Dickson, A. M., 1904, High School, Topeka.
Robt. K. Duncan, B. A., 1906, professor of industrial chemistry, Univ. of Pittsburg, Grand Boulevard, Pittsburg, Pa.
R. B. Dunlevy, M. A., 1896, S. W. Kansas Coll., Winfield.
E. H. Dunmire, B. S., 1895, Lawrence.
J. W. Eby, 1903, banker, Harvard.
C. W. Edmondson, Ph. D., 1909, professor of geology and histology, Eugene, Ore.
H. W. Emerson, B. S., 1904, Univ. of Kansas, Lawrence.
B. F. Eyer, B. S., E. E., 1904, professor of electrical engineering, Manhattan.
T. L. Eyerly, 1906, high school, department of physiography, Dallas, Tex.
Fred. Faragher, A. B., 1904, with Alden Spear's Sons Co., Chicago, Ill.
A. O. Garrett, 1901, teacher high school, Salt Lake City, Utah.
Roy W. Gragg, 1907, accountant, Bartlesville, Okla.
A. A. Graham, 1910, lawyer, Topeka.
O. S. Groner, Sc. M., 1907, professor of chemistry, Ottawa, Univ., Ottawa.
Mary Herman, Ph. D., 1912, Agr. Coll., Manhattan.
H. J. Harnly, B. S., 1903, professor, McPherson Coll., McPherson.
L. D. Havenhill, D. Phar., 1904, professor of pharmaceutical chemistry, Univ. of Kansas, Lawrence.
Thomas J. Headlee, Ph. D., 1907, professor of zöology and entomology, Rutgers Coll., New Brunswick, N. J.
W. C. Hoad, B. S., 1904, Univ. of Kansas, Lawrence.
W. F. Hoyt, A. M., 1902, State Normal School, Neb.
Albert K. Hubbard, Ph. D., 1904, Univ. of Kansas, Lawrence.
I. W. Humphrey, 1912, Pittsburg, Univ., Pa.
Thomas M. Iden, 1897, State Normal School, Emporia.
H. Louis Jackson, B. S., 1909, state food analyst, Univ. of Kansas, Lawrence.
E. C. Jerman 1911, electrician, Topeka.
*John J. Jewett, 1902, physicist, San Diego, Cal.
A. W. Jones, B. S., 1894, Wesleyan Univ., Salina.
F. E. Jones, 1909, manual training school, Lawrence.
W. H. Keller, 1898, high school, Emporia.
H. H. King, A. B., A. M., 1909, asst. professor of chemistry, Agr. Coll., Manhattan.
Leslie A. Kenoyer, 1906, Independence.
Harry L. Kent, 1904, nature study, Agr. Coll., Manhattan.
John H. Klopfer, 1904, collector and mining expert, Topeka.
Pierce Larkin, A. B., 1902, geology, Univ. Norman, Okla.
R. D. Landrum, B. S., 1909, Lisk Manufacturing Co., Canandaigua, N. Y.
Marcus A. Low, 1906, attorney C. R. I. & P. railway, Topeka.
L. A. Lowther, 1907, superintendent of schools, Emporia.
R. Matthews, D. D. S., 1898, dental surgery, Wichita.
J. W. McCulloch, 1911, field agent, Agr. Coll., Manhattan.

* Deceased.

David F. McFarland. Ph. D., State Univ., Urbana, Ill.
J. M McWharf, M. D., 1902, physician, Ottawa.
Grace R. Meeker, 1899, botanist, Ottawa.
C. F Menninger, M. D., 1903, physician, Topeka.
S. T. Millard, M. D., 1909, physician and surgeon, Topeka.
W. L. Moodie, 1906, State Normal, Bellingham, Wash.
Roy L. Moodie, Ph. D., 1909, instructor, Baylor Univ. Dallas, Tex.
Merle M. Moore, 1909, student, Ottawa Univ , Ottawa.
Celia Mulvehill, A. B., 1911, high school, Pittsburg.
R. K. Nabour, 1910, instructor in zoölogy, Agr. Coll., Manhattan.
C. A. Nash, 1907, Univ. of Kansas, Lawrence.
J. H. Newby, 1899, photographer, Osage City.
N. P. Neilson, 1906, architect, Topeka.
A. M. Nissen, A. M., 1901, farmer, Wetmore.
H. N. Olson, 1895, Bethany Coll , Lindsborg.
J. B. Parker, 1909, Agr. Coll., Manhattan.
Frank Patrick, 1903, microscopist, Kansas City, Mo.
Leslie F. Paull, B. S., 1903, Agr. Coll., Fort Collins, Neb.
Rev. P. B. Peabody, 1909, clergyman, (ornithologist), Blue Rapids.
L. M. Peace, A B., 904, Univ. of Kansas, Lawrence.
Arthur D Pitcher, A. M., 1906, Univ. of Kansas, Lawrence.
L. M. Plairs, asst. entomologist, Agr Coll., Manhattan.
L. M. Powell, M. D., 1906, physician, Topeka.
Silas Eber Price, D. D., president Ottawa Univ., Ottawa.
Charles Smith Prosser, D. Sc , Ph. D , 1892, educator and geologist, Columbus, Ohio.
Wm. S. Prout, 1904, M. D., Emmet, Kan.
Albert B. Reagan, 1904, director of Indian school, Orr, Minn.
L. J. Reiser, 1911, chemist, Topeka.
Geo. E. Rex, 1911, mgr. treating plants, A. T. & S. F. Rly., Topeka.
H. A. Rice, C. E , 1909, asst. professor of engineering, Univ. of Kansas, Lawrence.
B. R. Rogers, D. V., 1907, Agr. Coll., Manhattan.
Eulalia E. Roseberry, 1909, teacher of physiography, Pittsburg.
J. C. Russell, 911, professor of agricultural chemistry, Univ. of Minnesota, Minneapolis, Minn.
Frank K. Sanders, D. D., Ph. D., LL. D , 1909, president Washburn Coll., Topeka.
D. C. Schaffner, 1903, Coll. of Emporia, Emporia.
John H. Schaffner, A. M , M. S., 1902, professor of botany, Univ. of Ohio, Columbus, Ohio.
Theo. S. Scheffer, M. S., 1903, Dept. Agriculture, Washington, D. C.
J. W. Scott, Ph. D., Ag. Coll., Manhattan.
M. Sebastian, 1911, Parochial School, Parsons.
Miriam Sheldon, A. M , 1906, Univ. of Kansas, Lawrence.
Edwin Taylor Shelly, M. D , 1902, physician, Atchison.
Claude J Shirk, A. M., M. S., 1905, instructor in physics and chemistry, Ottawa.
J. A. G. Shirk, 1904, professor of physics, Pittsburg, Kan.
Eva Schley, A. B., 1903, natural history, Univ. of Chicago, Chicago, Ill.

Ralph C. Shuey, 1905, Univ. of Pittsburg, Pa.
Eugene G. Smyth, 1901, entomology, Dept. Agr., Santa Rita, P. R.
S. G. Stewart, M. D., 1904, physician and surgeon, Topeka.
Chas. M. Sterling, A. B., 1904, Univ. of Kansas, Lawrence.
Frank Strong, LL. D., Ph. D., 1905, chancellor of University, Lawrence.
E. F. Stimpson, 1904, Univ. of Kansas, Lawrence.
M. C. Tanquary, Ph. D., 1912, instructor of entomology, Ag. Coll., Manhattan.
E. L. Tague, A. M., professor of chemistry, Washburn Coll., Topeka.
Edgar H. Thomas, 1907, State Normal School, Emporia.
F. J. Titt, B. S., 1898, Kingfisher Coll., Kingfisher, Okla.
J. E. Todd, A. M., 1907, professor of geology, Univ. of Kansas, Lawrence.
David Train, 1907, Bethany Coll., Lindsborg.
E. S. Tucker, 1904, associate professor of entomology, Dept. Agriculture, Baton Rouge, La.
W. H. Twenhofel, 1910, professor of geology and paleontology, Univ of Kansas, Lawrence.
Edith M. Twiss, Ph. D., 1910, dean of women, Washburn Coll., Topeka.
W. A. VanVoris, 1907, State Normal School, Emporia.
P. F. Walker, 1905, Univ. of Kansas, Lawrence.
J. D. Walters, M. S., 1894, Agr. Coll., Manhattan.
E. C. Warfel, A. M., 1909, lawyer, Wamego.
H. J. Waters, B. Sc., 1909, president Agr. Coll., Manhattan.
E. R. Weidlein, 1911, Univ. of Pittsburg, Pa.
J. E. Welin, A. M., M. S., 1899, professor of chemistry, Bethany Coll., Lindsborg.
Archie J. Weith, 1906, Lawrence, Kan.
J. B. Whelan, 1909, professor of chemistry, Univ. of Kansas, Lawrence.
E. A. White, 1909, chemist, Kansas City, Mo.
Stanley D. Wilson, B. A., 1910, instructor in chemistry, Univ. of Chicago, Chicago, Ill.
W. B. Wilson, B. S., M. S., 1903, professor of biology, Ottawa Univ., Ottawa.
John A. Wilson, 1909, science teacher, Ely, Minn.
C. H. Withington, B. S., 1903, high school, Topeka.
T. M. Wood, B. S., 1909, instructor, M. T. S., Pittsburg.
H. I. Woods, M. S., 1902, professor physics and astronomy, Washburn Coll., Topeka.
Lyman C. Wooster, Ph. D., 1897, State Normal School, Emporia.
J. A. Yates, M. S., 1897, geologist, M. T. S., Pittsburg.
C. C. Young, 1909, chemist State Water Survey, Lawrence.

MINUTES

Forty-fifth Annual Meeting, Kansas Academy of Science,

Supreme Court Room, December 23 and 24, 1912.

PURSUANT to announcement of program, the Academy convened at 10:30 A. M. The secretary-librarian reported the minutes of the Pittsburg meeting and the present condition of the library. Forty bound volumes have been added, most of them being government publications, and 101 volumes of our paper-bound pamphlets have been bound in half-morocco at the state printing plant. We have yet remaining unbound 400 or 500 volumes of scientific publications, received as exchanges for our Transactions.

On motion this report was adopted.

Professor Havenhill next read his report as treasurer, as follows:

Balance November 20, 1911	$712.94
Interest on deposits	25.74
Dues paid to treasurer	26.00
Dues paid to secretary	62.00
Total	$826.68
Paid out	8.00
Balance on hand December 23, 1912	$818.68

On motion this report was referred to the Auditing Committee, who later reported that they found the treasurer's report correct, and on motion it was adopted.

President Bushong announced the standing committees for this meeting, as follows:

Program: J. A. G. Shirk, Agrelius, Mrs. Smyth.
Press: Dains, A. A. Graham, McWharf.
Audit: Wooster, A. J. Smith.
Membership: Deere, Randall, Mrs. Smyth.
Time and Place: Harshbarger, Shirk, McWharf.
Nominations: Bailey, Yates, Agrelius.
Resolutions: McWharf, Graham, Dains.
Necrology: Mrs. Smith, Lovewell.
Engineering Section: Yates, A. J. Smith, Nielson.

The hour of noon having arrived, the Academy adjourned till 1:30 for lunch.

December 23, 1:30 p. m.

The reading of papers was called for, and papers selected by the Program Committee from the list herewith given were read.

Before the reading began, on motion of A. J. Smith, a committee was appointed to consider a proposition of affiliation between the Academy and the Engineering Society. Professors Smith, Yates, and J. A. G. Shirk were named as a committee, to report later.

Prof. Wooster reported that the Audit Committee had examined and found the treasurer's report correct, and it was adopted, and the committee discharged.

Professor Wooster read a paper on The Glacial Moraine Southwest of Topeka. The paper was discussed by B. B. Smyth and A. J. Smith.

Professor Smith exhibited and described some California fossils found by him in the bitumen beds.

Mr. A. A. Graham read two interesting papers on the Formation, Disintegration and Growth of Rocks, and Ground Avalanches, which were discussed by Wooster and Shirk.

Professor Bailey read a paper discussing European Food Markets, being the results of observations made in his trip abroad last summer. The paper was discussed by Bushong, Harshbarger, and Smyth.

Professor Wooster read a paper on "Biotropism," and showed the term justified by analogy and a useful adjunct in scientific description.

L. D. Havenhill presented a paper showing that the quality of foods and medicines has been improved since the foods and drugs law went into operation. Discussion by Bailey and Dains.

Notes on the Fertilization of Corn; by B. B. Smyth.

A Fossil from Coal Beds; discussed by L. C. R. Smyth.

On the Formation of Some New Formamidines; by F. B. Dains.

The Longevity of College Graduates, illustrated by a chart compiled from a recent publication of the living graduates of Yale University; by J. T. Lovewell. Discussed by Bailey.

Mrs. Smyth spoke of investigations of certain fungi that might account for the horse disease in western Kansas.

The Occurrence of Tin in Canned Goods was presented by Jackson and discussed by Dains and Bushong.

The Flora of Kansas; by B. B. Smyth and L. C. R. Smyth; read by title and outline given.

The Committee on Affiliation with the Engineering Society reported as follows:

Provisional Union of the Academy with the Engineering Society.

1. All members of the Engineering Society shall become members of the Academy of Science, and shall be entitled to all the privileges of the regular members.

2. The Engineering Society shall be known as the Engineering Section of the Academy of Science. They may fix requirements for membership in this section, but members of other sections shall be entitled to attend their meetings.

3. One general president shall be elected from the whole Academy, also one permanent secretary.

4. One vice president and secretary shall be elected by each section annually, who shall preside and keep the records of the meetings of the section from which they are elected.

5. All papers presented before the sections of this Academy shall, before publication, be passed upon by a committee of that section, and then presented to the Committee on Publication of the Academy.

A. J. Smith,
J. A. G. Shirk,
J. A. Yates,
N. P. Nielson,
Committee.

This report was adopted, and directed to be submitted to the Engineering Society at their meeting in January.

Professor Bailey thought that other organizations, notably the architects, might desire to form sections in the Academy on similar terms.

The hour announced for the supper having arrived, the Academy adjourned to the Y. W. C. A. building, where the local members had provided a most excellent banquet, which all enjoyed. The members next repaired to the Y. W. C. A. assembly room to listen to the retiring president's address, and the lecture of the evening by Prof. A. V. H. Mory, of Chicago, both of which able productions are reported in full in the Transactions.

December 24.

The Committee on Membership reported the names of the following candidates, and recommended that they be admitted to membership:

Applicants for Life Membership: F. W. Bushong, Mrs. L. C. R. Smyth.

Applicants for Annual Membership: S. J. Crumb, Geo. A. Dean, Mary A. Harman, S. W. Humphrey, H. H. Oldendick, J. W. Scott, E. L. Tague, M. C. Tanquary.

On motion, the rules were suspended and the secretary cast the vote of the Academy, and the president declared the above-named persons duly elected.

To secure advantages for lantern projection, the Academy adjourned to the lecture room of Washburn College observatory.

The Committee on Nomination of Officers for 1912–'13 reported as follows:

President, A. J. Smith, Emporia.
First Vice President, W. A. Harshbarger, Topeka.
Second Vice President, J. A. G. Shirk, Pittsburg.
Treasurer, L. D. Havenhill, Lawrence.
Secretary, J. T. Lovewell, Topeka.

This report was adopted, and on motion the rules were suspended and the president cast the vote of the Academy and declared the above-named officers duly elected as officers for the ensuing year.

By vote of the Academy, the Executive Council was continued as last year: *Ex officio*, President Smith; by election, Bailey. *Ex officio*, Treasurer Havenhill; by election, Dains. *Ex officio*, Secretary Lovewell; by election, Crumbine. By election, Willard.

The Committee on Time and Place reported as follows:

Baldwin, Kan., to be the place, and the time to be fixed by the Executive Committee.

The report was adopted, with provision that both time and place may be referred to a joint committee of the Academy and the engineers, this committee to be named by the presidents of the two societies in case the affiliation goes into operation.

It was moved, seconded and carried that the Kansas Academy of Science go on record as favoring a national law for the protection of bird life in the United States, and that the secretary of the Academy communicate this action to the Kansas congressmen at Washington and urge them to support such a bill if presented to Congress.

The able lecture by Professor Edmondson, of Washburn College, was listened to with much interest. His subject was The Highways and Byways of Japan, and the elegant lantern slides were taken by the lecturer during his recent tour in that country.

The Committee on Necrology reported the death of one of our associate members, Mrs. Mary Savage, wife of Joseph Savage, one of our earliest members. The death of Prof. J. J. Jewett was also reported, and obituary notices will be published in our Transactions.

L. J. Reiser, in charge of the treating plant of the Rock Island railroad, read an interesting paper on the preservation of timber.

Professor Tague, of Washburn College, presented some investigations concerning the protein of corn. Discussed by Mrs. Smyth and Professors Bailey, Jackson, Agrelius, Reiser, and Warfel.

Prof. B. B. Smyth gave some illustrations of what he terms Paladin squares of 7, 11, and higher prime numbers.

The Committee on Resolutions reported the following:

1. *Resolved,* That the Kansas Academy of Science extends its thanks to the local members in Topeka for their very efficient entertainment and hospitality shown at the forty-fifth meeting of the Academy.

2. We also extend our thanks to the press of the city for the liberal treatment received at their hands.

A paper on the Immunity of Ground Water, by C. C. Young; read by Bailey.

Insecticides, by L. E. Sayre; read by Havenhill.

In absence of the authors, the remaining papers on the program were read by title and the meeting adjourned.

THE PRESIDENT'S ADDRESS.

WORTH AND DIGNITY OF THE TEACHERS' VOCATION.

By J. M. McWharf, Ottawa.

(Delivered at the forty-fourth annual meeting.)

THE suggestive thought of our theme is, first, the superior material upon which the teacher works. All useful labor is respectable and honorable. Labor is God's first ordinance to man. He does violence to his constitution and faculties, both physical and mental, who repudiates labor as a means of educing, invigorating and enriching those faculties, and advancing the general interests of humanity, and yet we can not avoid considering a higher and more dignified grade of labor, that works upon a more valuable and precious material and produces a more dignified and important result. The man who builds a wagon is as truly respectable, if he builds it well, as he who constructs a locomotive, and yet the one is a higher grade of mechanical pursuit than the other. The potter who rudely fashions a jug from common clay is as respectable as the artist who shapes the graceful vase from the delicate porcelain, yet the latter occupies a higher department of labor than the former. The man who paints your house, if he does it well, is as truly respectable as the artist who transfers to canvas the loveliest or sublimest scenes of nature; yet is there no distinction in their vocations as to the scale of dignity? The man who quarries the marble from the bowels of the mountain may be as respectable as the one who from the rude, unsightly block brings forth a form of commanding dignity or surpassing loveliness, but you do not place him in the same rank with the sculptor. Shall a man who molds a brick, however respectable a brickmaker he may be, rank in the same grade with one who designs and erects a magnificent cathedral?

The common sense of mankind universally graduates the dignity of any vocation according to the nature of the material with which it works and the results which it produces. If this principle is applied to the teacher's vocation, how forcibly does it illustrate the worth and dignity of that vocation. The material on which they work is not the transient, changing and perishable forms of matter, but the living, immortal mind. How far superior this to the best forms of matter I need hardly tell. Matter in its noblest forms, its most beautiful combinations, is matter still, and subject to the laws of corruption and decay. He who works upon material subjects, and for material results, must do it under the pressure of a conviction that the results of his labor must be transient and temporary, and that time will write on his noblest memoranda the significant words, "Passing away." What can be accomplished with material forces that will be permanent? It was a sublime achievement to rear the colossal pyramids, that stand covered with the dust of three thousand years upon their hoary summits, and for aught we know may stand for many thousand years to come, but the day will come when those mighty structures must crumble and not a stone be left to mark the place where they so long stood in their useless grandeur. But he that makes an impression on a human mind, for good or evil, is working with things that can not die, and achieving results that will survive forever.

One glance at the nature of the mind must set the worth and dignity of the teacher's vocation in a striking light. It is spiritual essence; hence above the power of change, decay, or corruption. It has nothing to fear from relentless time; its existence is not numbered by years; it takes no count of ages. After all the sublime and beautiful forms with which this creating is crowned have passed away, the mind, the thing on which the teacher works, will but have entered on the infancy of a being which knows no age, and blushes with the rosy dawn of a morning to which gray evening never comes. Then consider the essential powers of the mind, and learn something of the worth and dignity of a vocation which attempts to educe and cultivate these powers. The power of thought or reason is its birthright. You may combine and arrange the particles of matter into striking and beautiful forms, but you can not inspire them with reason; you can not make them think or act. The sculptor may chisel out of the marble a form of wondrous symmetry and matchless grace; it may stand before you, in its exquisite proportion and radiant beauty, like a thing of life; but after all it is a cold, passionless, dead thing; speak to it, it answers not; clasp it, you feel no returning pressure; call upon it to move, to act, and to do, there it stands to mock your urgent appeal. Why seek ye the living among the dead?

But who shall describe the powers and capabilities of the living mind? What words are mighty enough to tell the lofty heights it can scale? The profound abysses it can fathom; it can travel on untiring wing through the vast realm of space; it can ransack the ample storehouse of nature and bring the gems and gold to the light of day; it can bend the very elements to its control; it can oblige the air, the fire and the water to do its bidding; it can harness airy vapor in bands of steel and drive it with thundering speed along the iron road; it can make the sun its artist and compel him to burn upon polished plate the features of its friends. Yea more, it can stay the lightning in its course and send it obedient on its errands; it can sweep the outskirts of space, commune with suns and systems, learn their size, compute their distance, and track their orbits. The mountain is rooted to its place, the sun confined to its course, and the ocean must ebb and flow within its appointed limits; but who shall set a bound to the range of the living mind? Who presume to say to it, thus far shalt thou come and no further? Well did that eloquent orator say in his matchless discourse on the use of astronomy, the earth moves, and the great sweeping tides of air move, and the empires of men move, and the world of thought moves, ever onward and upward to higher facts and bolder theories. Physical things are moving; so the mind of man is ever moving too; but the former will reach their limit in the narrow circles of time before the latter stretches the illimitable area of eternity.

If we analyze the wonderful sensibilities of the mind we but increase our conception of its grandeur. The nerves of sensation which traverse the body are numerous, varied and delicate, yet how unworthy are they if compared with that harp whose thousand strings are strung within the mind. Every spirit, whether of joy or sadness, of hope or fear, desire or disappointment, of love or hate, of rapture or despair, sweep those chords and bring out responsive murmurs. What an ocean of feeling lies within the human heart — now slumbering in repose, now gently stirred with emotion, now swept into fury by the blast of passion, now calmed into stillness by the breath of love. What large capabilities of friendship, patriotism, philanthropy and piety, what deep sensibilities of joy or woe are cradled there. The mind is capable of bliss that exceeds the rapture of angels, or wretchedness that surpasses the anguish of fiends.

With what material thing can you compare the human mind? As well might you liken a painted bubble, vanishing into air, to a mighty orb careering in majesty along the path of ages. Even then the analogy would be imperfect. The bubble and the star are a like material; they differ only in the degree of their duration; for, not even those glorious constellations, which, Mr. Everett says, far up in the everlasting belfries of the skies chime twelve at midnight, can compare in their material glories with one infant mind. The youngest child who shall wait on the teacher's instructions gives material to work upon as far above the grandest objects of inanimate creation as the mighty substance of eternity surpasses the fitful and feverish shadows of time. Next to the infinite and everlasting God, the grandest thing in this whole creation is the human mind. How dignified, how responsible, how sublime that vocation which works on such material as this. An unskillful sculptor may spoil a block of marble, an unskillful physician may damage a mortal body, but an unskillful teacher may ruin forever an immortal mind. Working with such material, we naturally expect that the results of their labors would be of corresponding value and permanence. To demonstrate this the entire history of literature brings its records; its most illustrious names come forth at our command and give their testimony. All the world's learning is but the product of mind, the fruit of the teacher's work; the splendid and enduring results of that vocation. The illustrious disciple of Socrates centuries ago gave to the world a system of learning—a system which for insight into ultimate principles is to-day at the head of all human knowledge. The Novum Organum of Bacon and the Principia of Newton will outlive the proudest material works of the age which gave them birth.

Hugo Grotius, as he sat in his quiet retreat in one of the Italian cities where he sojourned in exile from his country, and there wrote in his secluded study a treatise which gave law to mankind in all future ages. On sea and on land, on all seas and all lands, he shall bear sway. In the silence of that quiet study the same Grotius forged a scepter which to-day compels the allegiance of princes and people, defines their rights, arranges their intercourse, and gives them terms of war and peace which they may not disregard. In the day of battle, too, when king and kingdoms are thundering in the shock of arms, this same thoughtful student shall be there in all the turmoil of passion and the smoke of ruin, as a presiding throne of law, commanding above the commanders, and, when the fortunes of the day are decided, prescribing to the victor terms of mercy and justice which not even his hatred of the foe nor the exultation of the hour may dare to transcend. When the splendid pile in which Butler, the prelate, officiated, shall have crumbled to dust, his analogy of religion to the constitution and course of nature will survive, an imperishable monument to his genius, a magnificent argument for Christianity, and an enduring contribution to the standard literature of the world.

The blind old man of Scio's isle still sings his melodious numbers, the orations of Demosthenes are the world's models of eloquence, while the Parthenon is in ruins, and broken arches and smoldering columns strive with stammering tongues to tell what Athens once was. Ages roll along; revolutions sweep over empires; the lofty piles of architectural grandeur disappear like palaces of clouds; but the products of the mind still live in the records of history, the strains of poetry, the teaching of philosophy, and the utterance of eloquence. The proudest effort of the architect, the finest conception of the painter, the lifelike creation of the sculptor, must perish and be no more; but the results of the teacher's work, as he educes, shapes and sends forth to action the glorious human mind, survives the wreck of material forms, and waxes more vigorous and potential with the lapse of ages. On an obscure street in London stands a small weather-beaten chapel. There years ago an English nobleman listened to the instruction of a humble Christian teacher. Very few have heard of Wheeler Street chapel, and the name of the minister is forgotten; but the civilized world has heard of Sir Thomas Fowell Buxton. The chains of the slave loosen at the mention of his name, and Ethiopia stretches out her hand to welcome him to her fond embrace, and the children of her schools, which were founded by his care, have learned his history by heart, and will engrave it on bracelets of gold around their wrists. The skill with which he gained the sympathy of his countryman, and the vigor with which he broke the bonds of the West India slave, he traces back to the educating influence of a pulpit in that humble sanctuary.

The world's history abundantly testifies from the great results of the teacher's work, whether they teach in a schoolhouse or in a church, to the exalted dignity of their vocation. The teacher is engaged in developing and making available the true wealth of the state. Our commonwealth is rich in all the varied elements of beauty and greatness. With a noble territory, a temperate climate, a fertile soil, an industrious, enterprising and intelligent population, and vast works of internal improvement, she has nothing to ask in the way of natural resources, and for the grand, the beautiful, the sublime, she can not be excelled by any equal portion of the round world. We do not point to these as our real wealth; they are some of our best and grandest resources. Our real treasures are the minds of our people. Take from Italy or Spain their purple and golden skies, their balmy air, their luscious fruits, their sparkling wines, and give them men, how long would they occupy their present insignificant position among the nations? They need no material elements of greatness or of power; they need men. This is our strength; it may be our glory. Rightly trained, wisely and thoroughly developed, started into action under right influence, the resources that lie in the minds of the people are incalculable and will secure our greatness.

In the past our men have been our real wealth, the means of our real life, our fortune, and our fame. What had we been in the dark elder days of our national history were it not for the men whom God gave us and whom he fitted so wonderfully for this mighty work? If the legacy which they purchased for us with tears and sacrifices and blood, and transmitted to us hallowed by their memories, is to be preserved in its purity, it must be by men of like spirit with their noble fathers. To form such men from the youthful minds of this state is the great, the solemn, the responsible work of the teacher. These minds are to be committed to their care. These jewels of the commonwealth have the stamp of a noble ancestry on them. The noblest races of the world have contributed to form the American mind. The best blood of Germany, Holland, France and the British Isles have contributed their quota. Gathered from such sources, formed under such influences, subjected to such a training, and transmitted by such a parentage, the American mind is no ordinary one. Energy, resolution, perseverance, ingenuity and boldness are its prominent characteristics. An unextinguishable love of freedom, an instinctive hatred of oppression, an entire independence of thought and action, a decided confidence of its own opinions, a bold, adventurous spirit, all enter into the constitution of the American mind. They are elements of noble nature and extraordinary power. This mind has made itself felt in the past, and it will make itself felt in the future.

These mighty elements, so potent for good or evil, demand that the best influences and most healthful discipline be brought to bear on them in order that they may be thoroughly trained for the best, the noblest action, and not become mighty engines of discord or ruin. The prevailing characteristics of such a mind under a free government, where the most ample scope is afforded for its activity, furnishes a fitting field for the demagogue and the charlatan, both in church and state. There is no form of impostor, however gross, however monstrous; no radicalism or fanaticism, however malignant or revolutionary, which this restless, speculative, busy, adventurous American mind is not ready to adopt; and there is no country, strange as it may appear, which affords such a field for reformers, fanatics, enthusiasts and demagogues of every class, color and sex as this same intelligent and free America. How responsible, then, the work of educating a mind like this. How great the task of giving to it proper tone, development, discipline, and concentrating its masterly qualities to the best and noblest ends.

The teachings of nature, the physical influences of our country, are on the grandest scale and of the loftiest character, well fitted in their degree to develop and invigorate the minds of the people. Our towering mountains, our ample prairies, our majestic rivers, our mighty inland seas, our sublime forests, our magnificent cataracts, furnish a fitting physical school for such a mind, a noble place for its education and activity. Let its mental training be of corresponding breadth and grandeur. Add to all the sciences of the earth the noble science of God; bring those principles of moral science, which are lofty, like our mountains; those fundamental precepts of Christianity, which are broad, like our plains; those motives of excellence presented by religion, whose power is like the rushing of our mighty streams, and those wholesome restraints of moral law which are as unyielding as our granite rocks—bring all to bear upon these vigorous, enthusiastic, active, adventurous minds, and you will insure their rapid and onward progress in all that exalts and adorns the state.

To such a solemn work as this; to a work with such noble material; a work with such grand results; a work which aims to develop and make available the real wealth and resources of the state, the teacher is engaged. A solemn trust is committed to their charge, for, in the school room the children of the masses and the classes are in touch. It is a time when character is being formed; it is here that the American boy and the German girl associate; the boy of the banker and the girl of the blacksmith meet. Upon this level all classes and conditions come together, and the lesson learned is, that brawn, will and intelligence. not the pocketbook and social distinction, constitute the essence of life. They are children of a democracy. upon one platform, one common level, and a common aspiration. These conditions make children self-respecting and representative citizens as they advance to manhood and womanhood. There are ideas, sentiments, aims and hopes which are held to be true and good by all; they lie at the root of human life and human character. He who awakens and confirms this priceless work of intellectual and moral power will turn all energies to the life work of education. There can be no higher aim. That man who is active in learning and doing what is true and good and beautiful in private and public life has not only education, but he will continue to educate along a higher and purer life. In the teachings of our great educators, poets and sages we find that they are the source from which has come the inspiration essential to the highest development and usefulness of mankind. Death will come to a nation if the home, the church and the school fail in their purpose of education and instruction. These institutions are the nursery of American patriotism. In fact, the nursery of absolute patriotism in every land, in every age and under every flag has and will continue to be the true Christian home.

True education, then, demands unity as its fundamental ideal. Each human power must receive special training, but not a development for itself alone. We find two basal elements in character —a well-balanced mind and a strong, fully nourished, responsive body. Correct physical training aids in the development of both; while it does not increase the number of brain cells, it develops and increases their energy and activity. Mental and spiritual forces are now to be the great controlling agents in shaping the history and directing the destinies of men and nations. In earlier ages the thoughtful mind was a power among men. The monarch of Egypt trembled as the youthful Hebrew read his dream, and silence and fear came upon the Babylonish king as the gifted Daniel unlocked for him the dark secrets of the future. If Marius had been able to have wielded the same power in the senate which he did on the battle-field, he would never, in fact could never, have sat among the ruins of Carthage an exile in disgrace. But in the coming ages the thoughtful mind is to be the greatest power among men. Those whose vocation is to train and furnish mind, they are the men who are to shape and color the destinies of the world. To that class I would say, go forth to the noble, the honorable, the responsible work that is before you. The state confides much to you; in return she expects much from you. You are furnished with the elements of power over youthful minds, and the state looks to you to so use those elements that they shall add to her strength and make permanent her glory.

You are to demonstrate that peculiarity of American institutions by which we are distinguished from the Old World. Their principles are concentration, ours diffusion; their chief regards are for the few, ours for the many. They tell us that we have as yet made no contribution to the distinguished scholarships of the world; we point to our common schools, and tell them that we would not exchange these for all the glory of English literature. We may be in our infancy, but it is the infancy of a giant. Your work, if well done, must bear fruitage in the years to come. You are erecting an imperishable monument—one not built with marble, but with years: the mortar is not made of lime or sand, but of brains and love, and it is not mixed with water, but with sweat and tears. Man can not live forever in a brownstone front, or in gold. Death, shod with eternity, will grind to dust libraries, churches, hospitals, and schools, but it can not destroy an eternal truth. If you wisely shape the environments of those about you and transmit that which is true and good, you will live. The waves of time shall then dash impotently against your life. Its work will live on through time.

The choicest treasures of our commonwealth are intrusted to our teachers; the glory of the state is committed to their charge. Make our children true men and women, fitted by cultivation of the intellectual and moral nature for the places which they ought to fill and the destiny to which they may be called. Thus you will contribute to the highest welfare and glory of our commonwealth.

Teachers, respect your work and respect yourselves. What you do for others you carry into the larger life as a part of the eternal possessions. You are developed, educated, and formed, and you can develop, educate and form others. Men of genius create masterpieces by throwing their whole life into their work. You must believe in it; you must love it. Teach the child to see, hear, feel, wonder, admire, revere, believe, hope, and love. To this end the process of teaching and discipline is to be made subservient.

Emerson said: "Cobble shoes, maul rails, pick up stones, plough, make hempen rope, hang yourself at the end of one of them, but don't teach school." Carlyle must have been imbued with the same spirit when he said: "Whom the Gods wish to make miserable they first make teachers of." But I say, no man or set of men entered upon a better, a grander, a more honorable, a more worthy or a more dignified class of work, a work so redolent with achievement and worth as that in which you are engaged.

Creative art or learning is justly proud of the distinguished names associated with it. Each inspires the same human interest and is characterized by the same passionate devotion.

The name of Galileo is to-day a vivid figure in history. We look with pride coupled with reverence upon the old bronze lamp as it swings suspended by the rope in the Duomo at Pisa. There it hung centuries ago, when Galileo watched it.

Copernicus turned over with stricken hand his book on the solar system—the one he dared not publish before. This figure excites sympathy and indignation. We see the genius of Michael Angelo as it presides over the art and the architecture of Rome. Raphael will forever stand beside the glowing canvas of the Sistine Madonna as it burns itself into the soul of every beholder. Can we not in our imagination see Scott standing within the deep shadows of Melrose Abbey, or strolling in the woods about Abbott's Ford? How sweetly the chimes of Holy Trinity Church ring out over the hills about Stratford on Avon.

In the corner of the Hathaway cottage lingers the shade of Ann Hathaway and William Shakespeare. Over three hundred years the ashes of Shakespeare have reposed beneath the marble slab in Holy Trinity, guarded by the famous couplet:

> "Blest be the man that spares these stones,
> And curst be he that moves my bones."

Through the ages these men live in history, so the work of the teacher will live on through the ages until time shall be no more, for—

> "Since the universe began,
> And till it shall be ended,
> The soul of nature, soul of man,
> And the soul of God are blended."

PRESIDENT'S ADDRESS.

THE OPTICAL ACTIVITY OF PETROLEUM AND ITS SIGNIFICANCE.

By F. W. Bushong.

(Delivered at the forty-fifth annual meeting.)

THE wide distribution of deposits of bitumen in its various forms is attested in the very earliest writings, both sacred and profane. In the book of Genesis we learn that slime was used for mortar, and in the second book of the Maccabees we are told that Neemias commanded the priests to sprinkle the sacrifices with the thick water, and when this was done there was a great fire kindled, so that every man marveled.

Herodotus gives us the following description of the manner of its collection: "At Ardericca is a well which produces three different substances, for asphalt, salt and oil are drawn up from it in the following manner: It is pumped up by means of a swipe, and, instead of a bucket, half a wine skin is attached to it. Having dipped down with this, a man draws it up, and then pours the contents into a reservoir, and, being poured from this into another, it assumes these different forms: the asphalt and the salt immediately become solid, but the oil they collect, and the Persians call it rhadinance. It is black and emits a strong oder."[1]

For more than 2500 years the disciples of Zoroaster have worshipped the "eternal fires" in the neighborhood of Baku, Russia, and not until recently have their temples been replaced by oil reservoirs and refineries.

Within the last half century a new shrine has been set up in oildom, and our modern devotees have shown such zeal and activity that it may again well be said that "every man marveled." But the marvelous development of the petroleum industry has been rendered possible only by reason of the gigantic strides which have been made in the fields of natural science and technology. We may look for even greater things in the future, for science is still in its infancy. I have chosen for my subject to-night what I consider to be one of the infant industries of science.

1. Petroleum and its Products, S. F. Peckham, 1882, p. 1.

In the year 1835 Jean Baptiste Biot published his memoir on the circular polarization of light and its application to organic chemistry,[2] which contains a table giving polarimetric data regarding essential oils. This includes a sample of "naphte" rectified by distillation, which examined by red light gave a rotation to the left equivalent to 15.21° for a tube length of 200 mm. It is, however, very unfortunate that we have no information as to the source of this very remarkable sample.

Nearly fifty years later, in connection with their researches upon the petroleum of the Caucasus,[3] Markownikow and Ogloblin examined the natural "white naphtha," as well as some petroleum distillates, and finding these samples inactive they did not continue this subject any further. In 1885, however, Demski and Morawski[4] examined some of the more important mineral oils of commerce, among which one rotated the plane of polarization 1.2° to the right. In 1898 Soltsien[5] found that the commercial paraffin oils are dextrorotatory, and that the amount of rotation increases with their specific gravity. Since that time general interest has been awakened in this subject, and petroleums from all parts of the world have been examined polarimetrically. In general, it has been found that the lightest and least colored oils (including the so-called white naphthas) manifest little or no optical activity, while the heavier, dark and viscous oils yield active products.[6]

In a typical Kansas oil, examined in connection with the work of the University Geological Survey, slight optical activity was detected in the upper kerosene fraction which distilled between 250° and 300° under ordinary atmospheric pressure. The higher boiling portions of this oil, after a fractional distillation under diminished pressure, were dextrorotatory, the amount of rotation gradually increasing with the rise in boiling point until in the neighborhood of 280° at 27 mm. it reached almost one degree of arc.[7]

In some oils a maximum activity has been observed in the vacuum distillates collected at about 275°, and in the case of a German oil a second maximum was reached at a temperature

2. Mem. de l'Acad. de Sciences, *13*, 39; 1835. See, also, "Die Polarimetrie der Erdole," M. A. Rakusin, Berlin-wien, p. 6; 1910.

3. Annales de chim. et de phys. (6), t. II, 387, 1884.

4. Dingler's Polytech. Jr., *258*, 82; 1885.

5. Chemisches Centralblatt, 1898, I, 869, II, 455.

6. Zaloziecki and Klarfeld, Chemiker Zeitung (1907), 1170.

7. Univ. Geol. Survey of Kansas, vol. IX, p. 317; 1908.

of 310°. Javanese petroleum yields vacuum fractions boiling about 150–180° which are lævorotatory, but the higher boiling fractions are dextrorotatory.[8] A sample of petroleum from Borneo yielded a distillate collected between 260° and 340° under atmospheric pressure which was lævorotatory.[9] A lævorotatory activity has also been reported in an oil from Argentine Republic.[10]

But the fractions obtained in the distillation of petroleum do not represent distinct chemical individuals, but consist of more or less complex mixtures. Hence it is necessary for us to make use of other processes before we can isolate the optically active constituents. The fact that the distillation products of petroleum have found such a ready market without the necessity of chemically transforming them has, no doubt, greatly hindered the development of chemical methods for their utilization. But in recent years competition in the refining of illuminating oils is beginning to force the refiners to look to the utilization of their waste products. In Russian refineries the alkaline sludges are now treated so as to recover the so-called naphthenic acids which find a ready market for the manufacture of cheap soaps.

The fact that the naphthenic acids derived from kerosene show greater optical rotation than the kerosene was first observed by Rakusin.[11] The naphthenic acids derived from lubricating oils were found by Marcusson[12] to be much more strongly active than those derived from kerosene.

A study of isomeric naphthenic acids[13] has recently been made in the laboratory of industrial research of the University of Kansas. Commercial naphthenic acids, after being freed from hydrocarbons, were converted into esters, which were repeatedly fractionally distilled. The lowest boiling fractions were strongly lævorotatory. The succeeding fractions showed a gradual decrease until in the intermediate fractions a neutral or inactive point was reached. Above this there was a gradual increase in dextrorotatory activity. A portion of free naphthenic acids, which were similarly purified, were separately fractionated and gave re-

8. "Die neueren Ansichten uber die Entstehung des Erdols," C. Engler, Berlin, p. 55; 1907

9. Jones and Wootton, Jr. Chem. Soc., 91, 1146; 1907.

10. Longobardi, Petroleum VI, 552; 1911. Jr. Russ. Phys.-Chem. Soc., *43*, 792; 1911.

11. Die Untersuchung des Erdols und seiner Produkte, p. 178, 1906.

12. Chemiker-Zeitung, 1907, No. 3?, p. 421.

13. Orig. Com. 8th Internat. Cong. Appl. Chem., VI, 57-67; 1912.

NOTE.—The same isomeric naphthenic acids have since been independently isolated by the method of repeated fractional crystallization of their amides, by Gadaskin and Zavershinskaya, jr. Russ. Phys.-Chem. Soc., *45*, 377, 1913.

sults exactly parallel to those of their esters, the only difference being that the boiling points of the free acids were uniformly about 50° higher than the boiling points of their methyl esters. In other words, each and every optically active constituent boiled 50° higher in the one case than in the other. This shows that these optically active constituents are acids which are esterifiable, and marks the first distinct step toward their isolation. The simplest interpretation of these facts is that the cause of the optical activity resides within the naphthenic acids themselves.

It does not necessarily follow, however, that the optically active constituents present in the commercial naphthenic acids are identical with those originally present in the petroleum. There seems to be good evidence that this is not the case, for it has been shown by Albrecht[14] that the optical activity of lubricating oils is not appreciably reduced by thorough refining by means of alkali. This result has also been confirmed by experiments with the Kansas oil distillates already mentioned, which retained most of their optical activity after being boiled with alcoholic potash. On the other hand, these experiments do not prove that no optically active acids are removed by the treatment with alkali, for it is quite possible that both lævorotatory and dextrorotatory acids may be removed in approximately equal quantities. To satisfactorily settle this question an experiment should be carried out at a refinery upon a large quantity of oil.

The naphthenic acids are generally believed to be the oxidation products of the naphthenes, or saturated cyclic hydrocarbons of the series C_nH_{2n}, which are present in most of the petroleums, but particularly in those of Russia. It is to be expected, therefore, that active acids should result from the oxidation of certain active hydrocarbons. The determination of the constitution of any of the active acids to be found in petroleum products would thus shed light upon the constitution of the active hydrocarbons from which they were formed.

The crucial test as to the correctness of our knowledge of the constitution and structure of organic compounds depends upon the methods for their synthesis. But chemical synthesis is a species of architecture, and just as the architect before beginning the erection of his structure must lay down his plans and draw his designs so that each and every part shall be fitly adapted to its specific use, so the chemist must first in his imagination plan the order

14. Chemische Revue, *18*, 189; 1911. See, also, "Die Polarimetrie der Erdole," M. A. Rakusin, p. 39.

and arrangement of the various elements and groupings which are to be combined in such a manner as to produce the desired specific results.

The distinguishing characteristic in the structure of the optically active organic substances is that they contain at least one carbon atom which is combined with four different atoms or groups. If we consider the space distribution of the four different atoms or groups about the central carbon atom we shall find that two arrangements are possible. The two resulting forms are related to each other in the same manner as an asymmetric object and its mirror image. Such a carbon atom is called an asymmetric carbon atom. We have for each substance containing such an asymmetric carbon atom the possibilities of a right-handed structure and a left-handed structure. Corresponding to these theoretical structures we find that nature has furnished us with dextrorotatory and lævorotatory isomeric substances, which are closely identical in all of their physical and chemical properties, but differing chiefly in that the one rotates the plane of polarized light as far to the right as the other does to the left. When these two so-called sterioisomeric substances are mixed in equal quantities the resulting product is inactive. So, also, when two asymmetric carbon atoms occur within the same molecule, inactivity may result from internal compensation. It is thus found that among substances of asymmetric structure there are two classes which are optically inactive. The members of the one class—said to be inactive by internal compensation—are not separable into active components, while the members of the other class—said to be inactive by external compensation—are separable into dextrorotatory and lævorotatory components.

We have three methods for the separation of the optically active components, all of which are due to the researches of Pasteur.[15]

1. In some instances enantiomorphic crystals may be formed which may be mechanically separated.

2. By the aid of suitable active substances compounds may be formed which differ in their solubility, thus permitting the two optical isomers to be separated by fractional crystallization.

3. Through the action of certain microörganisms one of the optical isomers may be destroyed by fermentation while the other remains unaffected.

The direct synthesis of optically active substances from inactive material has not been effected, because both of the stereoisomeric

15. "Researches on the Molecular Asymmetry of Natural Organic Products," by Louis Pasteur (1860); Alembic Club Reprint No. 14.

forms are simultaneously produced by synthetic processes, but the same result is accomplished indirectly by first synthesizing the inactive mixture, or compound, and then separating the components by one of the methods already mentioned.

When, however, we find in nature substances which show optical activity we know that they must contain constituents which are asymmetric in structure. In endeavoring to determine their constitution the chemist, therefore, gains the distinct advantage of leaving out of consideration all that vast array of substances which are symmetrically built, and of being permitted to concentrate his attention and efforts upon the relatively few possibilities of asymmetric structure.

But the chemist is not alone in the advantage thus gained. From what has been said regarding synthesis from inactive material, it follows that all theories accounting for the formation of petroleum from inorganic material, and excluding the action of optically active organic substances, must be rejected.

But still another factor which must be considered by the geologist with reference to the origin of petroleum and other optically active bitumens is that of temperature. All theories involving violently energetic chemical reactions and the production of high temperatures must likewise be rejected.

Having thus limited the possibilities of petroleum formation, it is well to inquire what sources remain which are capable, under the conditions imposed, of supplying a sufficient amount of material for the accumulation of the vast stores which are being unearthed, and also whether the study of the polarimetric data gives promise of furnishing positive specific evidence as to the kind of material from which petroleum has been derived.

In answer to the first of these questions I quote from the report of Professor Haworth:[16]

"Few people realize the vast amount of organic matter annually carried down to the ocean by surface drainage. Vegetation covers practically the entire dry-land area of the earth, and has done so throughout all geologic time. Varying climatic conditions and other influences doubtless have made a corresponding variation in the richness of organic materials in different rock masses. But when all allowances are made for such variations, it remains that the amount of organic matter thus entombed is and has been enormously great. And such matter need not be confined to vegetation, for our ocean water is teeming with animal life. Speaking broadly, it is well known that animals subsist on vegetation, and that the constant addition of food matter to the ocean water, for the ocean fauna comes from vegetation, as plants are the great agents for changing inorganic matter

16. The University Geological Survey of Kansas, vol. IX, 194-195.

into organic matter. . . . If one will put himself into a position which makes it necessary to give a reasonable account for the whereabouts of all this vast quantity of organic matter, animal and vegetable, which has been engulfed in the masses of stratified rock, one will find that the quantity of oil and gas now available is all too small, rather than too large, for such accounting."

Even though the study of the chemical constituents of petroleum is in its infancy, attempts have already been made to detect among them specific optically active substances which may definitely and with certainty reveal their origin. The substance which has received the greatest consideration from this standpoint is cholesterin, the optically active constituent of many animal fats, or phytosterin, its vegetable equivalent. Cholesterin, when distilled, yields products which closely resemble the distillation products of petroleum. Furthermore, the optically active petroleum distillates usually give the same color reactions as are given by cholesterin products.

Chemists are inclined, however, to view color reactions with suspicion, and demand more positive methods of proof of identity than the supporters of the cholesterin hypothesis have been able to furnish. On the other hand, the amino-acids and numerous other decomposition products of albuminous material, as well as the remains of balsams, resins, terpenes, tannins, etc., must all be looked upon as contributing to the optical activity of the organic remains which may retain them. The time is ripe for the study and solution of problems of this nature.

The knowledge of the nature of the substances contained in petroleum which is to be revealed through the instrumentality of their optical properties may be put to practical use in the development of methods for extracting them and utilizing them for industrial purposes. The output of petroleum refineries in the past, even though enormous in quantity, has been restricted almost entirely to the extraction and clarification of products which exist ready made in the crude oil. The various grades of gasoline and naphtha, illuminating oil, lubricating oil, paraffin, fuel oil and road oil are all marketed in a low-developed stage in the art of manufacture. The coal-tar industry, on the other hand, which utilizes a crude material closely resembling petroleum, and not a bit more inviting, has reached a high stage of development, in that its products are completely transformed into an almost infinite variety of costly dyestuffs, flavoring matters, medicinal preparations, and other articles which have contributed to our wealth, our comfort, and to the advance of our civilization. This utilization of what was formerly a waste product, which could be disposed of only at considerable expense, is a splendid example of what chemical industrial research has accomplished. The fact that petroleum products are not similarly utilized simply demonstrates that we lack the requisite knowledge.

II.

CHEMICAL AND PHYSICAL PAPERS.

1. "ON THE POWDERED SUGAR OF COMMERCE."
   By E. H. S. BAILEY and H. L. JACKSON.
2. "NOSTRUMS."
   By L. E. SAYRE.
3. "ON THE REACTIONS OF THE FORMAMIDINES."
   By F. B. DAINS and E. L. GRIFFIN.
4. "STANDARDIZATION OF INSECTICIDES AND DISINFECTANTS."
   By L. E. SAYRE.

ON THE POWDERED SUGAR OF COMMERCE.

By E. H. S. Bailey and H. L. Jackson.

IT has been said that although sugar constitutes about 30 per cent of the trade of the wholesale grocer, it gives him 75 per cent of his trouble. This is due to the fact that it is sold on such a close margin that, although it takes considerable capital to handle it, the profit is small, or may, indeed, in the fluctuations of the market, be a negative quantity.

The ordinary grocer handles only a few grades of sugar, as there is no demand for a great variety, but there are about thirty different grades on the market. These are of different colors and degrees of fineness. Those sugars upon which most work has been done in the process of manufacturing sell for a higher price, but the cost to the consumer of such grades as cube sugar and powdered sugar is entirely out of proportion to the increased cost of manufacture. In fact, these grades are to be classed as luxuries, or foods to be purchased only if the consumer has sufficient income so that he can afford to buy them.

Both cube sugar and powdered sugar are usually made from the same grade of stock as granulated sugar. The cube sugar has, however, been crystallized in lumps or "sugar loaves," and is then sawn into slices, and finally into cubes. Powdered sugar has been ground in a mill, similar to that used in making flour, and then sifted through bolting cloth, so as to be of uniform fineness. It is also very important that powdered sugar should be thoroughly dried, so as to prevent its caking upon storage. These sugars are sometimes colored blue with "ultramarine" so as to cover up the slightly yellow tint which is due to the retention of a small quantity of molasses. This process is of the same character as the bluing of clothes in the laundry, and is practiced for the same purpose.

On account of the recent high price of sugars, there would be greater danger of adulteration at the present time than formerly, and this adulteration, if it is practiced, would no doubt be tried on the most expensive sugars and those that were powdered, so that the presence of foreign sugars could not be so easily detected.

These facts have led us to make some examinations of the granulated sugars at present sold in this state, with the following results:

Something over twenty samples of the finest grade of powdered sugar, namely, the XXXX, have been collected by our inspectors and examined in the laboratory. As one requirement for powdered sugar is that it should be fine and free from lumps, some of the manufacturers have been putting a little starch into the sugar during the process of grinding. This can hardly be called adulteration, however, as it is not put in with the object of cheapening the product, but to improve its quality for a particular purpose. Starch is, furthermore, a food product, although less expensive than sugar. A mineral substance, if added to the sugar, would be considered an adulteration, as mineral substances are especially forbidden for use in sugar or confectionery.

Of the twenty samples analyzed five contained starch, and the maximum quantity found in any sample was 4 per cent. In one package, in which the label stated 2 per cent of starch was present, no starch was found. It is not uncommon, however, to find that the label does not truthfully describe the contents of the package. There was no indication of the presence of other substances than pure cane sugar in the samples examined.

Although the pure food and drugs laws are fairly well enforced, there is always the tendency in the trade to encroach as far as possible over the line. By ingenious labels, written by well-trained counsel, products are kept on the market almost in spite of the efforts of the authorities. Although the glaring frauds are eliminated, there is just as much need as ever for vigilance on the part of those who are working to protect the consumers from misrepresentation in foodstuffs.

NOSTRUMS.

By L. E. Sayre.

IT would seem that an apology would be in order before presenting a paper upon this subject before a scientific body, but if one considers the immense importance that nostrums have in the eyes of the public and the recognition of them by chemical analysts in the administration of the drug end of the food and drugs law, the reasonableness of such a paper becomes apparent. Nostrums are defined as medicines the ingredients of which are kept secret for the purpose of restricting the profits of sale to the inventor or proprietor. They have such synonyms as "quack medicines," "fake medicines," and "patent medicines." However, these synonyms do not necessarily mean exactly the same thing. The fallacy of secrecy on the part of pharmacists and physicians is becoming more and more apparent as the science of therapeutics progresses, and since the enactment of the food and drugs law more attention has been given to this problem of secrecy. Both professions, pharmacy and medicine, have been severely called to account. It is not the purpose of this paper to reflect upon the sister profession for any of its shortcomings. The profession is perfectly able to do that for itself. In discussing the subject of nostrums, however, it must not be conceded that the only guilty parties, if indeed there be any guilt, are attached to the pharmacy profession.

Since the term "patent medicines" has been applied to these, this would naturally lead to the query, What do we understand by this term?

Dr. F. E. Stewart, in his report to the committee of revision of the United States Pharmacopœia, discusses the subject as follows:

The history of the nostrum business will show where the names "patent" and "proprietary" medicines originated.

At first these preparations were known as secret nostrums and claimed to be inventions or discoveries in therapeutics. In process of time some of these secrets were betrayed or divulged, and it was then found that any one possessing the necessary knowledge and having obtained the same legitimately, has a perfect right to make and sell the same things. The next move was to patent these preparations under the provision allowing the patenting of compositions of matter. The board of examiners in chief finally decided that it "was never intended that any composition or mixture of simples should be the subject of monopoly. If rhubarb and senna, or calomel and jalap, were for the first time put together, he who should do it, whether regular practitioner or quack, would not be an inventor or discoverer under the law. If done by a physician, it would be only the exercise of ordinary professional skill. If by another, it would be but an ignorant jumble of things having supposed virtues and benefits to be obtained by the union of known drugs."

In the issue of January 13, 1910, the editor of the official organ of the National Association of Retail Druggists thus classified medicinal preparations:

1. Ethical preparations.
2. Druggists' own-make preparations.
3. Proprietaries.
4. Nostrums.
5. Fakes.

According to the editor, an "ethical preparation" is one "whose entire composition is known, and can be prepared by any capable pharmacist"; the "druggists' own-make preparations" are those "common domestic remedies which almost every druggist prepares for himself to meet a popular demand"; the "proprietaries," erroneously called patents, are such as have, through merit, and by the price-protecting efforts of their manufacturers, become a recognized article of merchandise in most drug stores"; the "nostrums" are those "secret and semisecret mixtures, either with or without coined names, about whose virtues such extravagant claims are generally made to the members of the medical profession or to the public"; the "fakes" include such compounds "as are intended more to defraud the public than anything else."

Doctor Stewart says:

When it is considered that the same preparation may belong to any one of these classes, and that some of the so-called "ethical preparations" of the Pharmacopœia were originally introduced as secret nostrums, it is at once apparent that this classification is faulty, because misleading. The question is in fact one of advertising. By advertising in this connection we mean recommending, whether such recommendation be spoken or printed on a label or published in a newspaper.

Judge McFarland, of Pennsylvania, in his decision in the case of the Dr. Miles Medical Company vs. The May Drug Company, brings out the legal attitude toward these preparations, in speaking of them as a method of prescribing at long range without diagnosis. He says:

We do not need to be told by medical authority—our own knowledge informs us—that not only a careful examination, but great skill is needed, for example, to detect the numerous valvular and other diseases of the heart.

Further, any intelligent, thoughtful person knows that many of the symptoms listed by the plaintiff (including heart troubles) are caused by other diseases or disorders. For one sick to diagnose his own case is the height of folly, yet this plaintiff advises the poor deluded victim to pass upon subjects often baffling the highest medical skill to settle the nature of the disease, and then to take "Dr. Miles' Nervine," or "Heart Cure," or some other high-sounding preparations of unknown ingredients, recommended in glowing "testimonials." The enormous business done by the proprietors of medicine and the serious menace which it is to the health and lives of the public requires us to scrutinize carefully the ground upon which the plaintiff stands, and as it has shown that it belongs to the reprehensible class, we decline to grant it a decree.

The proprietors, dealers and nostrum manufacturers in opposition to this legal attitude—that they are not deserving of legal recognition—state that the real fact is that nostrums are to a very large and almost universal extent the most successful prescriptions of our most advanced and successful physicians, etc. On the other hand, the American Pharmaceutical Association has formally protested against this system of business, and especially that part of the business which seems to say that the pharmacists have unfairly appropriated and launched upon the public, as specifics for disease, prescriptions of physicians. It most emphatically protested against such a statement as an injury and damaging to the reputation of the pharmacy profession. It furthermore states there is in fact no drug which may be truly described as a specific or cure for any disease. Furthermore, the highest medical skill is required to diagnose each disease and to recognize its various stages as they develop, and no prescription will answer the requirements of all the different stages of the same disease. When a medicine, whether it be the prescription of a reputable physician or not, is given a name and launched on the public as a *specific* or *cure*, when it is not, the person so doing is guilty of a moral wrong to the community. This principle is everywhere recognized by enlightened communities, and prohibitive or restrictive laws have been passed to control the secret nostrum business in such countries as France, Germany, Austria-Hungary, Japan, Brazil, Argentina, etc.

The public should at least have the opportunity of knowing the medicinal ingredients and their percentage in the composition of every agent used for the prevention and treatment of disease, so that the people may be protected from the machinations of quackery. It is admitted by the "Proprietary Association" in the foregoing quotation that so-called "patent medicines" are usually not new things, and the only invention about them is that of their names. When it is taken into consideration that no one except their manufacturers knows the true composition of these nostrums, the absurdity of claiming that the names given them are trade-marks used for the purpose of distinguishing between brands of well-known prescriptions is apparent. Again, as the claims made for these nostrums regarding their therapeutic value are not generally justified by the facts, it is evident that their manufacturers when they make false representations in regard to these prescriptions, can not come into court with clean hands to defend their alleged trademarks. The burden of proof must needs fall upon the advertisers of such claims, and proof can not be forthcoming unless the true composition of their medicines is made known.

The analysis of a very large number of these patent medicines or nostrums have been made in the drug laboratory of the University, and it has been found that almost universally they are composed of agents which are not only not new to medical science, but compounded by the use of simple, well-known medicinal articles. It is fair to say that on the average they are practically harmless, but a few have been found to be even dangerous when used with impunity, especially in the treatment of diseases of children. Since the law forbids the use of habit-producing drugs without a declaration on the label of such ingredients, the number of the harmful medicines of this class of "patent medicines" has been greatly reduced. The Board of Health Bulletins have from month to month reported upon the constitution of those sent in to the laboratory by inspectors. Some of these are interesting. For example, in the last report there is published the analysis of Fruitola, a comparatively new member of this class. Quoting from the report, it states about as follows:

Another interesting remedy which has been of considerable interest is known as Fruitola and Traxo. This compound is "a system cleanser, removes gall stones, and positively cures all stomach trouble," and is put up by the Pinos Medical Company, Los Angeles, Cal. Their pamphlet assures the reader that there is such a thing as a positive cure in remedial agents. The Fruitola, which they advertise, consists of a four-ounce bottle of olive oil, with a mixture of an agreeable volatile oil, and with this liquid are three Seidlitz powders. Accompanying Fruitola is a dark-colored liquid known as Traxo, which consists of a solution of vegetable extractives, the major part of which seems to be, thus far examined, Taraxacum.

In conclusion, this industry in nostrums seems to be growing, and is largely due to the developments in the art of advertising, and, as has been stated before, the worst feature of this business is to be found in that department. It is well to call attention to that phase of the subject. There seems to be no claim too extravagant for use by those who write the advertising literature for these nostrums, and much of this physicians are asked to read and believe. The United States government has endeavored to combat this evil of misrepresentation on labels and advertising matter, under regulation 17E of the food and drugs law, which, referring to misbranding, states that the descriptive matter upon the label shall be free from any statements, design or device regarding the article or the ingredients or substances contained therein or quality thereof, etc., which are false and misleading in any particular.

In the ruling of the United States supreme court (United States vs. O. A. Johnson; opinion May 29, 1911) we have a contradiction of law which is phenomenal. The ruling here is to the effect that the food and drugs act does not cover the knowingly false labeling of nostrums as to their curative effect. In the language of President Taft, "it follows that, without fear of punishment under the law, unscrupulous persons, knowing the medicines to have no curative or remedial value for the diseases for which they indicate them, may ship into interstate commerce medicines composed of substances possessing slight physiological action, and labeled as cures for diseases which, in the present state of science, may be recognized as incurable." In other words, these unblushing falsehoods and extravagant claims of literature, such as we find in the circulars, labels and advertisements, are legitimate, and, according to the ruling of the supreme court, the food and drugs law has no jurisdiction—a position which seems like an insult to the medical and pharmaceutical professions.

Unquestionably, Mr. Taft's message to Congress, in which he exposes the vital weaknesses of the pure food and drugs act in this direction, will arouse that body to act in such a way as to remove such weakness by either insisting on a different interpretation or by injecting into the law an unmistakable ruling which will apply to these cases. It is worthy of notice that the British Conference of Pharmaceutical Faculties, which was held in July last, have taken up this subject of patent medicines vigorously, and their report is to be found in the *Pharmaceutical Journal* for July 29, 1911, pages 165–168, in which it is stated: "This meeting of the British Pharmaceutical Conference is of the opinion that a public inquiry by a royal commission or a departmental committee should be held in regard to the advertising and sale of proprietary and secret medicines and the law relating thereto, with a view to further legislation for the prevention of fraud and quackery."

At the risk of being unduly lengthy in this conclusion, I wish to call attention to the patenting of a recent medicine discovered in Germany by Ehlich. I refer to the "Dioxydiamidoarsenobenzol," otherwise known as "Salversan." The patenting of this preparation, which is also known by the name "606," has been very much criticised, both by the medical and pharmaceutical professions, but it must be taken into consideration that Ehlich made these investigations under an arrangement with a German chemical house, whereby said house furnished him with the money necessary to carry on the experiments, with the understanding that if a product was obtained of sufficient value to warrant its being introduced, it was to be patented and the patent controlled by the commercial house. This fact puts a different phase upon the matter. In Germany, if the invention relates to the process for the production of a new substance, this patent protects the process and substance. Medicines, however, are excluded from patent protection not only in Germany, but also in France, Austria-Hungary, Italy, Japan, Denmark, Norway, Sweden, Portugal, Russia, and a number of other countries.

Dr. F. E. Stewart, in a recent circular, says, in effect: "I believe that the arrangement made by Ehlich with the German chemical house represents a plan of coöperation between professional and commercial interests which, if purged of the monopolistic feature now pertaining to it, might be made in every way commendable. The great manufacturing houses engaged in the chemical and pharmaceutical industry, with their scientific departments, are in a position to render the most valuable kind of service to the medical profession. Their equipment, influence and large facilities make it possible, by such arrangements with physiologists, pharmacists and others, to advance the science of medicine and pharmacy which otherwise would be impossible.

ON THE REACTIONS OF THE FORMAMIDINES.

Syntheses of Isoxazolon, Isoxazol, Cyanacetic and Benzoylacetic Acid Derivatives.

By F. B. DAINS and E. L. GRIFFIN.

IN previous papers it has been shown that compounds containing a methylene group, CH_2, such as acetoacetic ester, benzoylacetio ester and cyanacetic ester, are capable of reacting with substituted formamidines yielding derivatives of the type XYC : CHNHR, in which the two methylene hydrogens are replaced by the grouping :CHNHR. Phenyl isoxazolon, another compound containing methylene hydrogen, reacts in the same way, yielding substituted aminomethylene derivatives of phenylisoxazolon. The compounds made by this reaction were: 3-phenyl-4-anilidomethylene-5-isoxazolon, 3-phenyl-4-o-toluidomethylene-5-isoxazolon, 3-phenyl-4-p-toluidomethylene-5-isoxazolon, 3-phenyl-4-m-toluidomethylene-5-isoxazolon, 3-phenyl-4-o-anisidomethylene-5-isoxazolon, 3-phenyl-4-p-anisidomethylene-5-isoxazolon, 3-phenyl-4-p-phenetidomethylene-5-isoxazolon, 3-phenyl-4-pseudocumidomethylene-5-isoxazolon, 3-phenyl-4-nitroanilidomethylene-5-isoxazolon, and 3 phenyl-4-p-bromanilidomethylene-5-isoxazolon.

It was found that derivatives analogous to these could be formed by the reaction of either benzal-or anisal-methylisoxazolon on the formamidines, the substituted aninomethylene derivatives of methylisoxazolon and benzal-or anisal-amines being obtained. From benzalmethylisoxazolon were obtained 3-methyl-4-anilidomethylene-5-isoxazolon, 3 methyl-4-o-toluidomethylene-5-isoxazolon, 3-methyl-4-p-toluidomethylene-5-isoxazolon, 3-methyl-4-m-toluidomethylene-5-isoxazolon, 3-methyl-4-p-anisidomethylene-5-isoxazolon, 3-methyl-4-o-anisidomethylene-5-isoxazonon, 3-methyl-4-p-phenetidomethylene-5-isoxazolon, and 3-methyl-4-m-xylidomethylene-5-isoxazolon. From anisal methylisoxazolon and formamidines were made 3-methyl-4-anilidomethylene-5-isoxazolon, 3-methyl-4-p-anisidomethylene-5-isoxazolon, and 3-methyl-4-pseudocumidomethylene-5-isoxazolon. Anilidomethylememethylisoxazolon and anilidomethylene phenyl-isoxazolon were found to react with bromine, with the loss of hydrobromic acid, forming monobrom derivatives, which on solution in alcohol go over to p-bromanilido-methylene-methyl-isoxazolon and p-bromoanilido methylene-phenyl-isoxazolon. With dilute alkali these isoxazolon derivatives dissolved and formed a salt from which the same isoxazolon could be regained by adding hydrochloric acid. With heat and standing, however, this breaks down, giving the amine and another salt.

When hydroxylamine acts on the amides of aminomethylene-aceto or benzoylacetic acids, there are formed 5-methyl or phenyl-isoxazol 4-carboxylic acids. These isoxazols, under the influence of alkalies, rearrange to form substituted amides of acetyl or benzoylcyanacetic acid. To study these reactions several compounds were made, including the following: the o-totylamid of 5-phenylisoxazol-4-carbocylic acid, and from this by the action of NaOH benzoyl-cyanacet-o-toluid; p-tolylamide of 5-phenylisoxazol-4-carboxylic acid, and from this benzoyl-cyanacet-p-toluid; the p-anisylamid of 5-phenylisoxazol-4-carboxylic acid which with the alkali gives benzoylcyanacet-p-anisid; the anilid of 5-phenylisoxazol-4-carboxylic acid, which likewise rearranges; also, the O-totyl and p-totyl amides of 5-methylisoxazol-4-carboxylic acid were made, giving in the same way acetcyanaceto-o-toluid and p-toluid. The anilid of 5-methylisoxazol-4-carboxylic acid was separated with difficulty, but reacted in the same way to form acetcyanacetanilid.

STANDARDIZATION OF INSECTICIDES AND DISINFECTANTS.

By L. E. Sayre.

At the last annual meeting of this Academy the writer presented a brief review of the commercial insecticides, and referred to federal regulation No. 16, which requires certain ingredients of these compounds to be declared. Prominent among the constituents affected by this regulation is that of arsenic and any of its combinations.

Inasmuch as this class of agents, and those closely related, the bactericides (disinfectants), have come under the regulation affecting standards, I have thought it wise to present to this Academy in compact form the present legal status, so to speak, of these two classes of agents, so that we shall have for reference in our report of proceedings reliable data concerning them. In order to do this I may have to revise and add to what was stated on this subject in a paper presented to this Academy last year.

In the first place, it should be stated regarding insecticides, that insecticides other than arsenical combinations and fungicides containing inert substances which do not prevent, destroy, repel or mitigate insects or fungi, must bear a statement on the label of the name and percentage of each inert substance therein, unless the name and percentage of each active ingredient of the article is plainly and correctly stated, in which case it will be sufficient to state on the label that the article contains inert substances, giving correct percentage thereof.

The enactment of the federal law has naturally drawn much attention to the subject of the relative value of fumigants, sprays and powders acting as insecticides, and recent investigation of these in our own laboratory has shown that our opinions must be revised as to relative toxicity of members of this class. For example, it was believed at one time that formaldehyde ranked in the first class among these agents. Actual experiments, however, indicate that it is quite low in activity; for instance, it has one-tenth the power of sulphur dioxide.

For our work on insecticides, "Bell jar experiments" were carried out, such as described by Hamilton and Lowe.[1] This apparatus is so constructed as to make possible the measuring of

1. See Journal of the American Public Health Association, 1911.

definite amounts of gases, which may be drawn from a container for any experiment. Such gases as illuminating gas, sulphur dioxide, carbon dioxide, hydrogen sulphide, etc., have been employed. Insects confined within the chamber of the apparatus and subjected to the influence of various insecticides can be watched and timed so that the relative value of toxic action can be readily estimated.

Hamilton and Lowe have tabulated in their report the coefficients for thirty-eight different insecticides, including such articles as creosote, naphthalene, kerosene, oil of turpentine, hydrocyanic acid, and many powders.

Our own experiments have shown that a solution of carbolic acid, from 6 to 7 per cent, acts very powerfully by the contact method, but much less powerfully as a fumigant; it has $^1/_{50}$ the strength of sulphur vapor, for example. It may be said of many of the commercial plant powders that they are exceedingly weak as compared with sulphur. A powder known as "bugbane" (*Cimicifuga racemosa*) has long been considered efficacious. Our experiments with it, however, tend to show that this drug has been greatly overestimated in its toxic properties toward insects. Powdered cimicifuga seemed to be devoid of insecticidal properties. Crickets kept in contact with the powdered drug for hours showed no toxic effect.

For the chemical valuation of the well-known insect powder, H. Linke has suggested a method. (See Chem. Abstracts, vol. 6, No. 23, p. 3493.)

The following articles compounded with insecticides require to be guaranteed under the national insecticide act, when sold for insecticidal purposes:

Acid, carbolic, cryst.	Insect powder, foreign.
Acid, carbolic, crude.	Naphthalene.
Acid, cresylic.	Nitrobenzene.
Acid, muriatic.	Oil citronella.
Acid, nitric.	Oil camphor.
Acid, sulphuric.	Oil peppermint.
Ammonia, stronger.	Paris green.
Arsenic, white.	Phosphorus.
Borax.	Potassium cyanide.
Camphor.	Potassium permang.
Carbon bisulphide.	Potassium carb.
Carbon tetrachloride.	Potassium sulphide.
Copper sulphate.	Quassia.
Formaldehyde, sol. of.	Rosin.
Hellebore, white.	Sulphur, grd. or lump.
Iron sulphide.	Sulphur, refined.
Lead arsenate.	Turpentine.
London purple.	Whale oil soap.
Iron sulphate.	

DISINFECTANTS.

Having been appointed as one of the members of a committee to report on standards for disinfectants, it may be in place to call attention to the ruling of the Kansas Board of Health, which was based on the report of the committee. The tentative standard adopted by this board reads as follows:

> A substance may be said to be a disinfectant or germicide, or to act as a germicide, when under stated conditions of concentration, temperature, humidity, etc., it is able to kill any non-spore-bearing bacterium pathogenic to man within six hours. Unless otherwise expressly stated, temperature and other atmospheric conditions usually found in living rooms will be understood.
>
> Within the meaning of this definition the terms "germicide" and "disinfectant" are used interchangeably to mean substances that actually destroy, and not merely inhibit the growth of bacteria.

Various methods have been used for standardization of disinfectants, beginning with Pringle (1732), who attempted to arrest putrefaction by the addition of various substances, and including Kock's "thread method" (1881), which was the first systematic test for the germicidal power of disinfectants. Kock's method was followed by the Rideal and Walker or "drop method" (1903) and its various modifications.

After consideration of all these methods of different workers, the committee on standardization of disinfectants recommended for adoption as the standard methods the Hygienic Laboratory phenol coefficient methods, as devised by Doctors Anderson and McClintic and published in Hygienic Laboratory Bulletin No. 82.

To secure uniformity, the third distillate of Merck's Silver Label Phenol was used in making the 5 per cent stock dilutions, from which all other phenol dilutions were made.

To obtain a culture of even resistance, it was recommended to use *B. typhosus* from a 30-day at 20° C. stock culture on standard infusion agar. Transplants are made at intervals of twenty-four hours in usual manner. The procedure is, briefly, as follows:

Since most disinfectants have a coefficient of 1 or over, a stock dilution of 1–100 is made of the disinfectant, but for those having a coefficient less than one a 1–20 is used. These dilutions are measured by means of pipettes into sterile glass-stoppered graduated cylinders containing sterile distilled water, and made up to the mark with same. From these stock dilutions the necessary dilutions for tests are made, using sterile pipettes of several sizes, and adding the required amount of the stock dilution and distilled water from sterile lead-foil-topped flasks to lead-foil-topped sterile bottles.

The phenol dilutions are tested first, beginning with the strongest, and then taking up the disinfectants in the same order.

To each sterile seeding tube 5 cc. of the dilutions are added and inoculated with $\frac{1}{10}$ cc. of filtered culture from 24-hour *B. typhosus* by means of a sterile pipette graduated in tenths.

The inoculated seeding tubes are placed on water bath and kept at temperature of 20° for lengths of time $2\frac{1}{2}$ minutes to 15 minutes, making six tests in as many seeding tubes for each dilution.

The sterile subculture tubes of same number as dilutions, and 4 mm. platinum loops (4 in number) and fan-tail burner must be conveniently arranged for inoculation of subculture tubes and flaming of loops. These inoculations are made at intervals of $2\frac{1}{2}$ minutes until six inoculations have been made, at times $2\frac{1}{2}$ minutes, 5 minutes, $7\frac{1}{2}$ minutes, 10 minutes, $12\frac{1}{2}$ minutes and 15 minutes for each dilution.

The coefficient for the sample under investigation is obtained by dividing the weakest dilution of this sample of disinfectant that kills in $2\frac{1}{2}$ minutes by the weakest dilution of phenol that kills in $2\frac{1}{2}$ minutes, and dividing the weakest dilution of the above sample of disinfectant that kills in 15 minutes by the weakest dilution of phenol that kills in the same time; then taking the mean of these quotients.

For example, the weakest dilution of phenol proving effective in $2\frac{1}{2}$ minutes was 1–80 and the weakest dilution of the above disinfectant proving effective in $2\frac{1}{2}$ minutes was 1–375. The weakest phenol dilution proving effective in 15 minutes was 1–110 and the weakest dilution of the sample of disinfectant was 1–650; hence, $\frac{375}{80} = 4.69$ and $\frac{650}{110} = 5.91$; $5.91 + 4.69 = 10.60$. $\frac{10.60}{2} = 5.30$, the phenol coefficient for the sample of disinfectant under investigation. Its standard, therefore, would be 5.30; that is, 5.30 times as strong as a solution of phenol that kills in the same length of time.

III.

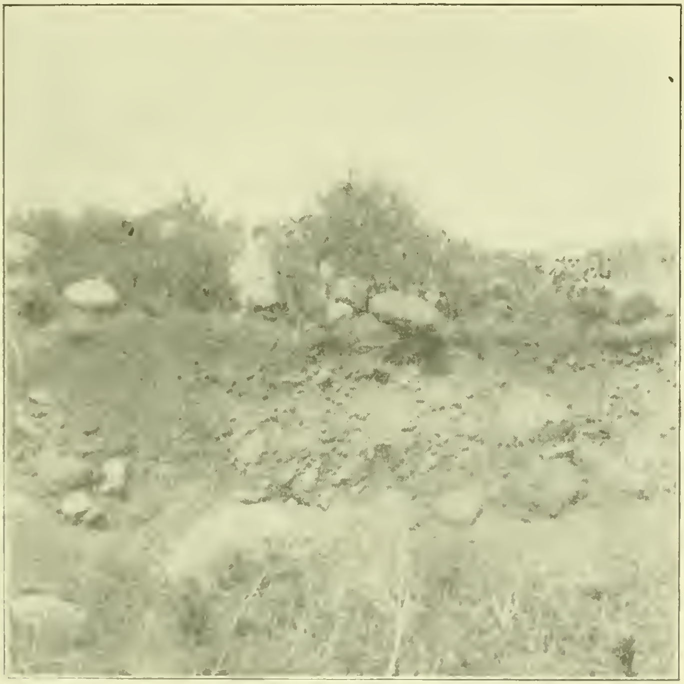
GEOLOGICAL PAPERS.

1. "Notes on the Moraine of the Kansas Glacier Southwest of Topeka."
   By L. C. Wooster.
2. "Expeditions to the Miocene of Wyoming and the Chalk Beds of Kansas."
   By Charles H. Sternberg.

NOTES ON THE MORAINE OF THE GLACIER SOUTHWEST OF TOPEKA.

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

MR. B. B. SMYTH, in volume XIV of the Transactions of this Academy, described the course of this moraine through Shawnee county, and I desire merely to add a little concerning the boulders in the moraine near Burnett's mound.



KANSAS GLACIER MORAINE,
Southwest of Topeka, near Burnett's Mound.

The drift in the ridge studied was less than eighteen feet thick, as was shown by a well on the ridge. A roadside excavation exposed about six feet of drift, stratified above and mostly unstratified below. One or two boulders were in positions of unstable equilibrium, as in all moraines not water-laid. The drift consisted of northern and local material. Fine-grained quartzite predominated everywhere at the surface, but the boulders of the deeper drift were fine and coarse quartzite, gray granite, gneiss, syenite, dyorite, and limestone. Many of the last contained Fusulinas, and much resembled the Upper Coal Measure limestones. Many of the boulders, including the limestone boulders, were planed and striated. The great age of this moraine, possibly a million years, was shown by the fact that the surface boulders were all fine-grained quartzite, while the protected ones were of mixed species. Even the coarse quartzite, where exp_sed, was badly weathered. The boulders of the deeper drift were common archæan species, and, according to all indications, were brought to Kansas by the same ice movement which brought the quartzite. The Kansas glacier may have picked up the granite, etc., in northern or central Minnesota, the quartzite in southwestern Minnesota or eastern South Dakota, and the limestone in northern Kansas.

Professor Popenoe showed us what seems to be the pseudomorph of the end of a huge calcite crystal consisting of basalt. Molds of similar crystals in great masses of copper from the copper mines near the western end of Lake Superior were on exhibition at the World's Fair at Chicago. This pseudomorph may have come in the Kansas glacier from that locality near Lake Superior.

EXPEDITIONS TO THE MIOCENE OF WYOMING AND THE CHALK BEDS OF KANSAS.

By Charles H. Sternberg.

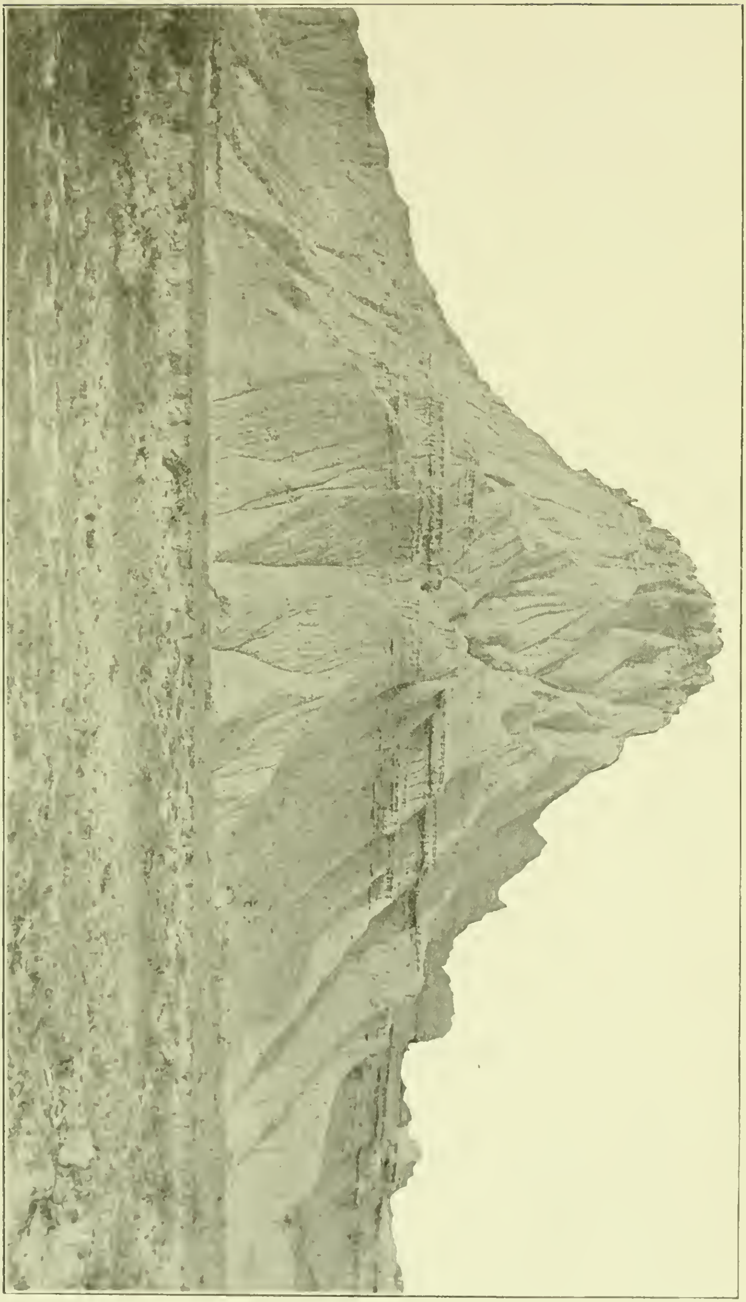
ON July 28 I reached my station at Edgemont, S. D. The next day I drove out to my son Charlie's cabin, thirty-five miles west, on Old Woman creek, in Converse county, Wyoming. I found that, with the assistance of my youngest son, Levi, and Conrad Jesperson, of Lawrence, he had secured a complete series of caudal vertebræ and bones of the pelvis and hind limbs of the great swimming dinosaur *Trachodon;* and three-quarters of a fine skull, six and a half feet long, of *Triceratops*, the huge three-horned lizard of the Laramie. The *Trachodon* material has gone to Munich to complete a composite open mount, I having sent the other material last year. The magnificent skeleton secured last year by my son Charlie went to the Senckenberg Museum. I believe these are the only complete skeletons of American dinosaurs in Europe. The seven-foot skull I discovered last year of *Triceratops*, which I was preparing for the Victoria Memorial Museum, was destroyed last year when the brick walls of the building at 617 Vermont street, in which it was housed, was blown in on top of it by a cyclone—a great loss to science and myself.

Having gone over the Laramie beds thoroughly during the last four years, on the fourth of August we moved over to the old deserted Seaman ranch on Sage creek, a branch of Old Woman creek, in Converse county, Wyoming. These beds are known as the Upper Harrison beds. The first day in this rich field that has been but little explored, I discovered the skeleton of the great titanothere *Brontotherium gigas*. The pelvic arch was partly exposed and measured four feet across the illia; the complete skull; vertebral column, with ribs continuous to first caudal; one humerus, and other bones. The lower limbs were absent. This specimen, according to Doctor Matthew, curator of vertebrate palæontology in the American Museum of Natural History, New York, is the best single specimen known, and is the size of their mounted composite specimen that measures over twelve feet long and about eight feet high. We are now preparing this noble specimen for the Victoria Memorial Museum at Ottawa, Canada, and will secure casts of the feet from the American Museum specimen.

We secured a great many specimens of the oreodont *Merychyus harrisonensis*, including a skeleton, over twenty good skulls, and many fragments of over a hundred individuals. This species, so common in these beds, was about the size of a sheep, with complete dentition. The strong, chisel-shaped incisors were doubtless often used in offense as well as defense. Without doubt he browsed on trees and bushes, and was also omniverous in habit. He was provided with four hoofed toes on each foot, and a dew claw that represented the fifth toe, showing that many of the animals of that day were getting away in foot structure from the five-toed plantigrade mammals of the Eocene. We secured a very fine skull of the hog-like *Elotherium*, and the large bear-like wolf *Amphicyon superbus*, besides jaws and teeth and parts of skulls of two species of three-toed horses, and a couple of species of rhinoceros, etc. Fresh-water and land turtles were very abundant. We secured some twenty-five or more specimens, ranging from five inches to twenty inches in length. *Stylemeys nebrascensis* and *Testudo laticuneus* were the most common.

We must have seen over a hundred broken-up shells over the area of about a quarter section we explored. The Upper Harrison beds present bold faces of tablelands that rise everywhere along the edge of this formation—a prolonged spur of the Pine Ridge of Nebraska. These tablelands and castellated buttes rise above the lower strata of this formation at least 600 feet. Usually, as remarked, the cap sheet, which is of hard clay and sandstone, has weathered into perpendicular walls, while the softer gray, comminuted, shale-like rock disintegrates below into fantastic sculptuary, as specially noted in the beautifully carved and fluted slopes of the butte, of which I show you a photograph (plate). This bold headland of the tableland behind has lost its protecting cap of harder rock, leaving the frost, wind and weather to freely sculpture it into the most beautiful butte I have ever seen in any formation.

The region that yielded the richest returns lay at the heads of two tablelands about a mile apart. I suppose about 600 feet of the Upper Harrison beds are exposed in the canyons and walls of the high tablelands. The strata is a shale-like gray rock that disintegrates easily and exposes the fossils once buried here. The material resembles the deposits of the flood plain of a river, and, to add to this belief, a wide river course crosses the beds and is traced by the washed sand and gravel of the old bed. The river was about a hundred yards wide. So the old theory of great lakes



One of the Nebraska buttes.

during Tertiary time must often give way, as in this locality, to river and flood plain. I noticed, as I walked over the open prairie to the bad-lands I explored, the remains of sheep that had died here and there and left complete skeletons, or a few bones and skull, or a single skull. Birds and coyotes had scattered the remaining parts of the skeletons. And so when I walked into the steep and denuded fossil beds I found as abundantly the remains of the oreodont—a skeleton here, a fragmentary one there; here a skull, there a pile of bones. They had died under similar conditions, perhaps, and lay in death a prey to wolves, etc. When the river overflowed her banks the scattered remains were covered and are preserved to this day, and the weathering of the rock has exposed them to the light of day again, after ages of burial. Now, owing to the efforts of us fossil hunters, we add other pages to Nature's great picture book that tells the story of the past.

My paper, a record of our work in the fossil fields, would not be complete without an account of my son George F. Sternberg's expedition into the rich field of the Niobrara, of western Kansas, which I have cultivated since 1875. This year he had full control, and I was not with him, and gladly give him credit for the best single year's collection we have ever taken out of the chalk. He had as his assistant Mr. Abe Easton, of Quinter, Kan., who proved an able helper. Among the noted specimens is the most complete skeleton so far discovered of the great fish *Portheus molossus*. All the fins were present, for the first time, with the complete skeleton, except the head, which we have been so fortunate to obtain from another individual of the same size. This skeleton lies on its side and is fourteen feet long; the tail fins thirty-one inches long. When this specimen has been described its entire anatomy will be known for the first time, although first described by Professor Cope in 1872. Another fine specimen is the complete hind limbs, with part of the skull, of *Pteranodon ingens*. Doctor Eaton, the authority on pterodactyls at Yale, told me that though they had 500 specimens, this was the first one in which all the bones of the feet were in position. This specimen has gone to the American museum.

Of the wonderful snout fish, or *Protophyræna*, of the Niobrara, George found a complete set of pectoral fins, with their arches. They measure 3 feet and 9 inches in length and are $10\frac{1}{2}$ inches wide at the base. The enameled edge is as sharp as a knife. In life they stood out at right angles to the body, like the scythes attached to the wheels of the chariot of some ancient war king.

They were rigid when they carved at pleasure the living *Portheii* or mosasaurs. The premaxilæ were prolonged into a long, dagger-like weapon of solid bone, and the teeth in the angles of the jaws were doubl-eedged and projected forward. So when, with the swimming force of this great fish, the snout entered the quivering flesh of his prey, these teeth opened wide the breach, permitting the whole head to enter. If the sharks of modern oceans are their terror, what can we say of the snout fishes of the Cretaceous?

George secured a complete skeleton, nearly, of a large *plate-carpus* nineteen feet long, the largest I have known—the entire column, head, and one paddle and ribs of one individual. Also, a splendid little tylosaur—most of the column, head, front and back paddles nearly complete, with breast bone and cartilagenous ribs. We are now mounting these great show specimens at my shop in Lawrence. Charlie is mounting the titanothere at his home on his homstead in Wyoming. George also secured fine skulls, in addition, of *platecarpus* and *tylosaurus* of *Portheus; Icthyodectes*, the great cat fish; *Anogmius*, *Empo*, *Gillicus*, etc. And more wonderful, the tail of a shark showing the dorsal fin for the first time. The shark we sold to the University of Kansas last year, now finely mounted by Mr. Martin, under whose skillful hands a skull was found beneath the scattered fragments that covered it. Thus a specimen of inestimable value of this rare shark is preserved in our University Museum.

IV.

BIOLOGICAL PAPERS.

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1. "FORMALDEHYDE GAS NOT EFFECTIVE UPON FLIES."
   By E. S. TUCKER, Baton Rouge, La.
2. "FURTHER RECORDS OF INSECTS PERSONALLY COLLECTED IN KANSAS AND COLORADO."
   By E. S. TUCKER, Baton Rouge, La.
3. "PROVISIONAL CATALOGUE OF THE FLORA OF KANSAS. PART II.—GYMNOSPERMS AND MONOCOTYLS."
   By BERNARD B. SMYTH, and L. C. R. SMYTH.
4. "A PARTIAL KEY TO THE GENERA OF NORTH AMERICAN JASSOIDEA."
   By S. E. CRUMB.
5. "INSECTICIDES."
   By L. E. SAYRE.
6. "A SYSTEM OF NOTATIONS APPLIED TO ENTOMOLOGICAL ACCESSIONS."
   By E. S. TUCKER.
7. "BITROPISM."
   By LYMAN C. WOOSTER.

FORMALDEHYDE GAS NOT EFFECTIVE UPON FLIES.

By E. S. Tucker.

(Published by permission of the Chief of the Bureau of Entomology, U. S. Department of Agriculture.)

During the disinfection of the contents of a room 12 by 14 feet, and having a height of 8 feet and 8 inches, for which 2 pounds of formalin and ½ pound of permanganate of potash crystals were used to produce formaldehyde gas, a number of house flies were imprisoned. This treatment was put into action at six P. M., on April 19, 1911, at Dallas, Texas, and the room was kept tightly closed until the following morning. No effect upon the flies could be detected after their confinement in the fumes over night. To all appearances they were just as numerous and active as they had been before the generation of the gas. Inspection failed to disclose a single dead fly, yet a strong odor of the gas remained in the room on opening it for venti ation.

Four hours of exposure to this gas, when it is produced according to prescribed directions and in ratio with the space to be filled, is considered an ample time for germicidal effect, if atmospheric conditions are suitable. But in this case the gas was confined fully 13 hours. The temperature of the air was moderate throughout the night of the treatment, the minimum of 56° being registered early in the morning, and water had been sprinkled liberally on the floor of the room to increase the humidity. These conditions should have brought about perfect chemical action. Besides, as may be noticed in the statement of amount of chemicals used, a double quantity of formalin was poured on the requisite quantity of permanganate of potash, the prescribed proportions being 10 ounces of the former to 5 ounces of the latter per 1000 cubic feet of space with suitable atmospheric conditions.

The test affords definite proof that formaldehyde gas, even in nearly double disinfectant strength, is useless as an insecticide, at least against flies. It is in fact only claimed to be effective upon insects when they are confined in concentrated gas for some time.

FURTHER RECORDS OF INSECTS PERSONALLY COLLECTED IN KANSAS AND COLORADO.

By E. S. TUCKER, Baton Rouge. La.

CONSIDERABLE progress has been made in the recognition of the different kinds of insects occurring in Kansas, and many lists giving the names have been published in past years. Hope is to be entertained that in the near future further advances in systematic study of the insect fauna of the state will be sufficient to warrant the publication of a catalogue of all species whose identifications will have reached a comprehensive extent, inclusive of those already reported. The ordinal compilation of species has so far received scarcely more than preliminary attention, except in regard to the Coleoptera and Lepidoptera, in greater part. A vast amount of work must be done before such a region as Kansas presents can be satisfactorily explored and the results made known with reference to a systematic comprehension of its insect life.

Owing to delays in the determination of some specimens personally collected in Kansas and Colorado, the following specific records could not be included in my former lists. Opportunity is now taken to present these recent results of study.

ORDER DIPTERA.

Aldrich's catalogue has been used as a guide for the arrangement of the Diptera, except in respect to the families Chironomidæ and Mycetophilidæ, in which the generic positions are made to conform with the system proposed by Prof. O. A. Johannsen.

Family TIPULIDÆ.

Tipula coloradensis Doane. (Psyche, v. 18, Oct. 1911, p. 164.) Colorado, Tabernash; August. One male, three females. (Types.)

Family CHIRONOMIDÆ.

(Determinations were made by Prof. O. A. Johannsen.)

Chironomus albimanus Meig. (N. Y. Mus. Bul. 86, p. 214.) Colorado, Denver; April, on shore of lake.

flavicingula Wk. Colorado, Denver; April, on shore of lake.

hyperboreus Stgr., var. meridionalis Joh. (N. Y. Mus. Bul. 124, p. 277.) Colorado, Denver; April, on shore of lake and at random. Species but not variety cited before for state.

maturus Joh. (N. Y. Mus. Bul. 124, p. 279.) Colorado, Denver; April, on shore of lake.

tendens Fab. Colorado, Denver; April, on shore of lake.

Ceratopogon specularis Coq. Colorado, Denver; April, on shore of lake.

Cricotopus trifasciatus Panz. (N. Y. Mus. Bul. 86, p. 253.) Colorado, Denver; March, in window; April, on shore of lake, also in alfalfa field and at random. Species formerly cited only for Kansas.

Orthocladius nivoriundus Fitch. Colorado, Denver; April, on shore of lake. Species formerly cited only for Kansas.

Tanytarsus fatigans Joh. (N. Y. Mus. Bul. 86, p. 292.) Colorado, Denver; April, on shore of lake.

nigripilus Joh. (N. Y. Mus. Bul. 86, p. 287.) Colorado, Denver; March, in window; April, on shore of lake, also in alfalfa field and at random. Species formerly cited only for Kansas.

Diamesa waltlii Meig. Colorado, Denver; March, in window.

Family MYCETOPHILIDÆ.

(Determinations were made by Prof. O. A. Jonannsen.)

Trichosia hebes Lw. Lawrence; May; June. New to Kansas list.

Mycetophila (Dynatosoma) scalaris Lw. (Me. Agr. Exp. Sta. Bul. 200, p. 98.) Kansas, Lawrence; July. New to Kansas list.

Sciara acuta Joh. (Me. Agr. Exp. Sta. Bul. 200, p. 136.) Kansas, Lawrence; April. Addition to Kansas list.

coprophila Lint., var. a. Joh. (Me. Agr. Exp. Sta. Bul. 200, pp. 136 and 137.) Kansas, Lawrence; May. New to Kansas list. Colorado, Colorado Springs; April. Denver; April. Also collected with *S. varians* Joh. at other places, concerning which see records of the latter species and explanation.

nigricans Joh. (Me. Agr. Exp. Sta. Bul. 200, p. 134.) Kansas, Lawrence; May, at night (paratype); June, twilight and at night; and August. twilight. Addition to Kansas list.

parilis Joh. (Me. Agr. Exp. Sta. Bul. 200, p. 132.) Kansas, Lawrence; May, at night; June, twilight (paratype); and August. Colorado, Colorado Springs; April. Addition to Kansas list.

prolifica Felt. Kansas, Lawrence; June; July, twilight. New to Kansas list.

varians Joh. (Me. Agr. Exp. Sta. Bul. 200, p. 135.) Kansas, Lawrence; March; April; May; June, at electric light; and June, twilight; July, twilight; and August. Addition to Kansas list.

Also probably in Colorado, Colorado Springs; April and August. Cheyenne canyon; August. Denver; April, at random and alfalfa field. On train near Limon; May. Tabernash; August.

EXPLANATION.—Specimens bearing the above Colorado records were too imperfect for accurate identification, but evidently represented the species *S. coprophila* Lint. and *S. varians* Joh. The records, therefore, are apt to apply to both species.

Family CECIDOMYIIDÆ.

Neolasioptera major n. sp. Felt. Colorado, Colorado Springs; August, 5915 ft. altitude.

Family BIBIONIDÆ.

Scatopse pulicaria Lw. Kansas, Lawrence; June. New to Kansas list.

Family SIMULIIDÆ.

Simulium venustum Say. Colorado, Colorado Springs; August, one female.

Family STRATIOMYIDÆ.

Sargus viridis Say. Colorado, Denver; April. New locality for state.

Family BOMBYLIIDÆ.

Exoprosopa dodrans O. S. Colorado, Colorado Springs; August. Det. by Prof. C. W. Johnson, who remarked about it as follows: "There is a trace of the usual white band on the second segment. It resembles *E. titubans* O. S., but is slightly smaller, the brown of the wing has an uniform tinge, and only the cross vein at the base of the fourth posterior cell is slightly clouded. Colorado Springs is the type locality for the species. It shows a character mentioned by Osten Sacken as peculiar to one specimen, *i. e.*, 'An adventitious stump of a vein inside of the discal cell.' My specimens from Clear Creek, Colo., do not show this."

Family ASILIDÆ.

Stenopogon (Scleropogon) helvolus Lw. (Trans. Amer. Ent. Soc., v. 35, Nos. 2 and 3, 1909, p. 208.) Kansas, Sedgwick county; August. (Determination by E. A. Back.) New to Kansas list.

Family DOLICHOPODIDÆ.

Dolichopus jugalis Tkr. (Trans. Kan. Acad. Sci., v. 23, 1911, pp. 106 and 107.) Colorado, Tabernash; August. One male. (Type.)

Family TACHINIDÆ.

Neæra longicornis Coq. Colorado, Denver; April. (Determination by D. W. Coquillett.)

Gonia capitata De G. Colorado, Denver; August. New locality for state.

Family MUSCIDÆ.

Lucilia sericata Meig. Colorado, Denver; April. Determination verified by D. W. Coquillett.) Reported before for same locality, but later for season.

Protophormia (Phormia) terræ-novæ Desv. Colorado, Denver; April.

Family ANTHOMYIDÆ.

Hydrotaæ armipes Fal. Colorado, Colorado Springs; July. Tabernash; August.

Homalomyia flavibasis Stein. Kansas, Wichita; April. New to Kansas list.

Phorbia cerealis Gil. (Not cited in Aldrich's catalogue.) Colorado, Tabernash; August. (Determination verified by D. W. Coquillett.)

cinerella Fal. Kansas, Lawrence; July. Colorado, Colorado Springs, April. Green Mountain Falls; July. (Determination verified by D. W. Coquillett.) Additional records for Colorado.

Phorbia (Hylemyia) fabricii Holmgn. Colorado, Colorado Springs; August.

fusciceps Zett. Colorado, Denver; April, commonly taken by sweeping. Additional record for state.

Pegomyia bicolor Wd. Colorado, Colorado Springs; July and August. Tabernash; August.

Cœnosia meditata Fal. (Not cited in Aldrich's catalogue.) Colorado, Colorado Springs; July and August. (Determination by D. W. Coquillett.)

Schœnomyza chrystoma Lw. Colorado, Denver; April.

dorsalis Lw. Colorado, Denver; April. Additional record for state.

Family SCATOPHAGIDÆ.

Scatophaga stercoraria L. Colorado, Denver; April.

Family HELOMYZIDÆ.

Œcothea fenestralis Fal. Colorado, Denver; March, in window. (Determination by D. W. Coquillett.)

Tephrochlamys rufiventris Meig. Colorado, Denver; March, in windows. (Determination by D. W. Coquillett.)

Family BORBORIDÆ.

Borborus geniculatus Macq. Colorado, Denver; April. Additional record for state.

Family TRYPETIDÆ.

Tephritis genalis Thom. Colorado, Denver; April. New locality for state.

Family EPHYDRIDÆ.

Dichæta caudata Fal., var. Colorado, Colorado Springs; August. (Determination by E. T. Cresson, jr.)

Pelina truncatula Lw. Colorado, Denver; April. New locality for state.

Family OSCINIDÆ.

Chlorops assimilis Macq. Colorado, Denver; April. New locality for state.

Oscinis coxendix Fitch. Colorado, Denver; April.

nigra Tk. Colorado, Denver; April, sweeping lawn grass. (Determination verified by D. W. Coquillett by comparison with type specimen.) They agree with description, except that some examples have metatarsi of middle and hind legs more or less brownish. New seasonal record for same locality.

Family DROSOPHILIDÆ.

Drosophila quinaria? Lw. Kansas, Lawrence; August. (Determination by E. T. Cresson, jr.) New to Kansas list.

ORDER LEPIDOPTERA.

The following list of Lepidoptera may possibly include the names of some species not previously reported for Kansas. All of the specimens excepting two species were collected at Lawrence, Kan. Hence, only the different locality will be cited with its specific records. The names and arrangement accord with Dyar's list.

Family ARCTIIDÆ.

Hypantria cunea Dru. (Pure white form.) May, at night and at electric light.

cunea Dru., var. (Black speckled form.) April and May, at electric light.

Apantesis nais Dru. May, at electric light.

Family NOCTUIDÆ.

Apatela populi Ril. May, at electric light.
Peridroma margaritosa Haw. June, twilight and at night.
Chorizagrotis agrestis Grt. May.
Heliophila unipuncta Haw. May, at electric light; June, twilight and at night.
albilinea Hbn. April, at electric light.
Papaipema nitella Gn., var. nebis Gn. September, at night. (Determination verified by H. G. Dyar.)
Heliothis obsoleta Fab. August, on red and white clover blossoms in bright sun during midday; October; and October, twilight and at electric light.
Autographa biloba Steph. May, at electric light.
ou Gn. May, at electric light.
falcigera Kir. May, at electric light.
Tarache erastrioides Gn. June, at night.
Drasteria erechtea Cram. April; April and May, at electric light.
Catocala junctura Wk. July twilight.

Family PYROMORPHIDÆ.

Acoloithus falsarius Clem. May; June, twilight, taken while pairing. (Determination by A. Busck.)

Family PYRALIDÆ.

Lipocosma sicalis Wk. May, twilight. (Determined by A. Busck.)
Nomophila noctuella D. and S. April and May, at electric light; August and September, at night.
Pyralis farinalis L. May.
Crambus teterrellus Zinc. June. (Determined by A. Busck.)
Plodia interpunctella Hubn. May, at night, and occurring in pantry where the species evidently bred, judging from the finding of pairs in copulation; also, June, at night.
Peoria approximella Wk. June, at night. (Determination by A. Busck.)

Family TORTRICIDÆ.

Tortrix peritana Clem. May, at night. (Determination by A. Busck.)
Eulia velutinana Wk. April; June, at night. (Determination by A. Busck.)

Family YPONOMEUTIDÆ.

Plutella maculipennis Curt. Colorado, Denver; April, on lawn grass. (Determination by W. G. Dietz.)

Family GELECHIIDÆ.

Phthorimæa glochinella Zell. May, at light in house at night. (Determination by W. G. Dietz.)
Ypsolophus ligulellus Hubn. May, at night. (Determination by A. Busck.)

Family ELACHISTIDÆ.

Scythris eboracensis Zell. June, twilight. (Determination by A. Busck.)

Family TINEIDÆ.

Gracilaria negundella? Cham. April, at night. (Determination as "probably" by W. G. Dietz.)

Argyresthia austerella Zell. On the morning of June 4 these moths were found resting on trunks of box elder trees. Their manner of holding the wings, folded outward at a right angle from the bark, was quite peculiar. (Determination by A. Busck.)

Tineola bisselliella Hum. April, appearing in dimly lighted room during daytime; also May, at night. (Determination by A. Busck.)

Tinea fuscipunctella Haw. May, at night. (Determination by W. G. Dietz.)

Setomorpha rutella Zell. Colorado, Denver; April, in lighted room at night. (Determination by W. G. Dietz.) As cited in Dyar's list, the following names may be applied: female = *operosella* Zell; male = *inamœnella* Zell.

Anaphora popeanella Clem. June.

Order HYMENOPTERA.

Since the system of classification proposed by Ashmead was generally followed in the arrangement of my former list of Hymenoptera, the same plan will be adopted for present purposes.

Family Bombidæ.

Bombus rufocinctus Cr. Colorado, Buffalo; August. New locality for state. A male specimen probably belonging to this species was taken at Colorado Springs in August. The latter locality, however, has been previously reported.

Family Megachilidæ.

Megachile cleomis Ckll. Colorado, Colorado Springs; August. A male specimen. (Determination by T. D. A. Cockerell.)

monardarum Ckll. Colorado, Denver; August. A female specimen. (Determined by T. D. A. Cockerell.)

sexdentata Robt. Colorado, Colorado Springs; August. (Determined by T. D. A. Cockerell.) The species has been labeled as *M. pruinosa* Cr. in the University of Kansas collection. Professor Cockerell has written that "This is close to *M. pruina* Sm., and has no doubt been confused wth it."

Dianthidium ulkei Cr. Colorado, Denver; August. A female specimen. (Determined by T. D. A. Cockerell.)

Family Andrenidæ.

Halictus (Evylæus) pectoralis Sm. Colorado, Denver; August.

Family Crabronidæ.

Crabro maculiclypeus Fox, var. with a black clypeus. Kansas, Lawrence; July. (Determined by S. A. Rohwer.) New to Kansas list.

(Ectemnius) parvulus Pack., var. Kansas, Lawrence; July. (Determined by S. A. Rohwer.) New to Kansas list.

Rhopalum modestum Roh. Kansas, Lawrence; June, twilight. (Determination by S. A. Rohwer.) New to Kansas list.

Family Pemphredonidæ.

Stigmus inordinatus Fox, var. universitatis Roh. Kansas, Lawrence; July and July, twilight. (Determination by S. A. Rohwer.) New to Kansas list.

lucidus Roh. (Tr. Amer. Ent. Soc., v. 35, p. 102.) Kansas, Lawrence; July. (Type.) Addition to Kansas list.

Diodontus brunneccornis Vr. Kansas, Lawrence; June. (Determination by S. A. Rohwer.) New locality for state.

nigritis Fox. Colorado, Buffalo; August. A female specimen. (Determination by S. A. Rohwer.)

occidentalis Fox. Colorado, Denver; August. (Determination by S. A. Rohwer.)

Family PHILANTHIDÆ.

Cerceris insolita Cr. Kansas, Lawrence; August. A male specimen. (Determination by S. A. Rohwer.) New to Kansas list.

Family TRYPOXYLIDÆ.

Trypoxylon carifrons Fox. Kansas, Lawrence; July. New to Kansas list.

rufocinctus Pack. Kansas, Lawrence; July. (Determination by S. A. Rohwer as "probably nearest to *rufocinctus* Pack., but the abdomen is wanting.") Formerly reported for state by J. C. Bridwell. as *T. rufocinctum* Pack.

Family VESPIDÆ.

Vespa germanica Fab. of H. W. Lewis. Kansas, Lawrence; October. (Determination by S. A. Rohwer.) Additional record for season.

Family MYRMECIDÆ.

Leptothorax sp. Colorado, Colorado Springs; August. A male specimen. (Determination by W. M. Wheeler.)

Family FORMICIDÆ.

Camponotus fallax Nyl., var. decipiens Emery. Kansas, Lawrence; October, all forms, male, female, soldier and worker, in beehive infested with bee moths. Cited as *C. marginatus* Lat., var. *decipiens* Em. in article by the author, entitled "The Bee Moth and its Wax Worm," published in *Kansas Farmer*, v. 44, March 8, 1906, p. 251. Variety new to Kansas list.

Family XYELIDÆ.

Xyela luteopicta Ckll. Colorado, Colorado Springs; August. (Determination by S. A. Rohwer.)

Family TENTHREDINIDÆ.

Erythraspides tuckeri Roh. (Can. Ent., v. 41, May, 1909, p. 145.) Kansas, Lawrence; April. (Type.) Addition to Kansas list.

ORDER COLEOPTERA.

Revised names and arrangements are adapted to Henshaw's list so far as consistency allows.

Family STAPHYLINIDÆ.

Mycetoporus lepidus Er. Colorado, Denver; April. (Determination by H. S. Barber.)

Family BOSTRICHIDÆ.

Sinoxylon basilare Say. Kansas, Lawrence; May.

Family Lariidæ (Bruchidæ.)

Laria (Bruchus) mima Say. Kansas, Lawrence; June, at night.

Family Curculionidæ.

Eugnamptus sulcifrons Gyll. Kansas, Lawrence; June, twilight.

Thecesternus albidus Pierce. (For description see Proc. U. S. Nat. Mus., v. 37, 1909, p. 338.) Kansas, Lawrence; March, April, May. (Determination verified by W. D. Pierce.) First record for Kansas.

Rhinoncus pyrrhopus Lec. Kansas, Lawrence; June, twilight.

Conotrachelus seniculus Lec. Kansas, Lawrence; May, at night; August, twilight.

cribricollis Say. Kansas, Lawrence; July, at night.

erinaceus Lec. Kansas, Lawrence; July, at night.

Anthonomus squamosus Lec. Colorado, Denver; August.

Smicronyx (Barytychius) amœnus Say. Kansas, Lawrence; August, at night.

vestitus Lec. Colorado, Denver; August.

Apion turbulentum Sm. Kansas, Lawrence; June, twilight and at night. (Determination by W. D. Pierce.)

decoloratum Sm. Kansas, Lawrence; July, twilight.

Family Calandridæ.

Rhodobænus tredecimpunctatus Ill. Kansas, Lawrence; June.

Sphenophorus parvulus Gyll. Kansas, Lawrence; May.

destructor Chttn. Kansas, Lawrence; May. (Determination by F. H. Chittenden.)

Order HEMIPTERA-HETEROPTERA.

Family Capsidæ.

Plagiognathus annulatus Uhl. Kansas, Lawrence; May. (This specimen, after having been held in doubt for some time, was finally determined by O. Heidemann.)

Order HEMIPTERA-HOMOPTERA.

Family Fulgoridæ.

Liburnia sp. (Too poor for satisfactory study.) Colorado, Denver; April. In former list, *L. osborni*? Van D. is cited as having been collected in same month at Colorado Springs.

Family Jassidæ.

Agillia sanguinolenta Prov. Colorado, Denver; April.

Deltocephalus signatifrons Van D. Colorado, Denver; April, on shore of lake. (Determination by H. Osborn.)

Phlepsius ovatus Van D. Colorado, Denver; March, in window. (Determination by H. Osborn.)

Thamnotettix belli Uhl. Colorado, Denver; April. (Determination by H. Osborn.)

Gnathodus impictus Van D. Colorado, Denver; April. (Determination by H. Osborn.)

Family PSYLLIDÆ.

Aphalara artemisiæ Forster. In K. U. Sci. Bul., v. 4, p. 69, this species is cited from Colorado, Green Mountain Falls, July (31), as *A. utahensis* Riley, which is a manuscript name. The identity has been established by D. L. Crawford. (Pomona Jr. Ent., v. 3, May 1911, pp. 496–498.)

artemisiæ Forster, var. angustipennis Crawf. In K. U. Sci. Bul., v. 4, p. 69, this form is cited from Colorado, Green Mountain Falls, July, as *A. angustipennis* Riley, which is a manuscript name. The identity has been established by D. L. Crawford. (Pomona Jr. Mnt., v. 3, May, 1911, p. 499)

calthæ Linne. (Pomona Jr. Ent., v. 3, May, 1911, pp. 495 and 496.) Colorado, Denver; April, sweeping at random and in alfalfa field. Colorado Springs; April. (Determined by D. L. Crawford.) In K. U. Sci. Bul., v. 4, p. 69, this species is also cited from Kansas, Douglas county, September, as *A. polygoni* Föerst. The name of this authority should be corrected to read Forster, according to Crawford, who has established the specific identity to which the first reference as given herewith applies. The record, "New to Kansas," holds good with this change of name.

ORDER ORTHOPTERA.

Family BLATTIDÆ.

Blatta (Stylopyga) orientalis L. Colorado, Denver; April, at night, in building. (Determination by A. N. Caudell.)

ORDER CORRODENTIA.

Family PSOCIDÆ.

Elipsocus sp., probably new, fide Banks. Colorado, Tabernash; August.

ORDER COLLEMBOLA.

Family ENTOMOBRYIDÆ.

Tomocerus sp. Kansas, Lawrence; March. (Identified by J. W. Folsom, who remarked as follows: "Impossible to determine specifically, as the legs and furcula were lacking.") New to Kansas.

Seira nigromaculata Lubb. Kansas, Lawrence; June. (Determined by J. W. Folsom.) For Kansas list.

PROVISIONAL CATALOGUE OF THE FLORA OF KANSAS.

PART II.—GYMNOSPERMS AND MONOCOTYLS.

By BERNARD B. SMYTH, Curator of the Kansas Museum of Natural History, assisted by LUMINA C. RIDDLE SMYTH, PH. D., Topeka.

(Read by title before the Academy at its annual meeting at Pittsburg, Kan., December 28, 1911, and again read in abstract at the annual meeting at Topeka, December 23, 1912.)

INTRODUCTION.

THE first part of this catalogue, covering the mosses and ferns, was published in volume 24 of these transactions, page 273, issued in October, 1911. The present part (II) includes the gymnosperms and monocotyls. In order to fill out the classification, some gymnospermous trees and a few important other plants, not native to the state but grown under cultivation, are included.

Part III of this catalogue is expected to include the Choripetalæ and part IV the Sympetalæ. Part V (final) will embrace the simplest forms, Sub-kingdom I, covering the Protophyta, including bacteria, diatoms, etc., and the Thallophyta, including algæ, fungi, and lichens.

This time it is hoped to include in the catalogue all species of plants growing naturally in the state, small as well as great, together with nearly all of the cultivated trees, grasses and flowers. In order to include the lower orders of plant life, much study for many years has been given the microscopic vegetation of the state, a work which involves no small amount of persistent and well-directed labor. With three or more powerful and well-equipped compound microscopes constantly under our hands and in daily use, and a perfect familiarity with them brought about by years of experience, many when all are added together as students and teachers, it is to be hoped that our labors may produce many useful facts, and that our lists when presented will be well worthy of consideration.

An attempt, reasonably successful, is made in this work to bring botanical classification into harmony with itself and to give the various groups uniform endings to roots indicative of the locus of the term. With that end in view, as far as possible, the great primary divisions (subkingdoms) end in *ata* as *Archegoniata*, *Carpellata;* primary subdivisions (phyla) end in *phyta*, as *Anthophyta;* and classes as usual end in *ineæ* or *iferæ*, as *Cycadineæ*, *Glumiferæ;* all based upon some characteristic that pervades the group. In the lower groups, subclasses end in *floræ*, as *Alismæfloræ, Orchidifloræ;* orders in *ales*, as *Poales, Liliales;* family names end in *aceæ* as *Cyperaceæ;* subfamilies in *oideæ*, and tribe names in *eæ*, as *Cabomboideæ, Festuceæ;* all based upon some typical genus of the group. Thus, all group endings are harmonized as far as circumstances will admit.

Of monocotyls there are only two classes of plants: those with glumaceous or chloroplastic floral envelopes, and those with chromoplastic floral envelopes. The first, *Glumiferæ*, is arranged to include not only the *Glumifloræ*, but also the *Spadicifloræ*, most of which have degenerate glumaceous floral envelopes, and very rarely only an incipient foliaceous perianth, as in the *Arales* and *Pandanales*. The other, *Petaliferæ*, includes all those monocotyls with petals having colors other than green.

The authors have but a limited botanical library at their command, even though everything in the three great state libraries, including our own beloved Academy of Science library, is within easy reach and immediate access and use at any time. Nevertheless, in giving classical generic and specific names, the authors can only follow the lead of such botanical works as are within their reach, and disclaim absolute knowledge as to which name is the oldest and therefore the one to be used. In all doubtful cases the names familiar to botanists for the last fifty years are still followed. Uniformity in names the world over is certainly most desirable; and no one will rejoice more than the authors to see any system adopted that will prevent the constant changing of generic names, such as has been heretofore in operation.

As to English names, it seems quite as important that a correct English name be given as that a correct classical name be given. An effort is here made to give one good English name, and no more, to each species; not necessarily the oldest or original name, but the one, rather, that is the most universally given, or otherwise the one that seems most appropriate. Where no one seems most appropriate, several are given, any one of which is not used for any other plant unless it should be another of the same genus as: blue-grass and spear-grass for *Poa;* bluestem or beard-grass for *Andropogon;* meadow-grass or love-grass for *Eragrostis;* bulrush or club-rush for *Scirpus*. Certain names are preferred for certain genera, as pigeon-grass for *Chætochloa*, foxtail for *Alopecurus*, dropseed- or rush-grass for *Sporobolus*, panic-grass for *Panicum*.

A published English name for every plant is not found. Many of the native plants of Kansas are unknown and have no English names. Indian names are too uncertain and too poorly known among the Indians themselves for adoption. In such cases a name is usually given, based upon some characteristic suggestive of the plant; otherwise a liberal translation of the classical name. Among such names are bog-sedge for *Fuirena*, mild-onion for *Nothoscordum*, elfin-crown for *Androstephium*, here used for the first time. Whether these names will meet the approval of the people will depend upon many circumstances, none of which need be enumerated. The fashion of giving a classical generic name as a common English name is one highly to be commended. What is more beautiful or expressive than applying those names of a lifetime, such as carex, calla, alisma, victoria, tritoma, yucca, trillium, smilax, iris, amaryllis, crocus, canna, orchis, geranium, cactus, and a host of others. especially of well-known garden flowers? In such cases it would seem like a sacrilege to change the generic name for one ostensibly older. After a name has been in constant use all over the world for a long series of years, it being the only name known in all that time, and has become a part of our literature by having alkaloids, fixed and essential oils, dyestuffs, drugs, and other nouns and adjectives derived from it and based upon it, it should not, except for the very best of reasons, be removed from the language or changed for another that some library searcher has discovered had been previously applied to it, perhaps by some unreliable author in some obscure publication, and rejected at the time for the best of reasons. The work of an unscientific, unskillful and unreliable author is unworthy and does not deserve perpetuation.

The authors are not in sympathy with systematists who give a new generic name to every plant having but slight differences of carpellate structure, and wish to disparage to the fullest extent the frequent practice of giving a new specific name to every new mutation that gives promise of permanency and being true to seed, thus answering all of their requirements of a new species. It were better by far to revise the taxonomic criteria for genera and species, and to consider such mutations in the light of horticultural variations of a species, even though of wild or uncultivated plants. Conditions and environment have much to do with the growth and appearance of plants. So the fewer the new species and genera the better.

To Prof. John H. Schaffner, professor of botany at the Ohio State University, we are sincerely indebted for much valuable as-

sistance and advice in the preparation of this catalogue. His advice in arrangement, classification, and nomenclature has been constantly sought by us and freely given by him; yet, seldom has his advice been closely followed. Nevertheless, his counsel has necessarily been of great service.

The foundation for this catalogue is Smyth's Checklist of the Plants of Kansas, published in 1892 (which was Smyth's third list, previous ones having been published in the transactions of the Graywood Botany Club and the Bulletin of the Washburn Laboratory of Natural History), since which time much has been learned of the botany of the state; yet the classification of that modest work has been departed from mainly in reversing the general arrangement in keeping with present-day methods and the introduction of some harmonic terms in classification and in description. A fourth catalogue, on a different plan, entitled "Plants and Flowers of Kansas," by the senior author, was published in 1900, by Crane & Co., of Topeka, in their "Twentieth Century Classics," thus making the present catalogue Smyth's fifth list of the plants of Kansas.

Quasi-new terms (*acicles* and *laminodia*) are here introduced for the leaves of some gymnosperms and monocotyls, which differ fundamentally and intrinsically from the ordinary leaves of dicotyls as much as do bracts, scales, sepals, phyllodia, and other forms of leaves to which are applied special terms. It is expected that these terms will commend themselves to botanists in general, and will, if worthy, meet their approval.

In the following pages herbaria in which specimens of the plants are contained are indicated by initials as far as known. (A) represents the herbarium of the Kansas Agricultural College, which is very full as to representatives of the Kansas flora, and which has been frequently consulted; (S) is the State Herbarium, in charge of the principal author and made in toto by him; it also stands for the private herbaria of the authors, as well as the herbarium of Professor Schaffner, which is richly supplied with Kansas plants, and is a part of the foundation of this catalogue; (U) is the herbarium of the Kansas State University, which the principal author has consulted, and of which the authors have a partial list of the plants. A few names are included on the authority of Mr. F. V. Coville, botanist of the Department of Agriculture at Washington.

That there should be errors in the present catalogue is unavoidable and rather to be expected. All such discovered in season will be eliminated in the permanent catalogue, publication of which will necessarily be some years off yet. Correspondents will be thanked for calling attention to any veiled errors; obvious ones are evident enough and will need no pointing out.

All persons interested in the flora of Kansas are invited to correspond with the authors. Let us know what you have learned of the flora of your region, whether we have listed it or not, and send us some specimens, if possible. Wake up and do something! Here is a good Kansas book; it is yours.

Herewith is presented a scheme of classification and arrangement that is adapted to the accompanying part of the catalogue of the Flora of Kansas.

SCHEME OF CLASSIFICATION AND ARRANGEMENT.

PART II.

(As adapted to the flora of Kansas.)

Subkingdom *III.* CARPELLATA. Carpellate Seen-bearing Plants.

Superphylum AAA. GYMNOSPERMÆ. Naked-seed Carpellates.

Phylum *III. CYCADOPHYTA. Cycadeous Gymnospérms.

Class VI.* CYCADINEÆ. Endogenous Palm-like Cycadophytes.

ORDER XI. CYCADALES. THE CYCADS.
Family 26. CYCADACEÆ. Cycad family.
Genus 89. Cycas. Cycad.

Class VII.* GINKGOINEÆ. Exogenous Fern-like Cycadophytes.

ORDER XII. GINKGOALES. THE MAIDENHAIR TREES.
Family 27. GINKGOACEÆ. Maidenhair-tree family.
Genus 90. Ginkgo. Ginkgo; Maidenhair tree.

Phylum *IV. STROBILOPHYTA. Cone-bearing Gymnosperms.

Class VIII.* CONIFERÆ. Exogenous Strobilophytes.

ORDER XIII. TAXALES. The yews.
Family 28. TAXACEÆ. Yew family.
Genus 91. Taxus. Yew.
ORDER XIV. CUPRESSALES. THE CYPRESSES AND CEDARS.
Family 29. JUNIPERACEÆ. Juniper family.
Genus 92. Juniperus. Juniper.
Family 30. CUPRESSACEÆ. Cypress family.
Genus 93. Thuya. Arbor-vitæ.
94. Chamæcyparis. Ground cypress.
95. Cupressus. Cypress.
96. Taxodium. Bald cypress.
97. Retinospora. Oriental cypress.
98. Cryptomeria. Japan cedar.
ORDER XV. PINALES. THE PINES AND THEIR ALLIES.
Family 31. PINACEÆ. Pine family.
Genus 99. Araucaria. Norfolk pine.
100. Abies. Fir.
101. Tsuga. Hemlock.
102. Picea. Spruce.
103. Pinus. Pine.

Superphylum BBB. ANGIOSPERMÆ. Hidden-seed Carpellates.

Phylum *V. **ANTHOPHYTA.** Flowering Angiosperms.

SUBPHYLUM DD. MONOCOTYLEDONES. SINGLE-SEED-LEAF ANTHOPHYTES.

Class IX.* GLUMIFERÆ. Monocotyls with Glumaceous Perianth.

Subclass A. GLUMIFLORÆ. Glume-flowered Monocotyls.

ORDER XVI. POALES. THE GRASSES AND CANES.

Family 32. PANICACEÆ. Panic-grass family.

Tribe *a*. Maydeæ. Maize tribe.

Genus 104. Euchlæna. Teosinte.
105. Zea. Indian corn.
106. Tripsacum. Gama grass.

Tribe *b*. Andropogoneæ. Bluestem tribe.

Genus 107. Coix. Tear-grass.
108. Eulalia. Eulalia.
109. Imperata. Blady-grass.
110. Erianthus. Plume-grass.
111. Andropogon. Beard-grass.
112. Sorghastrum. Indian grass.
113. Sorghum. Sugar cane.

Tribe *c*. Paniceæ. Panic-grass tribe.

Genus 114. Paspalum. Water-grass.
115. Eriochloa. Wool-grass.
116. Syntherisma. Crab-grass.
117. Brachiaria. Arm-grass.
118. Leptoloma. Witch-grass.
119. Panicum. Panic-grass.
120. Echinochloa. Cockspur-grass.
121. Chætochloa. Pigeon-grass.
122. Cenchrus. Bur-grass.
123. Penicillaria. Pearl millet.

Tribe *d*. Oryzeæ. Rice-grass tribe.

Genus 124. Zizania. Wild rice.
125. Homalocenchrus. Cut-grass.

Family 33. POACEÆ. Meadow-grass family.

Tribe *e*. Phalarideæ. Canary-grass tribe.

Genus 126. Phalaris. Canary grass.
127. Anthoxanthum. Vernal grass.
128. Oryzopsis. Mountain rice.

Tribe *f*. Agrostideæ. Reed-grass tribe.

Genus 129. Stipa. Weather-grass.
130. Aristida. Poverty-grass.
131. Muhlenbergia. Satin-grass.
132. Phleum. Timothy.
133. Alopecurus. Foxtail-grass.
134. Sporobolus. Dropseed-grass.
135. Cinna. Wood-reed-grass.
136. Agrostis. Bent-grass; Redtop.
137. Calamagrostis. Bluejoint-reed-grass.
138. Calamovilfa. Sand-reed-grass.

Tribe *g*. Aveneæ. Oat-grass tribe.

Genus 139. Holcus. Velvet-grass.
140. Sphenopholis. Prairie-grass.
141. Kœleria. Prairie-June-grass.
142. Trisetum. Three-bristle oat-grass.
143. Avena. Oats.
144. Arrhenatherum. Oat-grass.
145. Danthonia. Wild-oat-grass.

ORDER XVI. Family 33.—*continued.*

Tribe *h*. Chlorideæ. Crowfoot-grass tribe.

Genus 146. Cynodon. Bermuda grass.
147. Spartina. Cord-grass.
148. Chloris. Windmill-grass.
149. Gymnopogon. Naked-beard-grass.
150. Schedonnardus. Tumble-grass.
151. Bouteloua. Grama grass.
152. Beckmannia. Slough grass.
153. Eleusine. Goosefoot-grass.
154. Leptochloa. Slender-grass.
155. Buchlœ. Buffalo-grass.

Tribe *i*. Festuceæ. Meadow-grass tribe.

Genus 156. Pappophorum. Brush-grass.
157. Gynerium. Pampas grass.
158. Arundo. Reed-grass.
159. Phragmites. Reed.
160. Munroa. Thistle-grass.
161. Triodia. Purpletop-grass.
162. Redfieldia. Blowout-grass.
163. Diplachne. Feather-grass.
164. Eragrostis. Meadow-grass.
165. Melica. Melic-grass.
166. Diarrhena. Twin-grass.
167. Distichlis. Alkali-grass.
168. Uniola. Spike-grass.
169. Briza. Quaking-grass.
170. Dactylis. Orchard-grass.
171. Cynosurus. Dog-tail grass.
172. Poa. Blue-grass; spear-grass.
173. Glyceria. Manna-grass.
174. Puccinellia. Goose-grass.
175. Festuca. Fescue-grass.
176. Bromus. Brome-grass.

Tribe *k*. Hordeeæ. Rye-grass tribe.

Genus 177. Lolium. Darnel; ray-grass.
178. Agropyron. Wheat-grass.
179. Triticum. Wheat; emmer; spelt.
180. Secale. Rye.
181. Hordeum. Barley.
182. Elymus. Lyme-grass; wild-rye.
183. Sitanion. Bristle-grass.
184. Hystrix. Bottle-brush-grass.

Family 34. BAMBUSACEÆ. Bamboo family.

Genus 185. Arundinaria. Cane.
186. Bambusa. Bamboo.

ORDER XVII. CYPERALES. THE SEDGES.

Family 35. CYPERACEÆ. Sedge family.

Genus 187. Cyperus. Sedge; cyperus.
188. Kyllinga. Bur-sedge.
189. Dulichium. Reed-sedge.
190. Eleocharis. Spike-rush.
191. Fimbrystylis. Fringe-rush.
192. Scirpus. Club-rush; bulrush.
193. Eriophorum. Wool-rush.
194. Fuirena. Bog-rush.
194. Hemicarpha. Bog-rush.
195. Rynchospora. Beak-rush; beak-sedge.
196. Cladium. Twig-rush.

Family 36. CARICACEÆ. Carex family.

Genus 197. Scleria. Nut-rush; nut-sedge.
198. Carex. Carex; hop-sedge, etc.

ORDER XVIII. JUNCALES. THE TRUE RUSHES.
Family 37. JUNCACEÆ. Rush family.
Genus 199. Juncus. Rush.
200. Luzula. Wood-rush.

Subclass B. SPADICIFLORÆ. Spadix-flowered monocotyls.

ORDER XIX. ARALES. THE ARADS.
Family 38. LEMNACEÆ. Duckweed family.
Genus 201. Wolffia. Frog-spit.
202. Lemna. Duckweed.
203. Spirodela. Great duckweed.
Family 39. ARACEÆ. Arum family.
Genus 204. Acorus. Calamus.
295. Arisæma. Indian turnip.
206. Amorphophallus. Giant arum.
207. Caladium. Caladium.
208. Calla. Calla.
ORDER XX. PANDANALES. THE CATTAIL REEDS.
Family 40. TYPHACEÆ. Cattail family.
Genus 209. Typha. Cattail (flag).
Family 41. SPARGANIACEÆ. Bur-reed family.
Genus 210. Sparganium. Bur-reed.
Family 42. PANDANACEÆ. Screw-pine family.
Genus 211. Pandanus. Pandanus.
ORDER XX*b*. PALMALES. THE PALMS.
Family 42*b*. PHŒNICACEÆ. Date-palm family.
Genus 212. Phœnix. Date palm.
Family 42*c*. COCACEÆ. Coconut family.
Genus 213. Cocos. Coconut palm.
214. Areca. Betelnut palm.
215. Kentia. Feather palm.
Family 42*d*. SABATACEÆ. Fan-palm family.
Genus 216. Livistona. Bourbon palm.
ORDER XXI. NAIADALES. THE PONDWEEDS.
Family 43. ZANNICHELLIACEÆ. Pondweed family.
Genus 217. Potamogeton. Pondweed.
218. Ruppia. Ditch-grass.
219. Zannichellia. Horned pondweed.
Family 44. NAIADACEÆ. Water-nymph family.
Genus 220. Naias. Water-nymph.

Class X.* PETALIFERÆ. Monocotyls with Showy Perianth.

Subclass C. ALISMÆFLORÆ. Alisma-flowered Monocotyls.

ORDER XXII. HYDRALES. THE WATERWORTS.
Family 45. VALLISNERIACEÆ. Tape-grass family.
Genus 221. Philotria. Ditch-moss.
222. Vallisneria. Tape-grass.
223. Limnobium. Frog's-bit.
ORDER XXIII. ALISMALES. THE ALISMADS.
Family 46. SCHEUCHZERIACEÆ. Arrow-grass family.
Genus 224. Triglochin. Arrow-grass.
225. Scheuchzeria. Arrow-grass.
Family 47. ALISMACEÆ. Arrow-head family.
Genus 226. Alisma. Alisma; round-head.
227. Helianthium. Spear-head.
228. Echinodorus. Bur-head.
229. Lophotocarpus. Lance-head.
230. Sagittaria. Arrow-head.
ORDER XXIV. COMMELINALES. THE DAYFLOWERS.
Family 48. COMMELINACEÆ. Spiderwort family.
Genus 231. Tradescantia. Spiderwort.
232. Commelina. Dayflower.

ORDER XXIV.—*continued.*

Family 49. PONTEDERIACEÆ. Pickerel-weed family.

Genus 233. Heteranthera. Mud-plantain.

234. Piaropus. Water-hyacinth.

235. Pontederia. Pickerel-weed.

ORDER XXV. NYMPHÆALES. THE WATER-LILIES.

Family 50. NYMPHÆACEÆ. Water-lily family.

(*a*) Cabomboideæ. Water-shield subfamily.

Genus 236. Cabomba. Water-shield.

237. Brasenia. Water-target.

(*b*) Nymphæoideæ. Pond-lily subfamily.

Genus 238. Nymphæa. Pond-lily.

239. Castalia. Water-lily.

240. Victoria. Victoria.

(*c*) Nelumboideæ. Water-lotus subfamily.

Genus 241. Nelumbo. Water-lotus.

Subclass D. LILIIFLORÆ. Lily-flowered Monocotyls.

ORDER XXVI. LILIALES. THE LILIADS.

Family 51. MELANTHACEÆ. Bunch-flower family.

Genus 242. Colchicum. Saffron; meadow.

243. Chamælirum. Blazing-star.

244. Zygadenus. Zygadene.

245. Melanthium. Melanth.

246. Uvularia. Bellwort.

Family 52. LILIACEÆ. Lily family.

Genus 247. Hemerocallis. Day-lily.

247*b*. Funkia. Day-lily.

248. Agapanthus. Love-flower.

249. Allium. Wild-onion.

250. Nothoscordum. Mild-onion.

251. Androstephium. Elfin-crown.

252. Lilium. Lily; wood-lily.

253. Fritillaria. Fritillary.

254. Erythronium. Adder-tongue.

255. Tulipa. Tulip.

256. Camassia. Wild-hyacinth.

257. Hyacinthus. Hyacinth.

258. Ornithogalum. Star-of-Bethlehem.

259. Muscari. Grape-hyacinth.

260. Tritoma. Tritoma; red-hot-poker.

261. Sansevieria. Sansevieria.

262. Dracæna. Dragon-tree.

263. Yucca. Yucca; Spanish bayonet.

264. Asparagus. Asparagus.

265. Smilacina. Smilacina.

266. Streptopus. Twistfoot.

267. Polygonatum. Solomon-seal.

268. Convallaria. Lily-of-the-valley.

269. Trillium. Trillium.

Family 53. AMARYLLIDACEÆ. Amaryllis family.

Genus 270. Hymenocallis. Hymenocallis.

271. Narcissus. Narcissus, daffodil, etc.

272. Zephyranthes. Atamasco lily.

273. Amaryllis. Amaryllis, Jacobæa lily.

274. Leucojum. Snowflake.

275. Cooperia. Prairie rain-lily.

276. Hypoxis. Star-grass.

277. Galanthus. Snowdrop.

278. Polianthes. Tuberose.

279. Agave. Century-plant.

ORDER XXVII. SMILACALES. THE GREENBRIERS AND YAMS.

Family 54. SMILACACEÆ. Greenbrier family.

Genus 280. Smilax. Greenbrier; smilax.

Family 55. DIOSCOREACEÆ. Yam family.

Genus 281. Dioscorea. Yam-root; cinnamon-vine.

Subclass E. ORCHIDIFLORÆ. Orchis-flowered monocotyls.

ORDER XXVIII. IRIDALES. THE IRIDS.

Family 56. IRIDACEÆ. Iris family

Genus 282. Iris. Iris, blue-flag, etc.
283. Nemastylis. Twin-star-flower.
284. Belamcanda. Blackberry lily.
285. Sisyrinchium. Blue-eyed-grass.
286. Tigridia. Tiger-flower.
287. Gladiolus. Gladiolus; sword-flag.
288. Crocus. Crocus.

ORDER XXIX. SCITAMINALES. THE DAINTIES.

Family 57. MUSACEÆ. Banana family.

Genus 289. Musa. Banana.

Family 58. MARANTACEÆ. Arrowroot family.

Genus 290. Maranta. Arrowroot.
291. Canna. Canna.

ORDER XXX. ORCHIDALES. THE ORCHIDS.

Family 59. CYPRIPEDIACEÆ. Lady-slipper family.

Genus 292. Cypripedium. Lady-slipper.

Family 60. ORCHIDACEÆ. Orchis family.

Genus 293. Pogonia. Pogonia.
294. Triphora. Beard-lip.
295. Spiranthes. Lady-tresses.
296. Blephariglottis. Fringed-orchis.
297. Habenaria. Rein-orchis.
298. Oncidium. Tiger-orchis.
299. Cattleya. Cattleya.
300. Orchis. Orchis.

HARMONIES OF THE NOMENCLATURE.

PARTS I AND II. Liverworts to Orchids.

SUBKINGDOMS.

II.................. Archegoniata.
III.................. Carpellata.

SUPERPHYLA.

AAA.................. Gymnospermæ.
BBB.................. Angiospermæ.

PHYLA.

*I.................. Bryophyta.
*II.................. Pteridophyta.
*III.................. Cycadophyta.
*IV.................. Strobilophyta.
*V.................. Anthophyta.

SUBPHYLA.

AA.................. Stereocaulones.
BB.................. Arthrocaulones.
CC.................. Lepidocaulones.
DD.................. Monocotyledones.
EE.................. Dicotyledones.

CLASSES.

I*.................. Marchantineæ.
II*.................. Bryineæ.
III*.................. Pteridineæ.
IV*.................. Equisetineæ.
V*.................. Lycopodineæ.
VI*.................. Cycadineæ.
VII*.................. Ginkgoineæ.
VIII*.................. Coniferæ.
IX*.................. Glumiferæ.
X*.................. Petaliferæ.

SUBCLASSES.

A.................. Glumifloræ.
B.................. Spadicifloræ.
C.................. Alismæfloræ.
D.................. Liliifloræ.
E.................. Orchidifloræ.

ORDERS.

I.................. Marchantiales.
II.................. Jungermanniales.
III.................. Phascales.
IV.................. Bryales.
V.................. Pteridales.
VI.................. Ophioglossales.
VII.................. Hydropteridales.
VIII.................. Isœtales.
IX.................. Equisetales.
X.................. Selaginellales.
XI.................. Cycadales.
XII.................. Ginkgoales.
XIII.................. Taxales.
XIV.................. Cupressales.
XV.................. Pinales.
XVI.................. Poales.
XVII.................. Cyperales.
XVIII.................. Juncales.
XIX.................. Arales.
XX.................. Pandanales.
XXb.................. Palmales.
XXI.................. Naiadales.
XXII.................. Hydrales.
XXIII.................. Alismales.
XXIV.................. Commelinales.
XXV.................. Nymphæales.
XXVI.................. Liliales.
XXVII.................. Smilascales.
XXVIII.................. Iridales.
XXIX.................. Sciaminales.
XXX.................. Orchidales.

FAMILIES.

1.......................... Ricciaceæ.
2.......................... Marchantiaceæ.
3.......................... Anthocerotaceæ.
4.......................... Jungermanniaceæ.
5.......................... Micromitriaceæ.
6.......................... Phascaceæ.
7.......................... Archidiaceæ.
8.......................... Dicranaceæ.
9.......................... Pottiaceæ.
10.......................... Grimmiaceæ.
11.......................... Funariaceæ.
12.......................... Bryaceæ.
13.......................... Polytrichaceæ.
14.......................... Fontinalaceæ.
15.......................... Neckeraceæ.
16.......................... Fabroniaceæ.
17.......................... Leskeaceæ.
18.......................... Hypnaceæ.
19.......................... Polypodiaceæ.
20.......................... Ophioglossaceæ.
21.......................... Salviniaceæ.
22.......................... Marsileaceæ.
23.......................... Isœtaceæ.
24.......................... Equisetaceæ.
25.......................... Selaginellaceæ.
26.......................... Cycadaceæ.
27.......................... Ginkgoaceæ.
28.......................... Taxaceæ.
29.......................... Juniperaceæ.
30.......................... Cupressaceæ.
31.......................... Pinaceæ.
32.......................... Panicaceæ.
33.......................... Poaceæ.
34.......................... Bambusaceæ.
35.......................... Cyperaceæ.
36.......................... Caricaceæ.
37.......................... Juncaceæ.
38.......................... Lemnaceæ.
39.......................... Araceæ.
40.......................... Typhaceæ.
41.......................... Sparganiaceæ.
42.......................... Pandanaceæ.
42b.......................... Phœnicaceæ.
42c.......................... Cocaceæ.
43.......................... Zannichelliaceæ.
44.......................... Naiadaceæ.
45.......................... Vallisneriaceæ.
46.......................... Scheuchzeriaceæ.
47.......................... Alismaceæ.
48.......................... Commelinaceæ.
49.......................... Pontederiaceæ.
50.......................... Nymphæaceæ.
51.......................... Melanthaceæ.
52.......................... Liliaceæ.
53.......................... Smilacaceæ.
54.......................... Dioscoreaceæ.
55.......................... Amaryilidaceæ.
56.......................... Iridaceæ.
57.......................... Musaceæ.
58.......................... Marantaceæ.
59.......................... Cypripediaceæ.
60.......................... Orchidaceæ.

TRIBES.

Fam. 32, *a*.................. Maydeæ.
b.................. Andropogoneæ.
c.................. Paniceæ.
d.................. Oryzeæ.
Fam. 33, *e*.................. Phalarideæ.
f.................. Agrostideæ.
g.................. Aveneæ.
h.................. Chlorideæ.
i.................. Festuceæ.
k.................. Hordeeæ.

Subkingdom *III.* CARPELLATA. Carpellates.

Carpellate Seed-bearing Plants.

Plants with flowers containing anthers or ovules, or both. Anthers carrying one, two or four androsporangia, within which pollen (androspores) are perfected, are usually located at the summit of stamens (androphyls), from which, when mature, the pollen, each spore carrying one or more antherozoids or sperms, escapes through a slit, a pore, a trap-door, a wicket, a window, or other specialized form of dehiscence. Spores develop a pollen-tube.

Ovules (gynosporangia) are situated at the base of a specialized leaf, called a carpophyl or carpel, and are either naked always or for a time on the inner surface of a leaf, or are fully enclosed within a special cavity of the folded leaf.

Fecundation is effected by pollen (minute androspores bearing motile or nonmotile antherozoids) falling upon an ovule (gynosporangium) within a special chamber on or within a carpophyl (fruit-bearing leaf), germinating there, and passing through the micropyle (little gate) by means of its pollen-tube, which has grown for that special purpose, encounters an egg-cell (gynospore) with which one of the antherozoids fuses, thus producing an embryo. (As to what becomes of the other antherozo-id see Phylum *V, Anthophyta, *post.*)

Sporophyte (nonsexual plant) conspicuous, comparatively long-lived, firmly rooted in the earth, normally erect, and spreading its leaves in the air (or water). Bearing flowers, which is preparatory, is a condition precedent to bearing fruit, which is final.

Gametophyte (sexual plant) very minute and hidden, usually microscopic, totally parasitic on the sporophyte, and retained within the developed ovule until mature; then, having all the food materials stored up about it that are necessary for nursing the young embryo until it has become established as an independent existence by casting its roots into the soil and depending upon its own ability and surrounding resources, the future plant is organized into an independent and self-supporting creation, is separated from the parent plant and undergoes what is called a resting stage, but which is in reality a formative period, during which all the cells are very minutely divided and subdivided, assembled, and organized as required to constitute an orderly arrangement of the interior, in which the entire vegetative portion of the future-existing plant for one year is fully organized in miniature, *in embryo*, awaiting only development. This is the SEED, which, when the necessary time for complete organization has elapsed, and the proper and requisite conditions are encountered, germinates and grows into a plant like the parents. The reproductive portion of the plant is not organized in the seed; but is organized toward completion of development of the vegetative portion.

Thus, every carpellate plant in existence passes through four important periods or stages in its life, namely:

First. A *generative stage*, during which the nucleus of a gynospore within an ovule on or in a carpophyl undergoes definite division, and, under certain fixed conditions, becomes impregnated by fusion with it of a generative sperm-cell which comes to it within a pollen-tube through the micropyle, or sacred door (through which nothing else enters), along a specially prepared path, from an androphyl in a staminate or a perfect flower of its own kind; and thus a new being is created. This is the EMBRYOTIC PERIOD; and is the most important of all, though least (microscopic, in fact), and is least understood as to its inmost workings.

Second. A *formative stage*, during which all the parts of the future plant are created, assembled, and fully organized in embryo. This is the SEED-FORMING PERIOD in carpellates; it corresponds to the oösporal stage in archegoniates and with the egg stage in all animate creation. In all short-lived carpellates, such as annuals and biennials (or winter annuals), creation is determinate. All parts of the plant, except the reproductive bodies, are completely created and fully organized before ever the plant leaves the wall of the seed. In trees and perennials of temperate and cold regions growth is determinate. One complete year's growth is organized in the seed; afterward, each year's growth is organized in the bud, usually during the latter part of the year preceding development. Flowers and fruit are organized at the same time.

Third. A *development stage*, during which the plant, having become established as an independent existence, grows and develops to its full stature, so far as circumstances will permit. This is the PERIOD OF GROWTH; and is the most evident stage in all carpellates and in nearly all plants. It corresponds with the sporophytic stage in archegoniates, with the larval stage in insects, and with the young period in all animal life. Even in carpellates the plant during this period is called *sporophyte.* Toward its close the reproductive bodies are created, organized, and developed, and the gametophytes organized.

Fourth. An *executive stage*, during which the plant performs all the functions for which it was created: blossoms, bears fruit, and does its part toward the reproduction of other plants of its kind. This is the FRUIT-BEARING PERIOD, and corresponds to the gametophytic stage in archegoniates and to the adult period in all creation. While in archegoniates the oöspore when formed is separated from the sporophyte and develops as a separate existence, in carpellates it is not so. In this subkingdom the oöspore is retained within the body of the ovule; here the prothallia are formed containing the true sexual organs, the archegonia and antheridia, and here the gametophyte is fully developed, always within the wall of the seed which carries it. This whole operation is hidden within the wall of the seed; and so also in anthophytes is the seed hidden within the walls of the ovulary. This last period covers completely and includes the embryotic stage and the constructive portion of the seed stage of a future generation.

There are three main phyla of this subkingdom: (*i*) Palm-like and fern-like plants, in which the ovules are always uncovered, as in *cycadophytes;* (*ii*) plants without perianth, in which the ovules are at first uncovered, and later are partially covered by a scale, as in *strobilophytes;* (*iii*) plants with conspicuous perianth, in which the ovules are always completely concealed, as in *anthophytes.*

Superphylum AAA. GYMNOSPERMÆ. Gymnosperms.

NAKED-SEED CARPELLATES.

Exogenous, rarely endogenous, trees with unisexual flowers destitute of a perianth. Ovules (gynosporangia) naked, on the summit of a carpophyl or in the axil of a scaly carpophyl which may later cover the seed. Sperms motile or nonmotile, ciliate or nonciliate. Cotyledons two or more.

Phylum *III. CYCADOPHYTA. Cycadophytes.

Cycadaceous Gymnosperms.

Carpels (carpophyls) very primitive or reduced, often very minute, scarcely more than a mere disk on the end of a pinna or branchlet, or in the axils of scales of large and conspicuous carpophores. Ovules always naked. Pollen (androspores) subglobular, obscurely tetrahedral. Antherozo-ids (sperms) coiled, multiciliate, motile.

Sporophytes endogenous or exogenous, erect, ligneous, long-lived.

Gametophytes minute, developed entirely within naked seeds by the large, leafy-stemmed, firmly rooted sporophytes.

CLASS VI.* CYCADINEÆ. CYCADS.

Endogenous Palm-like Cycadophytes.

Plants diœcious, the staminate and carpellate flowers on separate plants. Androphores (anther-bearers) very large, persistent, quadrately or rhomboidally obconic. Androphyls (stamens) numerous. Anthers (androsporangia, properly androsporangiophores) in threes, radiating from the summit of the short filaments. Sporanges two (bisporangiate), dehiscing by a longitudinal slit down the middle of the face of each sporange. Pollen angular, somewhat tetrahedral, with one spherical face and three less curved ones. Pollination anemophilous. Carpophores very large, flat, pinnate, destitute of chlorophyl, and densely covered with pale, fawn-colored hair; only the lower pinnæ fertile. Ovules (gynosporangia) naked, on the ends of the lower shortened pinnæ of the carpophore. Seeds conspicuous, nut-like (with a hard shell), edible.

Species of this transitional class are very few in all the world; once in the earth's history they were very abundant. None are native in Kansas; probably few have lived here since the Cretaceous period; though once they were very abundant along the lower Cretaceous seashore from Sun City to Englewood. But exotic species of cycads and of maidenhair trees are cultivated in Kansas to a slight extent because of their rare beauty.

ORDER XI. CYCADALES. THE CYCADS.

Palm-like endogenous plants, with a short (one meter or less), thick, unbranched, ligneous trunk, bearing many large spirally arranged pinnate leaves. Flowers characterized by the absence of enveloping parts. Seeds borne on the ends of pinnæ of a large and conspicuous carpophore.

Family 26. CYCADACEÆ. Cycad Family.

Short, stout stems, bearing at the summit a conspicuous crown of circinate pinnate leaves, lasting for several years, each subtended by a small sharp-pointed hyaline scale. The leaves, on dropping, leave noticeable leaf scars. Remarkable for their rich, palm-like appearance and for their being a remnant of a class of plants that lived in great abundance and vigor in Mesozoic times.

Species 166. Cycas revoluta Thunberg. Cycad. A small tree (?), seldom more than a meter high, usually much less, with a diameter of 20 to 30 centimeters. Raised in tubs, mainly in greenhouses, often in private houses.

CLASS VII.* GINKGOINEÆ. GINKGOS.

Exogenous Fern-like Gymnosperms.

Trees monœcious, with androspores and gynospores on the same tree. Androphyls numerous, on small, ament-like, semipendulous racemes (androphores) arising from a leaf-fascicle. Androsporangia (anthers) two, each with a single sporangium attached by one end, pendulous, and dehiscing by a longitudinal slit. Androspores (pollen) tetrahedrally subspherical. Pollination anemophilous. Carpophores compound, subpaniculate, not conspicuous, with about two naked ovules (gynosporangia) on a carpophyl at the end of each branchlet; ovules provided with an embryo-sac (gynospore); only one ovule usually fertilizes and develops, making a small edible nut.

ORDER XII. GINKGOALES. THE MAIDENHAIR TREES.

Finely branching exogenous trees, with fascicled fern-like foliage. Trees bear naked seeds on carpophyls at the ends of a compound carpophore.

Family 27. GINKGOACEÆ. Maidenhair-tree Family.

Stately trees, with numerous branches and branchlets, and with leaves in scaly fascicles. Leaves annual (deciduous), petiolate, with the distal portion gradually expanded into a fan-shaped lamina with dichotomous radiating venation. Perifascicular scales opposite, obtuse, imbricate, in four ranks. Fruit of the form and size of plums, with a hard pericarp, on the tips of compound peduncles (carpophyls).

Species 167. Ginkgo biloba Linnæus. (*Salisburia adiantifolia* J. E. Smith.) Ginkgo; Maidenhair-tree. Occasional in cultivation, and grows readily where the soil is not too thin and dry and the sunshine too intense. A tree of Japan.

Phylum *IV. STROBILOPHYTA. Strobilophytes.

Cone-bearing Gymnosperms.

Carpels sometimes very minute; never form an ovulary. Ovules (gynosporangia) in the axils of prominent scales upon a conspicuous strobile or cone. Stigmas none. Anthers (androsporangia) spirally arranged on a small fugacious ament (androphore), on the under side of each anther-scale (androphyl), each anther carrying a single sporangium.

In fecundation pollen (minute androspores carrying unciliated nonmotile antherozoids or sperms) from an anther on a staminate ament falls directly upon an uncovered ovule on a carpellate ament; the antherozo-ids enter the micropyle (sacred entrance) of the ovule and fuse with the ovum within; when shortly the carpellate ament becomes a cone or fuses into a small berry. Pollination dependent upon the wind (anemophilous). The resulting seed becomes covered and protected by the scale. Such a seed differs from an oöspore (part I, page 5) mainly in being more elaborate in structure, as arising from a fully developed archegonium. Purpose is the same—perpetuation of species; methods differ.

CLASS VIII.* CONIFERÆ. CONE-BEARERS.

Exogenous Strobilophytes.

Sporophytes ligneous, exogenous, with distinct wood covered with bark, and with fascicled acicular foliage, somewhat equivalent to the leaf-petioles of Ginkgoineæ without the laminæ. Growth of new wood and bark by annual periods, in concentric cylindrical layers, continuously on the outside of the wood already formed, and on the inside of the bark. Tracheids (sap ducts) in the wood in strict radial vertical ranks, two to five ranks or thereabout between two contiguous radial plates. Radial plates in strobilophytes one cell thick, rarely more, and with a vertical breadth of from three to about sixteen cells, equivalent to a thickness of from 15 to 40 microns (thousandths of a millimeter) and to a vertical breadth of from one-twentieth to one-half a millimeter. Androspores on deciduous aments (androphores); gynospores on the upper side of scales (carpophyls) upon a perennial cone (carpophore).

Gametophytes minute, developed wholly within the seeds.

ORDER XIII. TAXALES. THE YEWS.

Slightly resinous trees or shrubs, with diœcious axiliary flowers. Androphores as scaly deciduous aments; scales few and small, each covering a small androphyl which bears at its summit five to nine little androsporangia (unisporangiate anthers), these pendent, attached by one end, and dehiscing in a peculiar manner, opening first at the lower ends a little, then gradually tearing upward till the entire androphyl looks like a tiny umbrella, holding the spores till a stiff breeze comes along and carries the ripe ones away. Carpophores solitary, erect, cone-shaped, at first terminal, later becoming axillary by development of a secondary terminal branch bud; ovule (gynosporangium) single, orthotropous, inclosed in integument; seed develops a red, fleshy aril, which is edible, though the seed is not.

Family 28. TAXACEÆ. Yew Family.

Evergreen trees, with scattered linear leaves (needles), occasionally forming two imperfect ranks by twisting of the leaves to a horizontal position upon a twig nearly or quite horizontal. Flowers diœcious, axillary, solitary, naked, or partially covered by opposite overlapping scales. Staminate flowers on a deciduous ament under the branch, the sporangia pendent. Carpellate flower (carpophore) a solitary straight ovule above the branch, in fruit becoming a bony-coated seed partially surrounded by a fleshy pericarp (the aril). Embryo in farinaceous albumen; cotyledons two.

168. Taxus canadensis Marsh. American Yew. Occasionally planted in choicest parks.

169. Taxus baccata Linn. European Yew. Occasional in cemeteries.

170. Taxus hibernica Hooker. Irish Yew. A choice tree for cemeteries, but not well adapted to this climate.

ORDER XIV. CUPRESSALES. THE CYPRESSES AND CEDARS.

Slightly resinous evergreen trees or shrubs, with unsheathed leaves (scale-like acicles) of several years' duration, rarely one (deciduous); leaves very small, scale-like, sharp-pointed. Androphores ament-like, drooping, with minute, sharp-pointed scales; androsporangia globular; dehiscence irregular. Carpophores (ovule-bearing aments) very short, of few woody or fleshy scales; after fertilization becoming globose or berry-like by coalescence; ovules erect, two or more under each scale. Seed solitary.

Family 29. JUNIPERACEÆ. Juniper Family.

Trees or shrubs diœcious, with leaves single, opposite, four-ranked, scale-like, minute and closely suppressed, or six-ranked (verticillate in threes), linear, pointed, divaricate. Trees of very slow growth; wood exceedingly fine-grained and durable; bark very thin, and separating, when old, into long, ragged shreds. Androphores with numerous ovate and peltate scales; the ovate scales, near the base, barren; scales at middle and tip of ament inversely shield-shaped and sharp-pointed, each an androphyl; at the base of each androphyl four to six globular androsporangia. Carpophores small, conoid, globular, or oblong, making a greatly modified, almost consolidated cone of three juicy scales coalesced into a berry, and enclosing a single bony-coated seed; otherwise dry and chartaceous, in which the scales open at maturity to liberate the seed.

171. Juniperus communis L. Juniper. Often grows but rarely does well in this dry climate when planted in parks.

172. Juniperus hibernicæ Loodiges. Irish Juniper. Occasional in cultivation in cemeteries; not well acclimated.

173. Juniperus hemisphærica Presl. Dome Juniper. A dozen trees, with short, stout, erect trunks, planted over thirty years ago on the thin soil of the limestone summit of Mount Oread, in front of Fraser Hall, at the Kansas University, Lawrence, are in excellent health and growing vigorously. They now have trunks six to nine decimeters around at the ground, a height of twelve decimeters, and a spread of branches on the ground fully nine meters across, thus making low, broad, beautiful domes.

174. Juniperus virginiana L. "Red Cedar"; Tree Juniper. Native on northern bluff sides, where protected from annual fires; various counties of the state; rare, scattered, and gradually disappearing, except where planted near residences, in parks, etc. April. (A. S. U.) People are now allowing these beautiful trees to become destroyed by bagworms (*Thyridopterix*) and cedar-apples (*Gymnosporangium*), when a very little judicious attention each year, even less than it took to plant them, would save them. Neglect of the trees in such manner is reprehensible and ought to be considered criminal, in allowing those insects and fungi to multiply and scatter to destroy one's neighbor's trees, not only the junipers, but the apple orchards near.

Family 30. CUPRESSACEÆ. Cypress Family.

Monoecious trees or shrubs, with minute, opposite, appressed, four-ranked or scattered scale-like leaves. Carpellate cones small, globular or oblong, of few valvate or peltate scales, sometimes only two fertile; ovules erect, two or more under each fertile scale; cotyledons two, rarely more.

175. Thuya occidentalis L. "White Cedar"; Arbor-vitæ. Cultivation often attempted without much success. A few trees twenty feet high and twenty-five years old are to be seen.

176. Thuya orientalis L. Chinese Arbor-vitæ. Preferred by some as an ornamental tree.

177. Thuya (Biota) tatarica Endlicher (1830). Tartarian Arbor-vitæ. Barely reaches a height of six meters where planted; climate too hot.

178. Thuya (Biota) sibirica Ende. Siberian Arbor-vitæ. A very handsome and apparently hardy species (or variety); only recently introduced; gives good promise.

179. Chamaecyparis thyoides B. S. P. (Britton, Stern and Poggenburg). Southern White Cedar. Sparingly planted; does fairly well for windbreaks.

180. Cupressus sempervirens L. Cypress. Occasional in cemeteries.

181. Taxodium distichum L. C. Richard. Bald Cypress. Leaves annual. Occasional in parks; endures the climate well; less of the twigs freeze than are cast off by ordinary annual self-pruning. Several trees in Topeka, planted forty years ago, are eight and one-half decimeters around the trunk snd fifteen meters high. Frequently collected by students who mistake the trees for native.

182. Retinospora plumosa Siebold. Oriental Cypress. Occasional in cemeteries.

183. Cryptomeria japonica D. Don. Japan Cedar. In cultivation.

ORDER XV. PINALES. THE PINES AND THEIR ALLIES.

Resinous evergreen trees, with acicles for foliage, these consisting of elaminate, single linear or scale-like, or fascicled acicular or awl-shaped, leaves, in this case representing leaf-petioles that are segmented or split in prefoliation, and popularly called "needles," of one (deciduous), two, or several years' duration. Pollen-grains or androspores bilobed, apparently triple, and consisting of one generative cell carrying two antherozoids or sperms, one large central vegetative cell, and two lateral gas-filled wing-sacs, which serve to buoy the androspore long distances through the air, and to orient it on approaching an ovule (gynosporangium) on another tree; while the vegetative cell serves to nourish the generative cell in its germination in order to facilitate fecundation. Electrical conditions within certain limitations of distance furnish the stimuli that guide the spore to its required destination, thus eliminating chance to a certain extent.

Family 31. PINACEÆ. Pine Family.

Trees with acerose leaves (acicles or needles) singly or in fascicles of two to five in each fascicle, with their bases enclosed in a modified scaly basal sheath (perifascicle); perifascicular scales imbricated, usually in four ranks, the final scales often long and fimbriated. When two leaves are in a fascicle a cross-section of each is semiterete; when three or five, the form is a sector of a cylinder, corresponding to the number of leaves. Tracheids in the wood each of many elongate-polyedral cells taperingly spliced end to end, in rectilineal radial ranges, each provided with four to six vertical rows of circular membrane-covered (cellulose) pits for osmotic action of the sap from cell to cell; resin-ducts large, equal to from fifteen to fifty cells, scattered mostly through the late-season wood. Fruit a cone, formed of numerous imbricated suberoid scales upon a conical receptacle. Ovules two, in the axil of each scale, each eight-celled. Cotyledons in the embryo acicular, 8-12.

185. Araucaria imbricata Willdenow. Norfolk Island Pine; "Monkey-puzzle." Dioecious. Raised in houses and out; not hardy, though becoming quite frequent.

186. Araucaria excelsa Robt. Brown. Araucaria; Norfolk Island Pine. Occasional in private houses.

187. Abies balsamea L. Balsam Fir. Rare in cultivation.

188. Abies taxifolia Desfontaine. Silver Fir. Rare in cultivation.

189. Tsuga canadensis Carriere. Hemlock. Rare in cultivation. Attempts have been made to establish timber tracts of this valuable tree, but without success.

190. Picea excelsa Link. Norway Spruce. Occasional in parks. Appears to do fairly well, though not so well as might be hoped.

191. Picea mariana Sargent. Black Spruce. Occasional in cultivation.

192. Picea pungens Engelmann. Blue Spruce. Does satisfactorily where planted; grows vigorously and is very beautiful.

193. Picea alba Link. White Spruce. Frequent in cultivation.

194. Pinus echinata Miller. (*P. mitis* Michaux.) Yellow Pine. Naturalized in several counties of southeastern Kansas, and planted successfully elsewhere to a small extent. May have once been native in Cherokee county; but doubtful if it ever grew native more than ten miles from the southeast corner.

196. Pinus sylvestris L. Scotch Pine. Apparently becoming naturalized in several places in eastern Kansas, adjacent to old Scotch plantations and nurseries. Planted extensively over the state.

197. Pinus austriaca Höss. Austrian Pine. Extensively planted throughout the state, equally with the Scotch pine.

198. Pinus strobus L. White Pine. Does well after having become established and able to send its spongioles down below the immediate effects of too much sunshine and water.

199. Pinus monticola Douglas, var. *latifolia* Engelmann. Dwarf Mountain Pine. Doing so well in cultivation that the trees bid fair to be standard in height, not dwarf.

Superphylum BBB. ANGIOSPERMÆ. Angiosperms.

HIDDEN-SEED CARPELLATES.

Endogenous or exogenous trees, shrubs, or herbs, with unisexual or bisexual flowers, conspicuously provided with a foliaceous perianth. Pollen (*androspores*) each producing a tube. Sperms nonciliate and nonmotile. Ovules (*gynosporangia*) concealed in an ovulary at or near the base of a specially constructed seed-vessel, consisting of a folded and closed carpophyl or carpel. This ovulary is on the face side of the carpel and entirely enclosed within it, but communicating with the outer world by a long, tortuous passageway, ending in the stigma at the summit of the carpel.

Phylum * V ANTHOPHYTA. Anthophytes.

Flowering Angiosperms.

Carpel a closed cavity formed by the uniting of the margins of a specialized leaf (*carpophyl* or *carpel*), thus forming a simple pistil, including always an ovulary and whatever of style and stigma are present. Usually several such leaves (carpels) are in a whorl, with their faces toward a common center, forming a compound pistil or *gynœcium*. The ovules (*gynosporangia*) are borne on the inner surface of the carpel cavity (the ovulary), and within it the seeds are matured. Seeds contain an embryo or minute future plant with cotyledons one or two.

Usually surrounding the gynœcium, when the plant is bisexual, are to be found a whorl of stamens or *androphyls*, called an *andrœcium*, each member of which bears at its summit an anther holding one or two double (rarely one single) androsporangia, which develop and hold the pollen (androspores); these are discharged at the proper time through specially prepared openings. Each androspore contains one or more nonmotile sperms.

Pollination is the act of a pollen-grain (androspore) alighting on the stigma (a specialized portion of the tip of a carpel), germinating there, and sending out a pollen-tube, which penetrates the tissues of the carpel along a specially prepared path, cleared for the passage of the pollen-tube and for no other purpose; and finally, on reaching an ovule in an ovulary near the foot of the carpel, the pollen-tube enters the ovule by its orifice (the micropyle or "little gate"), or rarely at the chalaza, after which it penetrates the nucellus and passes through the wall of the gynospore or embryo-sac, carrying with it two sperm cells.

Fertilization is effected by one of these sperm cells from the end of a pollen-tube coming in contact with the nucleus of an egg-cell in the embryo-sac (gynospore) within an ovule (gynosporangium) and fusion with it. The other sperm-cell may unite with the definitive nucleus to form the endosperm. The limits of such double fertilization are not yet known, but it is believed to be general, if not universal, in anthophytes.

When the gynœcium is surrounded on the same flower by an andrœcium, the flowers are called *perfect;* in case the gynœcia and androecia are in different flowers on the same plant, the plant is *monœcious;* when such flowers are on different plants or trees, such plants or trees are *diœcious.*

Flowers in anthophytes are nearly always surrounded by specially formed protecting leaves. In the Glumiferæ such protecting leaves are called scales, glumes, palets, perigynia, bracts, etc. Such flowers are always *anemophilous*, pollenized by the wind. In the Petaliferæ and dicotyls such protecting leaves are called *perianth*, which consists of two whorls called *calyx* and *corolla*, the several members of which are *sepals* and *petals*, either or both of which may be found enveloping a flower. The inner whorl, the petals, are prominent, high-colored and showy, to attract insects. Such flowers are *entomophilous* (insect-loving), pollenized by insects. Outside of the calyces, subtending groups of compound flowers, are to be found special systems of green leaves forming an *involucre*, the members of which are bracts, scales, etc.

Subphylum DD. MONOCOTYLEDONES. Monocotyls.

SINGLE-SEED-LEAF ANTHOPHYTES.

Stems endogenous, with no distinction or separation into wood, bark, or pith, and without medullary-ray plates. Plants represent continuous growth and formation at once, the accretions of new material being made all through the interior, which consists of a mass of soft parenchymatous tissue, interspersed with closed bundles of fibrovascular ducts (wood cells). Leaves (mostly laminodia and phyllodia, the blades being as flattened and modified petioles, rarely with laminæ at their tips) alternate, entire; nervation almost invariably parallel, the distal ends often radiating, campylodrome, or convergent; stomata (except in the *Smilacales*) longitudinally intracellular on both surfaces; the bases (sheaths) of the laminodia or phyllodia always with parallel nervation, greatly elongated, and commonly sheathing the stem of the plant. Parts of the flower in threes or a multiple of three, seldom in fours, rarely or never in fives. Embryo usually with a single terminal cotyledon and a lateral plumule.

CLAS IX.* GLUMIFERÆ. GLUME-BEARERS.

Monocotyl, with Glumaceous Perianth.

Floral envelopes glumaceous, persistent, or none. Perianth chaffy or of membranous or scarious scale-like or bristle-formed segments free from the ovulary. Fruit usually a grain inclosed in a husk, or a naked nut-like achene, rarely a utricle.

Subclass A. GLUMIFLORÆ. Husk-flowers.

GLUME-FLOWERED MONOCOTYLS.

Perianth three- or six-parted, the parts glumaceous, or of fewer hyaline scales, or mere bristles, or entirely wanting. Flowers solitary and sessile, in the axils of and subtended by or inclosed in husk-like scales or glumaceous bracts (glumes or chaff), or clustered in umbelloid or corymbose chaffy panicles in the axils of leafy bracts. Andrœcium normally of three or six stamens, though usually three or fewer, all with bisporangiate anthers. Pollination anemophilous. Gynœcium with a single unilocular one-ovuled ovulary, with styles two (one or three), and stigmas hairy or plumose. Fruit a grain or an achene, or a three-valved loculicidal capsule containing few or many seeds. Endosperm farinaceous.

ORDER XVI. POALES. THE GRASSES AND CANES.

Erect plants, usually herbaceous and perennial, rarely woody and arborescent, as in *Bambusaceæ*. Stems (culms) generally hollow, with solid nodes; sometimes comparatively solid throughout, as in common cornstalk; normally terete, with or without a groove on the side of the stem next each leaf, and always with a firm fibrous exterior and silicious cuticle.

Foliage consists of narrow, linear, dorsally compressed laminodia (never in this latitude with a true lamina and petiole), alternately on opposite sides of the stem. A *laminodium* of a grass consists of two conspicuous parts: (*a*) The upper or distal part, called the *blade*, corresponding to the petiole of a dicotyl leaf, which part is usually firm, flat, carinate, linear, parallel-nerved, and answers the same purpose as a dicotyl leaf, with important differences; and (*b*) the lower or proximal part, called the *sheath*, corresponding to the base of a dicotyl leaf, which part is generally lengthened and broadened, and surrounds and infolds the stem of the plant, with the edges free and separate or slightly overlapping, and having a small ciliate or smooth ring (ligule) at its summit or its junction with the blade.

Inflorescence paniculate, racemose, or spicate, consisting of flat spikelets composed of one to many florets, each spikelet subtended by an involucel of two glumaceous "empty scales," which may be larger than the flowering glumes, equal to them in size, or smaller, or either one or both entirely wanting. They may themselves be equal or unequal in size. The rachilla is articulated below the scales in *Panicaceæ*, above in *Poaceæ*.

Flowers (florets) perfect or unisexual, monœcious or diœcious. Perianth hypogynous, consisting of a dorsal glumaceous or hyaline sepal, called a *glume*, *flowering glume*, or *lemma*, and a double ventral sepal or a pair of ventral sepals modified and fused together into a single glumaceous leaf that partially encloses the seed and is called the *palet* or *palea*, these retaining their two carinæ and two points (teeth). Inside of these all that remain of three petals are one to three, usually two, minute hyaline scales dorsally (rarely one ventrally) placed and called *lodicules*.

Andrœcium of one to six, usually three, stamens; filaments slender; anthers bisporangiate (two-celled), exserted, versatile or adnate.

Gynœcium of two or three united carpels, rarely one. Ovulary unilocular, one-ovuled. Styles two or three, distinct or united, rarely one. Stigmas usually plumose. Fruit a seed-like grain (caryopsis), with a large farinaceous endosperm and a small embryo on the side opposite the hilum.

(This is the most important of all botanical orders, on account of its farinaceous seeds, which furnish the principal food of mankind, and of its herbage, which furnishes the principal food of domestic animals.)

Family 32. PANICACEÆ. Panic-grass Family.

Includes the following tribes: *a*, *Maydeæ* with spikelets unisexual; *b*, *Andropogoneæ*, with spikelets in pairs; *c*, *Paniceæ*, with spikelets perfect and spheroidal; and *d*, *Oryzeæ*, with spikelets laterally compressed.

Plants herbaceous, annual or perennial; culms always annual. Spikelets one- or two-flowered, subtended by an involucel of one or two empty scales, usually two; when two-flowered, the first or lower is staminate, the upper one perfect and fertile; rachilla articulated below the empty scales, the spherical or dorsally compressed spikelets falling from the pedicels entire, either singly or in groups, together with joints of the articulate rachilla.

Tribe *a*. *Maydeæ*. Maize Tribe. Spikelets monœcious; staminate and carpellate flowers on different parts of the same plant. Flowering glume and palet hyaline.

201. Euchlæna luxurians Schrader. Teosinte (God-gift Grass); Guatemala Grass. Planted for fodder. Does not ripen seeds here. Occasional.

202 Zea mays L. Indian Corn; Maize. Includes dent, flint, pop, sugar corn, and other horticultural subspecies. Survives the winter occasionally for a year or so, with but slight tendency toward becoming naturalized.

203. Tripsacum dactyloides L. Gama-grass. Sloughs and wet places all over the state, as far west as Ellis and Kinsley, or further; common; but rare beyond the points named. June. (ASU)

Tribe *b*. *Andropogoneæ*. Blue-stem Tribe. Spikelets in compound racemose spikes, two at each joint of the articulate rachis, the one sessile and perfect, the other pedicellate, and either staminate, neuter, or reduced to a mere pedicel and minute scale; empty involucel scales as large as the flowering glume and very firm; flowering glume usually awned and subtending a palet and perfect flower. Rachillæ and barren pedicels usually bearded.

204. Coix lachryma-jobi L. Tear-grass; Job's Tears. Often survives the winter and grows spontaneously from self-sown seeds. Not naturalized.

205. Eulalia japonica Trinius. Eulalia. Raised in gardens for its beauty.

206. Imperate sacchariflora Maxim. "Emperor-grass"; Great Blady-grass. Rare in gardens.

207. Erianthus ravennæ Beauvois. Plume-grass. Cultivated in parks and lawns occasionally.

208. Andropogon scoparius Mx. Little Bluestem; Besom Beard-grass. Dry soils and hillsides all over Kansas; common. Aug. (ASU)

209. Andropogon virginicus L. Virginia Beard-grass. Scattered throughout the eastern part of the state; not common. Aug. (ASU)

210. Andropogon furcatus Muhl. (Not *A. provincialis* Lam.) Bluestem. All over the valley lands of eastern Kansas, and working westward in the well-drained valleys of the western part. Does not stalk up and bear seed where too dry. Aug. (ASU)

211. Andropogon chrysocomus Nash. Yellow-haired Beard-grass. Dry soil, southwestern Kansas, according to Nash.

212. Andropogon hallii Hackel. Great-plain Beard-grass. Sandy lands of western and southwestern Kansas. Aug. (ASU)

213. Andropogon torreyanus Steudel. Staked-plain Beard-grass. Dry soil, southern and southwestern Kansas; frequent. Aug. (ASU)

214. Sorghastrum avenaceum Nash. (*Chrysopogon* Benth.) Indian grass. On comparatively damp and broken prairies, hedge shades, etc., throughout the state; frequent to common. Aug. (ASU)

215. Sorghum halepense Persoon. Johnson Grass; Aleppo-grass. Occasional on the lower dry prairies of southern Kansas. July. (A)

216. Sorghum vulgare Pers. Kafir, Durra or Egyptian Corn; Egyptian Millet; Shallu; Kaoliang; Guinea-corn; Milo-maize; Dwarf Milo. Seeds of these varieties often survive the winter and grow spontaneously.

217. Sorghum saccharatum Willd. Sorghum; Chinese Sugar-cane; Imphee; Broom-corn. Common in cultivation.

Tribe c. *Paniaceæ*. Panic-grass Tribe. Spikelets perfect, terete or dorsally flattened, in racemes or panicles; involucellate scales one or two, the first, when present, always small; glumes one or two, membranous, unequal; first flowering glume, when present, sometimes contains a staminate flower; uppermost flowering glume always firmer in texture than the outer scales; it and the palea indurated and firmly clasped together, inclosing the grain and falling away with it and with the scales of the involucel, the rachilla being articulated below the scales.

218. Paspalum mucronatum Muhl. (*P. fluitans* Kth.) Floating Water-grass. In water or very wet spots, Miami to Cherokee county; not common. Sept. (AS)

219. Paspalum læve Mx. Water-grass. Moist fields, E. K., west to Barton county; not common. Aug. (AS)

220. Paspalum angustifolium Le Conte. Narrow-leaf Water-grass. Sandy soils, E. and S. E. K.; frequent. Aug. (AS)

221. Paspalum glabratum Mohr. Smooth Water-grass. Moist places, S. E. K.; frequent. Aug. (AS)

222. Paspalum stramineum Nash. Straw-colored Water-grass. Sandy soil, N. K.; occasional. July. (AS)

223. Paspalum setaceum Mx. Downy Water-grass. Sandy soil, central and western Kansas; frequent. June. (AS)

224. Eriochloa punctata Hamilton. (*E. polystachya* H. B. K.) Dotted Wool-grass. Dry prairies, S. and S. W. K.; occasional. July. (AS)

225. Syntherisma filiformis Nash. (*Digitaria* Koeler.) Slender Crab-grass. Sandy soil, E. K.; frequent. July. (ASU)

226. Syntherisma lineæis Nash. (*Panicum* Krock). Smooth Crab-grass. Introduced and frequent in waste places, E. K. June. (ASU)

227. Syntherisma fimbriata Nash. Fringed Crab-grass. Frequent in fields, etc., E. K. June. (ASU)

228. Syntherisma sanguinalis Dulac. (*Panicum* L.) Crab-grass; Finger-grass. Fields and waste places, eastern and middle Kansas, and spreading westward; should be utilized wherever it becomes too common. Frequent and close mowing of lawns in this sunny climate disheartens blue-grass and encourages the growth of crab-grass; pasturing, if not too close, reverses that. June. (ASU)

229. Brachiaria obtusa Nash. (Panicum H. B. K. = Humboldt, Bentham and Kunth.) Little Arm-grass. Extreme southwest Kansas; 3–7 dm.; stoloniferous; not common. June. (AS)

230. Leptoloma capillaris (L) (*Panicum* L.) Old-witch-grass; Tickle-grass. In plowed fields all over the state; a real pest in barren fields, and often in stubble-fields of eastern Kansas; 3–6 dm.; common. July.

231. Leptoloma barbipulvinata (Nash.) (*Panicum* Nash.) Yellowstone Witch-grass. Open ground, C. and N. W. K.; 1–4 dm.; occasional. July. (AS)

232. Leptoloma cognatum Chase. (*Panicum autumnale* Bosc.) Fall Witch-grass. Dry soil, C. K.; 3–6 dm. high; common. July. (ASU)

233. Leptoloma miliacea (L) (*Panicum* L.) Hog Millet. Roadsides, E. K.; introduced as a crop and escaped from cultivation. Rare. July.

234. Leptoloma dichotomiflora (Mx.) (*Panicum geniculatum* Muhl.) Great Spreading Witch-grass. Rich damp soil, with stout creeping rootstocks simulating a perennial; commonly 10–18 dm. long; becoming frequent in E. K., especially in rich soil near houses, barns, parks, etc. July. (ASU) An excellent forage grass and worthy of cultivation, except that it is liable to smut.

235. Panicum virgatum L. Tall Panic-grass; Switch-grass; Fly-switch Panic-grass. Rich dry or moist soils, where the air is not too dry; in western Kansas in valleys only; farther east on hillsides and uplands as well; 6–12 dm. high; very common. July. (ASU)

236. Panicum agrostoides Sprengel. Redtop Panic-grass. Wet grounds, S. K., as far west as Arkalon; 4–8 dm. high; occasional. July. (AS)

237. Panicum anceps Mx. Flat-stem Panic-grass. Moist sandy soils, in thickets, S. E. K.; occasional; 4–10 dm. July. (AS)

238. Panicum depauperatum Muhl. Spindly Panic-grass. Dry, open places, poor soils, C. K.; 2–4 dm.; not common. Kansas soil is generally too rich for it. June. (S)

239. Panicum linearifolium Scribner. Long-leaf Panic-grass. Sandy soil, in woodlands, S. E. K.; 2–4 dm.; slender; frequent. June. (AS)

240. Panicum perlongum Nash. Prairie Panic-grass. Dry prairies, N. and C. K.; 1–4 dm.; occasional. June. (A)

241. Panicum lindheimeri Nash. Prostrate Panic-grass. Dry sandy soil, Sumner county; 4–8 dm. long; infrequent. July. (S)

242. Panicum huachucæ Ashe. Villous Panic-grass. Prairies and sandy fields, general; 3–7 dm. high; frequent. May–Sept. (ASU)

243. Panicum silvicolum H. & Ch. Satiny Panic-grass. Woods and clearings, E. and S. E. K.; 4–8 dm. high; occasional. July. (AS)

244. Panicum tennesseense Ashe. Tennessee Panic-grass. Moist ground near woods, S. E. K.; 2–5 dm.; rather rare. July. (S)

245. Panicum præcocius H. & Ch. Early Panic-grass. Dry prairies, N. K.; 1–3 dm.; rare. May. (A)

246. Panicum sphærocarpon Elliott. Bird-shot Panic-grass. Dry soil, thickets, E. K.; 2-6 dm.; frequent. May. (ASU)

247. Panicum scribnerianum Nash. Susquehanna Panic-grass. Dry or moist sandy soil, nearly all over Kansas; 2–5 dm. high; common. June. (ASU)

248. Panicum leibergii Scribn. Iowa Panic-grass. Prairies, N. E. K.; 3–5 dm.; rare. June. (A)

249. Panicum wilcoxianum Vasey. Nebraska Panic-grass. Prairies, gardens, shades, Shawnee county northward; 1–2 dm. high; common, or at least frequent. July. (AS)

250. Panicum clandestinum L. Hispid Panic-grass. Thickets, E. K.; 7–11 dm. high; occasional. June. (AU)

251. Panicum latifolium L. (*P. macrocarpon* Le C.) Broad-leaf Panic-grass. Rocky woods, E. K.; 4–6 dm. high; frequent. July. (ASU)

252. Panicum boscii Poiret. (*P. porterianum* Nash.) Forestine Panic-grass. Dry soil, in woods, S. E. K.; frequent. July. (S)

253. Echinochloa crus-galli Beauv. (*Panicum* L.) Cockspur-grass; Barnyard grass. Low grounds and in rich waste soils; common all over the state. Apparently native, rather than introduced. June. (ASU)

254 Echinochloa walteri Nash. (*Panicum* Pursh.) Salt-marsh Cockspur-grass. Saline lands along the Arkansas valley from Great Bend down; also S. E. K.; frequent. July. (ASU)

255. Echinochloa colona Link. (*Panicum* L.) Jungle-rice. Dry soil from Hutchinson southwest; not common. Similar to the two preceding grasses, but with awnless scales. July. (AS)

256. Chætochloa glauca Scribn. (*Panicum* L.) Yellow Pigeon-grass; "Bottle-grass." Common in all dry soils. July. (ASU) Spikes 1–10 cm. long.

257. Chætochloa imberbis Scribn. Beardless Pigeon-grass; Seaside Pigeon-grass.

Panicum glaucum L. Michx., as shown by A. S. Hitchcock, in "Grasses of Michaux's Flora Boreali-Americana," 1803, in Contrib. from U. S. Nat. Herbarium, xii, No. 3 (1908), p. 146. Professor Hitchcock also shows (p. 132, same volume and number) that Hans Sloane, in his History of Jamaica (1725 or earlier), had called the grass "*Gramen paniceum spica simplici lævi.*" which, of course, is no name at all, but may have been the suggestion that led to the use of the word *lævigata* by Muhlenberg, a name already used by Lamarck for another grass.—See *Flore de France*, ed. 1778, iii, p. 578.

(?) *Panicum imberbe* Poiret. Encyc. Supp. 4 (1816), p. 272. This citation is very questionable, and needs verification by original type specimens in herbarium.

Panicum lævigatum Muhl. Elliott, Sk. Bot. S. C. & Ga., i (1817), p. 112. Not, *p. lævigatum* Lam. (See citation above.)

Setaria imberbis (Poir.) Roemer & Schultes, Syst. ii (1817), 891. Coulter, Contrib. U. S. N. H., i (1890), p. 55, No. 678; same, vol. ii, No. 3 (1894), p. 510.

Setaria lævigata (Muhl.) Chapm. Flo. S. S., ed. 3, p. 387.

Chætochloa glauca, var. *perennis* Curtiss. Beal's Grasses of N. A., ii (1896), p. 156.

Chætochloa imberbis (Poir.) Scribn. Bull. 4, U. S. Dept. Agr., Div. Agrost. (1897), p. 39.

Chætochloa perennis (Curt.) Bicknell. Bull. Torr. Bot. Club, xxv (1898), p. 107.

Chætochloa lævigata Scribn. Bull. 21, U. S. Dept. Agr., Div. Agrost. (1900), p. 10, evidently repeated from some publication earlier.

A somewhat cespitose glabrous perennial, from slender, creeping rootstocks; culms slender, compressed, erect or ascending, somewhat geniculate at the base, scabrous below the panicle, otherwise smooth; nodes glabrous; sheaths glabrous, the lower longer than the internodes; ligule ciliate; blades 1–3 dm. long, 3–7 mm. wide, tapering to the tip; scabrous on the upper surface and margins, glabrous below. Panicles dense, spike-like, 2–5 cm. long, 1 cm. thick; exclusive of the setæ; rachis angular, pubescent; setæ 8–12, spreading, 5–10 mm. long, yellowish or purplish sometimes. Spikelets ovate, acute, 2-2½ mm. long, surpassed by the setæ. Moist soil, New Jersey to Florida, north to Kansas. May to October. F. L. Scribner, in Bull. 21, Div. Agrost.

258. Chætochloa perennis (Hall & Henry). Salt-meadow Pigeon-grass.

Setaria glauca Beauv., var. *lævigata* Chapm. Hall, *Plantæ Texanæ*, 1872, No. 839; Contr. U. S. Nat. Herb., iii, No. 1 (1891), 38.

Setaria perennis Hall & Henry. Dr. Joseph Henry, of Salina, Kan., in Bulletin of Washburn Lab. of Nat. Hist., by F. W. Cragin, ii (1889), p. 63.

Setaria glauca, P. Br., var. *lævigata* Chapm. Coulter, Contr. U. S. Nat. Herb., i (1890), p. 55 (No. 677).

Setaria perennis Hall. Smyth, in Check-list of the Plants of Kansas, Aug. 1892, p. 26 (No. 1728, incorrectly credited and imperfectly described). Same improper entry repeated in Transactions Kansas Acad of Science, xiii (1893), p. 192.

Setaria glauca (L.) Beauv., var. *lævigata* (Muhl.) Chapm. Coulter, in Cont. U. S. Nat. Herb., ii, No. 3 (1894), p. 509.

Chætochloa versicolor Bicknell. Bull. Torr. Bot. Club, xxv (1898), p. 105, pl. 329.

Chætochloa imberbis perennis (Hall) S. & M. Bull. 21, U. S. Dept. Agr., Div. Agrost. (1900), p. 12.

Setaria imberbis R. & S., var. *perennis* (Hall) Hitchc. Gray's Manual, 7th ed., 1908.

Culms scarcely tufted, slender, decumbent, ascending, or erect, 6–11 m. long; blades 2–6 dm. long; spike cylindrical, simple or slightly compound, long-exserted, 2-6 cm. long; spikelets generally purplish; bristles few, slender, yellowish-green, shading to purple, and scarcely extending beyond the spikelets. Propagates freely by slender perennial rootstocks, and seldom ripens seed where cattle freely graze. Frequent in damp alkaline and saline bottoms and meadows in Shawnee, Wabaunsee, Dickinson, Saline, McPherson, Reno, Sedgwick, Kingman, Pratt, Meade, Seward, and other counties of central and southern Kansas. August. (AS) A variable species; several forms, probably all of the same species, occur in Kansas.

The following perennial panicums, in which the panicle is a simple cylindrical or somewhat compound spike, the rachis of the inflorescence is prolonged beyond the upper spikelet into an awn or bristle, and one or more persistent setæ are inserted on the rachis below the articulation of the spikelets, thus answering the principal requirements of *Chætochloa* as now delimited by botanists, should be removed from the very large and heterogeneous genus *Panicum*, and added to the restricted genus *Chætochloa*, with which they are more nearly allied:

259. *Chætochloa reverchoni* (Vasey) n. comb. (*Panicum reverchoni* Vasey, Bull. No. 8, Bot. Div., Dept. Agr., p. 25.) Chapparal Millet. High lands of central and northern Texas.

260. *Chætochloa ramisetum* (Scribn.) n. comb. (*Panicum subspicatum* Vasey, same bulletin and page as above. 1889, name preoccupied; *P. ramisetum* Scribn., Circ. 27, Div. Agrost., Dept. Agr., p. 9; 1900.) Hidalgo Pigeon-grass. Plains of southern and western Texas.

261. Chætochloa occidentalis Nash. Western Pigeon-grass. Reported from Kansas.

262. Chætochloa viridis Scribn. Pigeon-grass; "Green Foxtail." General over the state; introduced; common. (ASU) Where this grass grows freely in rich cultivated ground the panicle is greatly increased in size, becoming decompound and heavily seeded, much like the next two.

263. Chætochloa italica Scribn. Italian Millet. Inclined occasionally to escape from cultivation; not naturalized. When it runs wild it tends to revert to a form approaching the preceding.

264. Chætochloa germanica (Mill.) Hungarian Grass. Escapes for a year or two; not naturalized.

265. Chætochloa verticillata Scribn. Bur Pigeon-grass; "Bristly Foxtail." Douglas county; rare. (S)

266. Cenchrus carolinianus Walt. (Not *C. tribuloides* L.) Bur-grass; "Sand-bur." Sandy lands and neglected fields anywhere; too frequent on some farms; it loves indolent people. An excellent fodder when cut young. (ASU)

267. Penicillaria spicata Willd. (*Pennisetum typhoideum* Rich.) Pearl Millet. Occasional in cultivation.

Tribe *d*. *Oryzeæ*. Rice-grass Tribe. Spikelets unisexual or perfect, in loose panicles; rachilla articulated below the scales; spikelets laterally compressed; stamens often 6.

268. Zizania palustris L. Indian Wild-rice; Water-oats. Frequently introduced by hunters and planted as food for wild ducks in little lakes of Linn, Miami, Johnson, Douglas, Franklin, Sedgwick and other counties of eastern and southern Kansas; yet not often seen; does not appear to do well. June.

269. Homalocenchrus virginicus Britt. White Cut-grass. Wet spots and slow streams, E. K.; frequent. Aug. (ASU)

270. Homalocenchrus oryzoides Pollich. Rice Cut-grass; Scratch-grass. Marshy and meadow lands, E. and S. K.; rare. Aug. (ASU)

271. Homalocenchrus lenticularis Scribn. Catchfly Cut-grass. Wet grounds, E. and S. K.; frequent. July. (ASU)

Family 33. POACEÆ. Meadow-grass Family.

Spikelets laterally or dorsally compressed, one- to many-flowered, the rudimentary floret, if any, usually uppermost; the rachilla articulated above the two "empty scales" of the involucel (below them in *Alopecurus*, *Polypogon*, *Cinna*, *Holcus*, *Sphenopholis*, *Spartina*, and *Beckmannia*). When the spikelets have two or more florets there is an articulation of the rachilla below each floret, so that the seeds fall either singly or in groups, leaving the two involucel scales attached to the end of the rachilla. The family comprises the following tribes: Tribe *e*, *Phalarideæ*, with empty scales two, and sterile glumes two; tribe *f*, *Agrostideæ*, with empty scales two; tribe *g*, *Aveneæ*, with two or more flowers in each spikelet; tribe *h*, *Chlorideæ*, with spikelets in two rows on each of several preæstivally divided spikes; tribe *i*, *Festuceæ*, with spikelets pedicellate in racemes, or in dense or loose panicles; and tribe *k*, *Hordeeæ*, with spikelets sessile alternately on opposite sides of a zigzag channeled rachis.

Tribe *e*. *Phalarideæ*. Canary-grass Tribe. Inflorescence spicate or paniculate; spikelets crowded on the spike, one- rarely three-flowered empty scales of the involucel below the first articulation of the rachilla, large and showy; the two sterile glumes small and narrow, rarely subtending staminate flowers; the fertile glume with a two-nerved or nerveless palea and a perfect flower.

272. Phalaris arundinacea L. Reed Canary-grass. The variety *picta* L., ribbon-grass, is frequent in gardens and spreads a little where planted; but does not run wild.

273. Phalaris caroliniana Walt. Carolina Canary-grass. Escapes from cultivation occasionally for a year or two; not seen as a wild grass. June.

274. Phalaris canariensis L. Canary-grass. Often escapes from cultivation for a short time. July.

275. Anthoxanthum odoratum L. Sweet Vernal-grass. An introduced grass, growing freely in lawns where planted, but not disposed to run wild.

276. Oryzopsis micrantha Thurb. Small-flowered Mountain-rice. Dry soils, Cheyenne county; rare. June. (S)

277. Oryzopsis asperifolia Mx. White Mountain-rice. Woods, N. E. K.; occasional. June. (S)

278. Oryzopsis melanocarpa Muhl. Black Mountain-rice. Rocky woods, Cherokee county; rare. July. (A)

279. Oryzopsis membranacea Vasey. Silky Mountain-rice. Sandy or gravelly prairies, not far from streams, Cheyenne, Sherman, Wallace, and Logan counties; rare. July. (AB)

Tribe *f*. *Agrostideæ*. Reed-grass Tribe. Spikelets perfect, one-flowered, the involucel scales as long as or longer than the floral glume; rachilla sometimes prolonged behind the palea into a naked or plumose bristle; palea two-nerved, double-nerved, one-nerved, nerveless or wanting.

280. Stipa viridula Trin. Wild-oat Weather-grass. Dry grounds, N. K.; infrequent. July. (AS)

281. Stipa vaseyi Scribn. (*S. viridula vaseyi.*) "Sleepy-grass"; Stout Weather-grass. Said to grow in the Cimarron river bottoms in Morton and Stevens counties. June.

282. Stipa avenacea L. Black-oat Weather-grass. Dry woods and thickets, E. K.; frequent. May. (ASU)

283. Stipa comata Trinius & Ruprecht. Thread-needle Weather-grass. Dry plains, W. K.; occasional. June. (ASU)

284. Stipa Spartea Trin. Porcupine Weather-grass. Low prairies, E. K.; common. June. (ASU)

285. Aristida dichotoma Mx. Poverty-grass. Sterile soils, E. K., west to Hutchinson; rare. Middle (longest) awn at right angles to spikelet. August. (ASU)

286. Aristida curtissii Nash. Atlantic Poverty-grass. Reported from Kansas by Nash.

287. Aristida basiramea Engelm. Forked Poverty-grass. Dry soils, more frequent in E. K. July. (AS)

288. Aristida ramosissima Eng. Branching Aristida. Dry prairies, many counties of E. K.; frequent. Longest awn reflexed. July. (ASU)

289. Aristida fasciculata Torr. (*A. dispersa* Trin. & Rupr.) Bushy Aristida. Dry plains, S. W. K.; frequent. Aug. (AS)

290. Aristida oligantha Mx. Few-flowered Poverty-grass Thin, dry soils, generally distributed. Aug. (ASU)

291. Aristida gracilis Ell. Slender Poverty-grass. Dry soils, E. and S. E. K.; not common. Aug. (AS)

292. Aristida purpurascens Poir. Purplish Dogtown-grass. Common in dry soils and generally distributed. Sept. (ASU)

293. Aristida fendleriana Steudel. (*A. purpurea* Nutt., in part.) Purple Dogtown-grass. Common in prairie-dog towns and other dry barren spots, W. K. July. (ASU)

294. Aristida longiseta Steud. (*A. purpurea* Nutt., in part.) Long-awned Dogtown-grass. Common in dry soils, E. and C. K. Aug. (ASU)

295. Aristida intermedia Scribn. & Ball. Spreading Three-awned-grass. Dry soil; awns all spreading. Aug. (A)

296. Aristida divaricata Humb. & Bonp. (*A. humboldtiana* Trin.) Great-plains Aristida. Sandy plains, S. W. K.; occasional. Aug.

297. Aristida desmantha Tr. & Rupr. Western Three-awned-grass. S. W. K.; not common. Aug. (S)

298. Muhlenbergia sobolifera Trin. Rock Wood-grass. Rocky woods, S. E. K.; not common. Sept. (ASU)

299. Muhlenbergia mexicana Trin. Meadow Wood-grass. Damp soils, all over the state; common. Aug. (ASU)

300. Muhlenbergia racemosa B. S. P. Marsh Wood-grass. Damp lands, everywhere; not common. Aug. (ASU)

301. Muhlenbergia sylvatica Torr. Wood-grass. Moist woods, E. K.; frequent. Aug. (ASU)

302. Muhlenbergia comata Benth. Hairy Wood-grass. Prairies, S. W. K.; occasional. Aug. (S)

303. Muhlenbergia schreberi Gmel. (*M. diffusa* Schreb.) Satin-grass; "Nimble-will." Dry hills and woods, C. to E. K.; frequent. Aug. (ASU) Astonishing though it may seem, the seed of this grass has been sold in Topeka for bluegrass seed.

304. Muhlenbergia tenuiflora B. S. P. (*Agrostis* Willd.) Slender Satin-grass. Rocky woods, E. K.; not common. Aug. (S)

305. Muhlenbergia microsperma Trin. Desert Satin-grass. Dry soil, S. W. K.; infrequent. Aug. (S)

306. Muhlenbergia capillaris Trin. Hair-like Satin-grass. Dry sandy or rocky soil, Labette county; not common. Sept. (ASU)

307. Muhlenbergia gracillima Torr. Silky Satin-grass. Prairies, S. W. K.; not common. Sept.

308. Muhlenbergia pungens Thurber. Prairie Satin-grass. Prairies, W. K.; frequent. Aug. (ASU)

309. Brachyelytrum erectum Beauv. Bearded Satin-grass. Low ground at Kaw's mouth; not common. July. (AS)

310. Phleum pratense L. Timothy. Fields and meadows, as cultivated; not thoroughly naturalized, though it sometimes escapes for a few years. Is perpetuated through annual tubers.

311. Alopecurus agrestis L. Slender Foxtail. Along railroads and waste places ; from the east.

312. Alopecurus geniculatus L. Floating Foxtail. Wet soils, E. K. ; not common. July. (ASU)

313. Alopecurus aristulatus Mx. Water Foxtail. Water and wet places, general ; frequent. July. (ASU)

314. Alopecurus pratensis L. Meadow Foxtail. Meadows, E. K.; common. June. (ASU)

315. Sporobolus asper Kth. Rough Rush-grass. Dry soil and sandy fields, E. and S. K.; occasional. Palets long-acuminate or awned. Aug. (S)

316. Sporobolus canovirens Nash. Southern Rush-grass. Dry sandy soil, S. E. and S. K., according to Mr. Nash.

317. Sporobolus longifolius Wood. Long-leaf Rush-grass. Dry soil, all over Kansas ; common. Palets obtuse. Aug. (ASU)

318. Sporobolus pilosus Vasey. Hairy Rush-grass. Dry soil, central to S. W. Kansas ; occasional. Aug. (AS)

319. Sporobolus vaginæflorus Wood. Sheathed Rush-grass. Dry soil, C. and S. K.; occasional. Aug. (ASU)

320. Sporobolus neglectus Nash. Small Rush-grass. Dry soil, N. and C. K.; common. (ASU)

321. Sporobolus cuspidatus Wood. Prairie Rush-grass. Dry soil, N. and E. K.; frequent. Aug. (ASU) Ligule very short ; glumes cuspidate.

322. Sporobolus brevifolius Scribn. Mountain Rush-grass. Very dry prairies, Wallace county ; occasional. Summer. (S) Ligule long; outer scale of the involucel obtuse or acute, not acuminate.

323. Sporobolus airoides Torr. Fine-top Salt-grass. Prairies and alkaline meadows, from Hutchinson and Russell southwest; frequent. Aug. (ASU) This grass forms a very dense and compact sod on slight hummocks several feet across and raised two to four inches above the surrounding saline prairie.

324. Sporobolus cryptandrus Gray. Sand Dropseed. Sandy soil, general; common. Aug. (ASU)

325. Sporobolus argutus Kth. Pointed Dropseed-grass. Southern Kansas; not common. July. (AU)

326. Sporobolus heterolepis Gray. Rank Dropseed. Dry soils, N. K.; not common. Aug. (A)

327. Sporobolus texanus Vasey. Texas Dropseed. Dry soil, Clark and Meade counties; rare. Collected in Cloud and Republic counties by Prof. J. H. Schaffner; this is the "farthest north" record for this grass. Aug. (S)

328. Sporobolus asperifolius Thurb. Rough-leaf Salt-grass. Dry, alkaline soils, W. K.; frequent. Aug. (ASU)

329. Sporobolus confusus Vasey. Nebraska Dropseed. Dry prairies, W. K.; occasional. Aug.

330. Cinna arundinacea L. Sweet Wood-reed-grass. Swamps and permanent creeks, E. K.; frequent, but not common. Aug. (ASU)

331. Agrostis alba L. "Dew-grass"; White Bent-grass. Fields, fence-corners, and meadows, near water; E. K.; introduced. July. (ASU)

332. Agrostis vulgaris Withering. Redtop (Bent-grass). Same soil and region; more general in cultivation; less liable to run wild. July. (ASU)

333. Agrostis exarata Trin. Mountain Redtop. Eastern Kansas; common. Aug. (ASU)

334. Agrostis asperifolia Trin. Rough-leaf Bent-grass. Found in the states all around Kansas; not yet reported from here. Dry soil. Aug.

335. Agrostis elliottiana Schult. Slender Bent-grass. Chautauqua county (Hitchcock). May. (A)

336. Agrostis perennans Tuckermann. Thin Bent-grass. Damp, shaded places, E. K.; not common. Sept. (AS)

337. Agrostis scabra Wild. Rough bent-grass; "Flyaway-grass." Dry soil, not far from water, E. K.; frequent. July. (ASU)

338. Calamagrostis canadensis Beauv. Big Blue-joint; "Sand Reed-grass." Water and permanently wet, sandy soils; rare in Kansas. July. (ASU)

339. Calamagrostis inexpansa Gray. Bog Reed-grass. Swamps and low prairies, E. and N. K.; occasional. July.

340. Calamovilfa longifolia Hackel. Long-leaf Reed-grass. Sandy places near water, C. and W. K.; frequent. July. (ASU)

Tribe *g*. *Aveneæ*. Oat-grass tribe. Inflorescence paniculate, seldom spicate; spikelets two- to several-flowered, the two involucel scales. when present, larger than the flowering glume, and persistent on the rachilla when the seeds have fallen; glumes bidentate, furnished with one to three awns on the back, usually from the base of the sinus between the two teeth; joints of the rachilla hairy.

341. Holcus lanatus L. Velvet-grass. Fields and waste places, E. K.; brought in from the east. June.

342. Sphenopholis obtusata Scribn. (*Eatonia* Gray.) Blunt-scale Prairie-grass. Dry soil, general; common. June. (ASU)

343. Sphenopholis pallens Scribn. (*Eatonia pennsylvanica* Gray.) Sharp-scale Prairie-grass. Hilly woods or moist soils, S. E. K.; west to Barton county, near streams; occasional. June. (ASU)

344. Kœleria cristata Pers. Crested Prairie-grass. Well-drained prairies, E. and C. K.; common. June. (ASU)

345. Trisetum flavescens R. & S. (*T. pratense* Pers.) Yellow Oat-grass. Meadows, E. K.; introduced; not common. July. (AS)

346. Trisetum subspicatum Beauv. Narrow Oat-grass. Rocky places, E. K.; occasional. August. (AS)

347. Trisetum interruptum Buckley. Seward to Morton counties, on dry prairies in river valleys; occasional. (SU)

348. Avena sativa L. Oats. Along railroads and neglected fields for a year or so outside of cultivation.

349. Avena fatua L. Fool Oat; Sand Oats. Woods and waste places; N. E. K.; occasional, introduced. July.

350. Arrhenatherum elatius Beauv. Tall Oat-grass. Fields and waste places, E. K.; introduced. June.

351. Danthonia spicata Beauv. Wild Oat-grass. Dry soil, N. E. K.; not common. July. (AS)

Tribe *h.* *Chlorideæ.* Crowfoot-grass tribe. Inflorescence on split spikes, in which the apex of the culm is longitudinally sectioned or segmented in preæstivation, sometimes a section occurs at a short distance down from the summit of the culm; spikelets one- to several-flowered, in two rows on one side of each of several umbellately terminal, or occasionally axillary one-sided spikes or racemes; flowering glumes keeled, entire, toothed, or with one or three short straight arms.

352 Cynodon dactylon Pens. (*Cabriola* Kuntze.) Dog-tooth grass; Bermuda-grass. Planted successfully for a lawn in spots too hot for blue-grass to thrive.

353. Spartina cynosuroides Richard (1781). "Slough-grass"; Fresh-water Cord-grass. Sloughs and water holes, general; common. Aug. (ASU)

354. Spartina polystachya Pursh (1881). Saltmarsh Cord-grass. Wet saline lands, C. K.; frequent. Aug. (S)

355. Spartina juncea Psh. (1781). Rush-leaf Cord-grass. Saline meadows, central Kansas, frequent. Aug. (AS)

356. Spartina gracilis Trin. Inland Cord-grass. Saline meadows, S W. K.; occasional. Aug. (AS)

357. Chloris verticillata Nutt. Prairie Windmill-grass. Low damp to dry saline prairies, middle and southwestern Kansas; common. May. (ASU)

358. Chloris elegans H. B. K. White Windmill-grass. To be looked for in dry alkaline prairie soils, extreme S. W. K. June. (A)

359. Gymnopogon ambiguus B. S. P. (Britton, Sterns and Poggenburg). (*G. racemosa* Beauv.) Naked-beard-grass. Dry sandy soil, Chautauqua county; not common. August. (ASU)

360. Schedonnardus paniculatus Trelease. (*Lepturus* Nutt.) Tumble-grass. Common in dry fields anywhere. Aug. (ASU) Heaps up high against hedges, fences, and other obstructions in the fall.

361. Bouteloua hirsuta Lagasca. Hairy Mesquit; Black Grama. Dry sandy loam, occasional in E. K.; frequent in west. July. (ASU)

362. Bouteloua gracillis Lag. (*B. oligostachya* Torr.) Blue Grama; Dainty Mesquit. Dry prairies of S. W. K., in sheltered situations. July. (ASU) Similar to *B. curtipendula*, but smaller, finer, and more delicate.

363. Bouteloua curtipendula Torr. (*B. racemosa* Lag.) Side-oats Grama; Tall Mesquit. Damp grounds, general; frequent or common. July. (ASU)

364. Beckmannia erucæformis Host. Slough-grass. Cheyenne and Sherman counties; frequent. July. (ASU)

365. Eleusine indica Gaertner. Large Crab-grass; Crowfoot-grass. Fields and cities, E. K.; becoming very common; likely to become a pest. June. Introduced.

366. Leptochloa mucronata Kth. Northern Slender-grass. Dry or moist soil, N. E. and C. K.; not common. July. (ASU)

367. Leptochloa filiformis (Lam.) Beauv. Sharp-scaled Slender-grass. Fields and sandy river bottoms, E. K.; rare.

368 Buchloe dactyloides Eng. Buffalo-grass. Dry prairies, W. K.; once common and universal; now entirely wanting in the eastern part of the state, and rapidly disappearing everywhere by being crowded out by

grasses that never could endure the constant trampling by buffalo, the annual fires, and the oft-recurring and continued drouths. June. (ASU) The provision possessed by this grass for withstanding long-continued drouth is one of the remarkable features told of these plants of the semiarid region. It has been recorded (see Transactions Kan. Acad. Sci., vol. vii, 1879–'80, page 53) that the roots of this lowly little buffalo-grass, seldom over four inches high, on the high mesas and prairie lands near the ninety-ninth meridian, sends its roots down fully fifteen feet into the dry, solid earth, and, while not on the highlands reaching the stratum of perpetual moisture, yet was able to reach a stratum of sufficient moisture—a stratum seldom affected by summer heat.

Tribe *i*. *Festuceæ.* Meadow-grass Tribe. Inflorescence paniculate or racemose, the panicles open or dense and spikelike; spikelets pedicellate, two- to many-flowered, usually perfect; flowering glumes longer than the empty glumes, awnless, or with one to several short, straight awns either terminal or borne just below the apex.

369. Pappophorum apertum Munro. Brush-grass. Dry plains, Meade to Morton county (Kellerman). Aug. (A)

370. Gynerium argenteum Nees. Pampas-grass. A splendid grass, occasionally in cultivation for winter boquets.

371. Arundo donax L. Giant Reed-grass. Tall, striking grasses, occasionally cultivated in water, both with and without variegated foliage.

372. Phragmites communis Trin. Reed. Swampy spots along streams, general; rare. Aug. (ASU)

373. Munroa squarrosa Torr. Stiff Thistle-grass. Dry soils, W. K.; a harsh, prickly annual grass, occasional on broken prairies. Aug. (ASU)

374. Triodia flava (L.) (*Poa flava* L.; *Triodia cuprea* Jacq.; *Tricuspis quinquefida* Beauv.; *Sieglingia seslerioides* Scribn.; *Tridens flavus* Hitchc.) Tall Purpletop. Damp, sandy fields, E. to C. K.; frequent. July–Sept. (ASU) This handsome grass has had to bear the burden of too many doctors officiating at its christening, some of whom came uninvited. Only the principal ones are named here.

375. Triodia stricta Vasey. (*Windsoria* Nutt.) Spicate Purpletop. Moist soil, Cherokee and Labette counties; occasional. July. (A)

376. Triodia acuminata Vasey. (*Tricuspis* Munro.) White Tuft-grass. Dry soils, W. K.; occasional. June. (S)

377. Triodia elongata Scribn. (*Uralepis* Buckl.) Wiry Purpletop. To be looked for on the dry plains of S. W. K.; it approaches quite close in Colorado and northern Texas. June–Aug.

378. Triodia pilosa (Buckl.) (*Uralepis* Buckl.) Hairy Purpletop. Dry soil, S. W. K.; occasional. Summer. (S)

379. Triodia albescens Vasey. (*Rhombolytrum* Nash). Whitish Purpletop. Reported from southwest Kansas.

380. Triodia purpurea (Walt.) (*Triplasis* Chapm.) Purpletop (Sandgrass). Sandy river bottoms and damp sands, E. and S. K.; not common. Aug. (ASU)

381. Redfieldia flexuosa Vasey. Blowout-grass. Plains and sandhills, especially in blow-outs, Finney to Morton counties; frequent. Aug. (ASU)

382. Diplachne fascicularis Beauv. Salt-meadow Feather-grass. Brackish marshes, scattered throughout the middle part of the state. Aug. (S)

383. Diplachne acuminata Nash. Sharp-scaled Feather-grass. Wet or moist soil; general; rare. Aug.

384. Diplachne imbricata Scribn. Shingled Feather-grass. To be looked for in S. W. K.; is found not far away in S. E. Colorado and Texas Panhandle.

385. (*Diplachne rigida* Vasey=*Eragrostis sessilispica* Buckl., *q. v.*)

386. Eragrostis capillaris Nees. Soft Lace-grass. Dry places, E. K.; not common. Aug. (ASU)

387. Eragrostis frankii Steud. Short-stalked Meadow-grass. Moist, sandy ground, N. E. K.; not common. Sept. (ASU)

388 Eragrostis pilosa Beauv. Tufted Meadow-grass. Fields and waste places, E. K.; not common. Introduced from the east.

390. Eragrostis purshii Schrader. Southern Meadow-grass. Dry places, E. K.; common. Aug. (ASU)

391. Eragrostis poæoides Beauv. (*E. minor* Host.) Low Meadow-grass; Small Love-grass. Waste sandy places, general; common. Aug. (ASU)

392. Eragrostis major Host. Stink-grass; Mule-candy; Great Love-grass. Waste sandy and cultivated lands, general; common. Aug. (ASU)

393. Eragrostis sessilispica Buckley. (*Diplachne rigida* Vasey.) Stiff Meadow-grass. Prairies, S. W. K.; occasional. Aug. (ASU) Spikelets appressed.

394. Eragrostis curtipedicellata Buckl. Short-pediceled Eragrostis. Prairies, Clark county west and north to Hamilton; occasional. Aug. (ASU)

395. Eragrostis pectinacea Steud. Purple Meadow-grass. Dry soil, E. and C. K.; common. Aug. (ASU)

396. Eragrostis trichodes Nash. Hair-like Love-grass. Dry sands, C. K., from Washington county to Barber; common. Aug. (ASU)

397. Eragrostis secundiflora Presl. (*E. oxylepis* Torr.) Purple Love-grass; Cluster-top Meadow-grass. Dry soil, S. W. K.; frequent. Aug. (S)

398. Eragrostis hypnoides B. S. P. (*E. reptans* Nees.) Creeping Low-grass. Sandy or gravelly shores, E. K.; common. Aug. (ASU)

399. Eragrostis capitata Nash. Big-head Low-grass. Wet sands in river beds, E. K.; frequent, though not common. July. (S) Lives like *E. hypnoides*; looks a little like *E. secundiflora*.

400. Melica mutica Walt. Honey-grass; Narrow Melic-grass. Open, rocky woods, N. E. K.; occasional. June.

401. Melica nitens Nutt. Tall Melic-grass. Dry, rocky woods and thickets, E. K.; 8–12 dm. high; not common. May. (AS)

402. Melica porteri Scribn. Small Melic-grass. Prairies, S. W. K.; 4–7 dm. high; rare. May. (AS)

403. Diarrhena diandra Wood. Twin-grass. Rich woods and shaded banks, E. K.; frequent. August. (ASU)

404. Distichlis spicata Greene. (*Uniola* L.) Alkali-grass; Salt-marsh Spike-grass. Dry or damp saline or alkaline meadows, N., C., S., and S. W. Kansas; very common. June. (ASU) Stolons from this grass root freely on fresh moist alkaline earth, where it can root at every point; on such occasions they may become thirty feet in length, and are occasionally exhibited at county fairs, as at Hutchinson.

405. Uniola latifolia Mx. Broad-leaf Spike-grass. Shaded, high earthy creek banks and rocky woods, E. K.; frequent. August. (ASU)

406. Briza media L. Quaking-grass. Occasional, in gardens.

407. Briza maxima L. Large Quaking-grass. Cultivated for its beauty.

408. Dactylis glomerata L. Orchard-grass. Introduced for good grass crops; escapes and grows naturally in rather moist soils.

409. Cynosurus cristatus L. Dogtail-grass. Street parks of the cities of E. K., and other waste places; introduced as adulteration in seeds of other grasses; rare. June.

410. Poa annua L. Annual Bluegrass; Low Spear-grass. Waste places and cultivated fields, E. K.; traveling westward. May. (ASU)

411. Poa compressa L. Flat-stem Bluegrass. Damp places on prairies and in fields, nearly all over Kansas; apparently native, having been here before ettlement; yet not common. June. (ASU) Makes a very compact sod; foliage deep blue-green; lives in spots too hot for Kentucky bluegrass.

412. Poa triflora Gilibert. (*P. serotina* Ehrh.) Fowl-meadow Bluegrass. Wet meadows, eastern two-thirds of the state; common. July. (ASU)

(For *Poa flava* L. see *Triodia flava*, ante, No. 374.)

413. Poa pratensis L. Bluegrass; Kentucky Bluegrass. On rich limy soils where slightly shaded during the hottest days of summer. May–June. Introduced, but not yet thoroughly naturalized, except perhaps in shade of hills, tall trees, and buildings. Should be but sparingly mowed in heat of summer. Too close mowing of lawns during the drier weeks of July and August exposes the roots of this grass to the hot sunshine and either kills it outright or so weakens it that the crab-grasses and pigeon-grasses choke it to death later.

414. Poa trivialis L. Rough Bluegrass. Meadows and waste places, Brown and other counties of N. E. K.; not naturalized. June.

415. Poa sylvestris Gray. Sylvan Spear-grass. Wooded meadows, Douglas county eastward; not common. June. (SU)

416. Poa autumnalis Muhl. Spring Spear-grass. Woods, extreme eastern Kansas; not common. March–April. Wonder if identification of this grass is correct?

417. Poa alsodes Gray. Grove Spear-grass. Thickets along streams, E. K.; frequent. May. (ASU)

418. Poa wolfii Scribn. Silky Bluegrass. Dry soils, E. K.; occasional. May. (A)

419. Poa arachnifera Torr. Texas Bluegrass. Cultivated occasionally for pasture in S. W. K.; with its strong perennial rootstocks, well adapted to hot dry lands of summer, it makes a more reliable pasture or lawn than our Kentucky bluegrass, *P. pratensis*. May. (S)

420. Poa arida Vasey. (Heretofore listed as *P. andina* Nutt. by error.) Prairie Spear-grass. Bottom lands, Dickinson county, northward and westward; not common. July. (AS)

421. Poa buckleyana Nash. Bench-land Spear-grass. Dry soil, Cheyenne county; not common. July.

422. Glyceria canadensis Trin. Manna-grass. Marshes, E. K.; not common. July. (ASU)

423. Glyceria nervata Trin. Ribbed Manna-grass. Wet places, E. K.; common. June. (ASU)

424. Glyceria Americana (Torr.) Great Manna-grass. Wet lands, E. K.; frequent. June. (ASU)

425. Glyceria fluitans R. Br. Floating Manna-grass. Water or wet places, E. K.; occasional. July. (ASU)

426. Puccinellia distans Parlatore. Spreading Goose-grass. Salt meadows, C. K.; occasional. July.

427. Puccinellia airoides Wats. & Coult. Slender Goose-grass. Saline soil, C. K.; occasional. July. (S)

428. Festuca octoflora Walt. (*F. tenella* Pursh.) Slender Fescue-grass. Dry sandy and sterile soil, western part of the state; frequent. June. (ASU)

429. Festuca ovina L. Sheep Fescue. Limy soils in fields and waste places, E. K.; infrequent. June. (ASU)

430. Festuca duriuscula L. Hard Fescue. Waste places, E. K.; rather frequent. June. (ASU)

431. Festuca pratensis Hudson. Meadow Fescue; "Randall Grass." Heavy clay and gumbo soils, E. K.; raised as a crop. It is on record that the territory from Johnson west to Butler and from Marshall south to Wilson county raises 75 per cent of all the fescue-grass seed and hay in the United States.

432. Festuca elatior L. Tall Fescue. Raised in the same territory and is a more profitable crop always, as the grass is said to be rust-free.

433. Festuca shortii Kth. Woodland Fescue. Thickets, N. E. K.; frequent. July.

434. Festuca nutans Willd. Nodding Fescue. Rocky woods, N. E. K.; not common. June. (AS)

435. Bromus inermis Leyss. Smooth Brome-grass; Hungarian Brome. Introduced first on government farm at Garden City and farms generally over the state; does best in eastern part. Not yet a pest and may not become so.

436. Bramus secalinus L. Chess. Escapes from wheat fields for a year or so; neither common nor troublesome. June.

437. Bromus ciliatus L. Fringed Brome-grass; Wood Chess. Woods and thickets, E. K.; as far west as Great Bend and Smith Center. July. (ASU)

438. Bromus rubens L. Reddish Brome-grass. Introduced into America from Mediterranean coast, and reported by Professor Beal as being found in Kansas.

439. Bromus purgans L. Cathartic Chess. Thickets, E. K.; frequent. July. (S)

440. Bromus incanus Hitchc. Hoary Chess. Wooded hills, E. K.; rare.

441. Bromus porteri Nash. Silky Chess. Norton county, north and west; not common. July. (S)

442. Bromus hordeaceus L. Soft Chess. Waste places, E. K., not often seen. July.

443. Bromus racemosus L. Upright Chess. Waste places, E. K.; introduced. June.

444. Bromus japonicus Thunberg. Japanese Chess. Introduced in fescue-grass seed and has become established along hedge rows and in fence corners, etc.

Tribe *k*. *Hordeeæ*. Rye-grass Tribe. Inflorescence in an equilateral terminal spike; spikelets several-flowered, dorsally compressed, uppermost imperfect, sessile and articulating alternately on opposite sides of a flat articulated zigzag rachis.

445. Lolium perenne L. Smooth Darnel; Perennial Ray-grass. Street parks in cities and other waste places; frequent. July.

446. Lolium temulentum L. Bearded Darnel; Poison Ray-grass. Waste places in fields, E. K.; reported from several places, though quite rare.

447. Agropyron repens Beauv. (*Triticum* L.) Creeping Wheat-grass; Quack-grass. Waste places, E. K.; occasional. July. Introduced from Europe.

448. Agropyron pseudorepens Scribn. & Sm. Rough Wheat-grass; Couch-grass. Waste places in dry fields, general, though commoner in W. K. July. (ASU)

449. Agropyron occidentale Scribn. (*A. glaucum occidentale* Vas. & Scribn.) Colorado Blue-joint; Western wheat-grass. Broken ground on prairies, hedgerows, and waste places in fields; generally over the state, though more frequent westward; not common eastward. July. (ASU)

450. Agropyron tenerum Vasey. Slender Wheat-grass. Dry prairies, W. K.; frequent. July. (ASU)

451. Agropyron caninum R. & S. (*Triticum* L.) Bearded Wheat-grass. In waste lands, N. E. K.; rare. July. (A)

452. Triticum sativum Lam. Wheat, including many subspecies, races and varieties, such as *T. vulgare* Vill., covering the Linnæan species *T. æstivum*, Spring, and *T. hybernum*, Winter Wheat, both smooth and bearded; *T. compactum*, "Dwarf" and "Hedgehog" Wheat; *T. turgidum* L., Soft English Wheat; and *T. durum* Desf., Flint Wheat. Along railroads, old wheat fields, etc.; seldom self-sows a second time from scattered grain.

453. Triticum dicoccum Schrank. Emmer; Rice-spelt. Numerous varieties, always awned. Sparingly grown as a crop at several points in C. and W. K.

454. Triticum spelta L. Spelt. Varieties, both awned and awnless, raised to some extent as a crop in Kansas.

455. Secale cereale L. Rye. Frequently self-sows a second time; yet does not become naturalized.

456. Hordeum nodosum L. Meadow Barley. Meadows and waste places, general. Quite common. June. (ASU)

457. Hordeum pusillum Nutt. Little Barley. Dry soil, general; common. June. (ASU)

458. Hordeum jubatum L. Squirreltail-grass. Dry soil, general; common in well-drained spots. July. (ASU)

459. Hordeum sativum Jessen. Barley, in several subspecies and varieties. Escapes from cultivation very rarely.

460. Elymus striatus Willd. Slender Wild-rye. Woods and banks, quite general; frequent in E. K.; occasional in W. K. June. (ASU)

461. Elymus virginicus L. Wild-rye. Moist soil along streams, general; common. July. (ASU)

462. Elymus submuticus (Hook.) Beardless Wild-rye. Shades, near water, E. and N. K.; frequent. July. (S)

463. Elymus canadensis L. Nodding Wild-rye; Canada Lyme-grass. Sandy soil, low ground, general; very common. July. (ASU)

464. Elymus brachystachys Scribn. & Ball. Short-spike Wild-rye. Moist open or shaded ground, N. and N. W. K.; frequent. Aug. (S)

465. Elymus robustus Scribn. & Sm. Stout Wild-rye. Low grounds, E. K.; frequent. Aug.

466. Elymus glaucus Buckl. Smooth Wild-rye. Moist soil, S. and S. W. Kansas; occasional. July. (S)

467. Elymus condensatus Presl. Rough Lyme-grass. Saline soils, C. and S. K.; frequent. July.

468. Sitanion elymoides Raf. Wild-rye Bristle-grass. Dry soil, W. K.; common. July. (ASU)

469. Sitanion longifolium J. G. Sm. Long-leaf Bristle-grass. Dry soils, C. to N. W. Kansas; occasional. July. (S)

470. Hystrix patula Moench. Bottle-brush-grass; Hedgehog-grass. Dry rocky woods, E. K.; frequent. June. (ASU)

Family 34. BAMBUSACEÆ. Bamboo Family.

Tree-like perennial grasses with woody culms. Foliage leaves rather broad, parallel-nerved, usually articulating with the sheath, with or without a petiole, often deciduous. Inflorescence paniculate or racemose, terminal or axillary, usually arranged in tufts or partial whorls at the nodes of the branches of the panicle. Spikelets three- to ten-flowered, rarely fewer; empty scales of involucel two to several, unequal, shorter than the glumes; flowering glumes many-nerved, awnless; paleæ two- to many-nerved; lodicules 3, remarkably large; stamens 3–6; styles 2-3, often grown together at the base. Fruit a free caryopsis, a caryopsis with a delicate pericarp, a nut with a thick free pericarp, or a berry.

471. Arundinaria tecta Muhl. Small Cane. Some small attempts are being made to introduce it into the swamps of southeastern Kansas, even near Topeka.

472. Bambusa arundinacea Retz. Cane Bamboo. Occasional in parks, etc.

ORDER XVII. CYPERALES. THE SEDGES.

Inflorescence clustered at the summit, in umbelloid, corymbose, cymose, or spicate panicles. Involucre of one to several large leaf-like bracts; involucels none, or of one to several minute scales. Flowers in two-edged, glumaceous, one- to many-flowered spikelets, one flower, rarely two, in the axil of each scale. Perianth hypogynous, of one to twelve or more, usually six, chaffy segments or bristles, or none. Andrœcium of one to three stamens, usually three, with anthers bisporangiate. Gynœcium of a single carpel; style one- two- or three-cleft, rarely two-toothed or entire. Ovulary unilocular, sessile or stipitate. Ovule one, erect, anatropous; fruit an achene, lenticular or plano-convex, trigonous when style is three-cleft; embryo minute; albumen floury.

Grass-like or rush-like annuals or perennial herbs, usually growing in or near water. Stems (culms) jointless, slender, solid, rarely hollow, normally triangular or even triquetrous, sometimes quadrangular, flattened, or terete.

Laminodia three-ranked; blades narrow, strongly carinate, and folded over an angle of the stem; sheath at base closed, edges united, enfolding the stem.

Family 35. CYPERACEÆ. Sedge Family.

Flowers all perfect; rarely with stamens or pistil undeveloped; spikelets few- to many-flowered; involucel scales one or more. Perianth consists of one to six hypogynous scales or bristles or hairs, or is entirely wanting.

473. Cyperus flavescens L. Yellow Sedge. Low ground, N. E. K.; 1–3 dm. high; not common. August. (A)

474. Cyperus diandrus Torr. Low Sedge. Marshy places, general; 1–3 dm. high; common. August. (AS)

475. Cyperus inflexus Muhl. Elm-odored Sedge. Sandy alkaline prairies, general; about 1 dm. high; frequent to common in spots. June. (ASU)

476. Cyperus pseudovegetus Steudel. Marsh Sedge. Marshes, S. E. K.; 3–12 dm. high; not common. July. (AS)

477. Cyperus acuminatus Torrey & Hooker. Pointed Cyperus. Moist soil, general; 1–4 dm. high; common. July. (ASU)

478. Cyperus rotundus L. Nut-grass; Nut-sedge. Sandy fields, E. K.; 2–6 dm. high; not common. July. (ASU)

479. Cyperus hallii Britton. Big-top Nut-sedge. Fields, S. K.; 5–9 dm.; frequent. July. (AS)

480. Cyperus esculentus L. Yellow Nut-sedge; Chufa. Sandy prairies and fields, general; 3–8 dm. tall; common. Aug. (ASU)

481. Cyperus erythrorhizos Muhlenberg. Red-root Umbrella-sedge. Wet soil, E. K.; 2–6 dm. high; frequent. Aug. (ASU)

482. Cyperus speciosus Vahl. Showy Umbrella-sedge. Marshes, tufted, 1–4 dm. tall; common. July. (ASU)

483. Cyperus ferruginescens Boeckeler. Rusty Umbrella-sedge. Marshes, S. E. K.; frequent. Aug. (S)

484. Cyperus ferax Richard. Coarse Umbrella-sedge. Wet soil, E. to C. K.; 3–8 dm. high; common. July. (ASU)

485. Cyperus strigosus L. Straw-colored Umbrella-grass. Moist meadows, general; 3–8 dm.; occasional. July. (ASU)

486. Cyperus ovularis Torr. Pompon Umbrella-grass. Dry hills, N. E. K.; 2–4 dm.; common. July. (AS)

487. Cyperus filiculmis Vahl. Slender Umbrella-grass. Dry hills and fields, general; 5–12 dm.; common. June. (AS)

488. Cyperus houghtoni Torr. Pale-brown Umbrella-grass. Dry sandy soil, C. K.; 3–6 dm.; common. July. (AS)

489. Cyperus echinatus Wood. Hedgehog Umbrella-grass. Rich sandy soil, E. K.; 2–5 dm.; common. July. (ASU)

490. Kyllinga pumila Mx. Low Bur-sedge. Moist soil, E. K.; 1–3 dm.; rare. Aug. (ASU)

491. Dulichium arundinaceum Britt. (*D. spathaceum* Pers.) Reed-sedge. Wet places, E. K.; 3–10 dm.; occasional. August. (AS)

492. Eleocharis quadrangulata Roemer & Schultes. Square Spike-rush. Shallow water, Cherokee county, 6–12 dm. tall; not common. July. (ASU)

493. Eleocharis atropurpurea Kunth. Little Purple Wire-sedge. Wet sands, C. and S. K.; less than 1 dm. high; frequent in certain spots. August. (S)

494. Eleocharis capitata R. Br. Capitate Wire-sedge. Moist sandy soil, S. and E K.; 1–2 dm. high; not common. July. (S)

495. Eleocharis obtusa Schultes. Ovoid Wire-sedge. Wet soil, E. K.; 1–5 dm.; common. July. (S)

496. Eleocharis engelmannii Steudel. Conical Wire-sedge. Wet soil, S. E. K.; 1–5 dm. high; common. August. (S)

497. Eleocharis palustris R. & S. Pipe-organ Spike-rush. Marshes and wet soils, general; 4–12 dm. high; common. August. (S)

498. Eleocharis acicularis R. and S. Needle Wire-grass. Wet soil, E. K.; ½–2 dm.; common. May. (S)

499. Eleocharis tenuis Schult. Slender Wire-grass. Wet soil, E. K.; 2–4 dm. high; frequent. May. (S)

500. Eleocharis acuminata Nees. (*E. compressa* Sullivant.) Flattish Wire-grass. Wet soil, N. K.; 2–5 dm. high; frequent. June. (S)

501. Eleocharis intermedia Schult. Matted Wire-grass. Marshes, E. to C. K.; 1–4 dm. long; common. July. (S)

502. Eleocharis rostellata Torr. Beaked Spike-rush. Marshes and alkaline meadows, E. to C. K.; 4–12 dm.; common. August. (S)

503. Fimbristylis capillaris Gray. Hair-like Fringe-rush. Dry or moist soil, E. to C. K.; 1–3 dm. tall; common. July. (S)

504. Fimbristylis spadicea Vahl. Fringe-rush. Marshes and brackish shores, general; 3–7 dm. high; frequent. Aug. (S)

505. Fimbristylis castanea Vahl. Marsh Fringe-rush. Salt marshes and wet sands, general; 2–5 dm.; common. July. (S)

506. Fimbristylis vahlii Link, Bird-nest Fringe-rush. Moist sands, S. E. K.; less than 1 dm. high; not common Aug.

507. Scirpus nanus Sprengel. Dwarf Club-rush. Near salt springs and muddy spots in edge of salt marshes, C. K., N. to S.; ½ dm. or less; frequent. July. (S)

508. Scirpus hallii Gray. Black-seed Club-rush. Wet soil, Norton county; 1–3 dm. high; not common. · July. (S)

509. Scirpus americanus Persoon. (*S. pungens* Vahl.) Chair-maker Club-rush Fresh or brackish waters, general; 4–12 dm. high; common. June. (A S)

510. Scirpus olneyi Gray. Sharp-angle Bulrush. Salt marshes, C. K. and westward; 6–18 dm. high; not common. June. (S)

511. Scirpus validus Vahl. Great Bulrush. Water, up to two feet deep, general throughout the state; 8–24 dm. high; common. June. (ASU)

512. Scirpus interior Britt. Prairie Bulrush. Wet prairies, general; 3–5 dm. high; not common. June. (AS)

513. Scirpus robustus Pursh. Salt-marsh Bulrush. Salt marshes, C. K.; 6–13 dm. high; common. July. (ASU)

514. Scirpus fluviatilis Gray. River Bulrush. Shallow water along streams, pretty general over the state; 7–16 dm. high; common. June. (ASU) Prof. D. E. Lantz says the tubers of this plant constitute the principal winter food of the muskrat in many localities.

515. Scirpus pallidus Fernald. Pale-green Bulrush. Water, N. and E. K.; 6–12 dm ; common. June. (ASU)

516. Scirpus polyphyllus Vahl. Leafy Bulrush. Swamps, wet woods, and borders of still waters, E. K.; 4–11 dm. high; common. July. (ASU)

517. Eriophorum lineatus Bentham & Hooker. Reddish Wool-rush. Swamps and wet meadows, E. K.; 3–10 dm.; common. June. (AS)

518. Eriophorum cyperinus L. Wool-rush. Swamps and wet meadows, E. K.; 6–18 dm. high; not common. Aug.

519. Eriophorum virginicum L. Virginia Wool-rush; "Cotton-grass." Bogs, Finney county; 5-dm.; abundant. June. (S)

520. Fuirena simplex Vahl. Western Bog-sedge. Moist soil, C. K.; 1–4 dm. high; common. June. (S)

521. Hemicarpha micrantha Pax. (*H. subsquarrosa* Nees.) Single-chaff Bog-sedge. Moist sandy soil, N. E. K.; 1 dm. or less; rare. July. (S)

522. Hemicarpha aristulata (Cov.) Beardy Bog-sedge. Moist soil, E. K.; about 1 dm. or less; frequent. July. (S)

523. Hemicarpha drummondi Nees. Compact Bog-sedge. Damp sand, S. E. K.; 0.5 to 1.3 dm. high; not common. July. (A)

524. Rynchospora corniculata Gray. Horned Beak-rush; Beak-sedge. Swampy spots along rivers, general; 10–20 dm. tall; common. July. (ASU)

525. Rynchospora macrostachya Torr. Great Beak-rush. Swampy spots along Kansas and Arkansas rivers to southern Kansas; 10–25 dm. high; not so common. July. (ASU)

526. Rynchospora alba Vahl. White Beak-rush. Permanently wet grounds, E. K.; 2–4 dm. high; not common. July. (ASU)

527. Rynchospora glomerata Vahl. Clustered Beak-rush. Moist soils, E. K.; 3–10 dm. high; frequent. July. (ASU)

528. Rynchospora cymosa Elliott. Grass-like Beak-rush. Moist soils, E. K.; 3–5 dm. high; not common. June.

529. Cladium mariscoides Torr. Twig-rush. Marshes, fresh or brackish, E. K.; 4–10 dm.; common. July. (ASU)

Family 36. CARICACEÆ. Carex Family.

Flowers unisexual, monœcious or diœcious. Perianth of staminate flowers none; stamens three, guarded by a small dorsal bract in lieu of a perianth; filaments slender; anthers bisporangiate. Perianth of carpellate flowers of two glumaceous bracts almost ventrally placed, closely united to their summits, ventrally and remotely united to their summits dorsally, thus forming a trigonous utricle called a *perigynium*, within which the seed is perfected; dorsal bract missing. Inner whorl of perianth consists merely of a few bristles or hairs, or is entirely wanting.

530. Scleria triglomerata Michaux. Tall Nut-rush. Sandy meadows and thickets, S. E. K.; 4–9 dm.; frequent. June. (AS)

531. Scleria pauciflora Muhl. Papillose Nut-rush. Dry sandy soils, S. E. K.; 2–5 dm.; frequent. June. (AS)

532. Scleria kansana Fernald. Kansas Nut-rush. Sandy soil, Cherokee county; achenes tuberculated. (A)

533. Carex lupulina Muhl. Hop-sedge. Ditches, Wyandotte and Labette counties; 4–9 dm.; occasional. June. (A)

534. Carex gigantea Rudge. Great Hop-sedge. Wet meadows, E. K., local; 5–12 dm. July.

535. Carex utriculata Boott. Bottle-sedge. Marshes, E. K.; 6–10 dm. June. (S)

536. Carex monile Tuckerman. Necklace Carex. Wet meadows, E. K.; 5–10 dm. June. (S)

537. Carex lurida Wahlenberg. Dirty-brown Carex. Wet meadows, general; 5-10 dm. June. (S)

538. Carex hystricina Muhl. Porcupine Carex. Low meadows and swales, N. and N. E. K.; 3-7 dm. June. (AS)

539. Carex squarrosa L. Squarrose Carex. Swamps, E. K.; 6-9 dm. June. (AS)

540. Carex frankii Kunth. (*C. stenolepis* Torr.) Narrow-scale Carex. Wet meadows, E. K.; 3-8 dm. June. (AS)

541. Carex trichocarpa Muhl. Hairy-fruit Carex. Wet meadows, N. E. K.; 9-12 dm. June. (AS) Includes var. *Deweyi.*

542. Carex aristata R. Br. Awned Carex. Marshes, E. K.; 6-12 dm. June. (S)

543. Carex riparia Curtis. River-bank Carex. Wet shores, E. K.; 6-11 dm. May. (AS)

544. Carex shortiana Dewey. Turk-fez Carex. Wet meadows, E. K.; 4-9 dm. May. (AS)

545. Carex lanuginosa Mx. Wooly Carex. Wet meadows, general; 6-10 dm. June. (A)

546. Carex kansana (Britt.) Kansas Wooly Carex. Similar, but leaves very narrow and rough. Reported from Kansas by Doctor Britton.

547. Carex stricta Lamarck. Tussock Carex. Swamps, general; 5-12 dm. July. (AS)

548. Carex nebraskensis Dewey. Nebraska Carex. Sandy soil, N. W. K.; 4-8 dm. May. (S)

549. Carex davisii Schweinitz & Torrey. Long-awned Carex. Moist thickets, lower Kaw valley; 5-12 dm. May. (A)

550. Carex castanea Wahl. Chestnut Carex. Thickets, E. K.; 4-9 dm.; occasional. June. (S)

551. Carex globosa (Bailey). Globose Carex. Low woods and meadows, S. E. and S. K.; occasional. May. (S)

352. Carex grisea Wahl. Gray Carex. Woods and thickets, E. K.; 3-8 dm. May. (AS)

553. Carex granularis Muhl. Meadow Carex. Moist meadows, E. K.; 2-8 dm.; occasional. May. (AS)

554. Carex oligocarpa Schkuhr. Small-top Carex. Dry woods, E. K.; 2-6 dm. May. (AS)

555. Carex tetanica Schk. Lock-jaw Carex. Wet meadows and woods, S. E. K.; 3-5 dm. May. (AS)

556. Carex meadii Dewey. Big Lock-jaw Carex. Swamps and wet meadows, E. K.; 3-7 dm. May. (AS)

557. Carex laxiflora Lam. Loose-flowered Carex. Meadows and thickets, E. K., or generally over the state; 2-6 dm. May. (AS)

558. Carex platyphylla Carey. Broad-leaf Carex. Rich woods, E. K.; 2-4 dm. May. (A)

559. Carex setifolia Britt. Bristly-leaf Carex. Dry sandy soil, on limestone rocks, W. K.; 1-4 dm. May. (AS)

560. Carex pennsylvanica Lam. Pennsylvania Carex. Dry soil, N. and W. K.; 2-4 dm. May. (AS)

561. Carex varia Muhl. Tufted Carex. Dry soil, W. K.; 2-6 dm. April. (A)

562. Carex umbellata Schk. Umbeled Carex. Dry soil, S. E. and S. K.; 1–3 dm. April. (S)

563. Carex filifolia Nutt. Thread-leaf Carex. Dry soil, W. K.; 1–3 dm. May. (S)

564. Carex stenophylla Wahl. Rolled-leaf Carex. Dry soil, N. W. K.; 1–2 dm. June. (AS)

565. Carex douglasii Boott. Light-green Carex. Dry soil, N. W. K.; 1–3 dm. June. (S)

566. Carex conjuncta Boott. Soft Fox-sedge. Moist meadows, E. K.; 3–10 dm. (A)

567. Carex stipata Muhl. Awl-fruit Fox-sedge. Wet meadows, E. K.; 3–10 dm. May. (A)

568. Carex crus-corvi Shuttleworth. Ravenfoot Fox-sedge. Swamps, E. K.; 6–12 dm. May. (AS)

569. Carex marcida Boott. Clustered Fox-sedge. Dry, chalky soil, N. W. K.; 3–6 dm. June. (S)

570. Carex diandra Schrank. Small-top Fox-sedge. Wet meadows, N. K.; 4–7 dm.; rare, apparently. May. (S)

571. Carex gravida Bailey. Heavy-top Fox-sedge. Thickets, E. K.; 5–10 dm.; occasional. May. (S)

572. Carex vulpinoidea Mx. Fox-sedge Carex. Wet meadows, general; 3–6 dm. June. (AS)

573. Carex cephalophora Muhl. Oval-head Carex. Dry fields and hills, S. E. K.; 3–6 dm. May. (A)

574. Carex leavenworthii Dewey. Orbicular Carex. Meadows, S. E. K., north and west to Topeka; 2–5 dm.; frequent. May. (S)

575. Carex muhlenbergii Schk. Ovoid Carex. Dry fields and sterile hills, general; 3–7 dm. May. (AS)

576. Carex interior Bailey. Inland Carex. Damp or wet soils, E. K.; 2–5 dm.; not common. June. (AS)

577. Carex xerantica Bailey. Silver-scale Carex. Open prairies, N. K.; 3–6 dm.; not common. July. (A)

578. Carex tribuloides Wahl. Blunt Broom-sedge. Meadows, E. K., west to Great Bend; 3–10 dm. July. (S)

579. Carex scoparia Schk. Pointed Broom-sedge. Moist soil, E. K., west to Council Grove; 2–6 dm.; not common. July. (S)

580. Carex straminea Willd. Straw-sedge. Dry fields, E. K.; 3–7 dm.; not common. June. (AS)

581. Carex mirabilis Dewey. Great Straw-sedge. Dry banks and rich copses, E. K.; 6–15 dm.; frequent in spots. (S)

582. Carex festucacea Willd. Broad-wing Straw-sedge. Dry or moist soil, 4–12 dm.; general; common. May. (AS)

583. Carex bicknellii Britt. Smooth-wing Straw-sedge. Dry soil, E. K.; 6–10 dm.; rather common. June. (AS)

Order XVIII. JUNCALES. The Rushes.

Inflorescence compound or decompound, in umbelloid or corymbose, often one-sided, panicles, in the axil of a leafy bract. Perianth hexaphyllous, segments small, chaffy, or partly foliaceous; flowers are liliaceous in structure, glumaceous in aspect and texture.

Family 37. JUNCACEÆ. Rush Family.

Erect perennial, rarely annual, tufted, grass-like herbs, growing in water or wet places. Roots fibrous; stems jointless, terete, often hollow; though normally filled with spongy tissue, the large hollow places filled with septa and carrying much air. Leaves invariably without laminæ, transformed into laminodia typically terete and cellular, occasionally merely channeled on the upper surface, often dorsally compressed, without carinæ; sheaths with edges free and lapping; ligule none; leaves rarely reduced to phyllodia. Flowers small, actinomorphous, hypogynous, persistent, with or without prophylla (bractlets). Stamens three or six, in one or two whorls; anthers bisporangiate, adnate, introrse, dehiscing by a slit. Style single, short; stigmas three, filiform. Pistil superior, tricarpous; ovulary trilocular, or unilocular by the placentæ, which are parietal, not reaching the axis. Ovules three to many, ascending, anatropous. Fruit a three-valved, loculicidal capsule. Seeds three to many, small, cylindrical, with caruncular appendages. Embryo minute at base of fleshy albumen.

584. Juncus effusus L. Rush. Swales along the Arkansas river, Barton to Sedgwick county, and elsewhere; 2–13 dm. high; common. May. (S).

585. Juncus bufonius L. Toad Rush. Damp open ground, E. K.; 2 dm. high, branching low; common. June. (S)

586. Juncus tenuis Willdenow. Door-yard Rush. Tufted, 2–6 dm. high; very common in most places where somewhat tramped by people. June. (S)

587. Juncus interior Wiegand. Prairie Rush. Prairies, general; 4–9 dm.; not common. June. (S)

588. Juncus dudleyi Wieg. Auricled Rush. Damp calcareous soil, N. E. K.; 3–10 dm.; not common. June.

589. Juncus littoralis (Engelm.) Salt-marsh Rush. Saline marshy shores, Washington county to Stafford, and southwest; 3–12 dm.; frequent. June. (S)

590. Juncus marginatus Rostkova. Grass-rush. Moist sandy grassy places, E. K.; 2–7 dm. high from branching rootstocks; common. July. (S)

591. Juncus aristulatus Michaux. Beardy Grass-rush. Wet sandy soil, S. E. K.; 4–10 dm.; occasional. July. (S)

592. Juncus setosus (Coville.) Bristly Grass-rush. Similar situations, S. E. K.; with bristly-tipped acuminate perianth-segments and smaller seeds. Not common. July.

593. Juncus torreyi Cov. Pompon Rush. Damp sandy soil, C. and S. K.; 4–10 dm.; frequent. July. (S)

594. Juncus brachycarpus Eng. Short-fruit rush. Damp soil, S. E. K.; occasional.

595. Juncus scirpoides Lamarck. Bulrush-like Rush. Wet sandy soil, S. E. K.; 4–9 dm.; common. July. (AS)

596. Juncus acuminatus Mx. Sharp-seed Rush. Water, S. E. K.; 3–7 dm.; heads numerous; not common. May.

597. Juncus robustus Cov. Stout Rush. Water, S. E. K.; 5–11 dm.; heads very numerous and small. Not common. June. (A)

598. Juncus diffusissimus Buckley. Diffuse Rush. Wet grounds, S. E. K.; 2–6 dm ; heads numerous and small; frequent. June. (S)

599. Luzula campestris DeCandolle. Wood-rush. Woodlands, S. E K.; 1-4 dm ; common. April. (S)

600. Luzula bulbosa (Wood). Bulbous Wood-rush. Woods, near streams, S. E. K.; 2–5 dm.; occasional. April. (S)

Subclass B. SPADICIFLORÆ. Jacks-in-Pulpit.

SPADIX-FLOWERED MONOCOTYLS.

Flowers crowded upon a fleshy spadix, or in a dense continuous or interrupted spike, or in an ovoid or globose head, often subtended by a foliaceous spathe, sometimes colored white or other than green. Perianth none, or what little there may be consisting of a few hairs or hyaline or chaffy scales free from the ovulary. Andrœcium normally of two to twelve stamens, in one or more whorls, three or fewer in each whorl, usually with very short filaments or none at all, and with bisporangiate anthers opening by pores or slits. Pollination anemophilous and hydrophilous. Gynœcium of numerous stipitate or sessile unilocular carpels, each ovulary with a single anatropous ovule.

ORDER XIX. ARALES. THE ARADS.

Inflorescence normally spadiceous and spathaceous. Flowers without a perianth, or perianth reduced to mere chaffy scales, but with the entire spadix protected by a spathe. Stamens two to ten, filaments short. Pistil tricarpellary, the ovulary in each carpel with two or more ovules.

Family 38. LEMNACEÆ. Duckweed Family.

Minute stemless and leafless floating herbs, reduced to mere thallus-like fronds, which multiply all summer by proliferous offsets from the edge or upper surface of the fronds. On approach of winter blossoming takes place, and hypnospermous seeds are formed, which sink to the bottom till warm weather next year; then they come to the surface, and multiply as before. Inflorescence reduced to three flowers, two of a single minute stamen having an anther with two to four sporanges each, the third an exceedingly simple carpel, the whole subtended by a minute scale-like spathe in a pit. Ovules two to several. Fruit a utricle containing a single seed with comparatively large endosperm. The smallest and simplest of flowering plants.

601. Wolffia columbiana Karsten. Columbian Frog-spit. Stagnant pools and shallow, permanent waters, E. K.; not common. Sept. Under the surface.

602. Wolffia punctata Grisebach. Dotted Frog-spit. Stagnant waters, E. K.; not common. Sept. (S) Floating on the surface.

603. Wolffia papulifera Thompson. Pimply Frog-spit. Still waters, Miami county (Mackenzie & Bush).

604. Lemna gibba L. Gibbous Duckweed. Ponds and slow streams, E. K.; frequent. Aug. (S)

605. Lemna minor L. Little Duckweed. Ponds and still waters, E. K.; occasional. Oct.

606. Lemna perpusilla Torr. Ovoid Duckweed. Ponds and lakes, E. and S. K.; common. Three-nerved. Sept. (S)

607. Lemna minima Philippi. Least Duckweed. Ponds, E. K.; not often seen, but sometimes in great abundance. Oct. (S)

608. Spirodela polyrrhiza Schleiden. Great Duckweed. Still waters, general; common, and at times very abundant. Oct. (ASU)

Family 39. Araceæ. Arum Family.

Plants arising from a large perennial corm, with very acrid sap caused by minute acicular crystals of calcium oxalate. Leaves with erect laterally compressed two-ranked laminodia with very deep carinæ and closely folded narrow wings, in *Acorus;* otherwise with petioles and broad laminæ of various forms, as ovate, simple or compound, peltate, cordate, auriculate, or hastate, all with netted venation and sheaths below the petioles, sometimes very short. Inflorescence of many minute naked six-parted or four-parted florets, closely crowded on a cylindrical spadix subtended by a conspicuous often highly colored spathe. Florets apparently perfect, in practice diœcious, as the stamens on one plant are suppressed, and on another the pistils, making the one practically carpellate and the other staminate. Fruit a berry. Seeds hypnospermous, with copious albumen and an axial embryo.

609. Acorus calamus L. Sweet-flag. Calamus. At a few places in eastern Kansas; but very little beyond where introduced. May. (ASU)

610. Arisæma triphyllum Torr. Jack-in-the-Pulpit. Indian Turnip. Rich soil in moist woods and thickets, E. K.; frequent. June. (ASU)

611. Arisæma dracontium Schott. Green-dragon, Dragon-root; Indian Turnip. Rich alluvial soils in woods and thickets, E. K.; common. May. (ASU)

612. Amorphophallus giganteus Blume. Giant Arum. From South Africa; occasional in gardens for the wonder of the plant.

613. Caladium esculentum L. (*Colocasia* Morandi). Caladium; Elephant-ear; frequent in gardens.

614. Calla æthiopica L. (type species, 1753). Calla. From Cape of Good Hope; frequent in house and garden culture. Later (1815) named *Richardia africana* by Kunth.

Order XX. PANDANALES. The Cattail Reeds.

Inflorescence in a compact spadix, or more or less interrupted spike, subtended by a fugacious bract, at the summit of a naked or leafy stem, the staminate flowers above the carpellate. Andrœcium of two to six stamens, surrounded by numerous bristles or scales. Gynœcium of a single carpel or of two united carpels; ovulary unilocular, one-ovuled, one-seeded.

Family 40. Typhaceæ. Reed-mace or Cattail Family.

Aquatic perennial herbs, from perennial horizontal rootstocks, and with tall appressed dorso-ventrally compressed laminodia, in two ranks, alternating, with faces toward the central stem and without a keel. Carpellate flowers very numerous, minute, closely crowded into a compact cylindrical spike at the summit of a naked, wand-like, solid stem, standing high out of water. Staminate flowers in a smaller spike above the carpellate (on the same stem) and early deciduous. Perianth of several delicate silky clavate hairs. Fruit nutlike, minute, ellipsoid or clavate, stipitate. Embryo cylindric, straight, in abundant farinaceous endosperm.

615. Typha latifolia L. Cattail (flag). General throughout the state; frequent in watery places. June. (ASU)

616. Typha angustifolia L. Narrow-leaf Cattail. Reno county, along the Ninnescah, and elsewhere in southern Kansas; rare. June. (ASU)

Family 41. SPARGANIACEÆ. Bur-reed Family.

Aquatic herbs, with linear, two-ranked laminodia, and with monœcious flowers in dense serial globose clusters (interrupted spadices), axillary to leaf-like spathes. Several upper heads staminate; lower ones carpellate. Ovulary unilocular or bilocular; ovule one. Fruit nutlike, ovoid, or spindle-shaped.

617. Sparganium eurycarpum Engelm. Broad-fruit Bur-reed. Scattered, in wet places, throughout the state. May. (ASU)

618. Sparganium androcladum Morong. Branching Bur-reed. Scattered, in wet places. June. (ASU)

Family 42. PANDANACEÆ. Screw-pine Family.

Greenhouse plants of foreign origin. Several species are raised; only the commonest one is here listed.

620. Pandanus elegans Du Petit Thouars. Elegant Pandanus; Screw-pine. Frequent in house culture.

ORDER XXb. PALMALES.

A very extensive order of ligneous arborescent monocotyls, comprising many species, genera, and even families of tropical trees and shrubs of widely different characteristics, some of them of comparatively easy greenhouse culture, such as (621) *Phœnix dactylifera* L., the date-palm, of the family (42b) *Phœnicaceæ;* (622) *Cocos weddelliana* H. Wendland, a cocoa-palm, and (623) *Areca lutescens* Bory, a betelnut-palm, and (624) *Kentia forsteriana* Muell., a feather-palm, all three of the family (42c) *Cocaceæ;* and (625) *Livistona humilis* R. Brown (*Latania borbonica* Hort.), Bourbon fan-palm, of the family (42d) *Sabalaceæ*, belong here. These are the best known; and some of them are often seen outside of conservatories.

ORDER XXI. NAIADALES. THE PONDWEEDS.

Inflorescence solitary or clustered in the leaf-axils, otherwise spirally arranged in a spike, or borne on a one-sided spadix, the spathe fugacious or disappearing early. Flowers perfect or unisexual, usually monœcious, the carpellate flowers often dimorphous. Perianth single, double, or none, glumaceous or hyaline, often imperfect. Andrœcium of one to four stamens, with very short filaments or none; anthers with one, two or four sporanges, and large strap-like or petaloid connectives. Gynœcium of one to several carpels, distinct or united; ovulary superior. Fruit nut-like or utricular.

Family 43. ZANNICHELLIACEÆ. Pondweed Family.

Perennial water-plants, with alternate or opposite leaves floating and submersed, and submerged laminodia, phyllodia, and stipules. Prolaminæ (blades) of floating leaves entire, of submersed leaves capillarily divided, both on the same plant or otherwise. Flowers in sessile or peduncled spikes (spadices), or in axillary clusters. Perianth very little; sometimes sepals four; but flowers usually enclosed in a fugacious hyaline spathe. Stamens one to four, filaments short; anthers extrorse, two to four sporangiate, the connectives broad, petal-like. Carpels two to ten, usually four, distinct, one-seeded. Fruits drupe-like, seed nut-like; embryo coiled; endosperm none, or very little.

626. Potamogeton natans L. Floating Pondweed. Ponds, E. K. and elsewhere; frequent. July. (ASU)

627. Potamogeton diversifolius Rafinesque. (*P. hybridus* Mx.) Bristly Pondweed. Still waters, Cherokee and Wyandotte counties; rare. June. (ASU)

628. Potamogeton spirillus Tuckerman. Spiral-seed Pondweed. Ponds and ditches, Shawnee and Riley counties; frequent. June. (AS)

629. Potamogeton amplifolius Tuck. Large-leaf Pondweed. Lakes and ponds, E. K.; not common. July. (U).

630. Potamogeton heterophyllus Schreber. Variable Pondweed. Still water, scattered; infrequent. July. (S)

631. Potamogeton lonchites Tuck. Long-leaf Pondweed. Slow streams, W. K., and some of the eastern counties; frequent. July. (ASU)

632. Potamogeton lucens L. Shining Pondweed. Comanche county (Hitchcock). Sept. (A)

633. Potamogeton obtusifolius Mertens & Koch. Blunt-leaf Pondweed. Clay county (Hitchcock). July. (A)

634. Potamogeton pusillus L. Small Pondweed. Ponds and slow streams, Ellis county, north and west; frequent to common. July. (ASU)

635. Potamogeton foliosus Raf. Leafy Pondweed. Streams in C. K., from Phillips and Jewell counties south to Pratt; frequent. Sept. (AS)

636. Potamogeton filiformis Pers. Thread-leaf Pondweed. Water in calcareous regions, Mitchell county, south and west. Aug. (AU)

637. Potamogeton pectinatus L. Fennel-leaf Pondweed. Brackish waters, northern and central Kansas; occasional. July. (AS)

638. Ruppia maritima L. Ditch-grass. Saline waters, Stafford, Rice, Barton, Saline, and other counties of C. K.; frequent. July. (S)

639. Ruppia occidentalis Wats. Western Ditch-grass. To be found in saline waters of N. W. K. July.

640. Zannichellia palustris L. Horned Pondweed. Permanent brackish waters, C. K.; not common. July. (AS)

Family 44. NAIADACEÆ. Water-nymph Family.

Submerged herbs, with fibrous roots and slender branching knotty stems. Leaves (laminodia) opposite or verticillate, minutely serrulate, or thread-like, and with broad basal sheaths. Flowers unisexual, monœcious or diœcious, solitary in the axils, sessile or short-pediceled. Staminate flowers with a double perianth, the outer four-pointed, the inner hyaline; stamen one, sessile; anther unisporangiate. Carpellate flowers with a single one-ovuled ovulary; style short; stigmas two or three, with subulate stigmoid processes between. Fruit an ellipsoid drupelet with a crustaceous straw-colored pericarp. Seed smooth or sculptured with many rows of minute tetragonal to hexagonal areolations. Embryo straight; endosperm none.

641. Naias flexilis Rostkof & Schmidt. Slender Water-nymph. Ponds and still waters, C. and W. K.; not common. June. (ASU)

642. Naias guadalupensis Morong. Guadalupe Water-nymph. Ponds and deep water-holes along the Prairie Dog and Republican rivers, N. W. K. (S)

CLASS X.* PETALIFERÆ. PETAL-BEARERS.

Monocotyls with Showy-colored Perianth.

Floral envelopes herbaceous, foliaceous, more or less colored, in two or more whorls surrounding the carpel, deciduous or partly persistent. Pollination principally entomophilous. Fruit mostly capsular; though it may be nuciform, follicular, utricular, or even bacciform.

Subclass C. ALISMÆFLORÆ. Water Plants.

ALISMA-FLOWERED MONOCOTYLS.

Perianth, when present, usually in two whorls, actinomorphous, heterochlamydeous, consisting of three persistent herbaceous green sepals and three deciduous chromoplastic highly colored petals. Andrœcium normally of six stamens, though they may be greater in number or fewer; filaments short; anthers with inconspicuous connectives. Gynœcium of three to many distinct carpels, sometimes coherent during anthesis; ovularies superior. Aquatic or marsh-inhabiting herbs, with various leaves, either with long petioles and broad laminæ or laminodia with their distal ends expanded into blade-like prolaminæ; often reduced to phyllodia.

ORDER XXII. HYDRALES. THE WATERWORTS.

Inflorescence spathaceous. Flowers arising from a spathe or involucre of one to three bracts. Perianth regular, with three herbaceous or petaloid sepals and three thin petals, or none. Stamens three, or a multiple of three, in one or more whorls, with distinct or partially united filaments. Pollination hydrophilous. Carpels 3 to 15, united, with as many parietal placentæ.

Family 45. VALLISNERIACEÆ. Tape-grass Family.

Submerged or floating water plants with perennial stolons. Leaves various, with linear grass-like submerged or floating laminodia and small one-nerved pellucid opposite or verticillate and minutely denticulate cauline leaves. Flowers monœcious, diœcious, and polygamous, rarely perfect, arising from an ovoid, obovoid, or tubular two-cleft spathe, with sepals and petals three each. Staminate flowers solitary, in threes, or numerous and crowded upon a sessile spadix, detaching at maturity and expanding on the surface of the water, to allow the dry pollen to float away to the stigmas; stamens on short filaments, in whorls of three or fewer, united at base into a column; anthers bisporangiate. Carpellate flowers solitary in the axils, but with a calyx-tube or a coiled scape just long enough to allow the flower to reach the surface and float on it for pollination; styles three to nine, short; stigmas, three, entire or two-cleft. Perfect flowers like the carpellate ones, but with three to nine stamens. Ovulary unilocular, with three parietal placentæ, or with loculi six to nine; ovules numerous, borne all over the placental walls, anatropous or orthotropous. Fruit an indehiscent utricle, ripening under water; seeds with straight embryo; without endosperm.

643. Philotria canadensis Britton. (*Elodea* Mx.) Ditch-moss. Fresh-water ponds and streams, Miami county. May. (U)

644. Philotria minor Small. Little Ditch-moss. Ponds and slow streams, S. E. K.; occasional. May. (AS)

645. Vallisneria spiralis L. Tape-grass. Quiet waters, Miami, McPherson, Rice, Reno and Pratt counties; not common. Aug. (ASU)

646. Limnobium spongia Rich. Frogbit. Stagnant water, Johnson county; rare, and only to be found in special years, when the weather is favorable.

Order XXIII. ALISMALES. The Alismads.

Inflorescence in spikes, racemes, or panicles; flowers perfect or unisexual. Perianth single or double; calyx of three persistent herbaceous sepals, and corolla of three deciduous showy petals, or none. Stamens three, six or more, sessile or with very short filaments; anthers with inconspicuous connectives. Carpels three to many, distinct, though often coherent during anthesis; ovulary superior; style short; stigma discoid; ovules solitary or few. Fruit a head of achenes, or capsular. Hydrophytes, from rootstocks usually tuber-bearing; caulescent or scapose. Leaves basal, alternate, sheathing; forms various—laminar, laminodiar, phyllodiar, or bladeless, sometimes juncoid, with spongy tissue; laminodia with their distal ends in all degrees of expansion, from not at all or only slightly, as in *Triglochin*, to a broad auriculate prolamina, closely simulating a true leaf blade, as in *Sagittaria;* nervation prominent, parallel, radiating, campylodromous, or convergent.

Family 46. Scheuchzeriaceæ. Arrow-grass Family.

Perennial marsh herbs, with semiterete rush-like or tapering bladeless laminodia, with expanded open sheaths. Flowers perfect, in spikes or racemes, without subtending bracts. Perianth in two series, the inner (corolla) deciduous. Stamens six; anthers sessile, bisporangiate, extrorse. Carpels three or six, unilocular, one- to two-ovuled, somewhat united till maturity; stigmas sessile. Fruit follicular or capsular; seeds anatropous; embryo straight; endosperm none.

647. Scheuchzeria palustris L. Arrow-grass. Reported from marshes of central Kansas; possibly the same as the next.

648. Triglochin maritima L. Salt-marsh Arrow-grass. Salt marshes in the sandy salt region of central Kansas; frequent. July. (AS)

Family 47. Alismaceæ. Arrow-head Family.

Annual or perennial scapose aquatic herbs, with roots fibrous or stoloniferous. Leaves various, basal, sheathing, ordinarily long-petioled, with broadly expanded, auriculate-lobed, cordate, ovate, or lanceolate, or even without expansion of the distal ends; sometimes reduced to stipular phyllodia; no dividing line can be drawn between the extreme forms. Inflorescence often in verticils of three, subtended by bracts. Flowers actinomorphic, pediceled; when monœcious the uppermost flowers are staminate, the lower carpellate or perfect. Perianth of three persistent green herbaceous sepals and three deciduous chromoplastic petals, imbricate in prefloration. Stamens six or more, distinct, in two whorls; anthers bisporangiate, extrorse, dehiscing by lateral vertical slits. Carpels numerous; ovularies superior, distinct, unilocular; ovules erect, campylotropous, solitary or several in each ovulary. Fruit a head of turgid achenes; seeds uncinate-curved, ribbed; embryo horseshoe-shaped; endosperm none.

649. Alisma plantago L. Water-plantain; Alisma. Mud and shallow water, in nearly every county; occasional. June. (ASU)

650. Helianthium tenellum Britt. (*Alisma* Martens.) Spear-head. Mud; occasional; not often recognized. April. (AS)

651. Echinodorus cordifolius Grisebach. (*Alisma* L.) Upright Burhead. Waterholes and ditches, general; common. June. (ASU)

652. Echinodorus radicans Engelm. Creeping Bur-head. Cherokee to Montgomery county; not common. June. (AS)

653. Lophotocarpus calycinus J. G. Smith. (*Sagittaria* Eng.) Variable Lance-head. Water, throughout the state; common.

654. Lophotocarpus depauperatus Sm. Elliptic Lance-head. Borders of ponds, S. E. K.; rare. July. (A)

655. Sagittaria platyphylla Sm. Ovate-leafed Arrow-head. Sloughs and shallow water, S. E. K.; frequent. July. (ASU)

656. Sagittaria graminea Mx. Grass-leafed Arrow-head. Mud or shallow water, S. E. K.; not common. July. (SU)

657. Sagittaria heterophylla Pursh. Variable Arrow-head. Muddy places, S. E. K.; frequent. July. (ASU)

658. Sagittaria ambigua Sm. Kansas Arrow-head. Borders of ponds, S. E. K., west to Meade county; frequent. July. (ASU)

659. Sagittaria longiloba Eng. Long-eared Arrow-head. Shallow water, W. K.; occasional. July. (AS)

660. Sagittaria brevirostra Mack. & B. Short-beaked Arrow-head. Sloughs and wet bottoms, Johnson county (Mackenzie & Bush). July.

661. Sagittaria arifola Nutt. (*S. cuneata* Sheld.) Arum-leafed Arrow-head. Shallow water, or deeper, C. and W. K.; occasional. August. (S) Developing laminodia or phyllodia, or both, according to circumstances.

662. Sagittaria latifolia Willd. Broad-leafed Arrow-head. Shallow spring water, throughout the state; common. July. (ASU)

ORDER XXIV. COMMELINALES. THE DAYFLOWERS.

Inflorescence in verticils, cymes, spikes, spadices, or solitary, subtended by spathe-like or leaf-like bracts. Perianth of six divisions, heterochlamydeous, zygomorphous, partially two-lipped, occasionally the lower lip consisting of a single specialized petal. Andrœcium of stamens. Six partly fertile and partly barren, or three, peculiarly arranged and partly unlike, as though they were portions of two whorls with certain units entirely suppressed, the whole in a tube separate from the gynœcium. Ovulary superior; ovules anatropous; seeds one to many; embryo straight, cylindric, central, enantiomorphous (opposite the hilum), in a copious farinaceous endosperm. In this order there are many orchidifloral characteristics, though not always clearly evident.

Family 48. COMMELINACEÆ. Spiderwort Family.

Jointed herbs from thickened, fibrous roots, with showy flowers in umbel-like cymes subtended by one or more leaf-like or spathe-like bracts. Calyx of three persistent herbaceous green sepals and corolla of three deliquescent chromocyanic membranous petals, the lower or dorsal one in *Commelina* rudimentary. Anthesis periodical, morning opening only; flowers close about midday. Stamens six, rarely fewer, hypogynous, in two series, two or three fertile, three or four larger and sterile; fertile anthers bisporangiate, longitudinally dehiscent; sterile anthers larger and -)-(- shaped. Ovulary sessile or nearly so, bilocular or trilocular; ovules one to several in each loculus, anatropous, or nearly so; style simple; stigma two- to three-lobed. Capsule two- to three-valved; seeds reticulated.

663. Tradescantia virginiana L. Spiderwort; "Spider Lily." Common in rich, alluvial soil in valley lands; more frequent east than west; 4–8 dm. Flowers deep blue, purple, lilac, violet, crimson, rose color, white; floral parts often duplicated; even four sepals, four petals, eight stamens, and a four-parted gynœcium is not unusual; capable of improvement by cultivation. May. (ASU)

664. Tradescantia occidentalis (Britt.) Western Spiderwort. Dry soils, W. K.; 1–4 dm.; frequent in the damper soils of the semiarid region. Flowers violet, lilac, rose, or white, much the same as *T. virginiana* reduced. Leaves narrow, hairy; bracts narrow. Occasionally found growing side by side with *T. virginiana*, which it most resembles. May. (AS)

665. Tradescantia bracteata Small. Large-bracted Spiderwort. Sandy soil, on low prairies, E. K.; occasional. May. (ASU)

666. Tradescantia reflexa Raf. Reflexed Spiderwort. Drift hills and well-drained drift soil, N. E. K.; frequent. June. (ASU)

667. Tradescantia brevicaulis Raf. Low Spiderwort. Moist sandy soil, ½ to 1½ dm. high; flowers large, frequent. April. (AS)

668. Commelina communis L. Asiatic Dayflower. Rich alluvial banks, Wyandotte and Cherokee counties; rare. July. (A)

669. Commelina virginica L. Dayflower. Moist or damp alluvial soils, general throughout E. K., though not very common. June. (ASU)

670. Commelina angustifolia Mx. Sandhill Dayflower. Common in the sand hills south of the Arkansas river, and as far northeast as Ottawa county. Similar to *C. virginica*, but leaves narrow and plant adapted to a dry soil and climate. Third petal twisted up and very small. July. (ASU)

671. Commelina crispa Wooton. Curly-leaf Dayflower. Moist soil and sheltered alluvial banks, general; frequent to common. June. (ASU)

672. Commelina hirtella Vahl. Bearded Dayflower. Moist and sheltered situations, Miami county; rare. July. (U)

Family 49. PONTEDERIACEÆ. Pickerel-weed Family.

Perennial aquatic plants, from creeping or floating rootstocks, with laminodia having cordate-ovate, orbicular, reniform, or ovate campylodrome-nerved prolaminæ, or entirely linear or grass-like laminodia. Flowers zygomorphous, perfect, few or several. Perianth of three colored petals and three dissimilarly shaped sepals, all united below into a two-lipped tube free from the ovulary. Stamens six, trimorphous, inserted on the tube of the perianth; anthers linear-oblong, bisporangiate, versatile. Ovulary imperfectly trilocular, with axile placentæ, or unilocular by suppression of two of the carpels or reduction of the three parietal placentæ; style trimorphous; stigmas minutely three-toothed.

673. Heteranthera dubia Macmillan. Water Mud-plantain. Still water, W. K.; frequent in spots. Leaves linear, subaqueous. July. (A)

674. Heteranthera limosa Willd. Small Mud-plantain. Mud or shallow water, W. K.; frequent. Aug. (AS)

675. Heteranthera reniformis Ruiz & Pavon. Mud-plantain. Muddy ditches and shallow water, E. K.; frequent some seasons, and not at all other years, depending on the rainfall at the proper time. July. (SU)

676. Piaropus crassipes Britt. (*Eichhornia* Solms.) Water-hyacinth. Planted in little lakes here and there in E. K. and S. E. K., as at Merriam Park, Gage Park, etc. Does not survive the winter. Leaves reniform.

677. Pontederia cordata L. Pickerel-weed. Borders of ponds, S. E. K.; not common. July. Leaves cordate-sagittate

ORDER XXV. NYAMPHÆALES. THE WATER-LILIES.

Inflorescence solitary, at the ends of long scapes or peduncles. Flowers commonly floating, perfect; perianth normally six-parted, hypogynous. Stamens six to many, hypogynous, part of the many stamens barren and more or less transformed into petals (staminodia). Anthesis periodical, day opening. Pollination entomophilous, rarely hydrophilous. Carpels three or more, distinct or united; ovules solitary or several in each ovulary. Fruit nut-like, indehiscent, with one or more seeds. (This order has many dicotyl characters, such as partially net-veined leaves, numerous petals, radiate stigmas, etc., allying it to the *Ranales* and *Papaverales;* yet, notwithstanding this, the plants are, in structure, mainly monocotyledonous.

Family 50. NYMPHAEACEÆ. Water-lily Family.

(*a*) *Cabomboideæ.* Water-shield Subfamily.

Stems slender, a meter or so in length, branching, and with the peduncles, petioles and under surface of the leaves coated with gelatinous matter. Floating laminæ peltate; submerged leaves palmately dissected into numerous capillary segments. Flowers axillary, small, various colors. Petals and sepals each three. Stamens three to eighteen. Carpels three to eighteen, separate; ovules commonly three, pendulous. Fruit one- to three-seeded, indehiscent.

678. Cabomba caroliniana Gray. Carolina Water-shield; Parrot-feather. Ponds and slow streams, S. E. K.; occasional. May. (S)

679. Brasenia purpurea Caspary. (*B. peltata* Pursh.) Water-shield. Ponds and slow streams, Cherokee to Montgomery county; occasional. Summer.

680. Brasenia schreberi Gmelin. Water-target. Grown occasionally in the little artificial ponds, in company with water-lilies, on account of its peltate floating floral leaves.

(*b*) *Nymphæoideæ.* Pond-lily Subfamily.

Rootstocks perennial and very thick, creeping in the soft, black earth in the bottom of ponds, with the water preferably one to two meters deep. Leaves very large and floating; petioles as long as the depth of the water; laminæ flat on the surface, auriculately lobed, orbicular to lance-ovate, the basal lobes often touching, leaving a deep sinus at the base of the lamina; nervation radiating, pinnate, and dichotomous; submersed leaves similar, but with shorter petioles. Perianth of three sepals and three petals; petalodia and staminodia, or petal-like and neutral stamens, numerous; fertile stamens many, always in whorls of three. Carpels many, united into a compound globose fruit; styles none; stigmas as many as the carpels, linear, radiating, poppy-like, on a disk on the upper surface of the ovularies. Seeds ovoid-globose, stipitate or sessile; embryo central; endosperm moderate.

681. Nymphæa advena Aiton. (*Nuphar* R. Br.) Large Yellow Pond-lily. Ponds and slow streams, E. K.; occasional. Summer.

682. Castalia odorata Woodv. & Wood. Sweet-scented (white) Water-lily. Spreading slowly from various points in E. K., where introduced. Not abundant anywhere. July. Flowers open at 6 A. M.; close regularly at 4 P. M.

683. Castalia elegans (Hooker). Blue Water-lily. Occasional in park ponds with *C. odorata*; native in western Texas and New Mexico.

684. Castalia rosea Pursh. Rose-colored Water-lily. In Chautauqua Park pond at Ottawa before the recent flood on the Marais des Cygnes, in company with *Castalia odorata* and *elegans;* though no effort had then been made to plant the tubers so as to have them bloom in the form of an American flag.

685. Victoria regia Lindl. Royal Water-lily; Victoria. In Gage Park, Topeka, and probably elsewhere. Leaves with an upturned rim.

(*c*) *Nelumboideæ*. Water-lotus Subfamily.

Rootstocks very thick, horizontal, in muck under water a meter or more in depth. Leaves basal, with long petioles, and large peltate orbicular slightly concave laminæ, floating or emersed. Flowers large, solitary, floating, on the end of long scapes. Perianth ample; outer whorl 3 to 6, more or less green; petals, petalodia and staminodia many, in numerous whorls, caducous; fertile stamens indefinite, in many whorls. Carpels numerous, distinct, immersed separately in the broad flat surface of the very large, fleshy receptacle; ovules one or two, pendulous or anatropous, one to mature. Seeds ovoid-globular, with a small neck above, formed by the short, persistent style; embryo nearly central, large, without endosperm.

686. Nelumbo lutea Pers. Yellow Water-lotus; Water-chinkapin. Ponds, E. K.; occasional, sometimes in great abundance, filling a pond to the exclusion of everything else. July. Flowers unfold at five A. M.; close at two P. M.

Subclass D. **LILIIFLORÆ. Hexaphyls.**

LILY-FLOWERED MONOCOTYLS.

Perianth hexaphyllous, mostly actinomorphous, homochlamydeous, the two whorls (calyx and corolla) so close together as to be almost or quite in one, the segments nearly equal in size, form, and color, seldom unlike, more or less united at base, sometimes quite tubular. Androecium hexandrous, the stamens alternating in two whorls so close together as to appear almost, and often are quite, in one; seldom less than six, never more without chorisis. Pollination entomophilous. Gynœcium a three-valved capsule, many-seeded, or a trilocular berry.

ORDER XXVI. LILIALES. THE LILIADS.

Inflorescence various. Flowers polysymmetrical, the perianth hypogynous or perigynous, the stamens hypogynous or epipetalous. Ovulary trilocular, the ovules numerous in each loculus. Fruit capsular, rarely baccate. Seeds various; embryo small, in copious albumen.

Family 51. MELANTHACEÆ. Bunch-flower Family.

Leafy-stemmed herbs, with perennial rootstocks or bulbs. Inflorescence panicled or racemose, rarely solitary. Flowers perfect, polygamous, or diœcious. Perianth of six nearly separate persistent segments. Stamens six, on the bases of the perianth-segments. Anthers with two sporanges, or confluently with one double, oblong or ovate, cordate or reniform, versatile, and extrorsely dehiscent. Ovulary trilocular, superior or partly inferior; ovules few or numerous, anatropous or amphitropous; styles separate. Capsule with septicidal dehiscence, rarely loculicidal. Seeds appendaged.

687. Colchicum autumnale L. Meadow Saffron. Occasional in gardens.

688. Chamælirium luteum Gray. (*Ch. caroliniana* Willd.) Blazing-star. Moist meadows, Miami county; not common. May. (U)

689. Zygadenus nuttalli Wats. Western Zygadene. Dry hills, W. K., as far east as Morris county; not common except where it occurs. May-June. (ASU)

690. Melanthium virginicum L. Bunch-flower; Melanth. Meadows, E. K.; rare. June. (U)

691. Uvularia grandiflora J. E. Smith. Large-flowered Bellwort. Rich, moist woods, extreme E. and S. E. K.; infrequent. May. (AU)

692. Uvularia sessilifolia L. Bellwort. Moist woods, Wyandotte county; rare. May. (U)

Family 52. LILIACEÆ. Lily Family.

Scapose or leafy-stemmed herbs, from bulbs, corms, or rootstocks. Inflorescence solitary, spicate, racemed, panicled, or umbeled, in different genera. Flowers perfect. Perianth-segments distinct, or more or less united into a tube. Stamens inserted on the throat of the perianth or at the base of the segments; anthers versatile, introrse, or extrorse, rarely declinate. Ovules anatropous or amphitropous; styles united; stigmas capitate or three-lobed. Fruit a loculicidal capsule or an indehiscent berry. Seeds winged or wingless.

693. Hemerocallis fulva L. Coppery Day-lily. Spreads from cultivation but very little; yet persists where planted for a long series of years.

694. Hemerocallis flava L. Yellow Day-lily. Often seen near houses after having been planted there many years before.

695. Funkia subcordata Sprengel. White Day-lily. With long, tubular, funnel-form flowers. Persists, like the other day-lilies, where planted.

696. Funkia ovata Spreng. Blue Day-lily. With nodding violet flowers abruptly expanded above the narrow tube. More tender than the others.

697. Agapanthus umbellatus L'Heritier. Love-flower; African Lily. Frequent in the best gardens and window pots. With a handsome umbel of large blue flowers.

698. Allium vineale L. Field Garlic. A pest in some wheat fields in E. K.: introduced in seed wheat from the east.

699. Allium cepa L. Onion. Seldom gets beyond cultivation. Some winter varieties occasionally persist for a few years.

700. Allium canadense L. Top-bulb Wild-onion. Meadows, general; frequent. May. (ASU)

701. Allium cernuum Roth. Nodding Wild-onion. Hillsides, near the Neosho river, also in Cowley county; occasional. July. (ASU)

702. Allium stellatum Ker. Prairie Wild-onion. Rocky banks and dry prairies, general; frequent. July. (ASU) Perianth pink-striped.

703. Allium mutabile Mx. Pink Wild-onion. Moist soil, general; common. April. (ASU)

704. Allium nuttallii Wats. Roseate Wild-onion. Prairies, general; common. April. (ASU)

705 Allium helleri Small. Twin Wild-onion. Dry soil. April–May. Credited to Kansas by Britton's Manual.

706. Allium reticulatum Don. Netted Wild-onion. Damp prairies, C. and W. K.; common. May. (ASU)

707. Nothoscordum bivalve Britt. Mild-onion; Pixie-cup. Prairies, W. K.; common. March. (ASU)

708. Androstephium cæruleum Green. Blue Elfin-crown. Prairies, Morton county; occasional. April. (U)

709. Lilium umbellatum Psh. Western Red Wood-lily. Dry wooded hills from Valley Falls northeastward; occasional. June. (SU)

710. Lilium canadense L. Yellow Wood-lily. Woods and fields, N. E. and S. E K.; rare. June. (AU)

711. Lilium tigrinum Andrews. Tiger Lily. Several varieties. Occasionally escapes from gardens by means its axillary bulblets.

712–716. Lilium martagon L. (Turk's-cap Lily), *speciosum* Thunb., *japonicum* Thunb., *longiflorum* Thunb., *candidum* L. (Madonna Lily), and other exotic lilies are in cultivation.

717. Fritillaria imperialis L. Crown-imperial Fritillary. Flowers large, orange-yellow or scarlet, hanging in an umbel under the terminal crown.

718. Erythronium dens-canis L. Dog-tooth Adder-tongue. Cultivated.

719. Erythronium albidum Nutt. White Adder-tongue. Moist woods, E. K.; common. Leaves white mottled. April. (ASU)

720. Erythronium mesachoreum Knerr. Midland Adder-tongue. Dry hills and prairies, E. K.; common. Leaves narrow, green. March. (ASU)

721–722. Tulipa gesneriana, *suaveolens*, and other species of tulip are in cultivation quite commonly.

723. Camassia esculenta Robinson. (*C. fraseri* Torr.) Wild-hyacinth. Dry ground near streams. Franklin county and eastward; 6–10 dm. high; frequent April–May. (ASU)

724. Hyacinthus amethystinus L., etc., often in open gardens.

725–726. Ornithogalum umbellatum and *nutans* L. Star-of-Bethlehem. Frequent in gardens; seldom tries to escape.

727. Muscari botryoides Mill. Grape-hyacinth. Frequent in gardens; occasionally escapes into lawns and fields.

728–729. Kniphofia aloides Moench, *tuckii* Baker, etc. Redhot-poker; Flame-flower; Zulu Boyonet. Frequent in gardens; leaves have sharp keels and edges.

730. Dracæna fragrans Ker-Gawl. Dragon-tree. A pot-plant in houses.

731–732. Sansevieria glauca, *zeylanica* Willd., etc. Zebra-leaf. Frequent in pot cultivation.

733. Yucca glauca Nut. (*Y. angustifolia* Pursh.; *Y. constricta* Buckl.) Yucca; Bear-grass; Spanish Bayonet. Dry hills, W. K., as far east as Sedgwick, Riley and Clay counties; common. May. (ASU)

734. Yucca filamentosa L. Yucca; Adam's Needle. Common in gardens.

Family 52*b*. CONVALLARIACEÆ. Lily-of-the-Valley Family.

Scapose or leafy-stemmed herbs, from simple or branched rootstocks, never from bulbs or corms. Inflorescence solitary, racemed, panicled, or umbeled. Leaves (laminodia) usually alternate, sometimes verticillate, and again reduced to evanescent scales. Asparagus has under each dry scale a cluster of minute green branchlets which serve as prophylla. Perianth-segments united at the base and six-parted, urceolate and six-lobed, or cylindric and six-toothed. Stamens borne on the perianth-segments or at the base of the carpel. Ovules anatropous or amphitropous; stigma three-lobed; fruit a fleshy berry.

735. Asparagus officinalis L. Asparagus. Frequently escapes into the woods and thickets for a number of years. Lasts longer on salty soil.

736–7. Asparagus plumosus, *sprengeri*, etc. Cultivated on account of their green prophylla, or minute branchlets, which answer the purpose of foliage and keep green long without wilting, when in a bouquet.

738. Smilacina racemosa Desfontaines. (*Vagnera* Morong.) Wild-spikenard. Moist thickets, near streams, E. K.; frequent. May. (ASU)

739. Smilacina stellata Desf. Blue-flowered Wild-spikenard. Moist soil, near water, W. K., to Salina and Hutchinson; frequent. May. (ASU)

740. Streptopus amplexifolius D. C. Clasp-leaf Twist-foot. Moist woods, Montgomery county; occasional. May. (U)

741. Polygonatum biflorum Elliott. Two-flowered Solomon-seal. Thickets, general; common. May. (ASU)

742. Polygonatum commutatum Dietr. Great Solomon-seal. Thickets and river banks; general over the state; common. June. (ASU)

743. Convallaria majalis L. Lily-of-the-valley. Has slight tendency to escape from gardens.

744. Trillium viride Beckw. Kansas Trillium. Rich woods and open hillsides, Miami and Johnson counties, perhaps elsewhere; not common. May. (U) Petals light green or purplish green; filaments flat.

745. Trillium viridescens Nutt. Narrow-leaf Trillium. Hillsides and rich woods, E. K. (Britton's Manual, 1907.) Petals very narrow.

Order XXVII. SMILACALES. The Greenbriers and Yams.

Inflorescence in umbels, racemes, or panicles; flowers small, greenish, monœcious or diœcious. Perianth-segments six, alike, deciduous or persistent. Andrœcium normally of six stamens, sometimes of three stamens and three staminodia. Gynœcium an inferior trilocular ovulary, with or without wings. Plants exogenous, with many dicotyl characters, such as net-veined laminæ articulated with the petiole, stomata transversely intercellular on the under surface of the laminæ, and petiole articulated with the vine. Yet they have but one cotyledon and the flowers are liliaceous.

Family 53. Smilacaceæ. Greenbrier Family.

Thorny, woody vines, climbing by stipular tendrils from woody rootstocks. Inflorescence in globular axillary umbels, of very many small hexaphyllous hexandrous flowers. Perianth-segments distinct. Stamens distinct; filaments ligulate; anthers basifixed, introrse. Ovulary trilocular, the loculi opposite the inner perianth-segments; ovules one or two in each loculus, orthotropous. Fruit a globose berry, containing one to six brownish seeds; endosperm horny, copious; embryo small, remote from the hilum.

746. Smilax herbacea L. Carrion-flower. Thickets, E. K.; occasional, not common. May. (ASU) Has no bad odor.

747. Smilax glauca Walt. Smooth-leaf Greenbrier. Dry soil in thickets, E. K.; frequent. May. (ASU)

748. Smilax rotundifolia L. Greenbrier. Woods and thickets, general over the state; common. May. (ASU)

749. Smilax hispida Muhl. Thorniest Greenbrier. Thickets, E. K.; occasional. April. (ASU)

750. Smilax pseudochina L. Thornless Greenbrier; China-root. Sandy soil, low grounds, E. K.; frequent. Armed at base when old. April. (ASU)

751. Smilax bona-nox L. Bristly-leaf Smilax; Bamboo-brier. Thickets and low grounds, E. K.; frequent. May.

Family 54. DIOSCOREACEÆ. Yam Family.

Smooth, slender, twining vines, from fleshy or woody rootstocks. Leaves with petioles and laminæ cordate to halberdoid, campylodrome-nerved and reticulate-veined; petioles articulating with the vine as in dicotyls. Inflorescence in racemes or panicles; flowers small, unisexual. Perianth six-parted, segments all alike; in the carpellate flowers persistent, united at the base and adherent to the ovulary. Staminate flowers with six or three fertile stamens, sometimes with a rudimentary ovulary. Carpellate flowers with an inferior trilocular ovulary; styles and stigmas distinct, sometimes with three or six staminodia. Ovules two in each loculus. Fruit a three-valved, three-angled, or three-winged capsule. Endosperm of the seed fleshy or cartilaginous; embryo small.

752. Dioscorea paniculata Mx. (*D. villosa* L.) Wild Yam-root. Moist woods and thickets in valleys of S. E. K.; frequent. June. (S) Medicinal.

753. Dioscorea divaricata Blanco. Cinnamon-vine. With a disposition to grow naturally from the little self-shed tuberlets on the vines, whenever they have fallen where they escape the severe frosts of winter. The growing tubers need but slight protection from frost; each successive year sends them deeper into the ground and increases the liability to escape winter-killing.

Subclass E. ORCHIDIFLORÆ. Heterophyls.

ORCHIS-FLOWERED MONOCOTYLS.

Perianth hexaphyllous, zygomorphous, rarely actinomorphous, the calyx and corolla often differing widely in form, color, texture, and purpose, monosymmetrical, more or less two-lipped, the various segments, unless they balance by being horizontally opposite, differing individually in some respect. Andrœcium seldom of six fertile stamens, but usually of one or more fertile stamens and enough staminodia to make the complement six or three. Pollination almost exclusively entomophilous. Gynœcium normally tricarpellate, but usually unilocular by suppression of two of the carpels or by reduction of the three parietal walls.

ORDER XXVIII. IRIDALES. THE IRIDS.

Inflorescence in umbels or umbellate clusters subtended by membranous bracts. Perianth heterophyllous, actinomorphous or zygomorphous; segments distinct or united at base and coherent with the ovulary. Andrœcium hexandrous, or of three stamens with or without three staminodia. Gynœcium an inferior trilocular capsule, many-seeded.

Family 55. AMARYLLIDACEÆ. Amaryllis Family.

Scapose or leafy-stemmed perennial herbs, from bulbs or rootstocks, and with soft, linear laminodia, rarely broadly expanded toward the distal end, and with rounded carinæ. Flowers perfect, nearly actinomorphous. Perianth six-lobed, the segments united below into a tube coherent with the ovulary. Stamens six, on the bases of the perianth-segments, often declinate; anthers versatile or basifixed, introrse, bisporangiate, longitudinally dehiscent. Ovulary inferior, trilocular; style filiform; stigmas three; ovules numerous, anatropous; fruit capsular; seeds black.

754. Hymenocallis occidentalis Kth. Hymenocallis. Marshy banks of streams, S. E. K.; not common. Aug.

755. Narcissus jonquilla L. Jonquil. Gardens; frequent.

756. Narcissus pseudo-narcissus L. Daffodil; Trumpet-daffodil. Common in residences.

757. Narcissus tazetta L. Polyanthus Narcissus. Common in houses.

758. Narcissus poeticus L. Poet's Narcissus. Houses and gardens.

759. Zephyranthes atamasco Herb. Atamasco Lily. Houses, frequent

760. Zephyranthes rosea Lindley. Fairy Lily. Frequent in windows.

761. Sprekelia formosissima Herb. Jacobea Lily. Houses, occasional.

762. Amaryllis lateritia Diet. Amaryllis. Many species of amaryllis are raised in homes, sometimes in gardens.

763. Leucojum vernum L. Spring Snowflake. A favorite in gardens.

764. Leucojum autumnale L. Fall Snowflake. Occasional in gardens.

765. Cooperia drummondii Herb. Prairie-lily; Rain-lily. Prairies S. E. K ; occasional, May. (AS)

766. Hypoxis hirsuta Cov. Hairy Star-grass. Dry soil, E. K.; not common. June. (A)

767. Galanthus nivalis L. Snowdrop. Frequent in gardens. March-April.

768. Polianthes tuberosa L. Tuberose. Gardens; common. Summer.

769. Agave americana L Century-plant. Common in residences and on lawns in summer. Several other species of *Agave* in house culture.

Family 56. IRIDACEÆ. Iris Family.

Herbs, from perennial rootstocks or bulbs, having linear two-ranked equitant laminodia, so folded as to appear laterally compressed, but without a deep keel. Flowers clustered, perfect, actinomorphous or zygomorphous. Perianth of six segments, in two series, the sepals and petals often markedly unlike, yet both showy, and convolute in prefloration. Stamens three, on the outer series of perianth-segments; anthers bisporangiate, extrorse; staminodia three, on the inner series of perianth segments. Ovulary inferior, trilocular; ovules numerous in each loculus, anatropous; style three-cleft, its branches flat, spreading, and petal-like, sometimes divided. Capsule three-valved, loculicidally dehiscent, or three-angled or three-lobed and many-seeded, rarely a berry after removal of the dry capsule.

770. Iris versicolor L. Large Blue Flag. Thickets, Leavenworth and Atchison counties; not common. May. Laminodia broad.

771. Iris germanica L. Iris; (Fleur-de-lis). Gardens; common in many varieties and horticultural subspecies.

772. Iris pumila L. Dwarf Garden Iris. Borders in gardens; common. April.

773. Iris persica L. Persian Iris. A choice house plant.

774. Nemastylis acuta Herb. (*N. geminiflora* Nutt.) Twin-star-flower. Prairies, S. E. K.; occasional. Perianth-segments similar. May. (A)

775. Belamcanda chinensis D. C. (*Pardanthus* Ker.) Blackberry-lily. Frequently escapes from gardens; yet not fully naturalized.

776. Sisyrinchium campestre Bickn. Prairie Blue-eyed-grass. Dry or damp sloping prairies, E. K.; common. June (ASU) Sometimes white.

777. Sisyrinchium kansanum (Bickn.) Kansas Blue-eyed-grass. Same situations; merely a form of the preceding.

778. Sisyrinchium angustifolium Mill. Blue-eyed-grass. Damp, sandy prairies, E. K.; frequent. May. (ASU) Violet and white varieties occur.

779. Sisyrinchium gramineum Curtis. (*S. anceps* Cav.) Winged Blue-eyed-grass. Damp woods and grassy meadows and slopes, E. K.; common. May. (ASU) White flowers are common; violet ones are rarer.

780. Tigridia pavonia Pers. Mexican Tiger-flower. Frequent in gardens.

781–783. Gladiolus communis L., *tuberosa L.*, *ensifolius* Ker., and numerous other species are raised in gardens. Gladiolus; Corn-flag; Sword-flag.

784. Crocus vernus L., and other species, some of them for very early spring flowers in the grass, are grown in gardens.

Order XXIX. SCITAMINALES. The Dainties.

Inflorescence in panicles, racemes, spikes, or solitary. Flowers perfect or polygamous, zygomorphous. Perianth in two series of three each, the petals differing from the sepals, and all united below into a tube coherent with the ovulary. Stamens one to five, with one to five staminodia. Ovulary unilocular to trilocular, inferior; ovules one in each loculus, anatropus. Embryo central, in copious albumen.

Family 57. Musaceæ. Banana Family.

Subtropical plants under cultivation, with leaves having distinct petiole and blade with pinnate nervation. Inflorescence in terminal drooping racemes. Perianth two-lipped, the lower lip three- to five-lobed and enclosing the upper smaller one. Stamens five fertile and one staminodium barren. Anthers bisporangiate. Fruit a berry.

785. Musa sapientum L. Banana. Occasionally cultivated in private gardens for its immense foliage. Never fruits outdoors here.

Family 58. Marantaceæ. Arrowroot Family.

Tall herbs, perennial by thick rootstocks or tubers, or annual with scapose or leafy stems. Inflorescence in terminal panicled spikes of heavily bracted flowers. Perianth superior, its segments distinct or united below into a tube. Fertile stamen one, with two double sporanges, one fertile, the other barren. Staminodia five, petal-like, separate or united by their bases and conforming to the requirements of a monosymmetrical flower. Ovulary unilocular, sometimes with two additional minute empty loculi. Base of staminodium-tube adnate to base of style or to the ovulary; stigma two-lipped. Fruit capsular or berry-like; seeds one in the one loculus.

786–787. Maranta ornata Linden. Ornate Arrowroot. In house cultivation, *M. zebrina* and other species are also found.

788–790. Canna indica Roscoe, *warszewiczii* Diet., *discolor*, and other species of canna are common in gardens.

ORDER XXX. ORCHIDALES. THE ORCHIDS.

Inflorescence in spikes, racemes, umbellate clusters, or solitary. Flowers zygomorphous, two-lipped. Perianth of six segments, heteromorphous, monosymmetric, in two series, the outer differing much from the inner; the two ventro-lateral sepals are similar, the dorsal one slightly smaller, and by a half-twist of the ovulary brought erect; the two dorso-lateral petals are similar, the ventral one larger, and by the same twist brought downward; often spurred at the base, and sometimes so contracted or drawn at the margin as to form a sort of cup or sac (moccasin). Andrœcium of one or two fertile stamens and one, two or five staminodia, the whole united with the ovulary and style into a zygomorphous gynandrous column. Pollination strictly entomophilous. Gynœcium an inferior tricarpellate unilocular ovulary, usually twisted so as to reverse the normal position of the floral organs. Fruit a three-valved capsule; ovules innumerable; seeds minute.

Family 59. CYPRIPEDIACEÆ. Lady-slipper Family.

Stems quite leafy and pubescent. Laminodia broad, many-nerved, sheathing at the base. Perianth spreading; sepals separate, or two of them united under the lip. Ventral petal (the lip) a large inflated sac opening upward; dorso-lateral petals very long and slender, simulating fancy shoe-laces. Fertile stamens two (the dorso-lateral ones of the inner whorl), sessile on each side of the style; anthers with two double sporanges each; barren stamen one (the dorsal one of the outer whorl), forming a dilated fleshy appendage above the stigma. Pollinia granular, not waxy. Stigma terminal, broad, rough.

791. Cypripedium parviflorum Salisbury. Small Yellow Lady-slipper. Woods and thickets, E. K., west to eastern edge of Shawnee county; rare. May–June. (ASU)

Family 60. ORCHIDACDEÆ. Orchis Family.

Perennial terrestrial herbs, often bog-plants, never epiphytic in this latitude, from bulbs, corms, rootstocks, or tubers, with soft, broadly expanded, campylodrome-nerved, sheathing or clasping laminodia, sometimes reduced to mere scales with full sheaths. Perianth-segments differing decidedly, the odd outer segment upward usually much prolonged, and the odd inner segment downward, termed the lip, of some bizarre shape different from all the rest and specialized for a particular purpose. Stamen one, the dorsal one of the outer whorl, above; anther with two or four single or doub e sporanges; dehiscence opercular. Pollinia in two or four, rarely eight, masses, cohering by waxy threads, attached at the base to a viscid disk and liberated when the proper kind of insect visits the flower. Staminodia two, the dorso-lateral ones of the inner whorl, each one lying in an androclinium on either side of the stigmatic column. Dorsal carpel above barren and prolonged into a rostellum overhanging the lip; ventro-lateral carpels below fertile; stigmas viscid and receptive, and facing the lower petal in such a way as to remove the pollen brought from another flower on the head or body of its special insect, while the insect is engaged in taking nectar from the nectar-cup. After this operation the insect receives a charge of pollen from the anther over its back. The nectar in the cup or chalice is the insect's reward for service performed, namely: pollination of the flower, which could scarcely be effected otherwise; yet is absolutely essential to perpetuation of the species. In the economy of nature the service and the reward are equal.

792. Pogonia ophioglossoides Ker. Snake-mouth. Damp meadows, E. K.; occasional. June.

793. Triphora trianthophora Rydberg. Nodding Beard-lip. Rich woods, E. K.

794. Spiranthes cernua Rich. Nodding Lady-tresses. Meadows, Kaw valley west to Ellsworth, and from Kinsley down in the Arkansas valley. July. (ASU)

795. Spiranthes vernalis Engelm. & Gray. Spring Lady-tresses. Grassy meadows, E. K., west to Council Grove; not common. July. (S)

796. Spiranthes gracilis Beck. Slender Lady-tresses. Dry woods, extreme E. K.; occasional. August.

797. Blephariglottis leucophæa Rydb. Prairie Fringed-orchis. Moist prairies, E. K.; frequent. June. (ASU)

798. Oncidium tigrinum La Llave and Lex. Tiger Orchis. Occasional in the best houses.

799. Cattleya mendellii (Hort.) Mendell's Cattleya. Occasional in private houses.

800. Orchis spectabilis L. Showy Orchis. Rich, shady woods, Doniphan to Wyandotte county, along the Missouri river; rare. May. (AU)

INDEX.

A PARTIAL KEY TO THE GENERA OF NORTH AMERICAN JASSOIDEA.

S. E. CRUMB.

(By permission of the Chief of the Bureau of Entomology.)

THE hemipterous group Jassoidea includes such Homoptera as have many spines on the hind tibiæ and also have the antennæ inserted between the eyes.

Because of their abundance, the increasing recognition of their economic importance, and the lack of knowledge concerning the distribution, habits and life histories of the greater number of the species, these interesting insects deserve more general study. The present paper is to some degree tentative and experimental, but is offered in the hope that it may be of use to students in arranging their material. The subfamily Athysaninæ, in the Acocephalidæ, and the family Typhlocybidæ are not treated.

Literature on the genera and higher groups of America north of Mexico has appeared as follows:

Mr. Wm. H. Ashmead (Ent. Amer., v. 5, July, 1889) and Mr. E. P. Van Duzee (Ent. Amer., v. 5, Sept. 1889) each published a key to the genera of Bythoscopidæ from Edwards' "Synopsis of the British Cicadinæ." Prof. Chas. W. Woodworth (Psyche, v. 5, pp. 211–214, July, 1889) gave a synopsis of the genera of Typhlocybidæ (Typhlocybini). Mr. Van Duzee (Trans. Am. Ent. Soc., v. 19, pp. 295–307, 1892), in his well-known "Synopsis," gives keys to the families and to the genera of Acocephalidæ (Jassidæ). Prof. C. F. Baker (Psyche, v. 8, p. 76, 1892) erected the family Kœbelidæ (Kœbeliinæ). Prof. C. P. Gillette (Proc. U. S. Natl. Museum, v. 20, pp. 709–773, 1898) monographs the Typhlocybidæ (Typhlocybinæ), and Dr. E. D. Ball (Proc. Iowa Acad. Sci., v. 8, 1901) has done the same for the Tettigoniellidæ (Tettigonidæ) in part. Prof. Herbert Osborn (Bull. 97 N. Y. State Museum, p. 500, 1905) gives a key to the families.

The late Dr. F. H. Snow and Prof. S. J. Hunter of the University of Kansas, by their kindness and coöperation made this paper possible. Much of its completeness is due to work done in the National Museum, through the courtesy of Dr. L. O. Howard and Messrs. J. C. Crawford, jr., Otto Heidemann, W. D. Hunter, and A. C. Morgan. To all these, and to those who by gifts of material

and other favors have been of assistance, the author desires to express his hearty thanks.

Several terms used in the keys may require explanation. The term *vertex* is loosely applied to all the head, exclusive of the eyes, which is visible from directly above. The width is measured at the narrowest point between the eyes. The part extending back of the eyes is not considered in discussing the shape of the vertex. The *face*, likewise, includes all of the head, exclusive of the eyes, which is visible from directly below. The clypeus is said to be expanded at the apex when it is broader at or near the apex than at some point nearer the clypeal suture. Other details are given in plate I.

Many species, especially in the Jassidæ and Acocephalidæ, are sexually dimorphic, and occur frequently in both short- and long-winged forms.

FAMILIES OF JASSOIDEA.

A. Ocelli on face below anterior margin of vertex.

B. With a broad, thin margin between vertex and front ....KŒBELIDÆ

BB. Without a broad, thin margin between vertex and front. Front less than three times as long as its width between the antennæ. Loræ usually enclosed below by the margin of the cheek.

C. Vertex and front distinctly limited............................PAROFIDÆ

CC. Vertex and front not distinctly limited, but rounding into each other. Ocelli exposed on the face in very slight impressions or none. BYTHOSCOPIDÆ

AA. Ocelli on the vertex.

B. Ocelli rarely nearer anterior margin of vertex than posterior. Inner margin of eye not depressed below the vertex bordering it. Lateral carina of pronotum not below center of eye (except in *Bathysmatophorus*). Ocelli prominent.

C. Form narrow, cylindrical. Profile of face and vertex rounded or obtuse Vertex usually bright colored or bearing curved or branching lines. TETTIGONIELLIDÆ

CC. Form depressed, broader. Profile of face and vertex acute, or the face impressed immediately beneath the vertex, producing a more or less rounding or overhanging ledge (except in *Bathysmatophorus*). Vertex rarely bright colored, and marked, if at all, with a few straight longitudinal stripes...GYPONIDÆ

BB. Ocelli very near anterior margin of vertex; much nearer anterior margin than posterior.[1] Inner margin of eye depressed distinctly below the vertex bordering it. Lateral carina of pronotum below center of the eye; usually abruptly descending back of eye. Ocelli often indistinct.................................JASSIDÆ

AAA. Ocelli on or very near anterior margin of vertex, or wanting.[1]

B. Elytra often subcoriaceous, usually angulated at tip of clavus; clavus acute, subacute or blunt, never attenuately pointed (plate I, fig. 7). Ocelli rarely absent although often hard to distinguish.........................ACOCEPHALIDÆ

BB. Elytra membranous, not angulated at tip of clavus; clavus attenuately pointed (plate I, fig. 5); elytra always much longer than the abdomen. Ocelli rarely present ....TYPHLOCYBIDÆ (Plate I, fig. 6.)

1. In such genera of Acocephalidæ (*Stronglylocephalus* and *Acocephalus*) as might be confused with Jassidæ because of the position of the ocelli, which are placed superiorly very near the anterior margin of the vertex, there is a strong, narrow emargination of the eye next the entennæ. This is not found in the preceding groups.

GENUS OF KŒBELIDÆ.

Front three times as long as its width between the antennæ. Loræ not enclosed below by the margin of the cheek....................................*Kœbelia* (Plate II, figs. 8 and 9.)

GENUS OF PAROPIDÆ.

Each ocellus set in a broad, deep, oblique groove....................................*Paropuloxa*

GENERA OF BYTHOSCOPIDÆ.

A. Pronotum without a lateral carina. Side margin of pronotum very short or absent.

B. Pronotum strongly, subangularly produced between the eyes. Extreme tip of elytron at or below the center of elytron. Venation clean-out, elevated.

C. Vertex rounded rectangular. Indefinite striations of pronotum extending diagonally backward each side of the median line...........*Pediopsis*

CC. Vertex rounded, angle greater than a right angle. Indefinite striations of pronotum usually transverse..............................*Bythoscopus*

BB. Pronotum rarely subangularly produced between the eyes (sometimes so in *Agallia*). Vertex transverse, obtusely angled, often parallel margined. Elytral veins not elevated.

C. Elytra not overlapping at apex (appendix not developed). Clypeus usually parallel margined. Extreme tip of elytron above center of elytron. (2) *Agallia*

CC. Elytra overlapping at apex (appendix strongly developed). Clypeus expanded at apex...*Idiocerus*

AA. Pronotum with a distinct lateral carina and comparatively long side margin; flaring behind; anterior margin broadly, gently, curved. Elytra more or less punctured, usually pubescent or hairy.

B. Pronotum not wider behind than the head. Clypeus strongly tapering. Front not wider than the clypeus at the suture.................................*Straganiopsis*

BB. Pronotum wider posteriorly than the head. Clypeus parallel margined. Front distinctly wider than the clypeus at the suture..........................*Macropsis*

GENERA OF TETTIGONIELLIDÆ.

A. Lateral carina of pronotum (arising back of center of eye) present; strongly obliquely ascending to the posterior angle of pronotum. Root of elytron, viewed from the side, higher than the eye.

B. Margin of vertex above antennal pit, viewed from above, not emarginate in front of eye; not exposing any basal joints of the antennæ. Clypeus as long as broad and widest beyond the base.

C. Profile of vertex rounding on to the front, from which it is not distinctly separated. Elytra subcoriaceous, membraneous only at tip..*Oncometopia*

CC. Profile of vertex flat and distinctly separated from the front. Elytra usually more or less vitreous throughout.....................*Homalodisca*

BB. Margin of vertex above antennal pit, viewed from above, emarginate in front of eye; exposing one or more basal joints of the antennæ. Clypeus broader than long and widest at base..*Aulacizes*

AA. Lateral carina of pronotum gently ascending, subhorizontal, or absent. Root of elytron, viewed from the side, not higher than the eye.

B. Posterior margin of pronotum long; the margin straight, or broadly gently, emarginate.

C. Elytra not reticulate veined at apex and not punctate. Lateral carina usually present on pronotum.

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2. Kirkaldy (Bull. 3. Hawaiian Sugar Planters' Ass., pp. 30–31; 1907) has divided the genus *Agallia* into three genera, *Aceratagallia*, *Agalliopsis*, and *Agallia*, representing groups AA., A. BB., and A. B., respectively, of Osborn and Ball's synopsis of *Agallia* (Proc. Dav. Acad. Sci., v. 7, pp. 47–48, 1898). These have not been included here, as the groups do not seem to have more than subgeneric value.

GENERA TETTIGONIELLIDÆ.—*continued.*

D. Vertex and front, in profile, not distinctly limited but rounding into each other. Vertex variously marked but without a dark line on anterior margin............................③ *Tettigoniella*

DD. Vertex and front, in profile, distinctly limited. Vertex usually with a dark line on anterior margin................*Diedrocephala*

CC. Elytra reticulate veined at apex. Lateral carina of pronotum absent. *Dræculacephala*

BB. Posterior margin of pronotum short; rather abruptly emarginate. Elytra closely punctured. Lateral carina of pronotum absent........................*Helochara*

GENERA OF GYPONIDÆ.

A. Pronotum with a distinct humeral margin (plate I, fig. 1, *Hm.*). Lateral carina of pronotum normal.

B. Humeral and posterior margins of pronotum subequal. Posterior margin narrowly emarginate. Pronotum and claval areas coarsely pitted. Profile of vertex and front acute and but very slightly depressed below the anterior margin. *Xerophloea*

BB. Humeral margin of pronotum less than half as long as posterior margin. Posterior margin broadly, gently, emarginate. Pronotum and claval areas neither punctate nor pitted.

C. Clavus not truncate at tip. Frontal sutures not appearing on the vertex...*Gypona*

CC. Clavus broadly truncate at tip. Frontal sutures attaining the ocelli. *Penthimia*

AA. Pronotum without a humeral margin.

B. Pronotum wider posteriorly than the head. Ocelli about midway between anterior and posterior margins of vertex. Lateral carina of pronotum usually abrubtly descending back of eye............................④ *Bathysmatophorus*

BB. Head as wide as pronotum. Pronotum but little flaring. Ocelli nearer anterior than posterior margin of vertex. Lateral carina of pronotum straight. *Errhomenellus*

GENERA OF JASSIDÆ.

A. Front widest at base. Clypeus at most but gradually enlarged toward the apex; usually parallel margined or tapering.

B. Vertex with a median carina, which also extends down the front. Clypeus tapering...*Euacanthus*

BB. Vertex and front without a median carina.

C. Clypeus tapering to a rounded apex. Vertex not distinctly or subequilaterally pentagonal. Anterior margin of pronotum produced far between the eyes and nearly straight. Eyes rather prominent. Vertex, and profile of front and vertex, strongly conical. Antennæ of normal length...*Pagaronia*

CC. Clypeus parallel margined or expanded at apex. Vertex distinctly and subequilaterally pentagonal. Anterior margin of pronotum gently curved. Profile of front and vertex usually obtuse. Antennæ exceedingly long..⑤ *Neocœlidia*

AA. Front as wide at clypeus as at base. Clypeus very strongly, abruptly, enlarged at apex.

B. Vertex cuneiform. Scutellum very small...*Tinobregmus* (Plate II, figs. 1 and 2.)

BB. Vertex subquadrate. Scutellum very large.........*Jassus* (Plate I, figs. 8 and 9.)

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3. Distant (Faun. Brit. India, v. 4, p. 223; 1907) has erected the genus *Kolla* to include such species of Tettigoniella (*tripunctata, geometrica, bifida*, etc.) as have the head particularly deep and short. Tettigoniella, as thus limited, would include such species as *hieroglyphica* and *gothica*.

4. These last two genera appear to have no special relationship with each other, and little with anything that precedes or follows.

5. *Paracœlidia* Baker was founded (Can. Ent., v. 30, p. 292) upon *P. tuberculata* from the Atlantic coast. It differs from *Neocœlidia* only in having the clypeus tuberculate near the apex, and is not included here, as this character does not seem to be of generic importance.

SUBFAMILIES OF ACOCEPHALIDÆ.

A. Frontal suture arising or directed between the ocelli (plate II, fig. 4), [6] or the ocelli placed superiorly near anterior margin of vertex. Pronotum usually with a lateral carina. Clypeus with margins parallel or strictly subparallel (except in *Platymetopius*). ACOCEPHALINÆ

AA. Frontal suture arising directly beneath ocellus or between ocellus and eye (plate I, fig. 2). Ocelli on anterior margin of vertex before the eye. Pronotum rarely with a lateral carina. Clypeus parallel margined or not..ATHYSANINÆ

GENERA OF ACOCEPHALINÆ.

A. Ocelli either placed superiorly near anterior margin of vertex or on the anterior margin with the profile of face and vertex broadly rounded. Elytra longer than abdomen. Claval suture not distinctly curved at tip..*Acocephalini*

- B. Vertex not rectangular, including distinctly less than two-thirds the length of the pronotum. Clavus not punctate-striate.
  - C. Ocelli superior. Front broad, flat. Size medium or rather small.
    - D. Extreme tip of elytron at center of elytron. Vertex with striæ parallel to anterior margin....................*Strongylocephalus*
    - DD. Extreme tip of elytron distinctly above center of elytron. Anterior margin of vertex not striate....................*Acocephalus*
  - CC. Ocelli on obtuse, rounded margin of vertex and margined with pale, Front swollen, very convex. Size very small. *Xestocephalus* (Plate II, figs. 10 and 11.)
- BB. Vertex rectangular, including two-thirds the length of the pronotum. Clavus strongly punctate-striate................*Goniagnathus* (Plate II, figs. 12 and 13.)

AA. Ocelli before middle of eye on anterior margin of vertex, Profile of face and vertex usually acute and never broadly rounded. Eyes without an antennal emargination. Elytra often shorter than abdomen. Claval suture curved at extreme tip......*Dorydini*

- B. Vertex and face in profile not separated by a thin margin or by a line beneath the anterior margin of vertex. Lateral carina of pronotum distinctly oblique. [7] *Memnonia* (Plate II, figs. 5 and 6.)
- BB. Vertex and face in profile, separated either by a thin margin or by a pigment line beneath anterior margin of vertex.
  - C, Vertex rarely acutely angled, but broad, ligulate, or roundingly produced. Clypeus not expanded at apex. Front usually distinctly less than three times as long as its middle breadth.
    - D. Without pigment lines in cells of elytra.
      - E. Vertex with a median carina. Claval veins united posteriorly.
        - F. Vertex usually ligulate; at least twice as long as broad. Pronotum without a distinct median carina................................*Dorycephalus*
        - FF. Vertex bluntly conical; less than twice as long as broad. [8] Pronotum with a distinct mediam carina. Color black, *Neoslossonia* (Plate II, fig. 7.)
      - EE. Vertex without a median carina. Claval veins not united posteriorly. but running separately to the margin of elytron (except in *Spanbergiella*).
        - F. With but one claval vein. Vertex and pronotum bearing converging red stripes. *Spanbergiella* (Plate II, figs. 3 and 4.)

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6. Be careful not to mistake a color line curving inward below the ocellus for the frontal suture.

7. In forms under BB, likely to be confusing because of the character of the profile, the lateral carina of pronotum is distinctly horizontal.

8. Only the male of *Neoslossonia* is known. The female may more closely resemble *Dorycephalus* in the character of the vertex.

GENERA OF ACOCEPHALINÆ.—*continued.*

FF. With two claval veins.

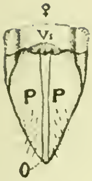
G. Vertex bearing parallel longitudinal stripes or none. Outline of vertex in female (plate I, figs. 3 and 4) with a slight, abrupt emargination at anterior point of eye................................*Hecalus*

GG. Vertex and pronotum never with more than a median white line. Vertex without an emargination at anterior point of eye........................*Parabolocratus*

DD. With pigment lines in cells of elytra..................*Dicyphonia*

CC. Vertex acutely angled. Clypeus distinctly expanded at apex. Front three or more times as long as its middle breadth..........*Platymetopius*

PLATE I.



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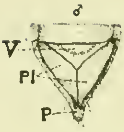

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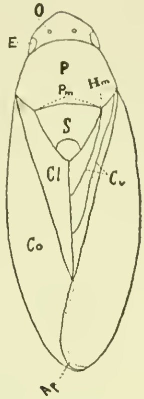

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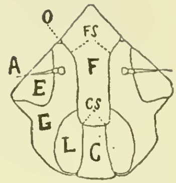

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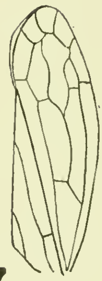

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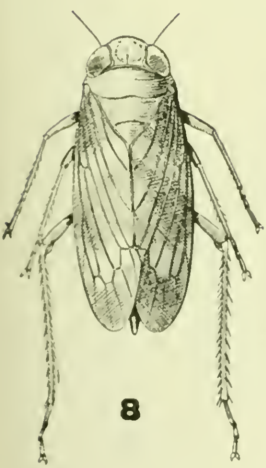

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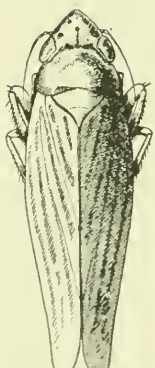

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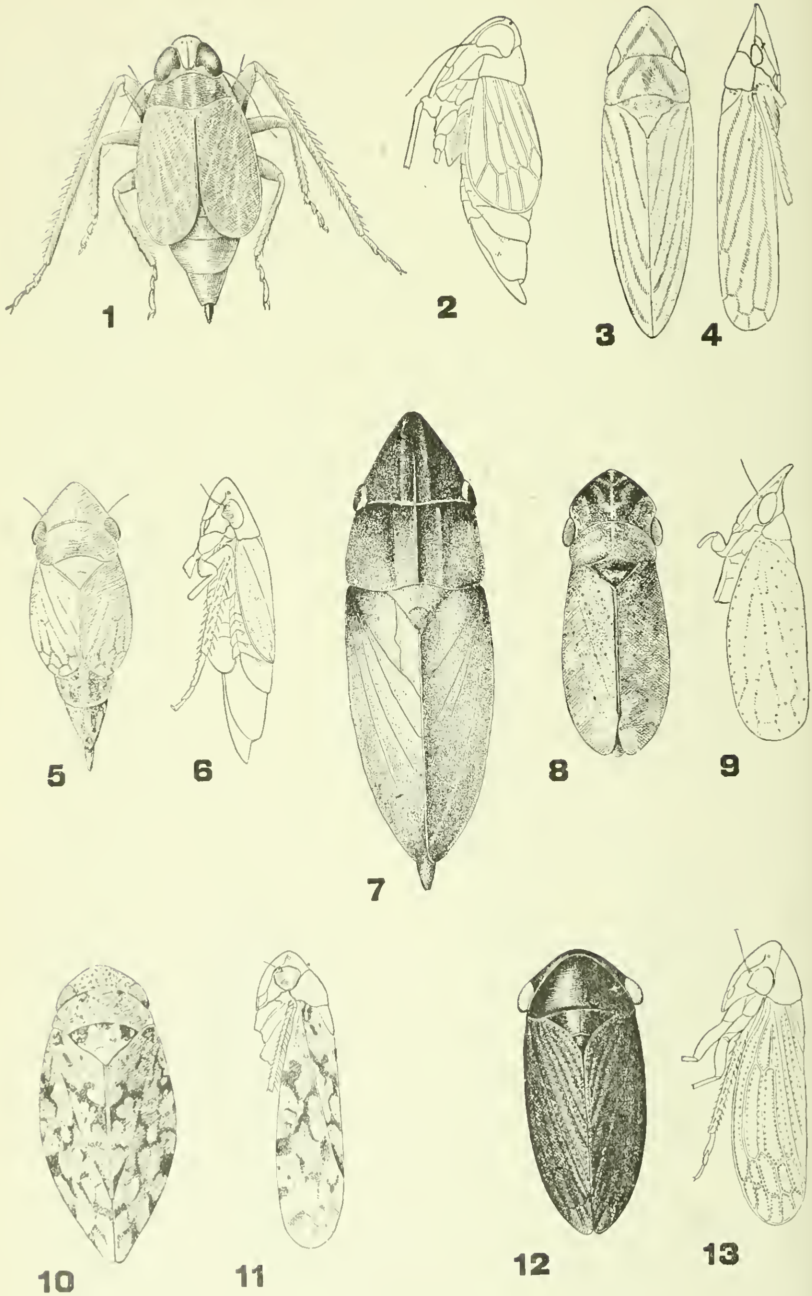
PLATE II.



Bibliographical data are given below on such genera included in this paper as have appeared in our fauna or have been erected since the publication of VanDuzee's "Catalogue of the Described Jassoidea of North America"(Trans. Am. Ent. Soc., v. 21, pp. 245-317; 1894). Type species are included in brackets.

Kœbelia Baker [californica Baker].
  Psyche, v. 8, pp. 76, 77; 1892.

Paropulopa Fieber [lineata Fieber].
  Neue Gattung und Arten in Homoptera. Verhandlungen der k. k. Zool Bot. Gesell., v. 16; Wien 1866.

Straganiopsis Baker [idioceroides Baker].
  Invertebrata Pacifica, v. 1, p. 10.

Kolla Distant [insignis Distant].
  Fauna British India, v. 4, pt. 1, p. 223; 1907.

Tettigoniella Jacobi [viridis Linn].
  Tetigonia Geoffroy Hist. abrégée des Ins., v. 1, p. 429; 1799. [nom. præocc.]
  Tettigoniella Jacobi Zool. Jahr. Syst., v. 19; p. 778; 1904. [nom. nov.]

Errhomenellus Puton [brachypterus Minck.] [Fieber.]
  Errhomenus Fieber Neue Gattung und Arten in Homoptern. Verh. der k. k. Zool-Bot. Gesell., v. 16, Wien, 1866. [nom. præocc.]
  Errhomenellus Puton Catalogue des Hémiptéres 1899. [nom. nov.]

Bathysmatophorus Baker [uhleri Baker] = [Uhler Mss. Lystridea conspersa].
  Psyche, Sept., 1898, pp. 260, 261.

Pagaronia Ball [13-punctata Ball].
  Can. Ent., v. 34, p. 19; 1902.

Neocœlidia Gillette and Baker [tumidifrons G. & B.].
  Colorado Ag. Ex. Sta. Bull. 31, p. 103; 1895. Emended Can. Ent., v. 30, p. 289; 1898.

Memnonia Ball [consobrina Ball].
  Proc. Iowa Acad. Sci. for 1899 (1900), p. 66.

Neoslossonia Van Duzee [putnami Osborn] = [atra Van Duzee].
  Van Duzee Bull. Buffalo Soc. Nat. Sci., v. 9, p. 218; 1909.
  Osborn Proc. Davenport Acad. Sci., v, 10, p. 163; 1907. Described putnami.

Dicyphonia Ball [ramentosa Ball].
  Proc. Iowa Acad. Sci. for 1899 (1900), p. 69.

INSECTICIDES.

By L. E. Sayre.

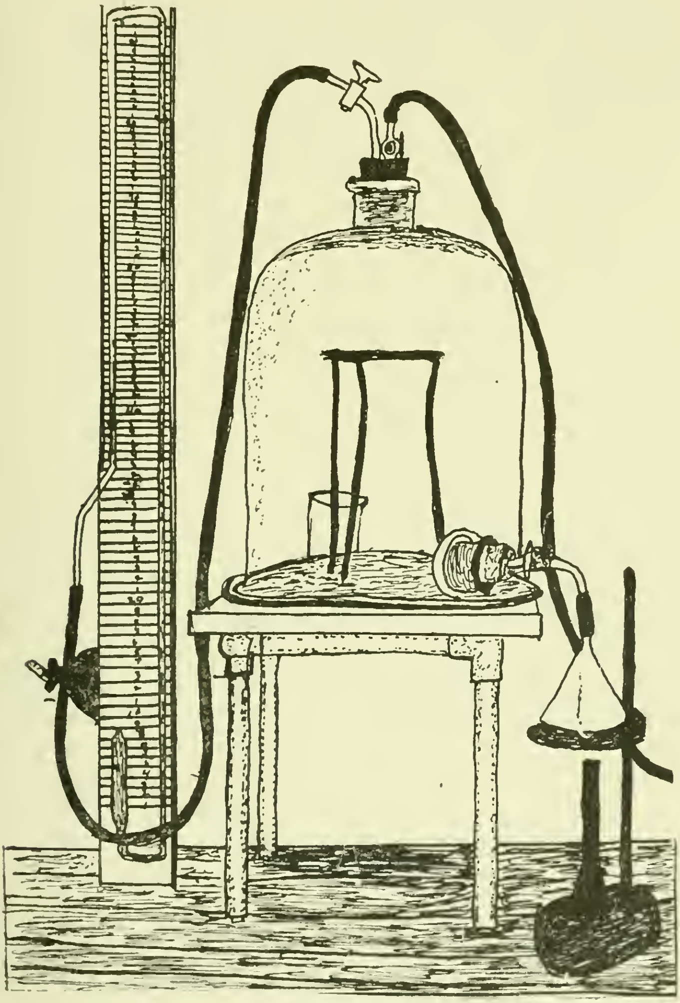
SINCE the enactment of the food and drugs law there has been a tendency toward standardization of all substances in any way allied to drugs and poisons, as well as of foods and food accessories. The federal insecticide regulation No. 16 requires the ingredients of insecticides to be disclosed when containing arsenic or any of its combinations.

Insecticides, other than arsenical combinations, and fungicides containing inert substances which do not prevent, destroy, repel or mitigate insects or fungi, must bear a statement on the label of the name and percentage of each inert substance therein, unless the name and percentage of each active ingredient of the article is plainly and correctly stated, in which case it will be sufficient to state on the label that the article contains inert substances, giving correct percentage thereof.

Our knowledge of insecticides and fumigants up to recent times has been very inaccurate. Investigators having been drawn to the subject by the attitude occasioned by the federal and state regulations, more accurate information concerning them is now possible.

In the Journal of the American Public Health Association, 1911, there is a valuable contribution to our knowledge of insecticides by McClintock, Hamilton, and Lowe. They have in this article ably discussed the subject, and have shown the results of their investigation, giving the relative value or cofficients of the popular toxic agents employed for the extermination of insect pests. An ingenuous apparatus has been devised by them, a rough diagram of which is here reproduced.

This apparatus is so constructed as to make possible the measuring of definite amounts of gases, which may be drawn from a container for any experiment. Such gases as illuminating gas. sulphur dioxide, carbon dioxide, hydrogen sulphide, etc., have been employed. Insects confined within the glass chamber of the apparatus and subjected to the influence of various insecticides can be watched and timed, so that the relative value of toxic action can be readily estimated. The insects experimented upon by the above investigators were bedbugs, cockroaches, house flies, clothes moths, and mosquitos. It was found that the minimum quantity necessary to kill the insects varied, of course, according to the toxic substances. For example, stating the quantity of sulphur dioxide necessary to kill the bedbug as 8, we have the quantity of formaldehyde (40 per cent solution) necessary to produce the same effect as 54 plus, making the calculated coefficient of sulphur dioxide,



Apparatus used by McClintock, Hamilton, and Lowe.

for this insect, as 1, and that of formaldehyde 0.1 The authors have tabulated in their report the coefficients of thirty-eight different insecticides, including such articles as the above mentioned, and, in addition, creosote, carbolic acid, naphthalene, kerosene, oil of turpentine, many essentials oils, benzaldehyde, hydrocyanic acid, such powdered substances as stramonium, sabadilla, and pyrethrum, etc.

Such investigations as the above and such regulations as made by the federal government make it now almost impossible for a manufacturer to delude or deceive the public by foisting upon it any insecticide nostrum whose ingredients are kept secret unless it bears the test which recent investigations have suggested.

Our own interest has been attracted to this subject by certain insecticides being sent to the drug laboratory to obtain a statement as to their efficiency. One such article, in particular, we have recently investigated. The article is sold on the market under a trade name, and in the advertisements it is stated that this article is "creating consternation and mortality among the bugs and insects in the jails, penitentiaries and public institutions in this country. It further says that it "kills bugs instantly, and they stay dead." This article is found to contain 6.5 per cent of carbolic acid, with other ingredients which are claimed to enhance the value of this popular insecticide. Applying the test of the above-mentioned investigators in an apparatus corresponding to theirs, which we have installed, we are able to state the following facts:

Bell-jar experiments were carried out to determine the effectiveness of a few of the well-known insecticides, as well as the commercial articles mentioned. Crickets (*Gryllus*) were the insects used in these experiments, their sensitiveness to toxic substances making them particularly valuable for this kind of work. Cimicifuga (bug bane) has long been considered an effective insecticide. Our experiments with cimicifuga, however, tend to show that this drug has been greatly overestimated in its toxic properties toward insects. Powdered cimicifuga seemed to be devoid of insecticidal properties. Crickets kept in contact with the powdered drug for hours showed no toxic effect.

As a fumigant cimicifuga proved unsatisfactory, acting more as an anæsthetic than as an insecticide. One hundred times as much powdered cimicifuga as the amount of sulphur that proved effective was used, or the fumes from two grammes of the drug in a space of 9000 cc. The insects were removed after a period of one hour, apparently dead, but recovered after an hour or two hours' time.

The fluid extract of cimicifuga was tried, employing the contact method in open jar. This preparation of the drug proved more effective, killing the insects almost instantly, but it was also observed that alcohol alone (which is the menstruum used in the manufacture of the fluid extract), would produce practically the same result, although recovery was noted in some cases. Aqueous preparations of cimicifuga were ineffective.

This is interesting, as cimicifuga is well known to be a plant which insects invariably shun in the open field, and hence its name — "cimic," a bug, and "fuga," to fly. This word was suggested by the peculiar property of the plant, which was in early times thought to be an insecticide.

The commercial insecticide above mentioned was tried in the same manner. By contact method in open jar it killed almost instantly. As a fumigant it had one-fiftieth of the toxic power of sulphur. This preparation, having the trade name of "Vermingo," is said to contain $6\frac{1}{2}$ per cent of carbolic acid, among other ingredients. As an insecticide, however, it is superior to $6\frac{1}{2}$ per cent of solution of carbolic acid by contact method, but not equal to a $6\frac{1}{2}$ per cent solution of carbolic acid used as a fumigant. The vapor from the commercial article, containing considerable oil not very volatile, seems to be heavy, and does not fill the space as readily as the vapors from an aqueous solution.

Pyrethrum was tested similarly as a fumigant, and proved not to be superior to cimicifuga, the insects recovering in every instance. Employing the contact method and using the powdered drug, the usual results were obtained that every one has experienced who has used this well-known insect powder.

I am indebted to Mr. G. N. Watson for his valuable assistance in these determinations.

A SYSTEM OF NOTATION APPLIED TO ENTOMOLOGICAL ACCESSIONS.

By E. S. TUCKER, Louisiana Agricultural Experiment Station, Baton Rogue, La.

THE object in presenting the following outlines for use of symbols to assign insect specimens with notes, and *vice versa*, is to proffer an aid such as has been utilized by the writer for the specification of different kinds and conditions of entomological material contained in an accession. When a collection is made of insects affecting one host or product, or otherwise pertaining to a certain subject, the specimens being obtained at the same time under like circumstances are recorded as an accession. Each accession is numbered consecutively, beginning with the figure 1, in accordance with the order of collection. Special symbols are proposed for the designation of particular steps in a progressive method of assorting the material of an accession with regard to classificatory and conditional discrimination of one or more species of insects.

In practice, the method has proved very convenient for conducting breeding experiments with different species belonging in a single accession. The procedure is especially valuable in preventing confusion or mistakes in the course of an investigation, and it effects an assignment of the records of biological facts in corresponding phases.

This plan is adapted to the expansible loose-leaf or card-filing system of keeping records. To maintain perfect connection between specimens and notes, the proper symbols used in each case need to be indicated with the detailed records, and the corresponding specimens should be similarly designated. When a specimen is mounted on a pin for preservation, a pin-label bearing the accession number and symbols should be given a prominent place among the other labels on the pin. Specimens in preservative solutions, or else mounted on slides, require the designations on an enclosed slip or attached tag. If distinguished by the symbols, any particular specimen, when wanted, may be readily picked out from a general collection. In breeding tests, specimens can be tagged in a suitable manner, but alteration of symbols is made to accord with change of stage and isolation. Connection between records, with modified symbols relating to a direct series, should always be signified by means of cross-references.

OUTLINES FOR USE OF SYMBOLS.

Characters possessing a more distinctive appearance than would be presented by a decimal arrangement, even if such could be conveniently applied, have been selected for the symbols. The accession number, in Arabic figures, must precede everything for designation of and reference to the original record, together with its specific notes and detailed additions.

First. For the first series of symbols, to indicate nature or general classification of specimens, use Roman numerals as assigned below. Consistency in the use of these symbols relates to all accessions alike.

I. Mixed collection if not specified further, and to include invertebrates other than insects or their associated allies.
II. Dipteroidea: the flies and fleas.
III. Lepidopteroidea: the butterflies and moths.
IV. Hymenopteroidea: bees, wasps, ants, stinging parasites, and sawflies.
V. Coleopteroidea: beetles, weevils, and twisted-winged parasites.
VI. Neuropteroidea: the inactive metomorphic nerve-winged insects.
VII. Hemipteroidea: the true sucking bugs and lice.
VIII. Orthopteroidea: the leathery-winged insects.
IX. Platyptera: termites and mandibulate lice.
X. Archiptera: the active metamorphic nerve-winged insects.
XI. Aptera: wingless and nonmetamorphic insects.
XII. Myriapoda: centipedes and thousand-legged worms.
XIII. Arachnida: spiders, ticks, mites, and their near relatives.

Second. For the second series of symbols to denote the separation of species for determination and investigation, use capital letters. Species should be recorded by scientific names if known at the time of assignment, but names may be learned later, since they are not required for conducting observations when symbols are used.

The necessity of a considerable latitude in the application of symbols in this series requires a different degree of fitness in comparison with the preceding and succeeding series, in so far that the assignment of a letter to a species in one of the groups as designated in the first series is made independent of the use of an identical letter in another group, either in the same or separate accession. The letters can therefore be used in any group without regard to another, but each character must not be applied to more than one species in the same accessional group.

In case more characters than are offered in the alphabet are needed for the designation of species in a group, the surplus material may be assigned to a separate accession, and then as-sorted independently. But if a continuation of specific assignments were desired, without resorting to a division of the material into limited accessions, letters can be used in double standing, and for further need use treble, and so forth. Such extensive demands for any group, however, is a very remote possibility.

Third. For the third series of symbols, to denote the stage or inseparable stages of a species, with or without host or enemy, either for rearing or preservation, use small letters as assigned herewith.

a. For adult, or mature stage.
b. For pupa or nymph, or metamorphic stage.
c. For larva or young, or larval stage.
d. For egg or ovum stage.
e. For inseparable stages, as in colonies.

Fourth. For the fourth series of symbols, to specify a separate specimen, pair or colony of any previously designated species, with regard to particular or collective stages, either to be preserved or else isolated for observational purposes, use Arabic figures in consecutive order.

SUMMARY.

An explanation of the entire plan for use of symbols may be summarized by steps composing the following course of procedure:

All insects contained in an accession are first sorted into superordinal groups as a basis of classification. Each group is then designated by a Roman numeral according to the assignment given.

The second step consists in separating the species in each group and indicating each species by a capital letter.

In the third step the separate or collective stages of each species are determined, and designated by a small letter, as per assignment.

Finally, each specimen or pair with respect to one stage, or colony with respect to collective stages, is numbered in consecutive order as desired for special designation. Arabic figures are used for numbering.

Example explained: 1.V.A.a.1.

1. Denotes first accession.
1.V. Indicates an assortment of insects belonging in the superordinal group Coleopteroidea, as found in the first accession.
1.V.A. Indicates the first specification of species sorted out from the previously designated group.
1.V.A.a. This refers the designated species to the adult stage, should such be the case.
1.V.A.a.1. Denotes first isolation or particular specification of one or a pair of adults as previously designated.

RECORD SHEETS.

The size of record sheets preferred by the writer is 5 by 8 inches. Its chief advantages are that it allows ample space for writing records, and is easily managed on a typewriter with which two forms are used, one being for accessions and experimental notes, and the other for references and bibliographies. Another specially prepared form of same size, however, is used for entering meteorological observations. Experimental data may first be written by hand on small temporary cards, but after being brought to a termination in respect to a degree of advancement, they should be copied onto the regular form for permanent filing.

BIOTROPISM.

By LYMAN C. WOOSTER, Ph. D.

WHEN Lamarck declared, in 1801 and 1809, that the effects of use and disuse on cells and organs are inherited, he raised such a storm of opposition that followers of Lamarck have been few from that time to the present. Indeed, Lamarck's theory has been killed many times, but always there have been a few faithful disciples ready to assist in its resurrection. Paleontologists have found Lamarck's theory so perfectly in accord with what they find in the crust of the earth that they, as a class, have followed his leadership in most things, styling themselves Neo-Lamarckians.

An increasing number of biologists in this twentieth century follow Lamarck in his contention respecting the inheritance of the effects of use and disuse of cells, organs and the individual; and declare, with him, that it is life (Aristotle's entelechy) that is the efficient agent in the modification of species to meet a changing environment, and that life is the bearer of such modifications, making possible their continued inheritance.

But the larger number of biologists (it is strange that they class themselves as biologists) maintain that the entelechies are the products of the chemist's crucible, and that environment, including the physical forces, is the chief agent in the development of the life powers. College textbooks on plant and animal physiology are loaded with discussions of geotropism, heliotropism, phototropism, thigmotropism, traumatropism, rheotropism, chemotropism, hydrotropism, aërotropism, thermotropism, and several other external influences, while not in a single textbook, not even in the latest dictionary, will be found biotropism, a perfectly legitimate word.

When a root pushes through the soil toward the center of the earth, this movement is said to be an example of geotropism, not biotropism; when a house plant bends toward a sunny window, the textbook makers say that it does so because of phototropism, and do not hint of biotropism, though the more careful ones admit that there is an inexplicable element in the problem.

This mechanistic tendency of so many human minds is probably due to the great preponderance of culture subjects in school and college curricula of the past several hundred years. The mathematical formulæ, especially, apply so readily in the explanation of the action of the physical forces, and the atomic theory serves the chemist so beautifully in the working out of his chemical reactions, that many old-time college-made biologists very naturally turn to these chemical and physical forces for the causes of vital phenomena. Hence we have the germ-plasm theory of Weismann, the laws of Mendel, and the attempts to find life in the crucible made by Loeb and Schaefer. The chemical and physical forces can be measured and expressed in terms of standard units, while life, a variable, does not lend itself so readily to the mathematically minded for expression.

Chemists, physicists and astronomers know that chemism, cohesion and adhesion, gravitation, all forms of radiant energy, and the influence that controls the arrangement of molecules in crystals, all obey laws that have not varied since the beginning of exact human observation. Every one, on the other hand, who has Aristotle's entelechy within him, knows that life is a variable which may do things differently to-morrow from what it does them to-day, in both instances under precisely the same external conditions.

This variability of life is worrying some of our modern biologists. Doctor Driesch, the great German vitalist, in a letter to Lovejoy, of Johns Hopkins University, says, in an excerpt quoted by Jennings, also of Johns Hopkins, and published in *Science* for October 4, 1912: "You are quite right in saying 'the biologist can not from the kowledge of total physical configuration predict what will happen even after he ha sobserved it.' This is, indeed, a consequence of my vitalism, and I am glad that you appreciate it. I reject absolute indeterminism, but accept experimental indeterminism." In their published correspondence in *Science*, continued for two or three years, neither Jennings nor Lovejoy gives any reasons for the fact that experiments on living organisms do give results of high certainty.

In several papers[1] read before this Academy during the past eight years I have reiterated the belief that the first activities of the first cell of protoplasm on earth must have been performed consciously; later, when these activities have been performed consciously many times, they became in part habitual in the individual, and by contined repetition through many generations they became largely subconscious and instinctive tendencies in the species.[2] We can

1. Volume XIX, The Genesis and Development of Human Instincts. Volume XXI, Part I, Antiquity of Man's Body-building Instincts. Volume XXII, Weismann's Germ-plasm Theory Untenable. Volume XXIV, Origin and Development of Plant and Animal Instincts.

2. Dr. Charles S. Minot, of Harvard, in his presidential address before the American Association for the Advancement of Science, in 1902, at Pittsburg, says, as a probable hypothesis, "that conscious actions are primary; reflex or instinctive actions secondary; or, in other words, that for the benefit of the organism, conscious actions have been transformed into instincts and reflexes."

merely prophesy as to the course of conscious activities in others; we can be fairly sure as to the form of movement of the subconscious activities; and can be nearly certain as to the ends that will be reached by the instinctive activities. The uncertainties in the second and third forms of activities are due to slow modifications of subconscious and instinctive powers by repeated additions and subtractions. Man shows in his body nearly one hundred and twenty vestigial parts, according to Wiedersheim, and sixty others whose functions are changing. But these slight daily variations in the subconscious and instinctive activities of plants and animals, with corresponding changes in the body parts, do not prevent successful experimentation with these organisms. This is common experience, and the fact that Jennings himself has been exceedingly successful in his experiments with lower organisms emphasizes this conclusion without in the least impairing the validity of indeterminate vitalism.

The conscious additions and subtractions to the various subconscious and instinctive forms of activity have another, though related, effect which is highly important in biology. These changes in the ego following the conscious use or disuse of parts finally result in the evolution of many new varieties, subspecies and species of plants and animals. These new forms are preserved through the inheritance of instincts modified consciously in the direction of greater efficiency, through isolation by means of barriers, and by the greater success of these organism, in their struggles for existence.

Many biologists deny the efficiency of consciousness in bringing about the evolution of new species, because they forget that consciousness, according to Doctor Minot, has the power to change the form of energy without itself being a form of energy or a state of protoplasm. From the simplest organisms, whether plant or animal, to most complex, consciousness is the directing influence. In organisms along the lines of ascent up to but not including man, with his powers of speech, and in the living protoplasmic cells of all organisms, including those of man's body, needs are felt, and met, not by a course of reasoning requiring language, but by a somewhat blind feeling that the action felt to be best is the one to be taken.

If consciousness did not have this power with race and individual memory to direct race and individual development, there could be no orthogenetic evolution. The bodies of organisms, however complex, could not be built from the simple fertilized egg cell, and cells of complex organisms could not modify their internal structure and multiply in number to meet increased needs nor fail to do so when disused. All our notions of efficiency compel us to believe that there are cell egos as well as individual egos to consciously superintend the multiform activities of every organism composed of many cells.

Man in some respects is in a class by himself. Language, with its rich supplies of concepts, is such a help to the conscious powers that this lord of creation can determine by a course of reasoning what is best to be done long before his body can evolve parts with which to do it. So he makes external provisions for his needs, and many of his body cells and organs, except those of his brain, stop evolving higher powers. It is for this reason that man's body is on a level with the world of animals, while his mind has kinship with the God of the universe.

V.

MISCELLANEOUS PAPERS.

1. "On the Immunity of the Kansas Bottom Ground Waters to Changes in the Composition of the Kansas River Water."
   By Prof. C. C. Young.
2. "The Common Mole—Runway Studies."
   By Theo. H. Scheffer, U. S. Biological Survey.
3. "The Longevity of Yale Graduates."
   By J. T. Lovewell.
4. "Has the Quality of Drugs Improved Since the Enactment of the Food and Drugs Law?"
   By M. N. Wedel and L. D. Havenhill.
5. "A Further Discussion of Municipal Ownership of Water and Light Plants."
   By J. A. G. Shirk.

ON THE IMMUNITY OF THE KANSAS BOTTOM GROUND WATERS TO CHANGES IN THE COMPOSITION OF THE KANSAS RIVER WATER.

By Prof. C. C. Young.

THE extended period of dry weather during the three years previous to the series of analyses following led to a shortage of ground water in the bottoms where the Lawrence Water Company obtains the supply furnished the city. It was deemed advisable to have some check on the water company, so that we would be able to tell when Kaw river water was used to reinforce the insufficient ground-water supply.

From time to time during the years 1909, 1910 and 1911 sufficient analyses of the Kaw and the Lawrence city supply had been made so that it was certain that the ground water was very nearly constant in composition, while the river varied over wide limits.

Collection of samples for comparative analyses from the Kaw and city supply was commenced on January 9, 1912. The chlorine content of the city supply at that time was 60 parts per million, which is about normal for that time of year. The river showed 168 parts per million. On January 10 the tap water contained 88 parts per million and the river 142. A trip to the pump house revealed the fact that the water company had the suction line to the river wide open and were pumping river water. The use of varying amounts of river water continued until February 9, when its use was discontinued until the period from November 22 to December 16.

The breaks in the chlorine content for the city water are very marked, and show readily the admixture of river water with the ground supply. A simple calculation will give almost the exact amount of river water that had been added at any one time.

The statement is often made by the layman, and, I am sorry to say, by some engineers, that the water pumped from the Kaw bottoms is nothing more than river water that filters back through the sand into the wells, but a study of the curve will show that the composition of the ground water is affected only slightly by season changes, and not at all by the composition of the Kaw. For instance, the time between February 15 and June 1 is the highest period of chlorine in the ground water and the lowest in the river.

The lowest values for chlorine in the city supply are during high time of chlorine in the river. It will be seen that the low values for chlorine in the river is during the period of greatest precipitation, and the opposite is true of the city supply. If the river had the slightest effect on the ground-water composition it would unquestionably show up on this supply, for, as may be seen by a

PLATE I.

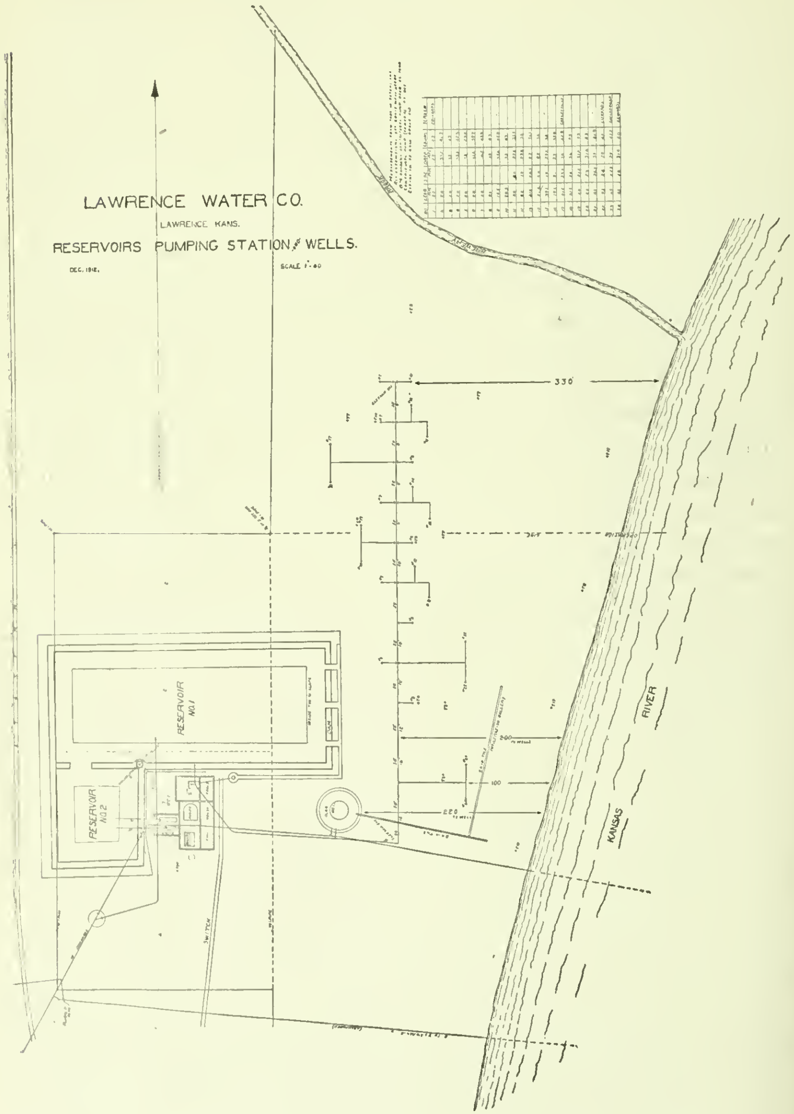
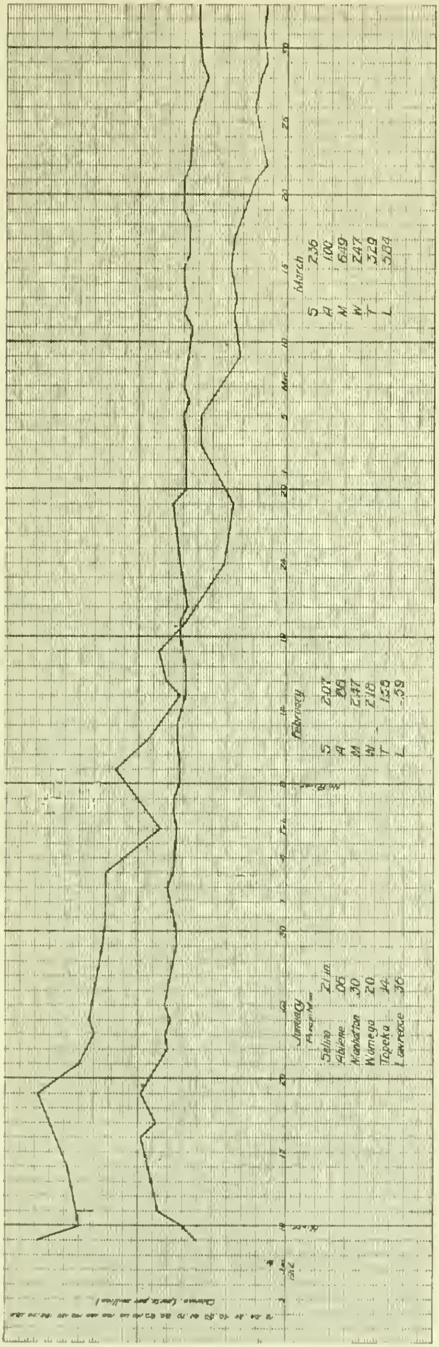
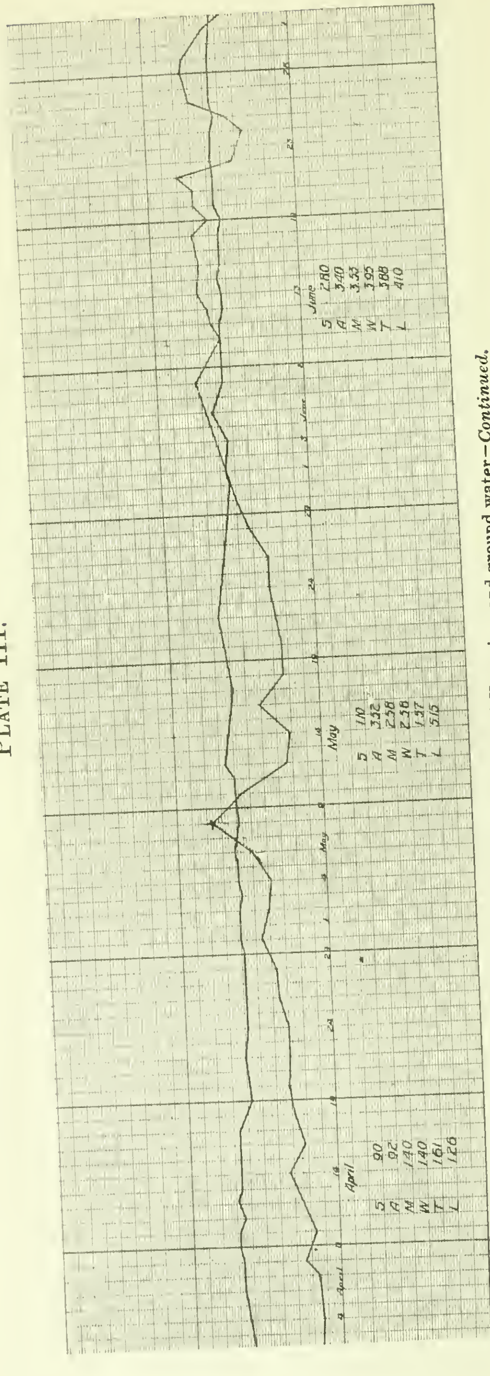


PLATE II.



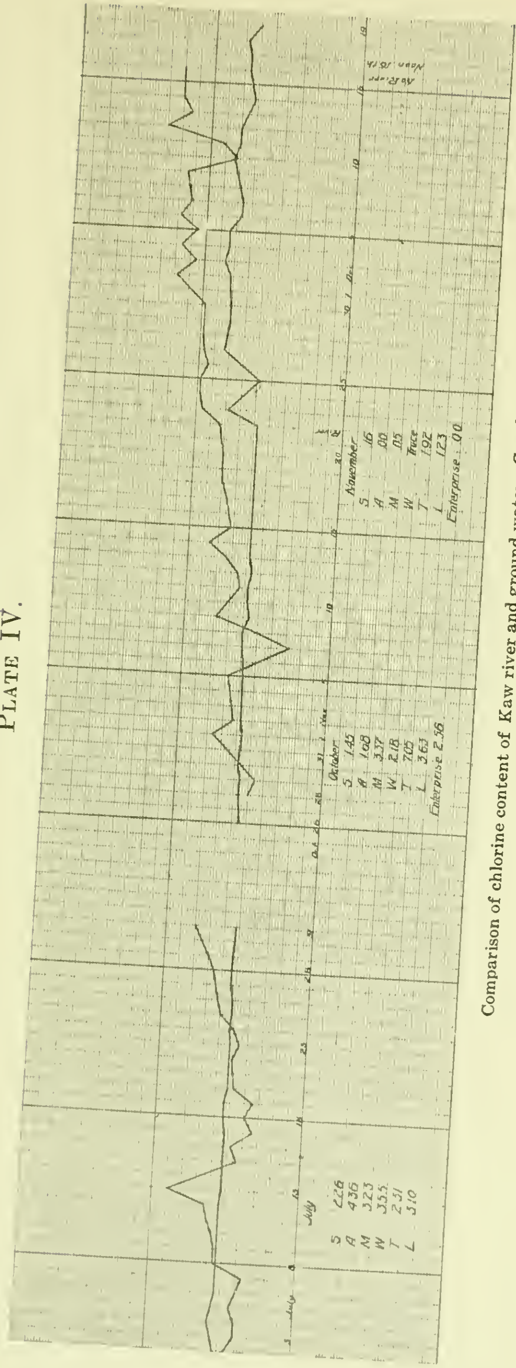
Comparison of chlorine content of Kaw river and ground water.

PLATE III.



Comparison of Chlorine content of Kaw river and ground water—*Continued.*

PLATE IV.



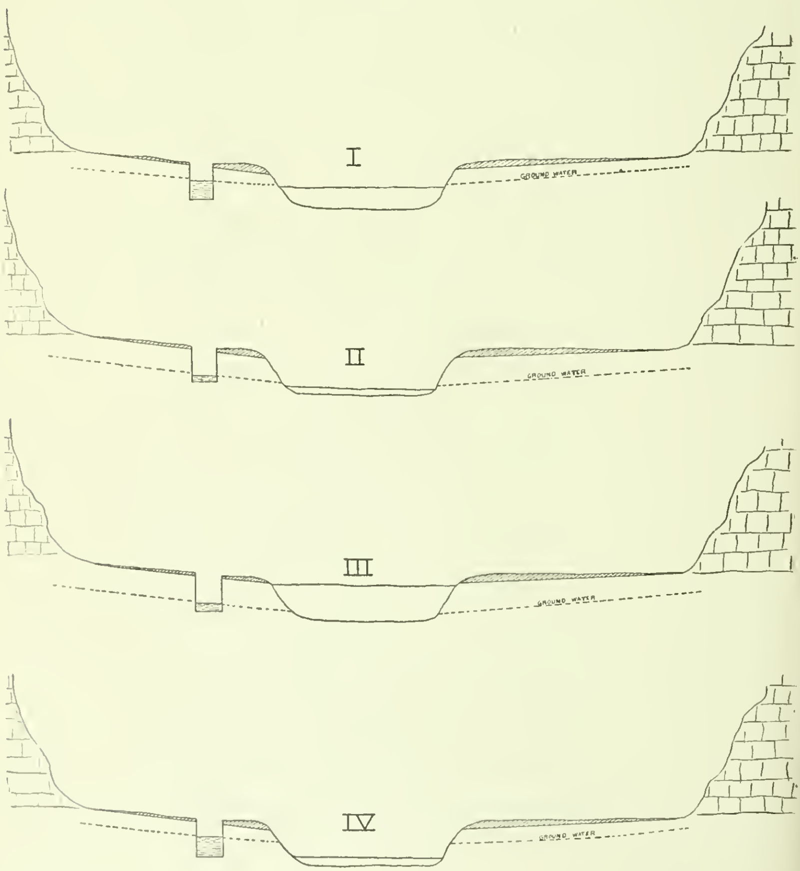
Comparison of chlorine content of Kaw river and ground water—*Concluded.*

glance at the map, a very large portion of the supply is obtained within 150 feet of the river banks. The plan of the Lawrence Water Company's collection system is shown herewith.

The one effect that the river has on the ground water is to cause it to raise or lower according to the height of the river. The river does not filter back through the sand to raise the water in the wells, however, but its effect is explained by the geologist in a similar way to that portrayed in the accompanying sketches.

No. 1 shows the normal condition of the river when it is flowing with the bed well filled and the ground water at sufficient height and working under just enough head to pass into the river against the back pressure of the water in the stream. That this condition exists ordinarily is illustrated by the fact that the flow over the dam at Lawrence is one-fourth greater than the combined flow of

PLATE V.



the Kaw at Manhattan and all streams tributary to the Kaw between Lawrence and Manhattan. This reinforcement could have come only from the ground water.

No. 2 shows the condition during a dry time, when if it were not for the stored ground water reinforcing the Kaw it would go dry in a few days.

No. 3 shows the condition that exists when there is a sudden rise in the river sufficient to make the water level much higher in the stream than in the wells. It is this condition that gives the appearance of the river flowing back through the sand into the ground, for the water commences at once to rise in the wells. From the opinion of many eminent geologists, and from a study of the chlorine curve of the river during March, 1912, when this condition existed, I can but conclude that the river does not flow back to the wells, but the raise in the bed is sufficient to create enough head so that the ground water can not enter the river, so must back up in the water-bearing sand and gravel, exactly like any large stream will back up a smaller when the rise comes quickly in the large stream.

No. 4 represents the condition that existed after the floods of 1903, 1904 and 1908, when the river receded rapidly after an extended period of high water, and the ground-water level had risen with the heavy rains and been held in the ground by the flooded streams. At the times mentioned water could be obtained easily by removing the surface soil and scooping out a few inches of sand or gravel.

A few days after the river went down the ground-water level commenced to lower, and continued to do so slowly until the condition shown by the first sketch was again established.

These facts, stated as briefly as possible, seem to prove to the writer, at least, that the Kaw can not affect the ground water in the bottoms.

THE COMMON MOLE.

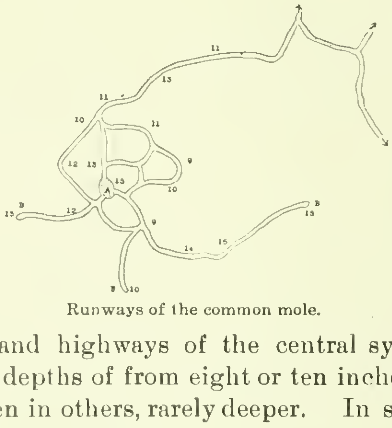
Runway Studies; Hours of Activity.

By THEO. H. SCHEFFER, U. S. Biological Survey.

RUNWAY STUDIES.

THE central part of a mole's system of runways can usually be located by the little piles of earth thrust up from the deeper tunnels. These are easily distinguishable from any elevations of the surface ridging due to the mole's burrowing just beneath the sod. They may be looked for on the higher spots of an open field or where natural objects offer some concealment and shelter. There are no "mole hills" in this country, such as those referred to in discussions of the European mole. The deeper tunnels constitute the real living quarters of the mole, the surface ridges being merely the paths ranging over his hunting grounds.

I have at various times spent many hours in digging out mole runways in places that promised interesting results. In all I have thus excavated parts of six central systems and prepared several diagrams, one of which accompanies this paper. In mapping out the runway of any burrowing animal my plan for securing accuracy of detail is to divide all the ground covered by the excavation into small squares by stakes and cross lines. Corresponding squares, on a smaller scale, are then drawn on the sheets of paper to be used for the map.



Runways of the common mole.

The galleries and highways of the central system of a mole's habitation run at depths of from eight or ten inches in some places to twelve or fifteen in others, rarely deeper. In several instances, however, I have found the blind runs, or "bolt runs" as the English call them, descending to a depth of two feet or even more.

There can be no question but that these branches of the deep runway system actually end each in a cul-de-sac, for in nearly a dozen cases they were carefully followed with spade and trowel to an abrupt termination. Usually the blind end was slightly enlarged on one side of the axis, as though the burrowing animal had scooped out a little leeway for turning to right or left.

Occasionally at any point on the surface ridge a mole's burrow will drop down abruptly and follow along in the subsoil for several feet before reappearing again at the surface. This is probably a provision for escaping the attacks of an enemy above ground, as these retreats are often at points remote from the main central system.

In my excavations I have unearthed at least a half-dozen nests, each in a chamber four to six inches in diameter and about a foot beneath the surface of the ground. In all cases the nesting material consisted mainly of closely cropped pasture grasses with the fine fibrous roots attached. It is probable that this grass stubble had been pulled down by the roots into the shallow surface burrows and carried from those to the nesting chambers. That the mole seeks some material above ground for its nests, however, is evident from the fact that there was a large admixture of leaves in the only two nests that were near trees.

But two of the six nests discovered were in a condition to indicate that they might be in use at the time (late fall months). The others were somewhat dilapidated, mixed with earth and infested with vermin. It is likely that these were occupied when the young were being reared in the spring.

In sifting the material of these old nests, hundreds of small, light-brown beetles (*Leptinus testaceus*) were secured. Their larvæ were also very plentiful, and in addition the material yielded mites in all stages, and some fleas. Specimens of all these parasites were also found on some of the moles trapped during the fall.

There is little doubt but that the mole is strictly a hermit in its relations to others of its kind, particularly in the fall season of the year. During the progress of my excavations one mole, and only one, showed up in each case to make repairs in the ruined galleries. When this mole was caught the place always remained in a state of desolation for some days at least. In a field well populated by moles the intersection of branch runs belonging to different systems is inevitable. Sooner or later, therefore, almost every spot where I have once captured a mole, by hand or by trap, has been visited by other moles and the deserted runways again occupied.

HOURS OF ACTIVITY.

It is commonly believed that moles work only at periods recurring regularly each day; that in the morning, at noon, and again in the evening the little animals are impelled by hunger to extend their surface runways in search of food. Between times they are supposed to sleep or rest quietly in their underground nests. It is possible that this idea may have gained popular credence through a course of reasoning from our own regularity of meal times. My observations go to show that during the fall season, at least, there is no stated time of day when the animal is more or less active than at other times. The results of these observations are given below.

It has been found that if a breach is made into the runway of a mole, the little animal will invariably repair the breach when he comes that way on his rounds. By taking advantage of this fact one can gain much information if he will visit, at short, regular intervals throughout the day, each of a circuit of runs in which a slight breach has been made. The following are the results of such an investigation :

Fifty runs were marked by stakes and a breach made in each as late in the evening as it was possible to see the marks. The first round of inspection was made between six and seven o'clock the next morning, and other rounds at intervals of one hour during that day and the following day. To the records of these two days were added those of two other nonconsecutive days, selected so as to include various kinds of weather

Number of places in which breaches were repaired during the night	135
Number of places in which repairs were made during the day	116
Breaks repaired in the forenoon	109
Breaks repaired in the afternoon	89
Breaks found repaired at—	
8 A. M.	19
9 A. M.	18
10 A. M.	22
11 A. M.	26
12 M	24
1 P. M	27
2 P. M.	17
3 P. M.	12
4 P. M.	20
5 P. M.	13

Another experiment, in which thirty-six runs were kept under observation, gives us the following results for a period of twenty-four hours, the original breaks having been made late in the evening:

Breaks found repaired at—

9–10 P. M.	15
3– 4 A. M.	16
9–10 A. M.	9
1– 2 P. M.	11
5– 6 P. M.	8

From a study of these figures it is very evident that the mole is not a creature of the periodical feeding habits commonly ascribed to him; moreover, that in his daily activities he may not be classed as diurnal, nocturnal, or crepuscular. To what extent, if any, he may vary from these observed habits in the summer season remains to be determined by further investigation.

THE LONGEVITY OF YALE GRADUATES,

As Shown by the Publication of Living Graduates of Yale University, 1912.

By J. T. Lovewell.

A DIRECTORY of living graduates has been issued in the last year from Yale University, and from it may be gleaned some facts which are of interest as showing the duration of life among college graduates.

The history of Yale goes back far enough to show the extinction of early classes, and we find up to the class of 1839 all are gone; and this class is represented by a single member. Dr. David F. Atwater, of Springfield, Mass., who at present has the distinction of being the oldest living Yale graduate. His class graduated 95, seventy-four years ago. The classes of '41 and '42 have each a single member remaining, and the class of '40 has only two, but coming to later dates the number increases.

In this paper only graduates in the arts course are considered. It is an interesting fact that those enrolled as graduates of Yale College (bachelors of arts) number 16,812, and of these there are living 8647, and deceased 8165, thus dividing the living and the dead graduates of Yale into two very nearly equal numbers.

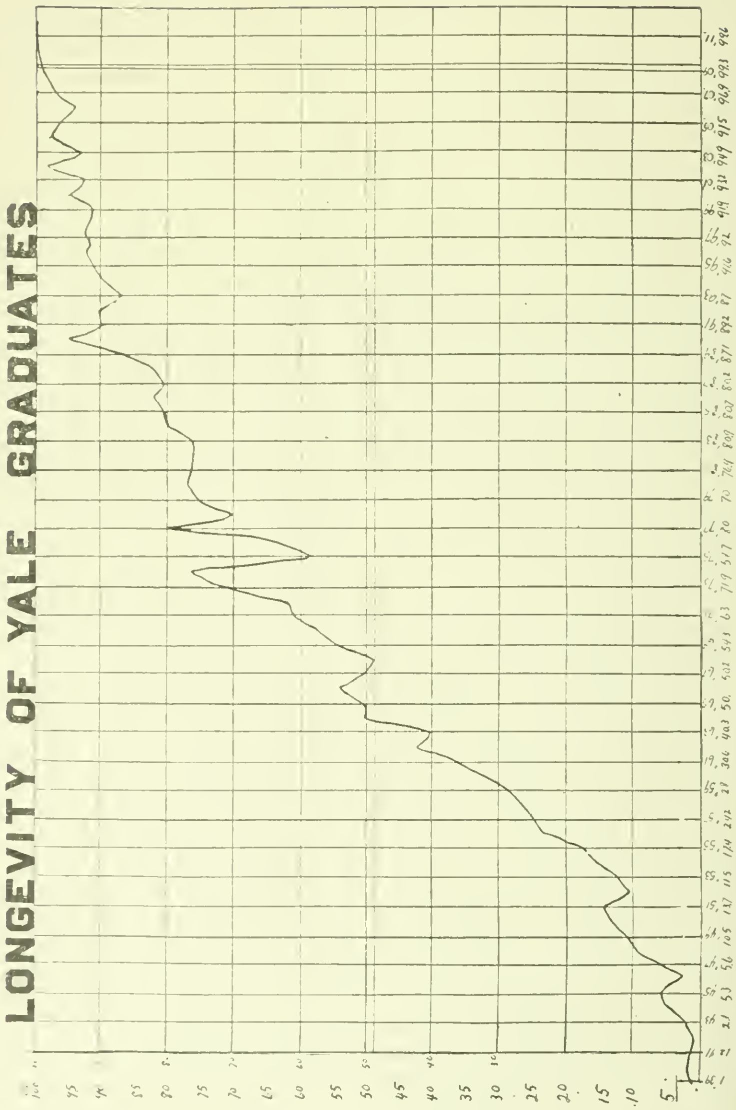
So far the greater number is on the side of the living, but as the years go on these figures are bound to shift, and most of the graduates of Yale, as of all other people, will have gone to join the "great majority." This condition would have been reached sooner in Yale only owing to the fact that the later classes of Yale far outnumber the earlier. Thus the class of '39 enrolled only 95 members, while the average enrollment of the last five classes is over 316.

In the accompanying table is shown opposite the date of classes, beginning with 1839, the total enrollment, the number living, and the percentage of the latter to the former. By making these percentages the ordinates to a curve whose abscissas mark the years of graduation, we have a sort of curve which shows at a glance how the expectation of life diminishes as the years roll on, and we reach the ground in about seventy-five years at the farthest. At this limit the graduates have attained a longevity of more than ninety years.

Class.	Total enrolled.	Living.	Per cent.	Class.	Total enrolled.	Living.	Per cent.
1839	95	1	1.05	1876	126	80	63.5
1840	106	2	1.90	1877	120	96	80.0
1841	79	1	1.27	1878	132	92	70.0
1842	110	1	0.9	1879	138	104	75.3
1843	96	2	2.1	1880	122	95	77.8
1844	105	5	4.8	1881	130	100	76 9
1845	75	4	5.3	1882	122	98	80.0
1846	83	2	2.4	1883	152	123	80.9
1847	124	7	5.6	1884	152	126	82.2
1848	88	8	9.1	1885	125	109	80.7
1849	96	10	10.5	1886	139	113	81.3
1850	86	11	13.7	1887	150	123	82.0
1851	93	13	14.0	1888	125	108	86.1
1852	95	10	10.5	1889	124	108	87.1
1853	110	20	11.8	1890	146	139	95.0
1854	102	16	15.7	1891	185	165	89.2
1855	92	17	17.4	1892	181	163	90.1
1856	97	23	23.5	1893	184	160	87.0
1857	107	27	24.2	1894	238	213	89.5
1858	105	28	26.2	1895	250	229	91.0
1859	107	30	28.0	1896	278	257	92.4
1860	112	36	32.1	1897	275	253	92.0
1861	97	35	36.0	1898	300	381	93.6
1862	100	42	42.0	1899	298	274	91.9
1863	129	52	40.3	1900	320	304	95.0
1864	112	59	50,2	1901	253	236	93.2
1865	102	57	50.0	1902	291	286	98.4
1866	98	53	54.0	1903	316	300	94.9
1867	106	55	50.2	1904	286	282	98.4
1868	110	53	48.2	1905	288	281	97.5
1869	116	61	54.3	1906	295	279	94.5
1870	120	69	57.9	1907	356	345	96.9
1871	105	66	63.0	1908	339	333	98.2
1872	133	84	63.1	1909	310	308	99.3
1873	114	82	71.9	1910	309?	?	?
1874	124	95	76.6	1911	296	295	99.6
1875	97	57	58.7	1912	284	284	100.0

The death rate is low for a few years succeeding graduation, as might be expected of young men in the prime of life. As the years go on the curve drops down and shows that about 50 per cent survive forty to forty-five years after graduation. It takes about twenty years to cut down the first 10 per cent of a class. Ten per cent more will be gone in about fourteen years more. An equal period will now remove as many as 20 per cent, while, as said above, 50 per cent will be dead in another ten years. As we approach the limit of seventy-five years the percentage of loss grows less, for at this period there are generally a few cases of extreme longevity, and these withered leaves drop off more slowly.

From thirty-five to fifty years after graduation there is witnessed a period of great irregularity, as if the vital forces of men's lives were often exhausted, and we might conclude that frequently they live too fast and the decay is not steady and normal. Probab y we could with a more complete record and with similar statistics from other colleges draw other interesting conclusions.


LONGEVITY OF YALE GRADUATES

HAS THE QUALITY OF DRUGS IMPROVED SINCE THE ENACTMENT OF THE FOOD AND DRUGS LAW?

By M. N. Wedel and L. D. Havenhill.

TO ANSWER this would require accurate data pertaining to the quality of drugs both before and after the passage of this law. Unfortunately there is but little suitable data upon which to base a reply. It would seem that the careful supervision exercised by the federal and state governments must have a salutary effect, but to offset this there are the published results of the various official laboratories, which show but little decrease in the percentage of adulteration. In this connection, however, it must be remembered that these official reports are upon substances which were collected mainly because they were thought to be adulterated. Practically no record is kept of the total number of samples examined and passed by the inspectors, and, therefore, conclusions other than that adulterated drugs still exist should not be drawn from such reports.

Nine years ago one of us, L. D. Havenhill, reported upon the quality of commercial cream of tartar to this Academy (1904 Kansas Academy of Science, vol. XIX, pages 66–68). At that time a complete canvass was made of the grocers and druggists in one Kansas town and the exact condition of the quality of this drug ascertained. This year we have canvassed the same town again, obtaining the results as are set forth in the subjoined table.

The columns have the following significance: I is the serial number of the sample; II, the source of the sample; III, the acidity in terms of pure potassium bitartrate; IV, the retail price per pound; V, the kind of goods, whether bulk or package; VI, the calculated price per pound based upon the amount of the purchase; VII, the measure delivered in terms of 100 per cent, as, for example, if the quantity was 1 oz. and the weight, as subsequently determined, was found to be $1\frac{1}{4}$ oz., the measure delivered was 125 per cent; VIII, general observations.

I.	II.	III.	IV.	V.	VI.	VII.	VIII.
1	Drug store....	99%	$0.50	Bulk......	$0.80	101%	Considered standard quality.
2	"	99	.50	"	.80	....	" " "
3	"	99	.50	"	.80	....	" " "
4	"	99	.50	"	.80	....	" " "
5	"	99	....	"	.80	112	" " "
6	"	99	....	"	.80	111	" " "
7	"	99	.50	"	.80	111	" " "
8	"	99	.50	"	.80	....	" " "
9	"	99	.60	"	.80	114	" " "
10	"	99	.50	"	.80	....	" " "
11	"	99	.50	"	.80	....	" " "
12	Grocers.......	99	....	Package..	1.20	....	" " "
13	"	99	....	" ..	.80	....	" " "
14	"	99	.50	....	....	....	" " "
15	"	99	....	Package..	1.60	....	" " "
16	"	99	....	" ..	1.20	110	Considered standard quality, although it contained a trace of calcium compounds.
17	"	99	.40	....	....	....	Considered standard quality.
18	"	99	....	Package..	.80	103	" " "
19	"	99	....	" ..	.80	99	" " "
20	"	99	....	" ..	1.60	....	" " "
21	"	99	.50	Bulk......	....	....	" " "
22	"	99	....	Package..	.80	109	" " "
23	"	99	.60	Bulk	....	115	" " "
24	"	99	....	Package..	.80	....	" " "
25	"	99	....	" ..	.80	....	" " "
26	"	99	.40	....	....	109	" " "
27	"	99	....	Package..	.80	109	" " "
28	"	99	....	" ..	.80	....	" " "
29	"	99	....	" ..	.80	156	" " "
30	"	99	.40	Bulk	....	....	" " "
31	"	99	....	Package..	1.60	124	" " "
32	"	99	.60	Bulk......	....	96	" " "
33	"	99	....	Package..	.80	99	" " "
34	"	99	....	" ..	.80	....	" " "
35	"	99	.50	Bulk	....	....	" " "
36	"	99	....	Package..	.80	....	" " "
37	"	99	....	" ..	.80	....	" " "
38	"	99	.65	Bulk......	....	....	" " "
39	"	99	.65	"	....	....	" " "
40	"	99	.60	"	....	....	" " "
41	"	99	.75	"	....	....	" " "
42	"	99	....	Package..	.80	....	" " "
43	"	Trace.	.60	Bulk......	....	....	A substitute, composed chiefly of calcium sulphate.

Summing the results from the table, it is found:

First. That eleven, or 100 per cent, of the druggists are selling high grade cream of tartar, fully up to the standard demanded by law, at a uniform price of five cents per single ounce.

Second. That 33 of the 34 grocers are selling cream of tartar that meets the legal requirements, at a price ranging from 5 cents to 10 cents per single ounce.

These samples, when treated with water, all have a minute quantity of insoluble woody matter. This indicates that the grocers are supplying a very slightly lower grade article than that supplied by the druggists.

Third That but one adulterated sample was found in the town.

Comparing this investigation with the one eight years previous, the following important points are noted:

First. That the number of drug stores has increased from 8 11. That the quality of the drug supplied is of the same high grade, and that the average price per pound has slightly decreased.

Second. That the number of grocers has increased from 28 to 34, while the percentage of them selling an adulterated article has decreased from nearly 50 per cent to less than 3 per cent That the price has been slightly advanced. Of the 28 former grocers only one sold package goods. Now 19 of the 34 handle this chemical in packages only.

Third. That the commercial quality of this chemical has very materially improved within the past eight years, while the average price of the pure article has not been materially affected either way.

FURTHER DISCUSSION OF MUNICIPAL OWNERSHIP OF WATER AND LIGHT PLANTS.

By J. A. G. Shirk, A. M., M. S.

THIS paper embodies the results of the observations of the author for four years, three of which were spent as a member of the water and light board of the city of Ottawa, Kan. In this particular city the results of municipal ownership have been quite satisfactory, as it has also been in a considerable number of other cities which have adopted this plan of securing the desired water and light service. In a few places, however, the plan has not been a success, and in some of these there has been a return to the privately owned plants. The author of this paper has endeavored to ascertain in a number of cases what the causes of the failure of municipal ownership were, so as to be able to present both sides of the question.

In any question of this kind it is almost impossible to secure unbiased information, as there are always staunch friends and also bitter enemies of any existing system. The aim has been to secure such information from reliable men outside the immediate group who were active in making changes or in maintaining present systems of management. Information obtained from those in charge of the plants is generally in favor of the system then in use, as these men wish to make the business management appear successful.

In the paper read last year before the Academy only the arguments in favor of municipal ownership were discussed. This time, however, both sides of the question will be given as impartially as possible. The reasons for and against are briefly given below, and then are considered more in detail.

Reasons For Municipal Ownership.

1. Better service at same rates, or at equitable rates.
2. Better rates for same service.
3. Ease of extending the service.
4. Ease of changing the character of the service when occasion demands it.

Reasons Against Municipal Ownership.

1. Usually better superintendents and managers under private ownership.
2. Usually better managing boards under private ownership.
3. Hard to get additional capital for extensive improvements or repairs.

Now let us consider in detail the arguments for municipal ownership. The first two reasons are not distinctive arguments for municipal ownership, because privately owned companies may, and generally do, give as good service and at as reasonable rates as could be secured through municipal ownership. But in many cities it has been found impossible to secure the desired service or reasonable rates as long as the plants were privately owned, and consequently the municipalities have been forced to take charge of these utilities. In a few towns which derive their supply of water from small rivers, which are at times quite muddy, the men who owned the water plants were petitioned to substitute filtered or treated water for the regular river water, and they could not be induced to do so, even when a fair rate was offered for the service. Again, in other places there has been difficulty in securing the necessary water pressure to maintain satisfactory domestic service in the suburbs of the town. Also the paessure was quite often inadequate in time of fires. Such things as these have driven many towns to municipal ownership, although the desired service could have been just as well rendered by the men who owned the plants had they been disposed to render the community good service at a reasonable rate.

There are, however, a few good reasons for municipal ownership in any locality. The two most prominent are: the ease of extending the service, and the ease of changing the character of the service. In many cities the business management of privately owned plants is not progressive, and often many citizens are forced to wait a long time before water or electric service is extended to their section of the town. Private corporations do not care to extend the service until there is plenty of business in sight to pay dividends on the investment. A municipality may, on the other hand, look farther into the future and extend service to a certain part of the town because they believe it will develop in the future. This matter, however, would depend on the character of the men operating the plant, whether the plant be privately or municipally owned. In general, however, there seems to be a great desire on the part of the municipal plants to supply all the people who wish the service.

In many cities the privately owned plants fully meet the needs of the people in this respect, and consequently there would need be no change as far as the character of the service is concerned.

There is one strong reason for municipal ownership, however, which holds in almost every community, and that is the ease of changing the character of the service. Under private ownership, whenever any change is desired the owners generally wish to make it appear that at the old rate they were just barely making interest on the investment, and consequently the rates must always be raised every time any changes are suggested which involve any outlay of money; hence there is generally a period of friction between the members of the city councils and the owners of the utilities. Under municipal ownership the people own the plants, and consequently there is not, or at least should not be, any clashing of interests, but the proposed change can be investigated as to its cost and desirability, and either adopted or rejected as seems best to the majority of those interested.

Now let us consider the objections of municipal ownership. First, the superintendents and managers are generally better men under private ownership, since their tenure of office does not depend upon the outcome of political elections. Consequently better men can be secured for these positions when the tenure of office is more certain. Also, in private ownership the managers usually own stock in the plant, and this fact makes such officers take a more vital interest in the welfare of the plant.

For the same reason the managing boards are better for a private plant than for a municipal one. In municipal ownership there is no direct investment in the plant, and the interest and attention of those who are in the responsible position of managers or directors is not so strong as when the investment feature is involved.

The last reason against municipal ownership which will be considered is that of securing additional capital for extensive improvements or repairs. After the people have once voted an issue of bonds to build or buy a water or light plant, it is a very difficult thing to get their consent to an additional issue of bonds for the purposes mentioned. Consequently such improvements and repairs must be made out of the earnings of the plants, and as long as there are bonds outstanding it is impossible to lay by money for future use without incurring the censure of many of the citizens.

They say it is not good business to have funds in the banks drawing only three per cent, while at the same time five per cent is being paid on bonds. In that one particular they are right, but they forget the impossibility of getting a new bond issue when the money is needed, even though much more in bonds has been paid. Small items of repairs or improvements can easily be allowed, but the author has not yet seen any town where the citizens have allowed a general overhauling of a plant.

Thus we see that the reasons for and against municipal ownership are quite evenly balanced, and any community will do well to investigate their present plans quite carefully before deciding on a change, and they should not assume that just because municipal ownership has been a success in some other town that it will be so in their own, or even that it would do as well as private ownership. The general observation is that the operation of privately owned plants is more economical, and the success of municipal ownership in any town will depend upon the character of the men who can be secured to operate the plants, and also upon whether politics will likely enter too strongly into the selection of the managers and directors.

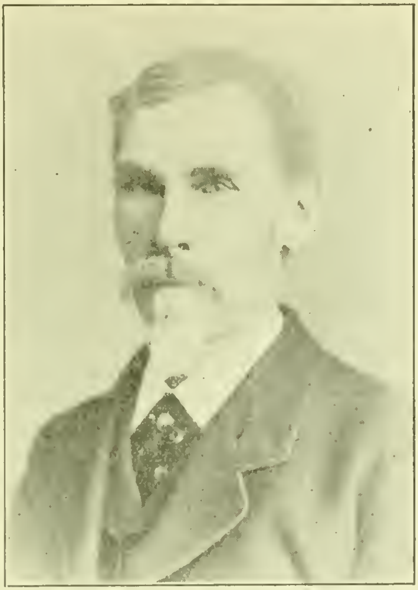
VI.

NECROLOGY.

1. Robert J. Brown.
2. John J. Jewett.
3. James C. Cooper.
4. Mary Burgess Savage.
5. Bernard Bryan Smyth.

ROBERT J. BROWN.

DR. ROBERT J. BROWN was one of the earliest members of the Academy, and was enrolled in its first list in 1868. He was chosen president, and served in this office in 1884 and 1885. His retiring address had for its theme "Natural Gas." He was an

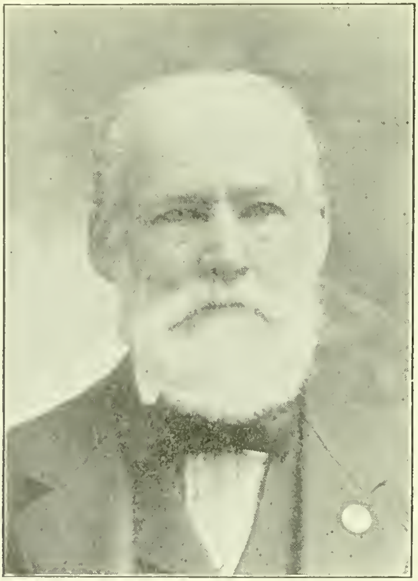


ROBERT J. BROWN.

enthusiastic friend and supporter of the Academy, took great interest in its meetings, and contributed papers. He also belonged to the American and the Kansas Pharmaceutical Associations, and was an active member of the Congregational church. He was born in Beaver county, Pennsylvania, September 5, 1834, and died in Leavenworth, Kan., August 19, 1897.

JOHN J. JEWETT.

JOHN J. JEWETT, was elected a member of the Academy in 1902. At that time he resided in Oakland, Kan., but later removed to New Mexico, and later was a resident of San Bernardino, Cal., until his death, about 1910. He was interested in physical problems concerning gravitation, and proposed some novel theories to account for tides.



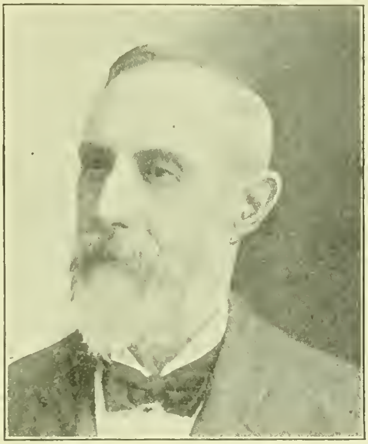
JOHN J. JEWETT.

JAMES C. COOPER.

By J. T. Lovewell.

In the past year our Academy has lost another valued member, James C. Cooper, who died at the home of his daughter, in Los Angeles, Cal., September 15, 1911.

Mr. Cooper was born near the city of Baltimore, Md., June 16, 1832. His early education was very rudimentary, consisting of four winters in the common schools of Maryland in the early forties of the last century. At an early age he went to sea on a merchant ship and spent five years before the mast. He went around



Cape Horn to California in 1849, and there the lure of gold discovery led him to give fourteen months to placer mining on the North Fork of the American river. He returned to Baltimore in 1851, and was for a while reporter on the *Daily Argus* of Baltimore, and later on Forney's Philadelphia *Press*. Subsequently he was connected with an engineer corps in the location survey of a railroad up the Shenandoah valley in Virginia.

On invitation of his uncle, Peter Cooper, who had a glue factory in Brooklyn, N. Y., he went there and worked three years in the factory of his uncle. This uncle was the builder of the first locomotive in America, but is better known as the philanthropist who founded Cooper Institute in New York city. In 1855 our Mr. Cooper married Miss Virginia V. V. F. Porter, of Brooklyn, and the young couple the same year moved to Iowa, where they spent five years in farming. Evidently this life did not suit him, for on January 1, 1860, he entered railway service, which was to be his occupation for half a century. His first engagement was with the Illinois Central Railroad, and while in that service he found time to publish for several years a newspaper in Centralia, Ill.

When the land department of the Atchison, Topeka & Santa Fe Railway was organized he was employed as its secretary, and remained with the Santa Fe in different positions until July 1, 1886, when he entered the service of the Rock Island as right of way agent, and after one year took charge of the tax business of this road, where he remained till he had, on his retirement, rounded out fifty years of railroad service. At the end of this period the tax business of the road was moved to Chicago, and Mr. Cooper was retired on a pension.

During all his eventful life he kept up a keen interest in scientific knowledge, and was especially well read in geology and mineralogy. Having unusual facilities in his railway employment for visiting many localities he bacame a collector of minerals, especially of crystalline forms, of which he gathered, named and classified 36,000 specimens. Mineral dealers and colleges became interested in his cabinets, and he sold valuable collections to Washburn College and to the Kansas State University. Besides these, he left a large private collection here in Topeka, which he contemplated moving to California had his life and health been prolonged.

About a year ago it seemed necessary for him to go to a hospital and undergo an operation for stomach trouble. He bore it well, and it was hoped for a time that he had obtained permanent relief, but he did not fully recover, and then, with the thought that he might be benefited by the milder climate of California, he decided to go there. His wife had died the February before his decease, and the bereavement and the long hot summer proved too great a strain for his low vitality, and after suffering for eleven days from his arrival in Los Angeles he sank to his long sleep in the home of his daughter, Mrs. Virginia C. Hartzell. Besides this daughter his only near surviving relatives are a granddaughter and his twin sister, Mrs. H. A. Merrill, of Grand Rapids, Neb

Mr. Cooper was a member of the A. A. A. S., a member of the Academy of Science, of which he had been president, a member of the National Geographical Society, and of several fraternal orders.

His long continuance in railroad employ shows the esteem in which he was held by his business associates, and this Academy will miss the enthusiasm with which a new mineral would always excite him. As a "forty-niner" from California it was interesting to hear him recount his experiences of those stormy times of which so few are now left who can bear personal testimony. His face was so alert and youthful that it was hard to realize that he could have been an actor in those far-off events.

Mr. Cooper illustrated in his life the possibilities of scientific culture open to a man while engaged in business pursuits. Without the advantages of early school training, he became an expert in mineralogy and made valuable contributions to this branch of science.

MARY BURGESS SAVAGE—1834-1912.

THE news that "Grandma Savage," "Aunt Mary," had passed away on Tuesday morning, February 7, 1912, meant for a large circle of the older residents of Lawrence the present extinction of a kindly light which has shown for them a great many years.

Mary Williston Burgess was born in Stirling, Scotland, March 5, 1834, within sight of the field of Bannockburn and the monument to William Wallace. At the age of fifteen she came with her

MARY BURGESS SAVAGE.

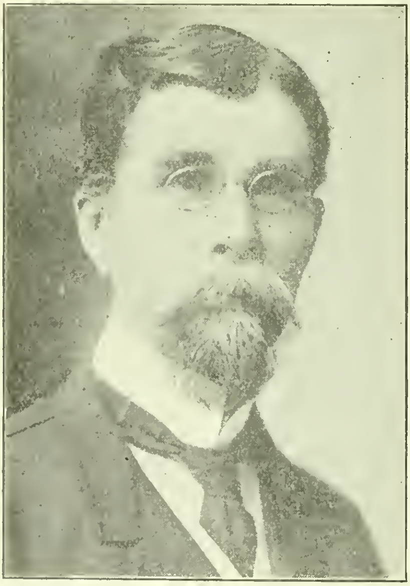
parents to New York, then to Massachusetts, whence later they removed to Lawrence with her husband, the late Joseph Savage, here to take charge of his home and four motherless children, the youngest an infant. The only one of these surviving her is Mrs. Susan D. Alford. Mr. Savage died in 1891. Two brothers and a sister survive Mrs. Savage, also her adopted daughter, Margaret Comrie.

Mrs. Savage was an ideal companion to her husband, as well as an ideal mother. She shared Mr. Savage's fondness for the study of natural history, and accompanied him on many of his collecting expeditions. Older residents and friends of the University of Kansas will recall that Mr. and Mrs. Savage were among the first of the amateur scientists who did much to support the work of Prof. F. H. Snow in building up the collections of the University. They were both among the early members of the Kansas Academy of Science, Mrs. Savage being, perhaps, the only woman member, and she enlivened many a banquet of the Academy with her quaint and gentle rhymes.

As her daughter was one of the very first students of the University, so Mrs. Savage continued to the last her interest in the institution, attending almost every commencement for forty years. The Savage home, southwest of Lawrence, was a favorite resort of scientific students—Gaumer, Dyche, Franklin, Kellogg, and many others—who easily dropped into the pleasant habit of calling Mrs. Savage "Aunt Mary."

BERNARD BRYAN SMYTH.

BERNARD BRYAN SMYTH was born in County Cavan, Ireland, March 8, 1843, and died in Topeka, Kan., August 12, 1913. His father, John Smyth, was an English schoolmaster, and while very young the boy became familiar with the life of the school room and acquired the studious habits that endured throughout his entire life. The sudden death of the father broke up the family, and the mother went to America, leaving three children, of whom Bernard was the oldest, in charge of her sister in Dublin. The lad had the advantages of the schools in Dublin until he was



BERNARD BRYAN SMYTH.

ten years of age, when he came to America in care of an uncle. The youngest brother, John, was with him, and they went to their mother in Norwalk, Ohio. From that time his school days were rather broken in upon, but he made the most of every chance to acquire knowledge. When he enlisted in the army he carried his little packet of books, adding to the number from time to time, and when the ordinary soldier was loafing or playing cards he was poring over his self-imposed lessons. He spent four and a half years in the army, and was discharged in November, 1865. He reëntered school after returning from the war, and finally spent one year in the Michigan Normal at Ypsilanti before beginning his career as a teacher.

On January 1, 1872, he married Mary Adams, and came to Kansas soon after. He and his brother John started a nursery in Barton county, but adverse weather conditions and the grasshoppers destroyed their stock entirely, so both brothers secured schools and began teaching. In 1880 he became a member of the Kansas Academy of Science, and was actively interested in the Society until his death. He served as librarian from 1886 to 1902. He was made curator of the Goss Collection in 1893, and has held the position through all the various political changes that occurred during the twenty years. He was well posted on such a variety of subjects that he was constantly consulted by others in the building, who knew and appreciated his ability to give a satisfactory reply to their questions. He was also professor of botany in the Kansas Medical College from 1890 to 1895.

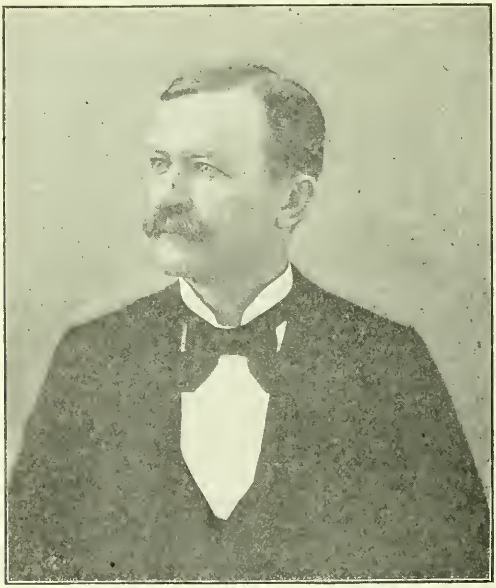
Botany, geology and mathematics were all of absorbing interest to him, and at the time of his death he was working on manuscripts in each of these subjects. The most important of his later papers, "A Provisional List of Kansas Plants," is now being published in the Academy reports. In this he was assisted by Mrs. L. C. R. Smyth, to whom he was married June 12, 1906. His first wife and the mother of his three children had died in 1893. The youngest son, Eugene, is a member of the Academy, and is engaged in scientific work in government employ, and bids fair to be a worthy son of his father, from whom he had his early training.

Professor Smyth was a man of retiring manners, gentle and kindly, especially with children, many of whom have a lasting memory of him. "He was my friend," said a ragged little urchin in the Museum as his eyes filled with tears on learning of his death. "I used to come in to see him lots of times, and he told me all about things." Dumb animals loved him, and he taught others to be kind to the lower forms of life, for they too have their place in the great world as well as man. He was tolerant of the opinions of others, but held himself rigidly to the ideals of manly virtue and clean living that had been taught him by his good mother in early childhood. He is missed in his home and among his associates, and his memory will endure as a man worthy of love and esteem.

PROF. EDWIN A. POPENOE

WAS born at Centerville, near Dayton, Ohio, July 1, 1853, on the ancestral farm. He was of French (Huguenot) extraction for several generations back on his father's side, while his maternal ancestors were English.

In 1860 he removed, with his parents, to McLean county, Illinois, where he acquired a common-school education. Upon moving to Topeka, Kan., in 1869, he entered Lincoln Academy.



PROF. EDWIN A. POPENOE.

Having completed the course at the latter institution, he in due season entered Washburn college, where he graduated in his twenty-third year, with the degree of B. A., from the classical literary course. Even during his student days Professor Popenoe showed that energy and ability which was to make his career a successful one. In his freshman and junior years at Washburn he taught classes in botany and zoölogy as a partial means of assisting him to pay his college expenses. In 1880 his Alma Mater conferred upon him the degree of M. A.

For three years subsequent to his graduation Professor Popenoe taught in the common schools of Shawnee county. At the expiration of that time, in June, 1879, when he was acting as principal of Quincy school, Topeka, he was elected to the chair of horticulture and entomology of K. S. A. C. This position he held, with the exception of the two years of populist administration, for twenty-two years, his work doing credit to both the institution and himself. His professorship was the most extended in the history of that college to date.

The professor's official connections have been numerous and arduous enough to have occupied fully the life of an ordinary individual. For ten years he was secretary and for one term president of the Kansas Academy of Science; he was for two terms secretary of the American Horticultural Society; special agent of the United States Department of Agriculture for the formation of an entomological exhibit for the division of experiment stations, World's Columbian Exposition, and for one term he was chairman of the section of horticulture, American Association of Agricultural Colleges and Experiment Stations, Washington meeting Besides the above connections, since 1876 he had been entomologist for the Kansas State Board of Agriculture, and by the governor's appointment he was state inspector of nurseries. He was a member in good standing of the Kansas State Horticultural Society, and of the Kansas Academy of Sciences, while the following other societies, of broader extent, claimed him as a member: American Pomological Society (life member); Washington Entomological Society; New York Entomological Society; American Association of Economic Entomologists; and the American Association for the Advancement of Agricultural Science. Such a wide social connection indicates not only an appreciation of the professor on the part of the various associations, but it also shows that Professor Popenoe was a wide-awake scientist who kept intimately in touch with the work of his contemporaries. His numerous and extensive scientific expeditions, which took him the length and breadth of the United States, were but another evidence of his intense and absorbing interest in his chosen profession.

During his professorship, as superintendent of the college grounds he had the responsibility of planning and planting the campus and college orchards. He personally set the stakes which mark the position of nearly every ornamental tree and group of shrubs now occupying the lawns and their borders. He, with the valued aid of his assistants, succeeded in changing the grounds from a cornfield to their present highly artistic state. He virtually founded the department of horticulture and entomology in this institution, and he will be remembered likewise as the one who formed the present entomological museum entirely, and chiefly that in geology.

Professor Popenoe was a man of great strength of character, whose sense of right was never warped by objects of policy. While never effusive in word or action, he was ever kind, gentle and helpful to those who sought his friendship or asked his advice.

In 1877 he was married to Florence Eleanor Hyde, of Topeka, who died in 1881. In 1883 he married Miss Carrie G. Holcomb, of Topeka. After a lingering sickness he died at his home November 17, 1913.

He is survived by his widow and by four sons, Charles H., an entomologist of the United States Department of Agriculture, Washington, D. C.; Hubert L., professor of agriculture in the high school of Alexandria, Minn.; and Edwin A., jr., and Willis P., who are yet at their beautiful home on the outskirts of Topeka.

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