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THE WEST VIRGINIA ACADEMY OF SCIENCE

Proceedings of The Montgomery Meeting

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PROCEEDINGS

of

THE WEST VIRGINIA ACADEMY OF SCIENCE

Volume 8

March 15, 1935

The Eleventh Annual Session

NEW RIVER STATE COLLEGE
MONTGOMERY WEST VIRGINIA

May 4-5, 1934

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MEMBERS OF THE WEST VIRGINIA ACADEMY OF SCIENCE

Akers, Bernice, math. teacher, high school, Athens
Albert, C. E., dean, Davis & Elkins College, Elkins
Ambler, C. H., prof. of hist., W. V. U., Morgantown
Amidon, Ruth Braden, Morgantown
†Ammons, Nellie P., instr. of botany, W. V. U., Morgantown
Archer, C. H., registrar, Concord State Teachers College, Athens
Arnett, Jerome C., Aurora
*Barnhart, J. D., asst. prof. of hist., W. V. U., Morgantown
Bartlett, J. F., Marshall College, Huntington
Bauer, H. A., prof. of geog., New River State College, Montgomery
Bell, Raymond, student, Home address, Smithers
Bergy, Gordon A., prof. of pharmacy, W. V. U., Morgantown
Bibbee, P. C., zoologist, Concord State Teachers College, Athens
Blackwell, A. C., prof. of chemistry, Morris Harvey College, Barboursville
Bloss, James R., physician, Huntington
Bobbitt, T. S., Principal Spanishburg H. S., Princeton
Boggess, Randolph, Oakvale High School
Bonar, Ross, high school principal, Buckhannon
Bond, H. D., prof. of biology, Salem College, Salem
†Bourn, W. S., Boyce Thompson Institute for Plant Research, Yonkers, N. Y.
†Bretnall, George, prof. of biology, Shepherd College, Shepherdstown
Brooks, Alonzo B., park naturalist, Oglebay Park, Wheeling
†Brooks, Maurice, teacher of biology, Upshur Co. High School, Buckhannon
Brouzas, C. G., assoc. prof. of classics, W. V. U., Morgantown
Brown, A. Coleman, Morgantown
Brown, Ruessell G., dept. of botany, Univ. of Maryland, College Park, Md.
†Burke, Stephen P., chairman of Graduate Council, W. V. U., Morgantown
Caldwell, R. C.
†Cameron, Hazel C., W. Va. Agr. Experiment Station, Morgantown
Campbell, Carl G., Huntington
Chapman, Daisy V., teacher of biology, Williamson High School
†Chidester, F. E., Morgantown
†Clark, Friend E., prof. of chem., W. V. U., Morgantown
Collett, A. R., assoc. prof. of chem., W. V. U., Morgantown
Collins, Bernice E., 1215 Quarrier St., Charleston
†Collins, H. H., prof. of zoology, Univ. of Pittsburgh
†Colwell, Rachel H., prof. of home economics, W. V. U., Morgantown
†Colwell, Robert C., prof. of physics, W. V. U., Morgantown
Conley, Phil, Editor, West Virginia Review, Charleston
Cook, Thos. A., dept. of math., Concord S. T. C., Athens
†Core, Earl L., instr. of botany, W. V. U., Morgantown
Craig, Waldo, entomologist, state dept. of agr., Charleston

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*New members elected to membership at the Montgomery meeting.
†Members of the American Association for the Advancement of Science.

Cushman, M. S., prof. of history, Concord S. T. C., Athens
Cutright, Frank, prof. of biology, Concord S. T. C., Athens
Dadisman, A. J., prof. of farm economics, W. V. U., Morgantown
*Darlington, H. C., asst. prof. of biology, Marshall Coll., Huntington
Darrah, William C., dept of botany (paleobotanist), Carnegie Museum, Pittsburgh, Pa.
*Dawson, Hubert, chemist, Boomer
Dawson, H. Donald, prof., Bethany College
†Davies, E. C. H., prof. of chemistry, W. V. U., Morgantown
†Davis, Hannibal A., prof. of mathematics, W. V. U., Morgantown
Davis, Lida L., prof. of geog., Concord S. T. C., Athens
Deatrick, Eugene P., Morgantown
†Dodds, Gideon S., prof. of histology, W. V. U., Morgantown
*Donnelly, T. C., prof. of history, Marshall College, Huntington
Downs, William S., consulting engineer, Morgantown
†Dustman, R. B., prof. of agr. chem., W. V. U., Morgantown
†Eiesland, John A., prof. of math., W. V. U., Morgantown
Fankhauser, Pearl, tchr. Concord S. T. C., Athens
Fenton, C. C., prof. of pathology, W. V. U., Morgantown
*Finch, D. E., manual training, New River S. C., Montgomery
Forman, A. H., prof. of elect. eng'n'g, W. V. U., Morgantown
Franzheim, Chas. M., Wheeling
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†Fridley, Harry M., assoc. prof. of geol., W. V. U., Morgantown
†Fromme, Fred D., dean, College of Agri., W. V. U., Morgantown
Frye, Wilbert M., tchr. Hanging Rock H. S., Capon Springs
Gabbert, Carl, tchr. of science, Talcott H. S.
†Galbraith, F. D., prof. of chem., Potomac State School, Keyser
Galpin, Sidney L., prof. of geology, W. V. U., Morgantown
†Garber, Ralph J., prof. of agronomy, W. V. U., Morgantown
Gardner, Mrs. S. O., Blacksville
Gatherum, R. S., prof. of math., Concord State T. Coll., Athens
Gilbert, Frank A., prof. of botany, Marshall College, Huntington
*Giltner, Virginia, sc. tchr., High School, Dunbar
Gist, Russell H., W. Va. Agr. Extension Service, Morgantown
*Gorrell, Elizabeth, math. tchr., Dunbar H. S.
Green, Bayard, tchr. of biology, Elkins H. S.
Greenleaf, Wm. E., dean, College of Arts & Science, Marshall College, Huntington
*Grey, Mrs. Katherine, tchr of biology, Woodrow Wilson H. S., Beckley
Gribble, Lloyd R., dept. of zoology, Morgantown
Grimm, R. T., assoc. prof. of chem., New River State Coll., Montgomery
Gwinn, Clyde W., prof. of social sci. and educ., Mansfield State College, Mansfield, Pa.
Hadden, Mildred, tchr. of biology, 1215 Quarrier St., Charleston
†Hall, Arthur A., Dept. Elect. Eng'n'g, W. V. U., Morgantown
Hall, Frank, tchr. professional subjects, Fairmont State Teachers College
Hance, Robert T., prof. of zoology, University of Pittsburgh
Handlan, John W., curator of museum, Oglebay Park, Wheeling

Harshbarger, Jennie, teacher of biology, Fairmont H. S.
Harris, T. L., prof. of sociology, W. V. U., Morgantown
*Harvey, C. C., tchr. Montgomery High School
Haught, C. D., prof. of physics, Fairmont S. T. C.
*Haught, D. L., dean, Concord State College, Athens
†Haught, O. L., grad. student in geol., W. V. U., Address Littleton
Hazlett, Mary R., science tchr., 333 Wellwood St., Pittsburgh, Pa.
Herndon, L. K., State Dept. of Health, Charleston
Hill, Caton N., principal, Sutton High School
Hill, George H., office engineer, State Road Commission
Hill, L. B., prof. of education, W. V. U., Morgantown
Hill, Hubert, prof. of chemistry, W. V. U., Morgantown
*Hill, Lawrence E., student, W. V. U., Morgantown
Hodge, W. W., prof. of chemical eng., W. V. U., Morgantown
Hornor, Carl L., mining engineer, Clarksburg
Hoskins, Homer A., Chemist, W. Va. Geol. Survey, Morgantown
†Hron, Ralph F., prof. of physics, Marshall College, Huntington
Hunt, Geo. R., prof. of zoology, Fairmont S. T. C.
*Hutchinson, Kenneth D., economics instructor, W. V. U., Morgantown
†Hyma, Nicholas, prof. of chemistry, W. Va. Wesleyan College, Buckhannon
Ice, Homer C., geologist, Morgantown
†Jacobson, Carl A., prof. of chemistry, W. V. U., Morgantown
†James, G. Claire (Miss), dept. of science, Glenville S. T. C.
*Johnson, A. W., prof. of economics, New River State Coll., Montgomery
Johnson, Clyde, tchr. high school, Bluefield
*Johnson, G. S., chemist, Malden
Jones, Harris A., meteorologist, U. S. Gov't., Elkins
Judson, J. E., prof. of biology, W. Va. Wesleyan Coll., Buckhannon
Karickhoff, J. Rosavelta, tch. of chem., Upshur Co. High School, Buckhannon
Kelly, Mathew J., Kelly Foundry & Mach. Co., Elkins
King, Genevieve N., grad. student, W. V. U., Morgantown
*Kirby, David, sec'y., State Board of Education, Charleston
*Kiser, R. P., chem. teacher, Dunbar H. S.
Klingesmith, R. W., prin. high school, Athens
*Knotts, Z. R., asst. prof. sociology, W. V. U., Morgantown
*Kraybill, D. B., dean, New River State College, Montgomery
*Lafferty, R. C., geologist, Charleston
Lang, Thos. S., city engineer, Clarksburg
*La Peire, George, geologist, Charleston
Lauterbach, C. E., prof. of education, W. Va. Wesleyan College, Buckhannon
Lawall, Chas. E., prof. of mining engineering, W. V. U., Morgantown
Largent, Robert J., dean Marshall Coll., Huntington
Layne, Mabelle A., science tchr., Burch H. S., Delbarton
*Lee, R. A., principal, Ansted H. S.
Lively, E. L., Fairmont S. T. C.
Loy, Melvin P., prof. of biology, Marshall College, Huntington
Ludwig, Ross, tchr. of science, Union District H. S., Dunbar
*Maclin, E. S., president, New River State College, Montgomery
Marsh, J. F., president, Concord State College, Athens

Martin, Elizabeth, tchr. of biology, Charleston H. S.
Martens, J. H. C., asst. prof. of geology, W. V. U., Morgantown
*Matheny, John W., asst. prof. of history, New River State College, Montgomery
Maxwell, C. W., attorney, Elkins
*McCray, Charles, teacher, Princeton H. S.
McGuire, A. E., prof. of education, Concord State Coll., Athens
McNeill, E. Meade, prof. of biology, Concord S. T. C., Athens
Miller, Myrtle, teacher of gen. science, Junior H. S., Fairmont
Montgomery, T. G., Jr., 308 Seneca St., Oil City, Pa.
Moore, Laura B., tchr. Parkersburg H. S.
Morris, Samuel, prof. of chemistry, W. V. U., Morgantown
Newins, Harold S., assoc. prof. of forestry, Mich. State College, East Lansing, Mich.
*Nicholson, A. B., chemist, Weir
*O'Brien, Lawrence, teacher, Montgomery H. S.
*Oliver, Joseph, Smithers
Packard, Russell L., prof. of geography, Concord S. T. C., Athens
Palmer, John C. Jr., Rock Ledge, Wheeling
Parks, Miss Atia C., Spencer High School
Patterson, J. H., principal, Thomas H. S.
†Patterson, Robert C., grad. ass't. in zoology, W. V. U., Morgantown
Phillips, D. E., prof. of math., Shepherd College, Shepherdstown
*Potter, C. J., chemist, Fairmont
*Power, F. Ray, asst. state supt. of schools, Charleston
Price, Calvin W., editor, Pocahontas Times, Marlinton
Price, Paul H., instr. of geol., W. V. U., Morgantown
Purdum, R. B., prof. of chemistry, Davis & Elkins College, Elkins
*Pyle, F. J., dept. of education, New River State College, Montgomery
Raub, Leo G., prof. of physics, New River State College, Montgomery
†Reese, Albert M., prof. of zoology, W. V. U., Morgantown
Reger, David B., consulting geologist, Morgantown
Regier, C. C., prof. of history, New River State College, Montgomery
Reynolds, Clarence N. Jr., prof. of math., W. V. U., Morgantown
Richards, Margaret, tchr. of biology, Morgantown H. S.
Roberts, C. M., prof. of biology, Fairmont State College
Rohr, H. D., prin., Weston High School
†Rogers, H. F., prof. of chemistry, Fairmont S. T. C.
*Ryan, Thomas, student, New River State College, Montgomery
Saleski, R. E., prof. of German, Bethany College, Bethany
†Saposnekow, Jacob, asst. prof. of sociology, W. V. U., Morgantown
*Schley, Linnie, asst. editor, W. Va. School Journal, Charleston
†Schneiderhan, F. J., Supt., University Experiment Farm, Kearneysville
*Scott, Robert H., tchr., Dunbar High School
*Seyster, E. W., asst. prof. biology, New River State College, Montgomery
*Shearer, M. L., coach, New River State Coll., Montgomery
Shouse, James B., dean, Teachers' College, Marshall Coll., Huntington
Shreve, Francis, prof. of education, Fairmont S. T. C.
*Shreve, John C., president, West Liberty State College
Shufflebarger, Earl, tchr. of science, Princeton

Shutts, H. A., dept. of math., Fairmont S. T. C.
Skuce, Thos. W., extension forester, W. V. U., Morgantown
*Sly, J. F., prof. of political science, W. V. U., Morgantown
Smith, Rhema, tchr. Montgomery H. S.
Smith, Wallace, prof. of math., New River St. Coll., Montgomery
Speicher, B. I., dept. of botany, W. V. U., Morgantown
Stathers, Allan, teacher, Sistersville H. S.
Stayman, Joseph W., president, Potomac State School, Keyser
*Stevenson, Chas. A., prof. of education, D. & E. College, Elkins
Stout, Wilbur, state geologist, Columbus, Ohio
†Straley, H. W., III, Stralehurst, Princeton
†Strausbaugh, Perry D., prof. of botany, W. V. U., Morgantown
Talbott, S. Benton, prof. of biology, Davis & Elkins Coll., Elkins
†Taylor, Leland H., assoc. prof. of zoology, W. V. U., Morgantown
†Todd, Leslie J., prof. of chemistry, Marshall College, Huntington
Toothman, Dr. H. F., dean, West Liberty College
Trent, W. W., State Superintendent of Schools, Charleston
Tucker, R. C., State Geol. Survey, Morgantown
†Turner, Bird M., prof. of math., W. V. U., Morgantown
Turner, John R., president, W. V. U., Morgantown
Ulbrich, Albert, medical student, Philadelphia, Pa.
†Utterback, W. I., prof. of zoology, Marshall College, Huntington
Van Tromp, H. O., physician, French Creek
Vehse, Chas. H., asst. prof. of math., W. V. U., Morgantown
Vest, M. Lewis, dept. of math., D. & E. College, Elkins
Wagner, John R., prof. of chem., Glenville St. T. C.
Ward, John Bayliss, coal prospector, Beverly
Weakley, Chas. E. Jr., Agr. Exp. Station, W. V. U., Morgantown
*Weekly, Harold
†Weimer, R. B., prof. of biology, Bethany College
Wells, Hawley, biologist, Concord State Teachers Coll., Athens
White, Frank S., prof. of psychology, Fairmont S. T. C.
White, Ryland, student, Fairmont S. T. C.
*Whitehead, Willis, teacher, Dunbar H. S.
*Wickline, Doyle, teacher, Montgomery H. S.
Wiles, I. A., School of Medicine, W. V. U., Morgantown
Williams, S. H., prof. of zoology, Univ. of Pittsburgh
Williamson, S. G., prof. of physics, Concord S. T. C., Athens
†Winter, John E., prof. of psychology, W. V. U., Morgantown
Woods, Roy C., prof. of education, Marshall College, Huntington
Wooddell, W. S., teacher, Mullens H. S.
Wolfe, Russell, M. D., Elkins
*Young, Ruth, student, Concord State College, Athens
Zucchero, Peter J., dept. of biology, W. V. U., Morgantown

CONSTITUTION OF THE WEST VIRGINIA ACADEMY OF SCIENCE

ARTICLE I.—*Name.* This organization shall be known as the West Virginia Academy of Science.

ARTICLE II.—*Object.* The object of the Academy shall be the encouragement of scientific work in the State of West Virginia.

ARTICLE III.—*Membership.* Membership of this Academy shall consist of active members and corresponding members. Active members shall be residents of the State of West Virginia who are interested in scientific work. They shall be of two classes, to-wit: national members, who are members of the American Association for the Advancement of Science as well as of the West Virginia Academy of Science, and local members, who are members of the West Virginia Academy of Science but not of the Association.

Corresponding members shall be persons who are actively engaged in scientific work not resident in the State of West Virginia. They shall have the same privileges and duties as active members.

For election to any class of membership the candidate must have been nominated in writing by two members, one of whom must know the applicant personally; and he must receive a majority vote of the executive committee and a three-fourths vote of the members of the Academy present at any session.

ARTICLE IV.—*Fees.* Each member shall pay in advance an annual fee of one dollar ($1.00) to the Treasurer of the Academy, due at each annual meeting; and in addition, each new member shall pay an initiation fee of one dollar ($1.00) due at the time of his election to membership.

ARTICLE V.—*Officers.* The officers of the Academy shall be a president, a vice-president, a secretary, and a treasurer. These officers shall be elected at the annual meeting from the active members in good standing on the recommendation of a nominating committee of three appointed by the president.

The executive committee consisting of the four above officers and the president of the previous year shall have the authority to fix the time and place of meetings and to transact such other business as may need attention between the meetings of the Academy.

The secretary and treasurer only shall be eligible to re-election for consecutive terms. The term of the secretary shall be three years.

ARTICLE VI.—*Standing Committees.* The standing committees shall be as follows:

A Committee on Membership consisting of three members appointed annually by the president.

A Committee on Publications consisting of the president, secretary, and a third member chosen annually by the Academy.

A Committee on Legislation consisting of three members appointed annually by the president.

ARTICLE VII.—*Meetings.* The regular meetings of the Academy shall be held at such time and place as the executive committee may select. The executive committee may call a special session, and a special session shall be called at the written request of twenty members.

ARTICLE VIII.—*Publications.* The Academy shall publish its transactions and papers which the Committee on Publications deems suitable. All papers presented to the Academy for publication shall be of a scientific nature. All members shall receive the publications of the Academy gratis.

ARTICLE IX.—*Sections.* Members, not less than ten in number, by special permission of the Academy may unite to form a section for the investigation of any branch of science. Each section shall bear the name of the science which it represents, thus: the Section of Geology of the West Virginia Academy of Science.

Each section is empowered to perfect its own organization as limited by the Constitution and By-Laws of the Academy.

ARTICLE X.—*Amendments.* This Constitution may be amended at any regular meeting by a three-fourths vote of all active members present, provided a notice of said amendment has been sent to each member ten days in advance of the meeting.

BY-LAWS

I.—The following shall be the order of business:

1. Call to Order.
2. Reports of Officers.
3. Report of Executive Committee.
4. Reports of Standing Committees.
5. Election of Members.
6. Reports of Special Committees.
7. Appointment of Special Committees.
8. Unfinished Business.
9. New Business.
10. Election of Officers.
11. Program.
12. Adjournment.

II.—No meeting of this Academy shall be held without thirty days' notice having been given by the secretary to all members.

III.—Twelve members shall constitute a quorum of the Academy for the transaction of business. Three of the Executive Committee shall constitute a quorum for the Executive Committee.

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

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

VI.—The president shall appoint annually an auditing committee of three who shall examine and report in writing upon the account of the treasurer.

The financial year shall end at 9 o'clock in the morning of the first day of the annual meeting, after which time the books shall be available to the Auditing Committee.

In case a section adjourns without electing a chairman for the succeeding meeting, or in case the chairmanship of a section becomes vacant between meetings through removal of the chairman from the state or otherwise, the president of the

Academy shall appoint the chairman for the next meeting of the section, and do so at as early a date as possible.

VII.—These By-Laws may be amended or suspended by a two-thirds vote of the members present at any meeting.

ARRANGEMENT BY SECTIONS

Biology: Botany, Zoology, Physiology, Medicine, Agriculture.

Chemistry: Chemistry, Chemical Engineering, Pharmacy.

Geology and Mining: Geology, Coal and Engineering, Road Commission, Building Material, Geophysics, Archaeology.

Mathematics and Physics: Mathematics, Astronomy, Physics, Mechanical Engineering, Electrical Engineering.

Social Sciences: Philosophy, Psychology, Education, Economics, Sociology, History.

MINUTES OF THE ELEVENTH ANNUAL MEETING

The first session of the Eleventh Annual meeting of the West Virginia Academy of Science was called to order by the president, David B. Reger, May 4, 1934, at New River State College at Montgomery, West Virginia.

President E. S. Maclin of New River State College extended greetings to the Society. President Reger replied in behalf of the Academy.

The following report of the Executive Committee was presented by the secretary, Samuel Morris:

The Executive Committee of the West Virginia Academy of Science recommends that a seventh Section in the Society, devoted to Engineering, be authorized, provided ten members make application. A second recommendation was made that the constitution and by-laws of the Society be published in the next bulletin, with the wording revised to conform to all amendments to date. The report was approved.

The report of the treasurer, Frank Cutright, presented and approved, follows:

TREASURER'S REPORT

West Virginia Academy of Science for the Period May 1, 1933, to May 1, 1934

SUMMARY

Receipts:		
Balance on hand June 1, 1933		$590.46
Deposits		33.00
Total receipts		$623.46
Expenditures:		
Checks	$107.99	
Federal tax	.16	
Total expenditures		$108.15
Balance on hand May 1, 1934, on deposit with the Bank of Athens, Athens, W. Va.		$515.31

There were no reports from the Membership or Legislative Committees, all members being absent.

A report of the Committee on Activities was given by Chairman Wallace Smith as follows:

REPORT OF ACTIVITIES COMMITTEE
1934

1. Last year this committee included in its report a suggestion that an attempt be made by some individual member or group of members to study ways and means of bringing about the establishment of a central dispensary for biology specimens. It would seem that this idea should be pressed with considerable interest by the Biology Section.

2. The science text-book situation in this state seems to need much attention from some one with the aim and purpose of teaching the various courses in science. I would question the ability of any person, with few exceptions, to be able to choose texts for our high schools and elementary schools, unless that person has pursued the study of the science in question beyond the average A. B. or B. S. degree. A great host of our science teachers have had very little work in the subject for which they are often asked to recommend texts. If the Academy would work out a plan for the study of good texts and exert an effort to have them adopted, much good could be accomplished.

In one instance brought to the attention of this committee a teacher who needed a job was employed and assigned to teach a science. That teacher told the principal he was unprepared. Difficulty was met in certification, but by allowing for certain high school credits a certificate was had. This teacher confessed to his class from time to time that some pupils in that class knew more about the subject than he. Yet the principal only recently asked the teacher to recommend a text for the particular courses he was teaching. This teacher will continue where he is next year and will name his texts. Something should be done about such a situation.

3. In a supplementary study to that of the committee on the Junior Academy, note might be made of the following:

The average high school science club is not a regularly organized club but a temporary arrangement of something for the science teacher to try to entertain her students during vacant periods throughout the day.

The highly-organized consolidated school system in this state makes it almost impossible to have science club meetings at any time other than recitation and class periods. This curtails almost all outside activity except in the larger cities.

The scholarship requirements for certification are so low that it is often more easy to interest the student than the teacher-sponsor.

There is not a close relationship between the Academy and the science sections of the State Education Association. The members of these latter groups look with much fear and anticipation upon the presence of a college man at their meeting. His line is too high brow, and therefore, it is the very boredom itself.

4. If we do not recognize what we have to work with and get down to that plane, we cannot hope to get far with the idea of a Junior Academy.

Practically every science teacher in the state would jump at any kind of suggestion of activities for her club. They are eager to get ideas and outlined programs. They need and want help, but that help must be in a concrete form.

5. The establishment of state forests on land worthless for farming, that has been taken for taxes, or has been donated, or has been owned by the state, would be a project well worth promoting by the Academy of Science.

6. The Academy might do some work toward publications on the natural resources of the state and on the flora and fauna, as has been done in New York, Connecticut, and other states.

(Signed) Wallace Smith, Chairman
Frank A. Gilbert

A motion was passed to refer the report to the Executive Committee for consideration and action.

The report of the representative to the latest meeting of the American Association for the Advancement of Science was given by R. C. Colwell.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE . . . . THE ACADEMY CONFERENCE

The annual session of the Academy Conference for the year 1933 was held at the Hotel Statler in Boston on Wednesday, December 27, 1933. Representatives from 18 states were present. Most of the discussion centered around the address of Dr. E. C. L. Miller of the University of Virginia, entitled "In computing a science teacher's hours of teaching, how many hours of laboratory teaching should be considered equivalent to an hour of class recitation?" It was pointed out that many of the accrediting agencies, many universities, and many high schools now require two hours of laboratory teaching for one of lecture work and that it would be a very long and tedious process to get all the different groups to agree upon one procedure. It also was emphasized that the laboratory work of students in high schools and colleges was given a definite credit of one hour for two hours of laboratory work. As a result of this paper by Dr. Miller, some effort probably will be made to change the rating of laboratory work for both students and teachers.

The suggestion was also made that the academy of science in each state should get into close touch with all the scientific agencies in its state: that is, we should welcome the opportunity afforded by associations of other scientific men as doctors, chemists, and engineers to increase the interest in science in the state.

Someone suggested that the academy of each state should collect pictures and original manuscripts of men in the state who had been noted for invention or scientific discovery.

The report was accepted, and a motion was passed that the report of Dr. Colwell should be printed in the next volume of the Proceedings of The Academy.

President Reger made the following committee appointments:

WEST VIRGINIA ACADEMY OF SCIENCE

COMMITTEES - - - 1934-1935

Membership Committee	J. E. Judson, chairman H. A. Davis Elizabeth G. Martin
Resolutions Committee	E. C. H. Davies, chairman H. M. Fridley C. C. Regier

Nominations Committee	H. F. Rogers, chairman
	E. Meade McNeill
	A. M. Reese
Legislative Committee	Claude W. Maxwell, chairman
	W. W. Trent
	Phil Conley
Activities Committee	Wallace Smith, chairman
	Maurice Brooks
	Dorothy Wilson
Auditing Committee	R. B. Purdum, chairman
	S. L. Galpin
	L. G. Raub
F. E. Brooks Arboretum Committee	P. D. Strausbaugh, chairman
	J. B. McLaughlin
	W. S. Downs

A motion was passed which referred to the Executive Committee for consideration the desirability of having the activities of the Academy published in the journal "Science."

At the second general meeting, May 5, the names of 39 proposed new members* were read and approved.

The following report of the Resolutions Committee was accepted:

Knowing the many details connected with arranging for a meeting such as ours, and appreciating the courteous hospitality extended to us, we duly authorize our secretary to extend our hearty thanks to Messrs. Wallace Smith, L. G. Raub, D. B. Finch, Raymond Belle, President E. S. Maclin of New River State College, and through them to all those who so kindly assisted in making our meeting both pleasant and profitable.

Committee: Earl C. H. Davies, chairman
H. M. Fridley
C. C. Regier

Dr. I. F. Boughter, a loyal member of the West Virginia Academy of Science, met with a fatal accident in Fairmont, West Virginia, on March 16, 1934. He was head of the social science department at Fairmont State Teachers' College, where his scholarship and ability as a teacher won for him the respect of students and faculty. Dr. Boughter was interested in promoting intercollegiate debates and an annual social-science conference.

The shock of his sudden death is shared by all who knew him. Therefore the West Virginia Academy of Science, meeting at New River State College at Montgomery, directs its secretary to convey our sympathy to Mrs. Vivian Reynolds Boughter, of Fairmont, and to incorporate a copy of this resolution in the minutes.

Committee: Earl C. H. Davies, chairman
H. M. Fridley
C. C. Regier

*New members of the Academy are indicated by names starred in the complete membership list on page 6.

The following report of the Auditing Committee was accepted:

May 5, 1934

REPORT OF THE AUDITING COMMITTEE

Mr. President:

We have examined the accounts of Frank Cutright, treasurer, and find them in satisfactory condition.

R. B. Purdum, chairman
S. L. Galpin
L. G. Raub

The report of the F. E. Brooks Memorial Committee, which follows, was accepted.

REPORT OF THE COMMITTEE ON THE F. E. BROOKS WILD-FLOWER MEMORIAL

The earlier efforts of the members of the committee were rather ineffective and for a time an apparent impasse had been reached. Recently through the faithful and effective work of Prof. Wallace Smith a new avenue of approach was discovered, and your committee, with full acknowledgment and appreciation of the service rendered by Mr. Smith, is now prepared to announce that the F. E. Brooks Wild-Flower Memorial is to be realized in the near future. The project now has the approval of the Governor, who has appointed a committee to represent him in the consideration of plans proposed by the Academy committee. A definite site for the plantings has been chosen, and a planting plan will be submitted to the Governor's committee within the next week or two.

Hon. J. B. McLaughlin, State Commissioner of Agriculture and member of the Academy, has rendered invaluable services in bringing our original proposal to fruition, and as he is now a member of both the Governor's committee and the Academy committee, there is every reason to believe that the development of the F. E. Brooks Wild-Flower Memorial is fully assured.

P. D. Strausbaugh, chairman

President Reger announced that Davis-Elkins College, Elkins, West Virginia, had been chosen as the place for the meeting in May, 1935.

Dr. Strausbaugh now gave a special report from the Biology section concerning a proposed state biological survey. The report, which was approved by the Society, follows:

RECOMMENDATIONS OF THE COMMITTEE OF THE BIOLOGY SECTION

It is recommended that:

1. The Academy sponsor a complete biological survey of the state of West Virginia.
2. A definite effort be made to encourage all persons who are interested to enlist in the campaign of the Academy.
3. Collections, data concerning collections, and publications be brought together in some one institution where they will be readily available for examination by any who may be interested.

4. A committee be appointed to plan, coordinate, and foster the work of the biological survey, consisting of one biologist from each institution of higher learning within the state, the State Forester, and the Park Naturalist of Oglebay Park. The present committee recommends that the following members be chosen to serve on this permanent committee:

1. Chairman—to be named by the Academy
2. Marshall College—Frank Gilbert
3. West Virginia Wesleyan—J. E. Judson
4. Davis-Elkins—S. Benton Talbott
5. Salem—H. D. Bond
6. Bethany—B. R. Weimer
7. Fairmont—C. M. Roberts
8. Glenville—E. R. Grose
9. Concord—E. Meade McNeill
10. University—L. M. Peairs
11. Potomac State—R. C. Patterson
12. Shepherd College—G. H. Bretnall
13. Morris-Harvey—C. L. Shilliday
14. West Liberty—J. E. Drummond
15. West Virginia State College—A. P. Hamblin
16. New River State College—E. W. Seyster
17. State Forester—H. W. Shawhan
18. Park Naturalist—A. B. Brooks

Members of the committee of the Biology section:

Frank Gilbert
A. M. Reese
P. D. Strausbaugh

A. M. Reese was unanimously chosen as chairman of the State Biological Survey.

Dr. Reese moved that the Academy become a "contributing organization" to the Committee on the Preservation of Natural Conditions of the Ecological Society of America and that the treasurer be instructed to send $1.00 and the necessary forms to the Ecological Society. The motion was carried.

By general consent President Reger added the subject of Geophysics to the Geological Section.

It was moved that a committee be appointed to ascertain the undesirable forms of wild life for elimination and that this list be made available to the various wild-life organizations of the state. The motion carried.

The resignation of the secretary of the Academy, Samuel Morris, was accepted.

The Nomination Committee proposed the following nominations for officers for the coming year:

President	C. E. Albert
Vice-President	G. S. Dodds
Secretary	M. L. Vest
Treasurer	Frank Cutright

The officers were unanimously elected.

The president then called for the reports of the chairmen of the sections, which were given as follows:

Biology: 60 members present. Chairman for 1935, Frank Gilbert. E. Meade McNeill, chairman.

Chemistry: 45 members present. Chairman for 1935, R. B. Purdum. A. R. Collett, chairman.

Geology and Mining: 10 members present. Chairman for 1935, H. M. Fridley. S. L. Galpin, chairman.

Mathematics and Physics: 26 members present. Chairman for 1935, H. A. Davis. Leo G. Raub, chairman.

Social Science, Group I: 20 members present. Chairman for 1935, C. G. Brouzas. C. G. Brouzas, chairman.

Social Science, Group II: 15 members present. Chairman for 1935, Chas. A. Stevenson. L. B. Hill, chairman.

After explanatory remarks as to the trips planned by the local committee, the meeting adjourned.

PAPERS READ AT THE MONTGOMERY MEETING

General Program

President's address: The Mountains of North America.

C. E. Albert: Science and the Shop.

J. E. Judson: Experiments of Magic.

Meetings By Sections

Biology

(Botany, Zoology, Physiology, Medicine, Agriculture)

Frank Gilbert, Huntington: Additions to the Slime Molds of West Virginia.

Hartley D. Bond, Salem: The Study of a Case of Quadruplets.

G. S. Dodds and H. C. Cameron, Morgantown: The Effect of Experimental Rickets Upon the Growth of Bones in Rats.

I. A. Wiles, E. Tomblyn, P. Zucchero, and F. E. Chidster, Morgantown: The Effects of Dessicated Thyroid, Anterior Pituitary, Adrenal Cortex, and Iodin Upon Inheritance, Growth, and Maturation of *Drosophila melanogaster.*

Melvin P. Loy, Huntington: Forward and Backward Locomotion of Severed Parts of *Lumbricus terrestris.*

S. Benton Talbott, Elkins: Notes on the Life History of a New Species of Trematode of the subfamily Allocreadiinae.

H. A. Wells, Athens: Life Cycle of *Menoidium pellucidum.*

P. C. Bibbee, Athens: Check List of Birds of Southern West Virginia.

Randolph Boggess, Oakvale: Ferns of the Smoky Mountain Region.

C. R. Orton, Morgantown: Colonization By Plant Parasites. (Lantern)

Nellie Ammons, Morgantown: Preliminary List of West Virginia Mosses.

Hazel C. Cameron, Morgantown: Salivary Secretion as an Index of Vitamin-A Deficiency.

Wilbert Frye, Capon Springs: Flora of Hampshire County, W. Va.

Robert F. Martin, Morgantown: A Key to the West Virginia Species of Panicum.

Earl L. Core, Morgantown: The Work of C. F. Millspaugh in West Virginia.

B. R. Weimer and Malvern Still, Bethany: A Peculiar Abnormality of the Left Pelvic Girdle and Appendage of a Lamb.

J. E. Judson, Buckhannon: The Floral Development of the Staminate and Pistillate Flowers of the Honey Rock Muskmelon.

Robert C. Patterson, Keyser: Some Notes on *Myotis lucifugus*, the Little Brown Bat.

C. N. Hill, Fairmont: A Botanical Survey of Marion County, W. Va.

A. M. Reese, Morgantown: A Two-Tailed Tadpole. (Lantern)

Chemistry

(Chemistry, Chemical Engineering, Pharmacy)

A. C. Blackwell, Barboursville: Introducing the Student to Organic Chemistry.

Earl C. H. Davies, Morgantown: Coal Flowers.

Hubert Hill, Morgantown: The Use of Ceric Sulfate in Volumetric Analysis.

C. A. Jacobson, Morgantown: Organic Fluosilicates. (Lantern)

Charles E. Weakley, Jr., Morgantown: Some Modified Extraction Apparatus. (Lantern)

H. F. Rogers, Fairmont: Sources of Material for Junior Academy Programs.

W. W. Hodge, Morgantown: Variations in the Mineral Content of Some Morgantown Water Supplies. (Lantern)

Samuel Morris and A. J. W. Headlee, Morgantown: Lecture Demonstrations in General Chemistry.

Geology and Mining

(Geology, Archaeology, Coal and Oil Engineering, Road Commission, Building Material)

Claude W. Maxwell, Elkins: The Reason the Tygart Valley River Flows through Laurel Hill.

H. M. Fridley, Morgantown: The Origin of the Green Bank Basin, Pocahontas County, W. Va.

Paul H. Price, Morgantown; Notes on the Mississippian of West Virginia.

H. W. Straley III, Princeton: Some Notes on the Nomenclature of Folds.

S. P. Burke, Morgantown: The Flow of Gas in Geological Strata.

S. L. Galpin, Morgantown; Fire-Clay Horizons of West Virginia.

Mathematics and Physics

(Mathematics, Astronomy, Physics, Mechanical Engineering, Electrical Engineering)

R. S. Gatherum, Athens: When will Mathematics Come into Her Own?

R. C. Colwell, Morgantown: The Vibrations of Membranes and Plates.

M. L. Vest, Elkins: A Formula in Differential Geometry.

M. L. Vest, Elkins: A Problem in Determinants.

Raymond Bell, Smithers: The Application of the Hamilton-Jacobi Partial Differential to the Solution of a Problem in Theoretical Physics.

A. T. Bragonier, Huntington: Statistical Methods Applied to a Study of Strength Tests.

Play—"The Case of Mathew Mattix," written by Alice K. Smith and given by the students of Rhema Y. Smith.

Chas. H. Vehse, Morgantown: Acceleration Stresses in a Heavy Wire Rope.

H. H. Dubs, Huntington: The General Theory of Relativity—A Criticism.

Social Sciences—Group I

(Philosophy, Psychology, Education, Economics, Sociology, History)

J. D. Barnhart, Morgantown: John Fairfax, An Overseer of George Washington.

M. S. Cushman, Athens: Economic Background of the Agricultural Story of the Old West, 1865-1880.

C. C. Regier, Montgomery: Can Capitalism Maintain Itself In The United States?

T. L. Harris, Morgantown: Some Sociological and Economic Experiments.

J. F. Sly, Morgantown: Political Planning in West Virginia.

R. E. Saleski, Woodridge, Va.: The Linguistic Question in Epistemology.

R. L. Packard, Athens: A Plea for the Study of Geography in West Virginia.

K. D. Hutchinson, Morgantown: An Opportunity Theory of Business Profits.

G. G. Brouzas, Morgantown: A Roman Who Refused to Become Emperor.

H. W. Straley III, Princeton: The Social Value of the Mineral Resources of West Virginia. (Lantern)

Social Sciences—Group II

(Education and Psychology)

H. H. Speicher: Studies at West Virginia University on the Graduate Level.

Frank S. White, Fairmont: Intelligence and Scholastic Marks.

John E. Winter, Morgantown: A Psycho-Clinic for West Virginia.

O. G. Wilson, Glenville: Note Books or no Note Books for College Students.

Roy C. Wood, Huntington: Financial Support and the Dollar Fluctuations.

Dinner Program, Friday, May 4

Address by Hon. John J. Cornwell, General Counsel, Baltimore and Ohio Railroad Company: "The Railroads' Future."

Papers Read at the Montgomery Meeting†

THE RAILROADS' FUTURE*

JOHN J. CORNWELL,
General Counsel of The Baltimore and Ohio Railroad Company

IN ASKING ME to discuss with you the future of the railroads you have commanded me to enter the field of speculation, inasmuch as the future of the railroads is dependent upon the public's attitude toward them as reflected in future legislation and future regulation, and one can do little other than speculate as to what that attitude will be.

Having made that statement, it behooves me to make plain to you why I think it true, and, in doing that, it is necessary to review, briefly, the past history of the American railroads and to consider their present situation and condition.

When the construction of railroads in this country began with the laying of the first stone on the right-of-way of the Baltimore and Ohio, at Baltimore, July 4, 1828 — one hundred and six years ago — most of the population was along the Atlantic Seaboard. Water transportation was the only kind of transportation available, for there were no highways worthy of the name, and even had there been there was nothing but wagons to traverse them. Settlements were growing up on the Great Lakes and along our principal rivers, but the vast interior sections were scantily populated and the great areas west of the Mississippi were populated only by wild men and wilder animals.

Time will not permit the tracing of railroad building in any detail. It commenced, as in the case of the Baltimore and Ohio, not as a business within itself, but because merchants, bankers, and tradesmen in cities and communities were struggling for the development of those communities, protecting their trade and their business. They put their money into the first railroads not so much as direct investments, not so much with the expectation of getting direct returns thereon as of securing indirect returns — increased commerce, trade, and population, with increased property values in consequence.

As railroads were constructed across the Allegheny Mountains into the Ohio Valley, connecting that rich area with the Atlantic ports; as they were constructed on through the Central West to the Mississippi, the country increased in wealth, commerce, and population amazingly.

Those were the motives which most largely prompted railroad construction prior to the great Civil War.

Following that War and during the era of inflation it produced, railroad building became a business, an industry. This was stimulated greatly by the Government's aid in constructing railroads across the Rocky Mountains, on to the Pacific Coast. During the next two decades railroad building was overdone. Railroad corporations were "promoted" and lines built into undeveloped areas in anticipation of business that was not promptly developed. Competitive lines were constructed

†In perusing the papers of these *Proceedings* the year of the annual meeting, rather than the date of publication, should be borne in mind.—Ed.

*The address of the visiting speaker.

which the volume of business in the area did not, at that time, justify, with these results:

In the depression periods of the seventies and the early nineties there were many railroad receiverships, and huge losses to investors in consequence. Many railroads were reorganized and many smaller ones absorbed by larger systems.

Earlier, however, especially during the seventies and early eighties, competitive lines engaged into cut-throat competition for business. Reckless rate-cutting and rebates to big shippers to secure their business tended to demoralize general business, for a man or concern engaged in any kind of commerce or trade had no way of knowing the cost of commodities to his competitor, as there were no standard freight rates.

Incidentally, traveling in a circle, we are back to the same situation to-day, due to truck transportation on our highways and the failure of Congress to regulate charges.

However, the conditions to which I have referred led to the passage, in 1887, by Congress, of the Interstate Commerce Law and the creation of the Interstate Commerce Commission. This was to be followed by many other regulatory acts, such as the Ash Pan Act, the Boiler Inspection Act, the Federal Employers' Liability Law, the Lafollette Valuation Act, and, in 1916, the Adamson Law giving to railway employees, in effect, an eight hour day with ten hours' pay, and now, on top of it all, we have the Railway Emergency Act of 1933 with the Federal Coordinator of Transportation.

Originally the Interstate Commerce Law was designed to assure the fair treatment of all shippers, big and little, by the railroads; it was a code of fair practice, guaranteeing every shipper, no matter how small, against discrimination in rates and practices in favor of the larger shippers. All kinds of private business could sell at wholesale cheaper than at retail, but railroads, being common carriers, affected with the public interest, must charge uniform rates. There must be no discrimination.

That was and is a sound governmental policy and one cannot but wonder why the Congress neglects to apply it to water carriers and highway transportation agencies.

The Interstate Commerce Commission was designed to be a policeman to enforce the Interstate Commerce Law and the other regulatory acts, to some of which I have referred.

Time will not permit me to trace the development and expansion of the power and authority of the Interstate Commerce Commission, but it is a fact that expansion of power has gone on, both by law and assumption, until the Government, through the Interstate Commerce Commission, has, for a number of years, been in complete control of the railroads, to a very great extent exercising managerial powers, devoid, however, of any financial responsibility for their success or failure.

With these facts before us we are forced to consider whether this government regulation, control and quasi-governmental management has been, at all times, safe, sane, and efficient.

However, before discussing that phase, let me pause to remark that I am not called upon, at this time, either to discuss or to defend the handling of individual railroad properties.

The men who managed the properties were human beings, with all the weaknesses, faults, and frailties of human beings. Some of them were disciples of the lower standard of business morals prevalent in those years — the era before the one-price system came into being; the era when every man engaged in business of any kind charged all his customers would pay; took all the toll he could get; when *caveat emptor* was the business rule. The railroad managers of that day were, on the whole, I think, no better and no worse than the average men in any other line of business. Many were men of supreme courage and great foresight. They were the real "makers of America." James J. Hill, the "Empire Builder," past fifty, took a few miles of railroad extending out of St. Paul, carried it across the uninhabited prairies of the Dakotas and Montana, through Marias Pass in the Rockies, and on to the Pacific Coast. His Great Northern Railway and his energy in developing the country along it brought people and prosperity to that great Northwest country. Hill and Huntington were the two outstanding railroad builders of their day. Many men did for smaller communities what these men did for great areas.

With all the mistakes and faults of individuals there was brought into existence in this country, taken all together and treated as a whole, a mighty railroad plant of 250,000 miles; the most efficient and the lowest capitalized of any railroad system in the world, rendering the best service, paying the highest taxes and the highest wages of any country and relatively making the lowest charges.

But going back to our past governmental policy with respect to the railroads: I have inferentially indicated the Interstate Commerce Commission was created as a policeman and evolved into a ringmaster. The entire history of our governmental regulations, except in a single, temporary instance, has been a succession of "don'ts" and penalties, and generally the Interstate Commerce Commission has been alert on the negative side.

I have said that soon after the Civil War, railroad building was overdone. It was overdone from the standpoint of the investors who put their money into them, but they developed the undeveloped sections. Our population increased by leaps and bounds, there being no restrictions on immigration, and commerce and trade grew and expanded amazingly.

Railroad receiverships and the tight hand of government regulation later tended to discourage investments in railroad securities, with the consequence that, at the beginning of the present century, the country and its business were growing rapidly and the railroads were standing still. Far-sighted railroad managers saw a crisis approaching. They plead with the people and petitioned the Commission.

They, men like James J. Hill and Daniel Willard, told the public that billions of private capital were needed to put the railroads abreast of the country and its development; that this capital could not be obtained except a more liberal public policy be adopted toward the carriers. The people listened but preferred to believe the politicians who said the railroads were robbing them; that their stocks and bonds were watered and their rates already too high.

The petition filed with the Interstate Commerce Commission in 1911 for a meagre five per cent. increase in rates was, for all practical purposes, denied. Instead, Congress gave them the Lafollette Valuation Law, designed to have the Interstate Commerce Commission find the actual physical value of the railroads to verify the politicians' promise it would prove that the roads were worth only one-half of the par value of their securities outstanding; that on this valuation freight rates might be reduced one-half.

Incidentally, instead of making the valuation in three years, at a cost of $3,000,000, as Congress claimed, the Interstate Commerce Commission consumed a decade doing the work, spent $40,000,000 of the tax-payers' money on the job, and the railroads were obliged to spend $140,000,000 co-operating. The Commission did its level best to keep down the valuation, going so far as to violate the law, as determined by the Supreme Court in the O'Fallon Case, but, even at that, what was its finding?

That the politicians were right? That the railroads were over-capitalized? Oh! no. On the other hand, that the railroad properties were actually worth several billion dollars more than the par value of all their stocks and bonds outstanding, but that was a high price for the public and the railroads to pay to disprove a political canard. The effect of that should have been sobering on the public mind, but new issues and new charges quickly diverted public attention.

In the meantime what was happening to the railroads?

The attitude of the Commission and the action of Congress made it impossible for them to secure sufficient new capital to expand their properties and the result was car shortages and blockades. So, in 1917 when this country entered the World War, the Government took over the railroads in order that its own laws and rules against co-operating and pooling could be disregarded and government shipments preferred.

At the end of the World War it was apparent to President Wilson, to Congress, and to the country that our past governmental policy, as it related to the railroads, was all wrong; that it ought to be changed.

President Wilson recommended and Congress, in the Transportation Act of 1920, directed that the Interstate Commerce Commission should allow and establish rates which would, under honest, efficient, and economical management, permit the roads to earn a fair return on the value of their properties. That sounded fair, did it not?

The Interstate Commerce Commission fixed five and three quarters percent as a "fair return," but at no time, during even the boom business period from 1922 to 1929, did the Commission establish or allow the railroads to initiate rates which would permit them, as a whole, or by rate-groups, to earn that five and three quarters percent on the value of their properties. Of course, it is true that a few roads particularly advantageously located did earn that much.

Private industries prospered, paid large dividends, and put by huge cash surpluses for the rainy days their managers knew would come bye and bye. Those rainy days dawned in the autumn of 1929. They grew rainier and darker during 1930, 1931, and 1932.

Railroad business and revenues declined day after day, week after week, and month after month until the average decline was between fifty percent and sixty percent. Even at that the decline in the volume of railroad business was not as great as in the case of some of the industries, for the automobile industry dropped below twenty-five percent and the steel industry below twenty percent of peak production.

But the railroads did not suffer from the depression alone. They were competing with new forms of unregulated, government-fostered competition — waterways, highway, and airway transportation — all, in effect, government-subsidized.

Much of the money used in subsidizing them was collected in taxes from the railroads.

While regulation of railroad rates and practices steadily grew stricter there continued to be, and is now, no federal regulation either of rates or practices of those competitors.

Of course the depression, plus such competition, brought many of the railroads to the threshold of bankruptcy.

When President Roosevelt came into office and shortly thereafter convened Congress in special session to pass emergency legislation, naturally he took cognizance of the serious plight of the railroads. During his campaign he had announced a sound railroad policy — that of giving them aid, for a reasonable period, in the shape of loans, or such of them as could reasonably be expected to remain solvent, and in the meantime bring their competitors under the same regulation as the rail carriers. However, at the special session he took the position this comprehensive program would require study, and he suggested emergency legislation to be put in effect in the interim. The Railroad Emergency Act was passed. It is divided into two parts — one supposedly a short cut for railroads unable to pay wages, interest, and taxes — fixed charges — to go into bankruptcy and reorganize their capital structures; the other creating the position of Federal Coordinator.

Originally the bill would have permitted the coordination of railroad services and facilities, but an amendment inserted at the instance of railway employees prohibiting reduction in forces naturally made this part of the Act largely ineffective.

However, Hon. Joseph B. Eastman, who was appointed Co-ordinator, has been and still is making a most thorough and searching investigation into the whole transportation situation. With his last report, recommending the bringing of other forms of transportation under the supervision of the Interstate Commerce Commission, he submitted a bill to carry the recommendation into effect, but, despite the fact that the President, in his campaign and since, expressed his approval of such a governmental policy, there are no indications that Congress will, at this session, at least, take any action.

In the Coordinator's first report he devoted much time and space to a discussion of government ownership and operation of the railroads, which he terms "public ownership." After presenting an extended list of reasons for government ownership he stated he did not advocate the adoption of such a policy now, assigning two reasons why he put it aside for the present. The first was a frank admission there is no great public demand for such a radical change of policy. The second reason, the more influential one with the Coordinator, was that with the Federal Government's present huge public debt it could not assume the additional burden of acquiring and supporting the railroads.

In the meantime the railroad picture has brightened considerably. A marked increase in the volume of traffic is enabling most of the roads to get out of the red; to meet bond interest and pay taxes. A very few, including the Chesapeake and Ohio and the Norfolk and Western, because of the increased demand for the coal produced in the fields they serve, are really prospering.

There is no time at my command to review the progress the railroads have made in efficient and economic operation. This is a long and interesting story within itself. Nor can I here discuss improvements in passenger service, with air-conditioned cars, or give facts and figures as to the safety of travel by rail as compared with other modes of travel.

I have briefly drawn an outline of railroad development and government regulation of the railroads and the present condition surrounding them.

Now as to their future:

If railroads in the future, as in the past, are to be regarded and treated as public enemies; if public authorities think their sole duty is to swat them at every opportunity and tax them as high as the Courts will permit, then I think it a serious question whether the railroads will long continue the efficient transportation agencies they are to-day.

Another thing somewhat obscures the picture:

We appear to be headed for further general development of waterways at public expense. Much of this money, in the future, as in the past, will come from the railroads. If they are to continue to pay taxes to provide free highways, water and land, for competitors and those competitors are to be allowed to go unregulated, cutting under the railroads on rates, then the future of the railroads will be most difficult.

With this waterway improvement are correlated giant hydro-electric power plants being developed at government expense. The clamor is growing for more of such plants. They will take the place of coal; they are doing it now. The bituminous coal industry is threatened. If your coal fields shut up or shut down, due to increased consumption of electric power from government plants, many of the rail carriers will be seriously affected.

What is to be the future government policy as to these things?

If you can answer those questions I can make a better guess as to the future of the railroads.

As I said in the beginning, their future is in the hands of the public which can and does control government. It is in your hands, in part at least.

Finally, one other phase; that is government ownership.

As you know, a few days ago President Roosevelt designated three members of his Cabinet, Attorney General Cummings and Secretaries Perkins and Roper, to make a study of the situation, confer with railroad managements, and report to him. Newspaper stories indicate that the proposed conferences are for the purpose of ascertaining whether railroad owners will voluntarily consent to a readjustment of the capital structure so as to reduce fixed charges, or "let nature take its course," with the threat of government ownership and operation as an alternative.

Railroad managements probably would be very happy if the owners of railroad bonds would voluntarily exchange them for stock, thus reducing interest charges, but in view of the vast number of people and institutions, especially savings banks and insurance companies, owning the bonds, great difficulties lie in the path of a consent arrangement for readjustment of the capital structure of any considerable number of railroads. The stock represents an investment, the bonds a loan. Those people who made loans and hold bonds, secured by a mortgage on the property, will be reluctant to surrender their bonds for stock.

Nor does the threat of government ownership frighten them. They would no doubt be glad to surrender their railroad bonds for government bonds.

So as to government ownership, we have these things facing us:

1. The railroad Coordinator appears to favor it. Even while a member of the Interstate Commerce Commission he advocated it.
2. The bondholders, from a selfish standpoint, may very well favor it.

3. The railway employees ,or some of them, through their labor organizations, have endorsed it.
4. It is believed that at least one member of the Cabinet Committee favors it.

While the President has indicated he recoils from the thought of it, as well he may with the huge debt the Federal Government already has hanging over it, a debt that is increasing by millions daily, with the present set-up, he and Congress may come face to face with that issue at the next session of Congress.

In the meantime the country is being propagandized to create a public sentiment favorable not only to government ownership of the railroads but of all other public utilities and "basic industries."

The extent of this propaganda and the organizations behind it are not generally appreciated. The colleges, even the public schools, are being made "spear heads" of the drive, using an appropriate communistic term. A few days ago three hundred ministers in the New York District, of a single denomination, endorsed such a policy.

Unless the great American public, the tax-payers, the citizens who believe in preserving our American form of government, arouse themselves, they may see us suddenly embarked upon that un-American policy.

Neither my subject nor the time at my command permits my going fully into this question of government ownership. I can pause only long enough to say the American system is private ownership with government regulation of utilities and industries affected with the public interest; that wherever and to what extent there may be failure it is not due to the system but to the persons and politicians who do the regulating; that government ownership would mean to abandon regulation and to hand over to the same politicians the *management* of the properties they have failed to regulate properly. It would be the first step in creating a communistic state on the ruins of a constitutional democracy formed by our forefathers. There is no half-way place. That is certain and we had as well recognize it.

For one, I am an American and am for the American system. I shall stand there regardless of who may swing to the other system.

May I say, in conclusion, if Congress will pass the bill to regulate the competitors of the railroads and to compel the common carriers on our inland waterways to pay sufficient toll charges for their use to maintain those waterways and reimburse the government and the tax-payers for the money expended on them, propositions the President has wisely endorsed, with the continuance of the present business revival, most of the railroads would get on their feet and go ahead in the future, as in the past, rendering the best service at the lowest relative cost to the shippers of any railroads in the world.

So, I finish as I began, by saying the future of the railroads lies not alone with their managements but perhaps in even greater degree with the American people.

THE MOUNTAINS OF NORTH AMERICA*

DAVID B. REGER, Morgantown

MOUNTAINS are the most spectacular things of the earth. Rising to great heights, sometimes from alluvial plains or even from the shores of oceans, their huge masses appear to be unchangeable and everlasting as time itself. Viewed from the standpoint of human structures, the greatest and most durable of which are mere trifles in mass and length of existence, such a conception of mountains appears to be true. Viewed in the light of natural processes, however, the picture is different. Mountains are born, they pass successively through periods of adolescence, maturity and old age; and, finally, they die and disintegrate under the attack of natural agencies. Their life cycles, although inconceivably long, are somewhat similar to those of organic things. Unlike animals they lack the power of locomotion and decisive action, but like plants their locations are natural accidents and can not be changed.

Great as the mountains are, however, they are exceeded by their invisible counterparts, the ocean depths. Viewed as a whole the surface of the earth consists of low-lying lands or plains, known as neutral areas, high lands known as positive areas, and submerged lands known as negative areas.

It is now proposed to discuss briefly the life history of the mountains of North America. With certain modifications they are typical of other elevated land masses throughout the world.

PRINCIPAL MOUNTAINS OF NORTH AMERICA

As shown by any standard map of North America, the continent of North America is divided into two portions of the Mississippi River and the general low-lying territory which extends northward from its source to Hudson Bay and the Arctic Archipelago.

East of these central lowlands the principal mountains are the Appalachians, the Laurentian Highlands of Ontario and Quebec, the United States Mountains west of the northern end of Greenland, and the Antillean uplifts of the West Indies.

West of the central lowlands are the relatively small Ozark, Ouachita, and Wichita uplifts of the southwest; the Rockies, which under various names extend from Alaska southward across Canada, the United States, and Mexico to the Isthmus of Tehuantepec; the Basin Ranges of Utah and adjacent states; the Sierra Nevada—Cascade Range; and the Coast Range.

GENERAL ARRANGEMENT OF MOUNTAINS

A map of North America shows at a glance that the principal mountains of the continent are somewhat adjacent and decidedly parallel to oceans or oceanic depths. If further amplified it would show that all others are adjacent to ancient coast lines or interior seas. To a large extent the same statement would be true of nearly all the great mountain chains of the world.

*The address of the president.

GENERAL NATURE OF MOUNTAIN FORMATION

Mountains, throughout North America and the world, are formed by uplifting of the crust of the earth. The forces required to produce them were tremendous and beyond the duplicative capacity of man. Among them may be listed gravity, heat, tidal stresses of the sun and moon, and the expansive force of rock crystallization. These forces, acting singly or in combination, at localities of crustal weakness, have repeatedly wrinkled the surface into huge ridges, some of which have long ago been degraded to the general continental levels and some of which still remain as the mountains of today. These forces, so far as known, are still in action and hence mountain formation still continues and will continue for ages to come.

Attention has been called to the fact that the present ranges of North America are closely parallel to coast lines or to present or past oceanic depths. On the landward side, moreover, they are parallel to, or in part coincide with, ancient shallow interior seas in which sediments from adjacent highlands were washed so that the loaded basins were gradually depressed until many thousands of feet of strata had accumulated, the resulting structural depressions being known to geologists as geosynclines. In the course of time most of these geosynclines have been elevated by crustal distortion so that their localities are the same as the present mountains. In or adjacent to all mountains there are central areas of igneous rocks, either granitic or basaltic, or both, which came up from great depths in molten condition. A young mountain range, therefore, generally consists of a central igneous mass, either exposed or unexposed, on which there may be super-imposed a further covering of stratified rock. In some cases the igneous mass may be comparatively low in elevation and located on the seaward side of the main range of uplifted strata. Excessive volcanic activity, which is an indication of crustal instability, usually precedes and often accompanies mountain building.

GRAVITY DIFFERENCES OF THE EARTH

Through the science of geophysics it is well known that the rocks beneath oceans are more dense than those which compose the continental, or neutral, areas. The difference is due to the fact that the sub-oceanic rocks are ferromagnesian in character and therefore basic or basaltic, while the sub-continental rocks are more siliceous and therefore granitic or acidic. The difference probably continues to a depth of 30 or 40 miles.

EARTH AND CONTINENTAL ORIGIN

The continents on which we live have, with certain minor exceptions, been stable areas for a tremendously long time. Their origin is enshrouded in a mystery which is comparable only to that of the earth itself. No theory of continental origin, in fact, which disregards the formation of the earth has been able to withstand the scrutiny of scientific thought.

The first theory of earth origin which gained general acceptance was the beautiful nebular hypothesis of Laplace, which was first advanced in 1796. This theory called for a gaseous cloud of hot vapor which was scattered throughout space but which separated into individual groups that gradually assumed spheroidal form and then cooled uniformly until their outer envelopes became solid and thus formed the heavenly bodies. The theory was popular for a century or more but is apparently defective in many ways. Without going into a discussion of the formation of

the distant stars it may be said that modern thought ascribes the beginning of all the planets to the accidental approach of a wandering star toward the sun but the theories differ greatly regarding the manner of planetary partition.

The solar system as now known consists of the parent star (the sun), nine planets, a group of small bodies known as asteroids or planetoids, 26 satellites of the planets in addition to the rings of Saturn, which are merely aggregations of minute planetesimals, and various comets. Certain essential facts about the planetary system are indicated in Table 1.

TABLE 1—*Elements of the Solar System*

Name	Mean distance from sun (millions of milse)	Mean diameter (miles)	Density (Earth=1)	Orbital velocity mi. per sec.)	No. of satellites
Sun	.....	860,000	0.255	....	.
Mercury	35.75	2,292	1.21	29.55	0
Venis	66.75	7,660	0.85	21.61	0
Earth	92.33	7,918	1.00	18.38	1
Mars	141.	4,211	0.737	14.99	2
Planetoids	.....	.....	.....	.....	.
Jupiter	480.	86,000	0.243	8.06	9
Satrun	881.	70,500	0.133	5.95	9
Uranus	1,771.	31,700	0.226	4.20	4
Neptune	2,775.	34,500	0.204	3.36	1
Pluto	3,675.	?	?	2.9	.

Note—The diameter and density of Pluto are unknown but are probably somewhat less than those of the earth.

It is evident from Table 1 that there is generally an increase in planetary diameters from Mercury to Jupiter; and that from Jupiter outward there is a general decrease. Without exception the densities and orbital velocities decrease with increasing distance from the sun.

According to the planetesimal hypothesis of Chamberlin the passing star had a curved hyperbolic motion, opposite to that of the sun, and in passing created a todal suction on the side of the sun next to the star and drew forth the gaseous cloud from which Jupiter and the outer planets were formed; and at the same time propelled from the opposite side of the sun a similar cloud which formed Mars and the inner planets, including the planetoids. Spiral motion, resulting in rotational movement, was caused at the moment or time of severance from the sun. Orbital motion of the outer group was imparted by gravitational drag from the passing star as it sped away from the sun and a similar motion was given to the inner group by the sun.

According to Sir James Jeans, however, the entire planetary mass was drawn from one side of the sun in the form of an elongated spindle or cigar shaped body, thick at the center and tapering toward the ends. In the subsequent cooling the spindle was separated into ten major bodies with diameters dependent on original position in the rotating spindle, and into various smaller bodies which became the satellites. He further assumes that the planetoids became a unit of this system but suffered later partition into small bodies. Chamberlin, however, does not agree that the planetoids have yet been united into a single body.

According to Chamberlin, moreover, the entire quantity of planetary matter, by the process of rapid cooling, was separated into small bodies or planetesimals

which later coalesced by gravitative attraction into the larger bodies which are the planets of today.

Without further digression into the domain of astronomy it is plain, or at least reasonable to believe, that the planetesimals which formed the earth were of varying sizes and densities and differed materially in their contained matter. When planetary accretion occurred, the heavier masses with superior gravity drew together first and formed the central heavy cores of the earth and the other planets of the inner group. The accretions which reached the earth in its later history plunged deeply or lightly into the crust, depending on their relative densities; and thus the surface inequalities now represented by continental areas and ocean deeps may have had their beginnings. Such selective accretion is in harmony with the known radial density of the sun and with the relative densities of the planets in their relation to the sun.

A further evident conclusion is that from the very beginning of accretion there were numerous zones of weakness and unassimilated strains, together with antagonistic chemical relationships which, in the presence of included water, made inevitable the generation of interior heat. In this matter of heat the known radio-active content of granitic magma may have been of supreme importance.

INTERIOR CONDITION OF THE EARTH

Students of the earth differ in regard to its present interior state. Chamberlin says that the outer seven-eighths is solid and that the remainder is yet to be determined. Bailey Willis agrees that the outer elastic envelope is about 2000 miles thick and that the inner 4000 miles is non-elastic and non-solid and probably a viscous liquid. An outer zone 2000 miles thick would represent about seven-eighths of the earth mass and hence these two authorities do not seriously disagree.

INITIAL DEGRADATION OF THE CONTINENTS

The initial appearance of the continental masses are only conjectural. At certain points they may have shown great heights. In any case the inequalities were planed off by meteoric water and carried into the oceanic basins, leaving only low land masses or continental shields, while at the same or at a later time it is probable that igneous or plutonic action covered the shields with a mantle of granite or lava that entirely concealed the eroded surface. In any case no vestige of the original earth surface can now be found.

The piling up of large quantities of material along ocean coasts which were already lines of probable weakness led to isostatic adjustments. In other words the newly accumulated sediments sank downward and became geosynclines while at the same time adjacent oceanic areas were raised into highlands, partly because of isostatic adjustment and partly because of earth shrinkage. These highlands, which were entirely igneous or plutonic, may have been raised concurrently with the initial degradation of the continents.

With this preview of probable early conditions which may have prevailed in ancestral North America as well as in other continents, it is now possible to follow, with some historic certainty, the topographic changes which occurred.

GEOLOGIC TIME SCALE OF NORTH AMERICA

A discussion of the subsequent physical events of North America can scarcely be made without frequent reference to time; and the only measure of prehistoric time is contained in the stratigraphic deposits which have a known sequence and to

which relative time values can be assigned. The classified record of these deposits accordingly is introduced as Table 2, which shows the geologic subdivisions for North America.

TABLE 2—*Geologic subdivisions for North America*

Era	Period or system	Subdivision	Length of period (years)	Total years since period began
Cenozoic	Quaternary	Recent (post-glacial) Pleistocene (glacial)	1,000,000	1,000,000
	Tertiary	Pliocene Miocene Oligocene Eocene	59,000,000	60,000,000
Mesozoic	Cretaceous	Upper Lower	60,000,000	120,000,000
	Jurassic	Upper Middle Lower	35,000,000	155,000,000
	Triassic	..... (various)	35,000,000	190,000,000
Paleozoic	Permian	..... (various)	25,000,000	215,000,000
	Pennsylvanian	..... (various)	35,000,000	250,000,000
	Mississippian	..... (various)	50,000,000	300,000,000
	Devonian	Upper Middle Lower	50,000,000	350,000,000
	Silurian	Upper (Cayugan) Middle (Niagaran) Lower (Oswegan)	40,000,000	390,000,000
	Ordovician	Upper (Cincinnatian) Middle (Mohawkian) Lower (Canadian)	90,000,000	480,000,000
	Cambrian	Upper (Saratogan) Middle (Acadian) Lower (Georgian)	70,000,000	550,000,000
Proterozoic	Algonkian	Keweenawan Huronian	450,000,000	1,000,000,000
Archeozoic	.....	Laurentian Keewatin (Grenville)	500,000,000	1,500,000,000
Azoic	.....		500,000,000	2,000,000,000

In this table it is apparent that the time elapsed since the begining of the Archaeozoic era, or since the beginning of life on the continent, has been about 1,500,000,000 years. To a large extent the figures are based on the disintegration of radio-active minerals for which standard methods of computation have been devised. It is further probable that the time of initial degradation of the continents, represented by the Azoic era, required another 500,000,000 years, so that North America as a definite land area may have existed 2,000,000,000 years or more.

THE AZOIC ERA

Little is known of the Azoic era. The earth was without life and probably without atmosphere, most of the gases which now compose the air and the water being contained in the interior masses. With tremendous force these gases were expelled and formed an envelope of hot vapor, certain portions of which eventually conrensed and fell upon the earth as rain when the surface cooled sufficiently.

THE ARCHEOZOIC ERA

The half billion years of the Archeozoic era also may be characterized as a time of boiling over. The new world, torn by internal stresses due to chemical and molecular adjustment, remained intensely heated at many interior points, and great out-pourings of igneous magma and lava forced their way to the surface through lines of weakness. In the region of the Great Lakes and in Canada and Greenland these bubbling vents covered the primitive land surface which, at the same time, was undergoing radial shrinkage so that its position with respect to sea level did not materially change. In Ontario and Quebec, however, the Laurentian Mountains, which are the oldest that now remain on the continent, arose above the general level, being in the form of granitic knobs of no great height. Farther south similar action may have occurred, but the Archeozoic is now deeply buried and the events are not clear. At various regions other igneous highlands of large extent must have been thrust upward, but with the exception of the Laurentians all these have vanished. In the northeastern part of the United States and in the adjacent portion of Canada the degradation of some of these highlands began and formed the Grenville beds, which are the oldest known sedimentary rocks.

THE PROTEROZOIC ERA

In early Proterozoic time the continent showed a large, low-lying land mass north of the Great Lakes and known generally as the Canadian Shield, broken only by the Laurentian uplift. Other land masses, possibly highlands, were visible east of the present Atlantic coast and reached from Newfoundland to the Antillean region of the sub-tropics. These lands were separated from the continent proper by a shallow interior sea. At the southwest there was land in the Mexican region and on the west a long land mass which even developed into a highland extended from Southern California to Alaska; and to the east of it there was a corresponding depression. Sediments were deposited generally throughout the interior seas and across the medial region of the United States, which occasionally sank below sea level. Igneous and plutonic activity occurred in many regions, being the most pronounced in the Keweenawan stage of the Algonkian period, when great flows occurred in the Lake Superior area, but it was not so widespread as in Archean time. The highlands from which the sediments were carried away may be classed as primordial mountains of which no vestiges now remain.

THE PALEOZOIC ERA

In the beginning of Paleozoic time the continent showed a great interior low-lying land mass or shield, extending from the southwestern portion of the United States northeastward to Greenland and perhaps beyond, and broken only by certain water areas in the northern region. On the Atlantic margin highlands were practically continuous from Newfoundland to the Antillean region. On the southwest another was present in the Mexican region, and on the west a great highland extended from southern California northward to Alaska and Siberia.

Rise and Growth of the Appalachians

In the Cambrian period of this area the eastern highland was elevated into a mountain range, representing the beginnings of the present Appalachian system. This was probably more than 500,000,000 years ago.

The further uplifting of the Appalachians, which are among the oldest mountains of the earth, mainly occurred in the Paleozoic era, although there was addi-

tional elevation in the late Cretaceous and the Tertiary. New ridges, lying successively west of the last one, were upraised in the late Ordovician, the Lower Devonian, the late Mississippian, and the Permian, the latter period being known as the time of the Appalachian Revolution. Each ridge, or series of ridges, except the last, was successively eroded, part of the sediments being carried eastward into the Atlantic and part of them westward into the Appalachian Sea, where they were deposited on its subsiding floor until a new marginal elevation took place. The subsidence of this interior sea, or geosyncline, varied from 15,000 to 40,000 feet and the uplifts may have had comparable height. It is reasonable to believe that mountains of 30,000 feet in height may have existed at various times. From time to time the shrinkage of the earth's crust, amounting to perhaps 200 miles in the Appalachian region and having a thrust which came from the seaward side, literally overturned huge ridges and slid the remains northwestward for many miles over the younger strata. The watershed, or summit, of the Appalachians, in Cambrian time may have been 200 miles or more east of the present Atlantic coast. Its progress westward is therefore 300 or 400 miles. The present status of the Appalachian is one of erosion and degradation; the practical absence of earthquakes indicates great structural stability.

Rise and Growth of the United States Mountains

The little-known United States Mountains, which are the most northern of the earth and which extend from Cape Morris Jessup in northern Greenland westward to Robeson Channel and across it into Grant, Grinnell, and Peary lands, were uplifted in late Pennsylvanian time. The range is intensely folded, some of the peaks being 8,000 feet high.

Rise and Growth of the Ouachitas

In addition to the Appalachians and to various uplifts which occurred in Alaska, mountains of small size were raised in the Ouachita region of Texas, Oklahoma, and Arkansas, starting with the Mississippian and extending into the Permian period. Some of these were granitic ridges which are now completely covered by later deposits, as shown by drill holes.

The Ancestral Rockies

Through the Proterozoic era and most of the Paleozoic the region now occupied by the Rocky Mountains was a subsiding basin, or geosyncline, into which sediments were being carried, mainly from the west. In the Pennsylvanian period of the Paleozoic era a high range of mountains, evidently uplifted by vertical pressure from beneath, arose in northwestern Texas, western Oklahoma, western Kansas, eastern New Mexico, and eastern Colorado. This range, which may have had a height of 15,000 feet, is known as the Ancestral Rockies. It was completely degraded and has disappeared before Cretaceous time, its total life having been 125,000,000 years or less.

THE MESOZOIC ERA

In the Triassic period of the Mesozoic, mountain building occurred in Alaska and northern California, while in the east there was a silght uplifting of the Appalachians.

In the Jurassic period the Sierra Nevada—Cascade uplift, extending from Siberia through Alaska and then southward through the Pacific coastal States and

farther south into Mexico and Central America, was mainly formed. This range or series of ranges may be termed the patriarch among the western mountains, but a mere infant in comparison to the Appalachians. In Oregon and Washington it is characterized by huge lava flows which occurred in the Tertiary period and which almost obliterated the original mountain structure.

At the same time the Coast Ranges, lying west of the Cascades and extending from southern Mexico to the southern coast of Alaska, began their initial folding.

The Mesozoic era ended with the Cretaceous period, which was generally a time of degradation and sedimentation, but toward its close the so-called Laramide Revolution which began with extensive volcanic activity, reversed the movement into an upward direction and initiated the Rocky Mountains.

THE CENOZOIC ERA

With the exception of the Sierra Nevada—Cascade system practically all the mountains of western North America have been built up chiefly during the Cenozoic era. Some of them still appear to be in process of formation and hence less than half of their history can now be written. The greatest uplifts have occurred during the Miocene and Pliocene subdivisions of the Tertiary period, within the last 30,000,000 years.

Rise and Growth of the Rocky Mountains

The Rocky Mountains rise practically from the shore of the Arctic Ocean in northern Alaska and extend south-south-eastward across Canada west of the Mackenzie River basin, entering the United States in western Montana and thence continuing across Montana, Idaho, Wyoming, Colorado, New Mexico, and western Texas. In Mexico they may be traced to the Isthmus of Tehuantepec, where they apparently end. From northwestern Alaska to the Gulf of Tehuantepec the distance is nearly 5000 miles.

In general these mountains occupy part of the geosynclinal territory which was filled with sediments during Cretaceous time. The uplifting known as the Laramide Revolution began in late Cretaceous time of the Mesozoic but became more pronounced in the Cenozoic and continued with some interruptions throughout the four main subdivisions of the Tertiary period, being most active during the Miocene and Pliocene, when the Cascadian Revolution occurred. In Montana and Idaho there are great overthrusts eastward toward the Canadian Shield indicating lateral compression or shortening of the earth's crust. Farther south, in portions of Wyoming and in Colorado, the movement was mainly vertical and caused by igneous intrusions.

Rise and Growth of the Basin Ranges

The so-called Basin Ranges, of which the Wasatch is the principal feature, center about the state of Utah and extend into portions of Nevada, southern California, Arizona, and New Mexico. The Wasatch has been described by G. K. Gilbert as a horst, or uplifted fault block, the movement of which took place in the Tertiary period, possibly in Oligocene or Miocene time. At the western side of the mountain, where the faulting was most severe, the vertical displacement was 10,000 feet or more. The vertical pressure was evidently due to intrusive matter from beneath.

Rise and Growth of the Coast Range

The Coast Range of California, Oregon, and Washington forms an outer continental buttress next to the Pacific Ocean. It is the youngest of all North Amer-

ican mountains, dating mainly from the late Tertiary although having its origin during the Jurassic, and having risen by the upthrust of great faults, many of which are active at the present time and which are the cause of the destructive California earthquakes. This range was developed on the coastal plain which had become overloaded by deposition from the Sierra Nevada—Cascade Mountains and which therefore required isostatic relief.

Rise and Growth of the Antillean Mountains

In the Antillean, or West Indian, region there are numerous high mountains, some of which rise abruptly from the sea. They rest on a foundered land (Antillia) which was part of the North American continent as late as Triassic time. Upon this foundered basement more recent land has been built by volcanic action followed by subsidence and later uplifts, the last of which occurred in Miocene and Pliocene time, when block faulting lifted great escarpments from the sea. This movement, aided by volcanic action, still appears to continue, although with lessened movement.

THE PRESENT SITUATION

At present it is evident that the mountains of eastern and southern North America, with the exception of the Antillean region, are all ancient folds which have acquired stability and which are now being degraded and carried to the sea. The Appalachian geosyncline, the overloading of which was responsible for the series of westwardly transgressing Appalachian Mountains, has now been completely filled except in the Gulf of Mexico region, and further western progress of these ranges does not appear probable. On the other hand the Atlantic shelf is being overloaded and an eventual uplift in that region, similar to the Coast Range of California, may occur at some future date. Extensive block faulting in the Piedmont region east of the mountains, which took place mainly in the Triassic period, is an indication of such eventual uplift. In the Gulf region, also, where huge rivers are discharging their cargoes of mud, the stage is being set for a local revolution.

In the west, the Rocky Mountain geosyncline is completely filled and hence the eastward progress of the Rockies appears to have been halted, but on the coast overloading and faulting is in active progress and further uplifts are in order.

In general, the progress of mountain building, which for perhaps two billion years has been mainly from the borderlands inward toward the neutral area of the continent, may now be reversed and proceed outward toward the ocean depths.

The Biology Section

ADDITIONS TO THE SLIME-MOULD FLORA OF WEST VIRGINIA: I.

FRANK A. GILBERT*

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A LIST of West Virginia Slime Moulds appeared in the 1929 Proceedings† and included all species reported from the state up to that time. Since 1929 the writer has collected and placed in his herbarium several hundred slime moulds of which eleven are new to the state. The list of new and noteworthy species is as follows:

PHYSARACEÆ

Badhamia orbiculata Rex. (*Badhamia affinis* var. *orbiculata*)

This easily recognized species was found in abundance on the decaying logs of an old wood pile in Cabell Co. June 24, 1931. Miss Lister the English authority considers it to be a variety of *Badhamia affinis* but in the United States, at least, it is quite distinct.

Physarum columbinum (Rost.) Sturg. (*Physarum wingatense* McB.)

Collected on the bark of a fallen chestnut log in Cabell Co. on July 25, 1931.

Physarum didermoides (Pers.) Rost.

This has been found but once here in the last few years. It was taken from the bark of a fence post in Cabell Co., Aug. 30, 1933.

Physarum pusillum List. (*Physarum nodulosum* Cke. & Balf.)

One of the smallest of physarums and apparently not common in the United States, although widely distributed throughout the world. A considerable amount of this species was found in the leaves and siliques of culivated Arabis in a rock garden. It is always surprising to find fructifications like this under such dry conditions. July 15, 1932, Cabell Co.

Physarum vernum Somm.

This species has been found a number of times in drying hay infusions. It has also been found in moist chambers in which dead buxus and zinnia leaves were placed. Apparently the plasmodium is of the type that develops on the remains of herbaceous plants, for another specimen was found on lawn grass Aug. 1, 1933, and brought to the writer for identification. *P. vernum* resembles the allied *P. cinereum* but has larger, darker spores. It is apparently much more common than the latter species in this part of the country.

STEMONITACEÆ

Comatricha typhoides (Bull) Rost.

One of the most common species in the world, occurring on dead wood in damp places, but has escaped the notice of collectors in this state until a specimen was found in Cabell Co. Aug. 1, 1931.

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*Contribution No. 5 from the botany department of Marshall College.

†Proc. W. Va. Acad. Sci. 3: 71-73, 1929.

HETERODERMACEÆ

Cribraria intricata (Schrad.) Rost. var. *dictydioides* List. (*Cribraria dictydioides* Cke. & Balf.)

The status of this slime mould as a distinct species is yet questionable. There is no doubt that intergrading specimens occur. Typical var. *dictydioides* was found on a dead beech log in Cabell Co. Oct. 10, 1931.

Cribraria tenella Schrad.

C. tenella also intergrades with *C. intricata* to some extent but may be distinguished in most cases by the smaller size and the rounded rather than angular nodes. Collected on a decorticated log near Huntington Oct. 10, 1931.

RETICULARIACEÆ

Reticularia Lycoperdon (Bull.) Rost.

Reticularia Lycoperdon has been reported before from West Virginia but is not of common occurrence. Attention should be brought to the fact that here in the eastern part of the country at least this species is a spring form, whereas most slime moulds do not commence to become common before early summer. This species is excellent for class use because of the ease and rapidity with which the spores germinate. Found occasionally on tree trunks in the spring. Cabell Co.

TRICHIACEÆ

Calonema aureum Morgan.

This very rare and not entirely distinct species was collected for the first time in West Virginia from an old log in Cabell Co. on Nov. 10, 1931.

ARCYRIACEÆ

Arcyria insignis Kalkbr. & Cke.

From the number of reported collections in this country, *A. insignis* apparently is one of the rarest slime moulds, but perhaps has been confused with *A. incarnata* and *A. denudata* by those who do not have authentic specimens with which to make comparisons. The writer has cellected it a number of times in the eastern states and located it for the first time in West Virginia on dead vitis vine in Cabell Co., Sept. 1, 1932.

Perichaena chrysosperma List. (*Ophiotheca wrightii* Berk.)

Apparently not uncommon but overlooked by the ordinary collector because of the small size and brown or black coloring which closely matches the substratum. The often completely annular shape of the plasmodiocarps is very characteristic and serves as a distinguishing character. Collected on a decaying beech log, Cabell Co., July 24, 1931.

A STUDY OF A CASE OF QUADRUPLETS

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THE BIRTH OF QUADRUPLETS is sufficiently rare that when it occurs we are naturally interested concerning other cases in the same family. So on October 12, 1933, when quadruplets were born to Mr. and Mrs. Grover Benedum of Salem, W. Va., a newspaper clipping sent to Dr. A. M. Reese of Morgantown was for-

warded to Dr. C. B. Davenport of the Eugenics Record Office. Dr. Davenport asked that I help fill in a schedule for the family, and the present paper is the resume of the findings of the schedule.

From this plural birth only one member survives. He is a boy and seems normal in every way. Of the girls, one was dead at birth and the other two died two weeks after birth. Dr. Edward Davis of Salem, who was present at their birth, reports that the boy was attached to one placenta and the girls to another. Evidently it was potentially a normal case of fraternal twins. The two girls who lived for a time after birth seemed undernourished from the first and it was difficult for them to take food. After a few days they began taking nourishment from a medicine dropper, but on the day of their death, October 25, they refused to take food. They died within four hours of each other.

The maternal ancestry of these children has been studied for four generations on the side of the maternal grandmother, and the paternal ancestry for three generations. Four brothers and sisters to the quadruplets survive, all single births. The mother has twin brothers, and Dr. Davis, who was present also at their birth, reports that they were attached to a single placenta. Neither of these boys has offspring, being only eighteen years old. The mother was from a family of nine children with the single plural birth. Continuing with the maternal ancestry, the grandmother to the quadruplets was from a family of twelve children, with one plural birth, a boy and girl. Neither of these has had plural births in their offspring. There were many children in the family of the maternal grandfather, and so far as data are available there were no twins as brothers and sisters. However, one set of twins are first cousins to the mother, and two sets of twins are second cousins to the quadruplets, but the exact number of children in these generations is unknown. The great-grandparents to the children were from families of four and seven children, all single births.

Considering the paternal ancestry, the father was one of eight children, all single births. His father was one of four children and his mother one of six, all single births. One of the father's uncles had twin boys, the only known set of twins on the paternal side.

Now in recapitulation, in the direct line three plural births are recorded including the quadruplets. The first cousins to the father, the first cousins to the mother, and the second cousins to the quadruplets we shall not consider since they are not in the direct line. Of 60 individuals considered, with 53 births, there are three plural births. This makes approximately one plural birth in every 18, or a percentage of 5.6 plural births. If we considered cousins it would make a larger percentage of plural births. Comparing with the average number of twins, approximately one in seventy births, we find the ratio of plural to single births unusually large.

No study had been made of the brothers of the mother. They are very much alike in appearance, and since they were attached to a single placenta, they are in all likelihood identical.

(ABSTRACT)

THE EFFECT OF DESICCATED THYROID, ANTERIOR PITUITARY, ADRENAL CORTEX, AND IODINE UPON INHERITANCE, GROWTH, AND MATURATION OF *Drosophila melanogaster*.

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THREE COLONIES of pure wild *Drosophila melanogaster* were established for each experimental group. The desiccated endocrine substances were added to the basal medium of corn-meal agar in the proportion of 1 gram of dry substance to 75 grams of the medium. Iodine was used in a dosage equal to the iodine content of the thyroid group. As soon as the animals of any one group reached sexual maturity, the animals of all groups were separated according to sex and carefully weighed. A second weighing was carried out after eggs and sperms had been liberated.

Thyroid, anterior pituitary, adrenal cortex, and mixtures of anterior pituitary and thyroid induced acceleration of ovulation. These same groups with the exception of adrenal cortex caused a hastening of the sexual development of the male flies. In the case of males of the adrenal group the first effect was depression which in turn was followed by an acceleration.

Inorganic iodine caused acceleration of sexual development (male and female) in the first generation but had a cumulative depressant action on successive generations, this being more marked in the case of the male.

No influences upon inheritance or growth were detected.

FORWARD AND BACKWARD LOCOMOTION OF SEVERED PARTS OF *LUMBRICUS TERRESTRIS*

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THE PURPOSE of these eperiments was to note the direction any part of the worm would crawl after having been severed from any part of the body.

EXPERIMENTAL PROCEDURE

The worms used in these experiments were collected by the author. They ranged in length from nine to twelve inches. They were placed on filter paper or a smooth piece of slate, dampened with a sponge, and allowed to crawl forward or backward to determine whether they were normal and active. Then they were placed on a moistened cardboard and severed with a very sharp scalpel. Following the operation the parts were placed on the filter paper and the direction of the crawling was observed. If the crawling was not voluntary, the worm was induced to crawl by prodding it with a toothpick on the outer surface, making it a skin stimulus only. The room was darkened sufficiently to avoid any probable influence of light on the experiment. A large reading glass was used to assist in counting segments and making other observations.

EXPERIMENTAL DATA

The following tables do not show the number of worms used for each experiment. In some experiments a very few worms were required for definite results, while in others many trials were necessary.

TABLE 1.—*Severance of parts of earthworm, beginning at the anterior end for results of forward and backward locomotion*

Experiment number	Number of segments removed from head end	Direction of movement of part removed	Direction of movement of remainder of worm
1	3		forward and backward
2	4		forward and backward
3	5		forward and backward
4	7		forward and backward
5	10		forward and backward
6	11		forward and backward
7	12		forward and backward
8	13		forward and backward
9	14	forward	forward and backward
10	15	forward and backward	forward and backward
11	17	forward and backward	forward and backward
12	(To cl'm) 31	forward and backward	forward and backward
13	31 plus ½ cl'm. 34	forward and backward	forward and backward
14	31 plus cl'm. 37	forward and backward	forward and backward

Beginning at the anterior end of the worm, a certain number of segments were removed and the reactions observed each time for forward and backward locomotion of both the anterior part removed and the remainder of the worm. The anterior parts removed were unable to crawl in either direction until they were 14 segments in length. However, the shorter pieces made an effort to crawl, but could only squirm around. The effort to crawl was very pronounced, but the movement was very slow. When parts of 15 segments were severed from other worms the movement was both forward and backward. Any anterior part of the anterior region, beginning with the prostomium, exceeding 14 segments, was able to crawl forward and backward. The longer the part the greater was the speed in crawling. In experiment 12 (Table 1) the worm was cut in two in the middle of the clitellum. In this instance there was a forward and backward movement of both parts, anterior and posterior. In the 14th experiment an observation was made of the anterior region including the clitellum. The locomotion was forward and backward, but the backward crawling was very feeble and slow due to the stiffness of the clitellum. In each experiment after a certain portion of the anterior region was removed, the remainder of the worm crawled forward and backward very actively. Sometimes the worm would crawl voluntarily, while others were induced to crawl by prodding with a toothpick.

A length of 11 segments severed from the posterior end of the worm was required for locomotion. The crawling was forward only which was also true of a greater number of segments up to 17. Beyond that number there was both forward and backward crawling. When three segments of the clitellum were included and when the whole clitellum was included there was a forward and backward locomotion. Throughout all the experiments the remainder of the worm crawled both forward and backward.

TABLE 2.—*Severance of parts of earthworm, beginning at the posterior end for results of forward and backward locomotion*

Experiment number	Number of segments removed	Direction of movement of part removed	Direction of movement of remainder of worm
1	7		forward and backward
2	9		forward and backward
3	10		forward and backward
4	11	forward	forward and backward
5	14	forward	forward and backward
6	15	forward	forward and backward
7	16	forward	forward and backward
8	17	forward and backward	forward and backward
9	20	forward and backward	forward and backward
10	58	forward and backward	forward and backward
11	109	forward and backward	forward and backward
12	Post. part to cl'm	forward and backward	forward and backward
13	Post part ½ cl'm	forward and backward	forward and backward
14	Post part plus cl'm	forward and backward	forward and backward

A few of the experiments as shown in Table 3 are repetitions of experiments given in Tables 1 and 2. However, they serve as a ready comparison with the other experiments. The locomotion of the posterior half of the anterior region was a forward movement only, while the posterior half of the posterior region crawled both forward and backward. The posterior half of the anterior region was an intercalated part of the worm, having had segments removed from both ends. That was not true of the posterior half of the posterior region, there being no segments removed from the caudal end. All parts, with segments removed from both ends, of both the anterior and posterior regions of ten segments or more in length crawled forward only, and usually voluntarily if given sufficient time. All attempts to bring about backward movement were unsuccessful.

The coordination of the nervous system and the muscular system promotes locomotion and the tendency is to move forward more readily than backward. When

TABLE 3.—*Locomotion of certain parts of the anterior and posterior regions of the earthworm in general*

REGION	ANTERIOR HALF	POSTERIOR	MIDDLE PORTIONS OF EITHER HALF	
	Direction of movement	Direction of movement	Number of segments	Direction of movements
ANTERIOR REGION	Forward and backward	Forward	17	Forward
			12	Forward
			11	Forward
			10	Forward
			9	
POSTERIOR REGION	Forward	Forward and backward	50	Forward
			25	Forward
			15	Forward
			11	Forward
			10	Forward
			9	

the number of segments for locomotion of the part severed were sufficient, it was enabled to crawl forward. Table 1 shows that a part consisting of 14 segments was the shortest part that would crawl. This was the anterior end of the anterior region. Table 2 shows that 11 posterior segments at the posterior end made up the shortest part that would crawl. Apparently there was a difference in requirement. According to the record in Table 3, crawling took place at a length of ten segments with parts other than end parts of either the anterior or posterior regions. If we consider the structure of the nervous system, it is probable that there was no marked difference in the requirements of the number of segments necessary for locomotion. If only ten segments are required for locomotion of any part other than end parts, why not the same number of segments for the end parts? According to Hess ('25) all segments of the earthworm are supplied with three paired segmental nerve trunks except the first four of the anterior end and the one at the caudal end. In both the former and latter, the number, structure, and termination of the nerve trunks are different from the rest of the body. The first four segments of the anterior end have a special nerve structure which is chiefly that of the "brain". The most caudal segment is of special structure consisting of six paired nerve trunks. Even though the brain controls the movement of the worm largely and is the center of highest dominance, the ganglion of each segment controls the activities of that segment, and a part of the worm can crawl without the aid of the brain.

The point in mind is that if the first four segments of the anterior end of the worm functions chiefly as a brain, and the caudal segment has a special function also, then subtracting the first four segments from the first 14 of the anterior region would leave ten segments controlled by the ganglia for locomotion chiefly. The 11 segments of the posterior end, an amount necessary for crawling, minus the most caudal segment, leave ten segments for crawling. From this it is conclusive that ten segments are the least number with which there can be locomotion of any consequence.

SUMMARY

1. Parts of the worm removed from the anterior end could not crawl until composed of at least 14 segments. This part crawled forward only.

2. An anterior part of the anterior end 15 segments or more in length crawled both forward and backward.

3. Any part of the anterior region of 10 segments or more, with segments removed from both ends, crawled forward only. One under 10 segments in length made no progress in crawling.

4. When parts of different lengths were severed from the anterior region, the remainder of the worm always crawled both forward and backward.

5. Parts of the worm removed from the posterior end of the posterior region could not crawl until composed of at least 11 segments. This part crawled forward only.

6. A posterior part of the posterior end, composed of 17 segments or more, crawled both forward and backward.

7. Any part of the posterior region of 10 segments or more with segments removed from both ends crawled forward only. Parts composed of less than 10 segments made no progress in crawling.

8. When parts of different lengths were removed from the posterior region the remainder of the worm crawled forward and backward.

9. The anterior region, including one-half of the clitellum, crawled forward and backward.

10. The posterior region, including one-half of the clitellum, crawled forward and backward.

11. The anterior region including all the clitellum crawled forward and backward.

12. The posterior region including all the clitellum crawled forward and backward.

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THE DESCRIPTION OF A NEW TREMATODE OF THE SUBFAMILY ALLOCREADIINÆ, WITH NOTES ON ITS LIFE HISTORY*

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DURING THE SUMMERS of 1932-1933, 25 water snakes, *Natrix spetemvitatta,* were collected in the vicinity of Tygart River, Randolph county, and examined for parasites. Twenty-four snakes of this number were found to be infected with a new intestinal trematode belonging to the genus *Crepidostomum* Braun 1900, a member of the subfamily Allocreadiinae, which is described in this paper as *Crepidostomum serpentinum* n. sp. Following the description of *C. serpentinum* n. sp. a brief discussion of the life history stages of this parasite is presented.

Specific diagnosis Crepidostomum — Body without spines, 2.00 ± 0.45 mm. long by 0.57 ± 0.097 mm. wide. Anterior end spatulate, tapering to a blunt point posteriorly. Six circumoral papillae, arranged in two groups, not separated. Oral sucker subterminal, 0.28 ± 0.036 mm. in diameter. Acetabulum 0.27 ± 0.032 mm. in diameter, situated slightly anterior to middle of body. Prepharynx short. Pharynx strongly muscular, 0.12 ± 0.019 mm. wide. Oesophagus 0.15 ± 0.040 mm. long. Intestinal ceca extend into posterior third of body. Genital pore median between intestinal bifurcation and acetabulum. Cirrus pouch long and slender, 0.64 ± 0.15 mm. long, extending to center of body, containing large seminal vesicle and well-developed prostate gland. Ovary elliptical, 0.13 ± 0.03 mm. by 0.12 ± 0.015 mm., situate to left of midline close to termination of cirrus pouch. Testes equal in size, tandem, 0.21 ± 0.43 mm. long by 0.15 ± 0.03 mm. wide, situate in posterior third of body. Vitellaria composed of large follicles which extend the full length of the intestinal ceca. Seminal receptacle large. Laurer's canal present. Uterus consisting of a few coils in midline of body between posterior margin of acetabulum and the anterior testis. Metraterm weak. Eggs, few, light brown, 60 microns to 70 by 35 microns to 40.

Host—*Natrix septemvitatta.*

Habitat—Small intestine.

Locality—Randolph county, West Virginia, U. S. A.

Type Specimen—U. S. Nat. Mus. Helm. Coll. No.—

Remarks—*Crepidostomum serpentinum* n. sp. appears to be more closely related to *C. cooperi* Hopkins 1931 but it differs from this species in that the cirrus pouch is longer and more muscular and the ventral papillae much larger. The fact that *C. serpentinum* n. sp. is found in a reptilian host and *C. cooperi* in a piscine host would strongly suggest that the two should be separated.

THE LIFE HISTORY OF *C. serpentinum* n. sp.

Faust (1918) presented a life history scheme for the various species of Allocreadiinae in which he suggested the snail as the first intermediate host and an

*A more complete description of the morphology of the life history stages of *Crepidostomum serpentinum* n. sp. will be presented in a future paper.

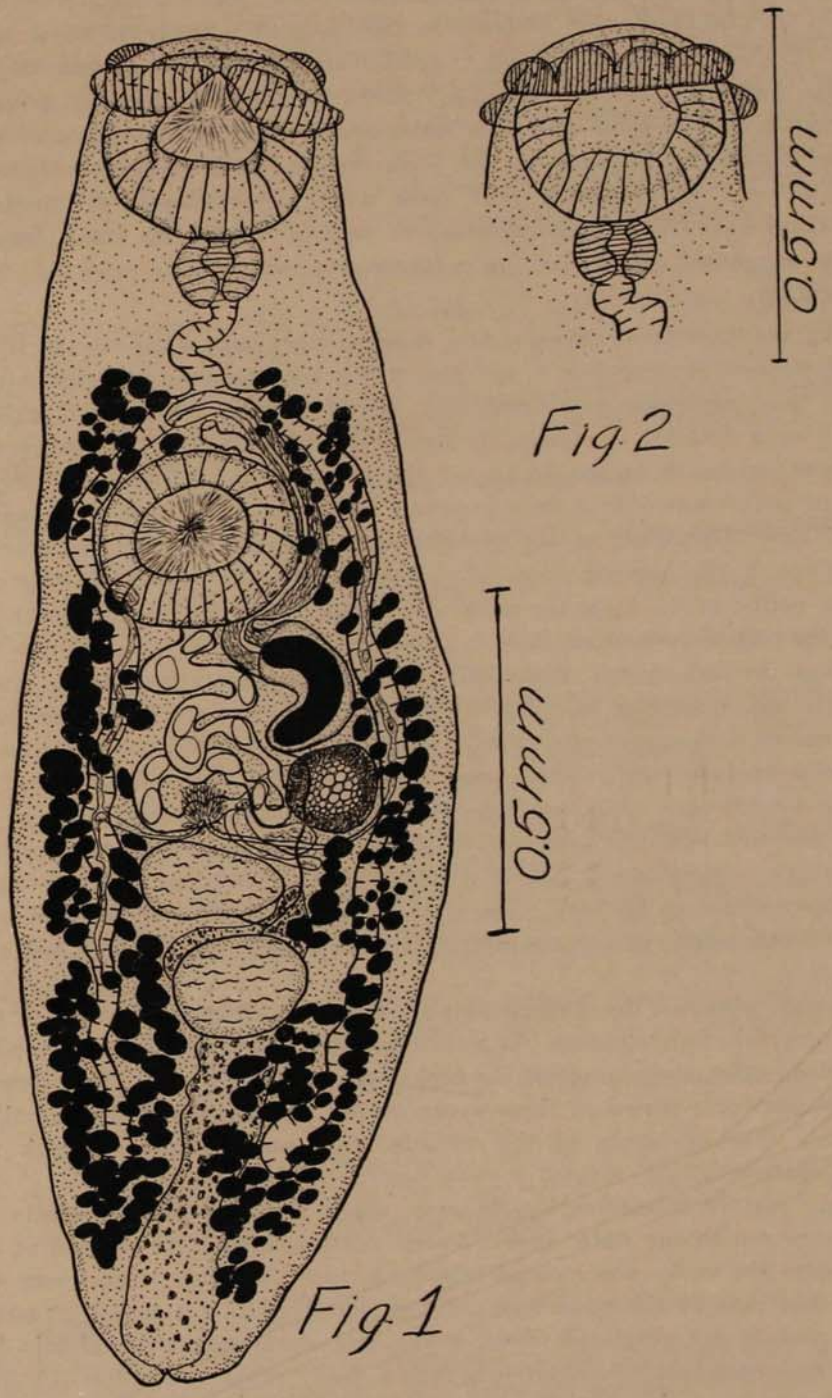

FIG. 1—Ventral view of *Crepidostomum serpentinum* n. sp. (*Camera lucida*)

FIG. 2—Dorsal view of anterior end of *Crepidostomum serpentinum* n. sp., showing the four dorsal circumoral papillae (*Camera lucida* drawing)

insect or crustacean as the second intermediate host. Brown (1927) described the life history of *Crepidostomum farionis* on the basis of a study of the larval stages found in *Pisidium anmicum* (Muell.), *Sphaerium corneum* (L.), and the larva of the mayfly, *Ephemera danica* (Muell.). Since he found pigmented granules in a cercaria found in Sphaerium and in a metacercaria found in the larva of Ephemera as well as circumoral papillae in the metacercaria, both structures found in the adult *C. farionis,* he concluded that these were larval stages of this trematode. Other workers have found metacercariae in various species of insect larvae which they have suggested might be the metacercaria stage of species of the genus Crepidostomum.

During the past year, experimental studies have been made on the life history of *Crepidostomum serpentinum* n. sp., and it has been possible to produce the larval stages of this trematode experimentally. It is not the purpose of this present paper to give a detailed discussion of the morphology of the life history stages of this parasite, inasmuch as the details of the experimental evidence for the life history are to be presented in a future paper. However, it is considered worth while to give a brief discussion of the general course of the life history at this time. The eggs are in the one-cell stage when passed from the trematode, but after an incubation period of 15 days, the miracidia escape from the egg and swim about in serch of the first intermediate host. The miracidium of *C. serpentinum* n. sp. is characterized by having two flame cells, two small penetration glands and a posterior germ sac containing many germ cells. Hatching miracidia were exposed to 65 Sphaeria sp. and speciments from this group were examined from time to time for evidence of infection. At the end of two months rediae containing cercarial germ balls were found. Only one generation of rediae was found. Mature cercariae were not produced until the end of from three to four months after infection. The cercaria of *C. serpentinum* n. sp. is a stylet type of cercaria with a long slender tail and short excretory bladder. The most distinctive feature of this cercaria is the presence of two large eye spots situated on a level with the pharynx and on either side of it.

Cercariae, obtained by experimentally infecting Sphaerium, were exposed to five small crayfish, Cambarus sp. It was found that the cercariae readily penetrated and encysted in the musculature of the cephalothorax of this host. The metacercariae increase in size for a period of three weeks during which time six circumoral papillae are formed. The eye spots of the cercaria stage are retained although they are somewhat scattered.

Twenty mature metacercariae, in cyst, taken from an experimentally infected crayfish, were fed to one water snake, *Natrix septemvitatta.* At the end of a period of seven days the snake was autopsied and fourteen immature worms were obtained from the first part of the duodenum. These worms while not sexually mature were found to contain differentiated testes, ovary, and cirrus sac, which clearly indicates that the development in the definitive host is a fairly rapid one.

On the basis of the foregoing preliminary studies, the life history of *C. serpentinum* n. sp. may be summarized as follows: The ova are expelled in the feces of the snake in the one-cell stage. An incubation period of 15 days is required outside the host. At the end of this period miracidia hatch and enter the first intermediate host, Sphaerium sp., and a period of three months' development is required in this host. In the first intermediate host a mother sporocyst is formed which pro-

duces a generation of rediae and finally stylet cercariae with prominent eye spots. The cercariae escape from the Sphaerium, penetrate, and encyst in the musculature of the cephalothorax of the crayfish, species of Cambarus, second intermediate host. The definitive host, the water snake *Natix septemvitatta*, eats the crayfish containing metacercariae. The metacercariae excyst and become established in the first part of the duodenum of the snake. Full development to sexual maturity is probably reached within one month, as at the end of seven days almost sexually mature worms were obtained from the duodenum of an experimentally infected snake.

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STUDIES OF THE LIFE CYCLE OF *MENOIDIUM PELLUCIDUM*

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THE STUDY OF LIFE in the flagellates is realized more and more as important. The group, according to our generally accepted view of the evolution of the animal and plant kingdom, stands at the base of the phylogenetic arrangement. From the standpoint of development we may best approach the study of higher forms of life, including man, from the unicellular flagellated type, because from this class have sprung, perhaps in a poly-phyletic fashion, the other phyla. The origin of biological phenomena of life in man might well be sought by a wider

acquaintance with the fundamental processes taking place in the flagellates. By a careful study we may arrive at a clearer understanding of the way in which the basic structures of all organisms have developed. Any study of this field is of service to man because of the principles of life that may be reached. From the esthetic viewpoint some of the species of Menoidium furnish excellent examples of grace and beautiful designs. They provide the arena in which the primitive pageant of all life makes its grand parade before it settles down into the more monotonous and less amusing mediocrity of metazoan conformity.

Protozoa of the order Euglenoidia under the supervision of Dr. Robt. C. Rhodes at Emory Biological Laboratory, Emory University, Ga., have been extensively studied. The need of investigation in the Astasiidae was suggested to me during my recent graduate work by Dr. Rhodes of Emory University.

Twenty-four cultures were made by placing dead oak leaves in half-pint milk bottles filled half full of tap water. After standing a week the cultures were examined in vain for astasia, until inoculated from an established culture containing astasia, euglena, and other protozoa. At the end of four weeks the contents of these bottles were emptied into a large glass container, where the decomposition of the leaves continued and furnished a media for a later preparation. Before using it, however, the leaves were removed by straining, and after boiling long enough to kill all organisms living in it from the first inoculation, the media were ready for making new cultures. Other new cultures were made by using only red-oak leaves, which proved successful after inoculating with astasia. In examining these cultures a constant-appearing, curved, colorless, crescent-shaped, unicellular flagellate was noticed. Upon this form, later identified as *Menoidium pellucidum* the present work was attempted. It was found only in one of the glass jars containing red-oak leaves, and since the inoculation for all the cultures had been the same, this flat, new-moon shaped organism aroused curiosity. After several unsuccessful attempts to get the flagellate to live in other solutions a colorometric determination for hydrogen-ion concentration proved successful for making suitable media with a hydrogen-ion concentration of 6.2.

My observations are as follows: The body of the organism is 45-50 micra long. The nucleus appears near the center of the body. The paramylon bodies appear roundish as well as cylinder-shaped and longish. The body has a flat appearance and in swimming the convex surface is uppermost as it rocks back and forth on its long axis, occasionally rotating. The ventral anterior lip of the gullet extends in all cases farther than the upper end. The animal is characterized by its body lines of beauty and grace in swimming. It has a rhythmical, waltz-like motion as it glides along from side to side through the water.

The body of a well-nourished organism is practically filled, except for a clear space in the posterior end, with paramylon bodies. Most of them are cylinder-shaped, but a few are oval or spherical. The average number in the individual in one culture was 15. The size, shape, and number seem to vary in different cultures or at various stages in the life cycle. The lack of organic medium in the culture is correlated with the increase of paramylon in size and decrease in number. In the anterior region of the body near the base of the reservoir usually is found a large, oval-shaped paramylon body. No hydrostatic action has been observed in any of these bodies, but they are thought to be related to the anabolic and katabolic activities of the cell. During the resting stage of the nucleus nearly all the plastids in

the organism are transparent. In the living organism the plastids are colorless. When treated with iodine they appear yellow. A tinge of purple has been observed, but the test was not definite enough for starch. The long, cylinder-shaped paramylon bodies measure from 6 to 8 micra long and 2 to 3 micra wide.

The periplast is sufficiently stiff so that the body is uniform in shape and no metaboly can be detected. No sign of encystment has been found in Menoidium, nor has desiccation been observed. When allowed to dry up on a slide the body form remains the same.

A culture was placed in the sunshine for four hours to see the effect of the sun-rays on the increase in temperature. The organisms were found active and a few division forms occurred after the exposure. When examined the following day all the organisms in the culture were dead. After seven days they were still in the culture without any visible signs of disintegration. In fixing this material, re-killing in hot Shandinn's, it was noticed that the stain penetrated very poorly into the body. Some reaction in the periplast must have taken place in the dead organisms, which made them difficult to stain, for the same technique was used as for the normal individuals. No other difference was discovered except that in some of the organisms killed by sun-rays a few paramylon bodies had become irregular in shape.

The motor apparatus in *Menoidium pellucidum* consists essentially of a single flagellum, the blepharoplast and the rhizoplast. The flagellum can be seen entering near the center-end opening of the neck-shaped gullet. In the posterior region of the gullet the flagellum seems to arise from a heavy elongated mass of deeply-staining material. From this mass there appear to extend two branches ending in granules at the base of the reservoir. One of the filaments crosses the middle of the reservoir to the basal granule; the other filament is thicker and shorter and seems to connect the deeply-staining mass in the gullet to the ventral wall of the reservoir. The centrosome or extra nuclear bodies have been seen in the material stained with Bordeaux red and iron haemotoxylin.

The nucleus in *Menoidium pellucidum* lies near the center of the body or slightly posterior to the center. The nucleus is spherical to ovoid in shape and is from 6 to 8 micra long and 5 to 6 micra wide. It is vesicular in type and has a dark-staining central body or endosome. The chromatin material appears in knots lodged in the nodes of the network arranged around the endosome. The hyaline area in *Menoidium pellucidum* has not been distinct in all cases observed. A nuclear membrane has not been definitely distinguished. The endosome appears deeply stained in all parts equally in the resting stage. Light areas can be seen at other times in the life cycle. The size of the nucleus increases in the early stages of division with the size of the body as a whole; therefore, the nuclei cell ratio remains the same.

The division in *Menoidium pellucidum* is as in most of the flagellates by a longitudinal splitting of the body into equal or nearly equal daughter cells. In the majority of cases the individuals divide while freely swimming. The process begins anteriorly near the gullet. Before the actual splitting of the body occurs the nucleus has undergone several changes and has migrated in close proximity with the reservoir system. The nucleus has enlarged by this time together with a general thickening of the cell body.

The early prophase of the nucleus is recognized by the numerously coiled chromatin in a thread-like formation. At this stage a darkly-staining structure on the border of the nucleus resembling a centriole has been noticed.

The conclusions reached in this study follow:

1. *Menoidium pellucidum* is a delicately curved, crescentic, saprozoic Astasiidae that is characterized by its constant shape and the appearance of clear paramylon bodies.

2. Red-oak-leaf solution makes the best culture media, although other culture material may be used if the hydrogen-ion contents are fixed.

3. Longitudinal division occurs and the plane of division begins anteriorly, dividing the animal into two daughter cells of about the same size and structure with an even distribution of paramylon.

4. The nucleus moves anteriorly toward the reservoir during division.

5. The rotation in swimming is both clock-wise and counter-clock-wise.

The problems suggested in this beginning study are:

1. Paramylon: The composition and function in the life history.

2. The significance and place of Menoidium as related to other flagellates.

3. Details concerning the Mitochondria and Golgi apparatus in Menoidium.

4. The cause of the anterior movement of the nucleus and the origin of the new flagellum and basal granule in division.

5. The function of the new reservoir and the formation of the gullet.

SOME NOTES ON *MYOTIS LUCIFUGUS*

ROBERT C. PATTERSON, Morgantown

THE BAT, *Myotis lucifugus*, is a small and inconspicuous mammal. It appears as a flying mouse and the bats are given that name by the Germans, "fledermaus." On closer inspection they show few points in common with a mouse with the possible exception of body size and in some cases the color.

Myotis lucifugus is a medium-sized bat among the American species. Its total length is between 80 and 86 mm, the tail, about 36 mm, being about 45% of the total length. The forearm averages 38 mm. The entire construction of the bat is light, as would be expected in an animal whose only means of locomotion is flight.

The body may be divided into four regions; the head, neck, trunk, and tail. The trunk may be further divided into the thoracic, lumbar, and sacral regions.

The body of the animal is covered with a pelage which is full but not fleecy. The hairs are long and fine, the longest of which measure 10 mm. This hair varies in various regions of the body both in texture and amount (Allen 1893). The pelage is thickest on the crown of the head, the neck, and the lateral and ventral surfaces of the body and on the sacral and pubic regions. There are several areas practically devoid of hair: the distal portions of the ears, the nipples, and the external genitalia. The snout is covered with a very scant pelage but presents a few vibrissae which arise from "wart-like structures" (Ackert 1914).

The integument varies in thickness, being the thinnest in the dorsal thoracic, crown, ventral thoracic, and sacral regions, and being thickest on the palmar and plantar portions and on the face.

The ventral surface of the wing is scantily marked with hair from the knee to the distal three-fourths of the wing membrane. The inter-femoral membrane is also scantily haired to a line a little below the knees. The dorsal surfaces of these membranes are not so marked.

The bat *Myotis lucifugus* in adult stage pelage can usually be recognized by the long, glossy tips of the hairs on the dorsal surface, along with the faintly yellow belly and the presence of a dark shoulder spot.

The body of the animal is compressed dorso-ventrally. The head is compact and may be said to be large as compared to the body, although this character is more or less obscured by the rather short neck and thick pelage of this region. The tail is long, being 45% of the total length. The pectoral appendages are entirely modified for flight, this modification being the most striking feature of the animal and profoundly affecting the whole structure. But one of the digits of the manus is clawed — the hallus; the others are enormously elongate to form the support for the flying membrane.

The pelvic appendages are short and poorly developed generally. To them is attached the wing membrane which arises from the lateral side of the foot near the distal end of the metatarsal. Medially between these appendages is stretched the inter-femoral membrane. Its most posterior border is attached to the calcar. The tail supports this membrane in the mid-line. The extreme tip of the tail is free, extending beyond the membrane. The foot is rather large and presents five clawed digits of about equal length. It is by these claws that the bats hangs suspended while at rest.

The eyes of the bat are very small and glistening black in color. They are surrounded by fur and are inconspicuous, spaced rather far apart. The snout is broad and pronounced, being marked distally by a pair of prominent nostrils. The chin is recessive and tapers from the symphisis to the angle of the mouth in a convex line.

The ears are the most prominent feature of the head. They are moderate in length as regards Chiroptera, reaching the nostril when laid forward. The anterior medial edge is concave, ending distally in a more or less straight margin where it meets the bluntly rounded tip. The posterior lateral margin below the tip is slightly concave in the upper portion and convex in the lower forming where these lines meet a more or less abrupt offset in the margin. The tragus is approximately one half the height of the ear. The medial margin of the tragus is nearly straight, the lateral one slightly convex meeting the medial margin in a rounded tip.

The external genitalia are practically devoid of hair. The tip of the penis is marked by a few scattered hairs, however. The penis in its proximal portion is directed forward for a short distance, about 2 mm; the distal portion is directed posteriorly and is approximately 4 mm. in length. The testes are located posterior and lateral to the penis and lateral to the anus. The scrotum is distended when the males are in season and almost wanting at other times.

The anus is situated in the mid-line of the body just beneath the terminal end of the penis; the area around it is naked.

The neck of the animal is short, thick, and very strong. The thoracic region is well developed. Extending from it laterally are the wings. From the shoulder of the animal to the wrist, when the wings are extended in flight, is a straight anterior border formed by a tendon and blood vessels. The proximal and middle divisions of the pectoral appendage posterior to this margin mark off a part of the flying membrane into a triangular prebrachial area. The membranes are marked by numerous striations and are more heavily pigmented on the dorsal surface than on the ventral.

THE INTEGUMENT

The varying thickness of the skin and the distribution of the hair over the surface of the body of *Myotis lucifugus* have been discussed.

The membranes of the wings and interforal region are sac-like continuations of the dorsal and ventral integument extended beyond the limits of the body proper to form an envelope in which are located the bones of the appendages which give the support for these structures. This is easily demonstrated by separating the two layers.

The membranes may be said to be tough and very elastic. The proximal portions of the membrane are covered with a very sparse pelage similar to that of the rest of the body. The distal portions are more sparsely haired and these hairs are more or less modified and much shorter than the hair of the body. The membrane is made up of small hexagonal, plate-like cells which form a continuous membrane. The membranes show a great number of wrinklings due to numerous elastic tissues running throughout the membranes. The membrane is thickest proximally and thinner distally. There are thickenings throughout the membrane marked by those areas through which nerves and blood vessels pass.

The skin of bats is very sensitive to tactile stimuli, the animals responding readily when touched. This phenomenon has been extensively studied by various investigators from the eighteenth century to date. Spallanzani and Cuvier believed this power of avoiding objects while in flight and blinded was accomplished through the development of this sense, and Cuvier, Schobl, Redtel, and more recently Ackert have demonstrated the vast numbers of nerve and nerve endings in the wings and integument generally. Ackert (1914) used *Myotis lucifugus* and *M. subulatus* in his work and records many points of interest as regards the innervation of the integument in these animals. He says of the superficial layer, "As in other mammals, the corium contains blood vessels, hair follicles, sebaceous glands, sudoriferous glands, striated and smooth muscle fibres, nerve trunks, medullated and non-medullated nerve fibres, tactile corpuscles, and nerve endings."

It is believed by Ackert that bats on the wing probably perceive obstacles through the sense of touch by the effect of condensations of the atmosphere upon the free nerve terminals in the epidermis and the superficial nerve rings of the hair follicles.

BIRDS OF SOUTHERN WEST VIRGINIA

P. C. BIBBEE

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THIS LIST OF BIRDS of southern West Virginia is made from records and personal observations in the three southernmost counties of the state, McDowell, Mercer, and Monroe. The greater part of McDowell county is made up of steep hills and deep ravines covered with waste timber. Mercer county also contains a great amount of waste timber land. This territory provides shelter and food for many species of birds such as ruffed grouse, many owls, hawks, warblers, and woodpeckers. Mercer county also is made up of a great deal of rolling farming and grazing land mixed with the waste timber sections. Monroe county is made up largely of comparatively level and fertile farming and grazing land. This open

farming country offers many additional attractions for a great diversity of bird life.

For a very short distance New River separates Mercer and Monroe counties. This is a large stream. It arises in North Carolina and flows due north across the state of Virginia. Just a few miles south of the point where it separates Mercer and Monroe counties it passes through a deep gap in the mountain range. This gap, known as the Narrows, tends to force all migrating birds to follow the river closely for some distance. This point on the stream where it borders both Mercer and Monroe counties offers many interesting possibilities of southern species of birds which might wander north along the river as well as the finest possible concentration point during migration.

Bluestone River, a small stream, flows through the center of Mercer county from southwest to northeast. In a low, swampy bottom along this stream a small artificial lake known as Lake Shawnee has been constructed. This point is about the center of the county. This small lake with its adjoining swamp and the bordering Bluestone River makes this region one of the most attractive spots in southern West Virginia for ducks, waders, swamp-inhabiting species, and shore birds. The greater part of the writer's observations on these groups of birds have been made in this locality.

Practically all the territory in these three counties lies at an elevation placing it as a typical Transition or Alleghanian Life Zone. The following list of birds shows many species common to this life zone. The highest section in this region is the extreme northern part of Mercer county known as Flattop. It has an elevation of 3566 feet, which suggests possibilities of bird life from the Canadian Life Zone. The lowest sections of Monroe county are not typical upper Austral or Carolinian fauna and flora. However, they offer possibilities for the occurrence of other Carolinian species of birds besides those in this list.

It is impossible to compile a complete list of birds from any region without authentic data from many competent observers and collectors. These data must include many years of faithful work. The writer, having no such data from other observers, has used only his own personal records made during the past seven years of his residence in Mercer county. In only one instance has a species been included in this list on the authority of another and that case was where there could be no possible chance for mistaken identity. This list of species comprises only a part of the birds which might be found in these three southern counties. It is hoped that this list with the brief notes on the occurrence of various species will prove of interest and value to students of ornithology and biology; also that it will serve as a nucleus for a much more complete check-list which it is contemplated to follow. The list of 151 species follows:* Horned Grebe, Pied-billed Grebe, Loon, Bonaparte's Gull, Caspian Tern, Mallard, Black Duck, Blue-winged Teal, Shoveller, Redhead, Lesser Scaup Duck, Golden-eye, Buffle-head, Ruddy Duck, Canada Goose, Bittern, Least Bittern, Great Blue Heron, Egret, Little Blue Heron, Green Heron, Black-crowned Night Heron, Sora, Coot, Woodcock, Wilson's Snipe, Pectoral Sandpiper, Yellow-legs, Spotted Sandpiper, Killdeer, Ring-necked Pheasant, Bob-white, Ruffed Grouse, Mourning Dove, Turkey Vulture, Marsh Hawk, Sharp-shinned Hawk,

*For classification, scientific names, and other descriptions of the birds listed, *cf.* P. C. Bibbee, WEST VIRGINIA BIRDS. Bulletin 228, West Va. Agr. Exp. Sta. April, 1934.

Cooper's Hawk, Red-tailed Hawk, Red-shouldered Hawk, Broad-winged Hawk, Sparrow Hawk, Barn Owl, Barred Owl, Screech Owl, Great Horned Owl, Snowy Owl, Yellow-billed Cuckoo, Black-billed Cuckoo, Belted Kingfisher, Hairy Woodpecker, Downy Woodpecker, Yellow-bellied Sapsucker, Northern Pileated Woodpecker, Red-headed Woodpecker, Red-bellied Woodpecker, Northern Flicker, Whip-poor-will, Nighthawk, Chimney Swift, Ruby-throated Hummingbird, Kingbird, Crested Flycatcher, Phoebe, Wood Pewee, Least Flycatcher, Prairie Horned Lark, Blue Jay, Northern Raven, Crow, Starling, Bobolink, Cowbird, Red-winged Blackbird, Meadowlark, Orchard Oriole, Baltimore Oriole, Rusty Blackbird, Bronzed Grackle, Goldfinch, Snow Bunting, English Sparrow, Vesper Sparrow, Savannah Sparrow, Grasshopper Sparrow, Lark Sparrow, White-throated Sparrow, White-crowned Sparrow, Tree Sparrow, Chipping Sparrow, Field Sparrow, Slate-colored Junco, Carolina Junco, Song Sparrow, Swamp Sparrow, Fox Sparrow, Towhee, Cardinal, Indigo Bunting, Scarlet Tanager, Purple Martin, Barn Swallow, Tree Swallow, Cedar Waxwing, Migrant Shrike, Red-eyed Vireo, Yellow-throated Vireo, Blue-headed Vireo, White-eyed Vireo, Black and White Warbler, Worm-eating Warbler, Golden-winged Warbler, Northern Parula Warbler, Cape May Warbler, Yellow Warbler, Black-throated Blue Warbler, Myrtle Warbler, Magnolia Warbler, Chestnut-sided Warbler, Bay-breasted Warbler, Black-poll Warbler, Blackburnian Warbler, Palm Warbler, Prairie Warbler, Oven-bird, Louisiana Water-thrush, Maryland Yellow-throat, Yellow-breasted Chat, Hooded Warbler, Redstart, Mockingbird, Catbird, Brown Thrasher, Carolina Wren, Bewick's Wren, House Wren, Winter Wren, Brown Creeper, White-breasted Nuthatch, Red-breasted Nuthatch, Tufted Titmouse, Carolina Chickadee, Golden-crowned Kinglet, Ruby-crowned Kinglet, Blue-gray Gnatcatcher, Wood Thrush, Olive-backed Thrush, Hermit Thrush, Robin, Bluebird. Also *Egretta candidissima candidissima*. Snowy Egret. There is only one positive record of this rare species.

FERNS OF THE SMOKY MOUNTAIN REGION

RANDOLPH BOGGESS, Oakvale

A STUDY OF THE FERNS of any region is of interest not only to the botanist but to the layman as well. This paper is presented as a preliminary survey of the ferns in the Smoky Mountain region of North Carolina. It is not a complete check-list, but includes all those collected and observed by the writer during the summer of 1933, while doing graduate work in botany at the Duke University Extension, located at Lake Junaluska, N. C., and under the supervision of Dr. Hugo L. Blomquist of the Duke botany department.

Before considering the flora it would be well first to consider the topography and geographical conditions of the region collected. Haywood county, in which most of this work was done, is situated between the Smoky Mountain range, on the north, the Balsam range on the west, the Pisgah range on the south, and the New Found Mountains on the east. Many of the mountain peaks tower above 6000 feet, and many others reach 5000 feet in elevation. Mt. Guyot at 6621 feet is reputed as being the second highest peak east of the rockies. Following in order of elevation are Richland Balsam (6540), Jones Knob (6425), Plott Balsam (6250), and Black Mountain (6200). Those over 5000 feet include Mt. Sterling (5835), and Mt. Pisgah (5749).

Pigeon River forms the main artery of drainage. Rising in the Pisgah region and flowing northward through a broad valley, it finally cuts through the Smokies and flows into the Little Tennessee River. The eastern slope of the Balsam range is drained by Richland, Jonathon, and Cataloochee creeks. The eastern section of the county is drained by East Fork, Fines Creek, and Springs Creek, all finally emptying into Pigeon River.

This region offers an exceptional field for the study of ferns. A wide variety of habitats is offered, ranging from marshy and swamp areas to high mountain tops, with many intermediate forms. The various members of this group will be taken in the order presented by Gray's New Manual of Botany, although the terminology used in Gray is not strictly followed.

The following members of the Polypodiaceæ family were collected or observed:

Polypodium vulgare, the common polypody, was very common in this region, being found on rocks in most of the places collected.

Polypodium polypodioides was collected only twice during the entire summer, on Pigeon River, and near Weaverville, in Buncombe county.

Phegopteris hexagonoptera, the Beech Fern, was found abundantly in rich woods and along slopes.

Adiantum pedatum, or Maidenhair Fern, is a common form collected in this region. It occurs in rich woods, especially those surrounding Lake Junaluska.

Pteris aquilina is another fern very common to this region. It can be collected along almost any roadside. It is said that the Indians formerly used the stipes of this fern in basket making.

Cheilanthes lanosa, locally known as the Hair-lipped Fern, was collected only on Pigeon River, along with *Polypodium polypodioides*. It was found growing on rocks in a moss-lichen association.

Pellea atropurpurea, the Cliff Brake, was very rare in this immediate region, but it occurred in abundance in some of the counties east and south of Haywood.

The genus *Asplenium* is well represented by five species: viz., *Asplenium trichomanes*, *Asplenium platyneuron*, *Asplenium montanum*, *Asplenium acrostichoides*, and *Asplenium asplenioides*. The most interesting as well as the most common of the species mentioned is *Asplenium asplenioides*, known commonly as the Lady Fern. This fern is very uncertain, and presents many variable forms. It is easily recognized, in most instances, by the curved appearance of the fruit dots. The species is sometimes divided into two varieties, the upland and lowland forms, but the writer could not distinguish between the two, since the species is so variable within itself. The Lady Fern is collected abundantly from the lower to the higher altitudes.

Asplenium acrostichoides, the Silver Spleenwort, while not as common as the Lady Fern, was collected in two places, Plott Creek and Tuckaseigee Falls, being common at the latter. This fern is very striking in the silvery appearance of the fruiting bodies.

Asplenium montanum, the Mountain Spleenwort, was rather rare. It was collected on Mt. Sterling and at Tuckaseigee Falls.

Asplenium platyneuron, or Ebony Spleenwort, is one of the more common ferns of this vicinity. It can be collected in most localities.

Asplenium trichomanes, another of the smaller forms, is found on many of the

shaded rocks and is usually found growing in a moss association. While it is not common, a much wider distribution is noted than in *Asplenium montanum*.

Camptosoris rhizophyllus, the Walking Fern, was collected mainly in two places, Turners Creek and Soco Falls. It is usually found growing on rocks in a moss association.

The most common fern of this region probably is *Polystichum acrostichoides*, the Christmas Fern. It is found abundantly on Wooded slopes. A very interesting variety of this species, *Polystichum acrostichoides var. incisum*, was found at Lake Junaluska and Tuckaseigee Falls. This is a variable from with larger fronds and the lower pinnæ toothed or pinnatifid.

The genus *Dryopteris* is another of the better represented groups, including six species. Some of these are limited in distribution, and difficulty was experienced in finding fertile fronds.

Dryopteris marginale, the Marginal Fern, is the most common member of this genus. It is common in rich woods and along wooded slopes.

Dryopteris thelypteris, the Marsh Fern, and *Dryopteris cristatum*, were limited in their distribution. They were collected in a marshy area, along the state highway about mid-way between Lake Junaluska and Balsam. The former was especially difficult to find in fruit.

Dryopteris noveboracense, sometimes called the New York Fern, was collected in most parts of this region. It is easily recognized by the pale green frond with the lower pinnæ much shorter than the others.

The true *Dryopteris spinulosum* was not collected, but two varieties, *intermedium* and *dilatatum*, were found. The former, *Dryopteris spinulosum* var. *intermedium*, was common in the woods of lower altitudes. This variety can easily be recognized under the microscope by the slightly dentate indusium set with minute stalked glands. The latter, *Dryopteris spinulosum* var. *dilatatum* was collected only on Mt. Sterling at an altitude of nearly 6000 feet. The distinguishing character of this variety in contrast with the other, previously mentioned, is the fact that the lower pinnules are much elongated, and the indusium is entirely destitute of glands.

Cystopteris fragilis, the Fragile Bulb Fern, was common along Plott and Turner's Creek, and in other woodland regions. The other member of this genus, *Cystopteris bulbifera*, was not collected by the writer, but was brought in from Nantahala Gorge, about 90 miles distance.

Only one representative of the genus Woodsia was collected, that being *Woodsia abtusa*, and it can be classified as one of the less common forms.

Another of the more common ferns is *Dicksonia punctilobula*, commonly called the Hay Scented Fern. It was common in most of the places collected.

Onoclea sensibilis, the Sensitive Fern was collected in abundance in the moist meadows and thickets surrounding the lake.

Osmundaceæ, the Flowering Fern Family, gives this region three species of the genus Osmunda. These three can be listed as occurring frequently in the regions suited to their growth.

Osmunda cinnamomea, the Cinnamon Fern, is the more common of the three species. The other two, *Osmunda regalis* and *Osmunda claytoniana*, were collected, however, in abundance in several places. The finest specimens of this genus were collected in an upland bog area, near Tuckaseigee Falls, where at times they attained a height of three feet.

SALIVARY SECRETION AS AN INDEX OF VITAMIN-A DEFICIENCY (Abstract)

HAZEL C. CAMERON
West Virginia University

COMMON COLDS in human beings involve changes in secretions of the eyes and nose, with respiratory infections as does vitamin-A deficiency in experimental animals; hence study of the mode of action of such deficiency may reveal a relation between the two conditions, which has been assumed but as yet not adequately proved.

Salivary secretion has been measured in dogs with salivary fistula kept on diet lacking in vitamin A in an effort to determine whether such deficiency injures the nervous mechanism involved in secretion or in the dilatation of blood vessels of the glands which usually accompanies secretion. Since the locations in which vitamin-A deficiency manifests itself follow rather closely the locations where vaso-dilator fibers have been demonstrated in the human being, and are largely parasympathetic, it was thought possible that vitamin-A deficiency might produce its effects chiefly through its action on the parasympathetic system.

Over a period of three months, salivary secretion in these dogs has remained remarkably constant, with the exception of two periods of temporary marked increase and a short period of decline. Unless such changes become constant as the deficiency becomes more severe, the conclusion must be reached that the nervous mechanism involved in the secretory fibers of the gland itself remain uninjured by vitamin-A deficiency. The salivary center remains to be investigated.

THE FLORA OF HAMPSHIRE COUNTY, WEST VIRGINIA

WILBERT M. FRYE, Capon Springs

HAMPSHIRE COUNTY is almost a square, with an area of 640 square miles, and forms the neck of the Eastern panhandle of West Virginia. It borders the Potomac River on the north and Frederick county, Virginia, on the east. The following counties of West Virginia border on Hampshire: Hardy on the south, Mineral on the west, and Morgan on the northeast.

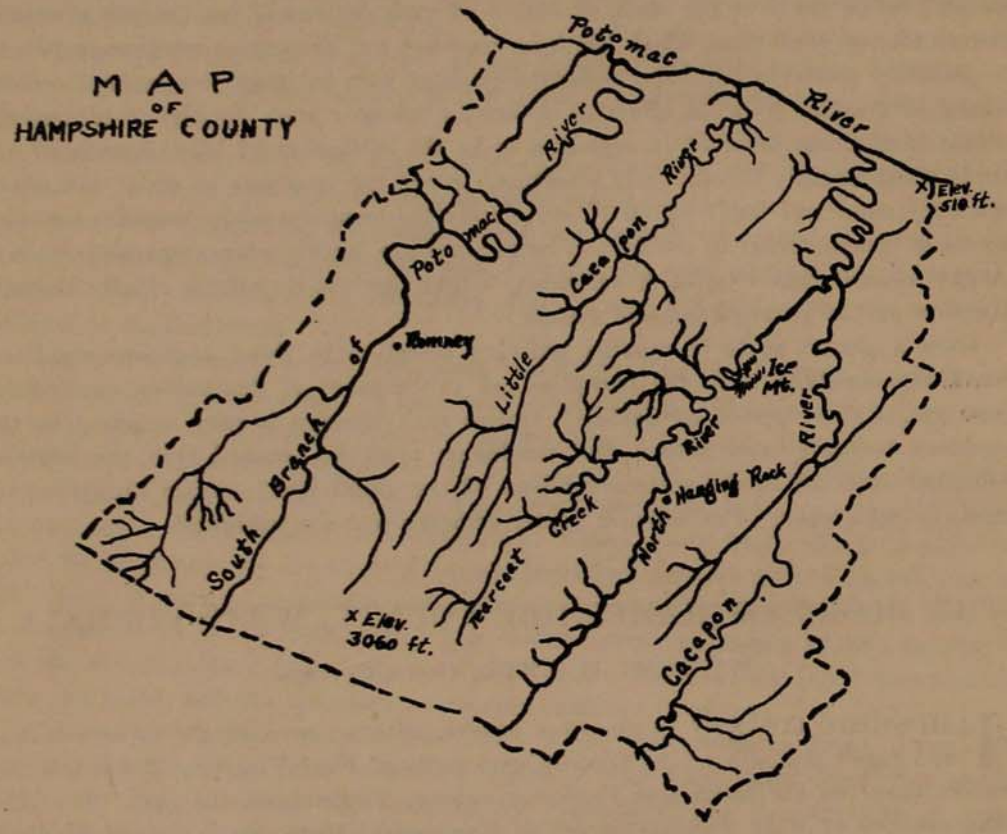
The topography of Hampshire is rugged, as the county is cut into numerous parallel mountains and ridges which extend northeast and southwest across the entire county for a distance of thirty miles. Many of the mountain sides are steep, rugged, and are timbered, while many of the ridges are of a rolling nature and have been cleared for agricultural purposes. In general the mountain formations are of massive sandstone, but the ridges are predominantly shale formations.

The elevation of the county varies from an altitude of 510 feet on the Potomac River at the Morgan county line to 3060 feet on South Branch Mountain four miles east of Sector.

The numerous faults, anticlines, and synclines give evidence of the amount of upheaval which has taken place throughout the county and have aided in forming the numerous soil series and soil types from the different shales, sandstones, and limestones found distributed over it. Twelve of these soil series are reported in the

county by the Geological Survey and are divided into 26 soil types. The Dekalb series constitutes 57% of the area; the Meigs is credited with 13% of the area; and 10% is given as rough stony land.

Because of the predominance of the sandstone and shale and the erosion of these, most of the soils of the county are predominantly acid, as evidenced by the dense growth of pine, which soon appears on the abandoned areas or undisturbed fields. The growths of pine on the mountains and ridges give further evidence of the acidity of the virgin soils when limestone is not present.



Originally the county was covered with a dense growth of pines, oaks, gum, chestnut, poplar, wild cherry, sugarberry, hickory, sassafras, birth, walnut, sumac, willow, cedar, dogwood, sycamore, elm, hemlock, tulip, and many shrubs.

The poor husbandry which has been practiced in the county since its settlement in 1738 has resulted in many eroded areas and neglected fields besides the deforestation of the steep lands. Each of these areas has its special and characteristic vegetation, while the well-cared-for land adds many more kinds of plants to the list.

The best agricultural soils of the county are the alluvial and limestone soils. The soil formed from the red shales is famous for the commercial orchards. The yellow shales form very poor soils and soon after deforestration are abandoned for agricultural purposes. However, it is a practice here to abandon the worn-out land for a period and then reclear it and farm it for a number of crops and then abandon it again. Nature in her attempt to prevent erosion quickly covers this soil with lespedezas, beggar-lice, hickories, oaks, pines, blackberries, dewberries, sumacs, and

many other poor, acid-soil plants. As *Pinus rigida* is the great soil protector for this section, the young seedlings can be counted by the thousands per acre on the abandoned fields.

The county can be called a plateau as the highest point is on the western side of the county while the next highest point is two hundred feet lower and is found on the eastern rim of the county. We think of this plateau with an average elevation of 1800 feet, with a northern slope completely traversed by the South Branch, Cacapon, and North Rivers, which drain into the Potomac on the northern border.

The temperature of the county is fairly even, as there are no long excessive heat waves or long periods of low temperatures during the winter months. The high land masses are not sufficiently massive to cause an appreciable variation in temperature between the highest and lowest points of the county. The frost-free date of the county is a little more than five months for tender vegetation.

Minimum and maximum temperatures for Hampshire county, 1900-1934

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Low	-20	-11	2	16	28	32	40	42	31	20	6	-15	-20
High	77	74	94	101	98	100	102	109	100	93	83	72	109

All-time extreme temperatures

December 1917 --20
August 1930 109

The rainfall is well distributed throughout the year, being the heaviest during the hot summer months, when the flora is growing.

Maximum and minimum precipitation for Hampshire county, 1900-1934

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Low	0.73	1.26	1.89	1.82	0.93	3.19	0.54	1.54	1.73	0.10	0.66	3.26	17.50
High	3.30	1.79	2.54	9.14	2.77	4.19	3.84	3.51	3.88	2.44	1.17	4.71	42.92

All-time extreme monthly precipitation

October 1930 .10
April 1918 9.14

Average temperature and precipitation for Hampshire County, 1900-1934

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Temp.	31.5	34.2	42.4	51.7	62.9	69.9	74.9	72.6	66.8	54.9	43.1	34.5	53.3
Prec.	2.33	2.04	2.81	2.97	3.64	3.97	3.48	3.64	2.72	2.60	1.87	2.28	34.30

Average annual snow fall, 1900-1934

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
9.1	9.4	7	.6	0	0	0	0	0	.3	.9	4.8	32.1

The streams with their tributaries provide the county with an excellent drainage system, with the exception of numerous small ponds, swamps, and fens along the flood plains. These with the fertile flood plains and cool, shady dells provide an excellent place for companionate and successive growths of flora. The ravines, gorges, sunny barrens, stony slopes, rock cliffs, open woods, abandoned fields, pastures, meadows, road banks, stream beds, and banks, elevations, and the variations in soil fertility and climatic conditions contribute to the great numbers of species. This number is increased each year by importation of farm seeds and from cargoes

passing along the highways, where the seed is blown from the load and deposited along the roadside. Recently the teasel and orange hawkweed have established themselves along highways in localities far from their nearest stations.

The total number of species contributed by all the factors makes it almost impossible for the collector to say, "I have made an exhaustive study of the flora of Hampshire county". Therefore it is the purpose of this study to determine to some degree of accuracy the number of different species of plants found within the borders of the county. After a period of two years' study the author has located and collected about 1000 species and he is certain that there are many more to be located and identified.

To date more than 700 species have been located within a radius of three miles of Hanging Rock. This plot was selected for an intensified study because it varied in elevation from 900 to a little more than 1600 feet. It has sections of limestone, shale, and sandy soils of all gradations. Within this area nearly all the natural features of the county are represented.

It was from the Antennaria mats of this section that plants were taken and sent to Dr. G. L. Stebbins of Colgate University at Hamilton, New York, a specialist in this group of plants, for special study. Among this group of specimens Dr. Stebbins found two Antennaria specimens unknown to the botanical world. One he named *Antennaria virginica*, and the other one he called *A. argillicola*.

However, the study was not limited to this small portion of the county, for frequent trips were made to the different sections and elevations of the county to collect plants in their season of the year. Because the flood plains are the most fertile collecting grounds, a great deal of attention was paid to collecting from these at different points of interest. As the flora above 1600 feet appeared to remain constant after contributing the species: *Angelica vilosa, Bartonia virginica,* Hay-scented Fern, Cotton Grass, Mountain Holly, *Menziesia pilosa,* and Burnet, but little effort was made to visit all the highest points in the county. Each flood plain has its characteristic predominating flora.

Cacapon flood plain has a profusion of Skunk cabbage, Arrowhead, and White Elm; Tearcoat Creek has a profusion of Golden Club; North River flood plain has great quantities of Red Elm; South Branch flood plain has a more equal distribution of flora than the other flood plains.

The steep southern slopes are usually severely eroded and support less vegetation than the northern slopes, which are usually heavily covered with litter and are very fertile. Due to freezing and thawing, the steep southern slopes do not include more typical southern flora than the more gentle northern slopes. The steep, cool, fertile northern slopes support beech, birch, hemlock, sugar maple, ginseng, spikenard, and other northern species.

To add to the profusion of flora of the county, Ice Mountain, the natural refrigerator, presents such specimens as Skunk Currant, Twin Flower, Bush Honeysuckle, Bedstraw, Flame-colored Azalea, besides many other northern species. Plants growing on this formation find their roots in a boreal soil while their foliage is fanned by cool breezes blowing up from between the rock debris, which is coated or cemented with frost or ice most of the year. This unique natural refrigerator at an elevation of less than 800 feet has a total length of 400 feet and a maximum width of 150 feet, and is composed of sandstone debris, which is covered with a dense foliage of mosses and cool-climate plants.

THE RARE PLANTS OF HAMPSHIRE COUNTY

Phoradendron flavescens, American mistletoe, is found near Hoy at an elevation of 1200 feet. At this location the parasite is found growing on the Sour Gum and has been there for 60 years without spreading to other trees. This gum is about two feet in diameter and towers above the other timber, above which the parasitic plant is found growing on the branches of the host. The author counted thirty bunches of the parasites on the one tree. The largest of the masses is six feet in diameter and seven feet tall.

Acer pennsylvanicum, Striped Maple, is limited to a few plants which are found on a sandy ridge two miles west of Capon bridge.

Trifolium virginicum, Kate's Mountain Clover, is found on a dark shale barren two miles north of Hanging Rock and is limited to less than 100 plants.

Corylus rostrata, Beaked Hazelnut, was located in the mountains near Kirby.

Ilex opaca, American Holly, and Picea rubra, Red Spruce, are both limited to a very few specimens on a sandy ridge two miles west of Capon bridge.

Ptelea trifolia, Hop Tree, is found on the bank of Cacapon River three miles below Yellow Springs.

Proserpinaca palustris, Mermaid Weed, has been found in one location, a shallow pond three miles north of Hanging Rock.

Habenaria ciliaris, Yellow-Fringed Orchis, was located in a shady northern dell one mile north of North River Mills.

Opuntia compressa, Prickley Pear Cactus, is found on the sandstone ledges west of Cacapon River above and below Yellow Springs.

Quercus stellata, Post Oak, is very limited in this county; however, an excellent specimen was found on a river flood plain two miles north of Hanging Rock.

Oenothera argillicola, evening primrose, is found on shale barrens in limited numbers.

Rhamnus lanceolata, Smooth Buckthorn, is limited to a few specimens near the Fork of Cacapon.

Pseudotaenidia montana, Mountain Parsnip, is limited to the dry shale barrens.

The two specimens new to the botanical world, *Antennaria virginica* and *Antennaria argillicola,* Pussy Toes, were collected on a shale barren three miles north of Hanging Rock.

The following is a check-list of the plants of Hampshire county:

THE FLORA OF HAMPSHIRE COUNTY

POLYPODIACEÆ (Fern Family)

Polypodium vulgare L. (polypody)
Phegopteris polypodioides Fee. (Beech Fern)
" *dryopteris* (L.) Fee. (Oak Fern)
Adiantum pedatum L. (Maidenhair)
Pteris aquilina L. (Common Brake)
Woodwardia virginica (L.) Sm.
" *angustifolia* Sm.
Asplenium trichomanes L.
" *parvulum* Mart. & Gal.
" *platyneuron* (L.) Oakes.
" *montanum* Willd.
" *angustifolium* Michx.
" *acrostichoides* Sw.
" *filix-femina* (L.) Bernh. (Lady Fern)

Polystichum acrostichoides (Michx.) Schott. (Christmas Fern)
Aspidium thelypteris (L.) Sw.
" *simulatum* Davenp.
" *noveboracense* (L.) Sw.
" *marginale* (L.) Sw.
" *cristatum* (L.) Sw.
" *spinulosum* (O. F. Mueller) Sw.
Cystopteris bulbifera (L.) Bernh. (Bladder Fern)
" *fragilis* (L.) Bernh.
Woodsia obtusa (Spreng.) Torr.
Dicksonia punctilobula (Michx.) Gray (Hay-scented Fern)
Onoclea sensibilis L. (Sensitive Fern)

OSMUNDACEÆ (Flowering Fern Family)
Osmunda regalis L. (Flowering Fern)
" *claytoniana* L.
" *cinnamomea* L. (Cinnamon Fern)

OPHIOGLOSSACEÆ (Adder's Tongue Family)
Ophioglossum vulgatum L. (Adder's Tongue)
Botrychium obliquum Muhl. (Moonwort)
" *virginianum* (L.) Sw. (Rattlesnake Fern)

EQUISETACEÆ (Horsetail Family)
Equisetum arvense L. (Common Horsetail)
" *hyemale* L. (Scouring Rush)

LYCOPODIACEÆ (Club-moss Family)
Lycopodium obscurum L.
" *carolinianum* L.
" *complanatum* L. var. *flabelliforme* Fernald
" *tristachyum* Pursh.

SELAGINELLACEÆ
Selaginella rupestris (L.) Spring

PINACEÆ (Pine Family)
Pinus strobus L. (White Pine)
" *rigida* Mill. (Pitch Pine)
" *pungens* Lamb. (Table Mountain Pine)
" *virginiana* Mill. (Jersey or Scrub Pine)
" *echinata* Mill. (Yellow Pine)
" *resinosa* Ait. (Red Pine)
Picea rubra (DuRoi) Dietr. (Red Spruce)
Tsuga canadensis (L.) Carr.
Thuja occidentalis L. (Arbor Vitæ, White Cedar)
Juniperus virginiana L. (Red Cedar or Savin)

TYPHACEÆ (Cat-tail Family)
Typha latifolia L. (Common Cat-tail)

SPARGANIACEÆ (Bur-reed Family)
Sparganium americanum Nutt.
" *angustifolium* Michx.

NAJADACEÆ (Pondweed Family)
Potamogeton natans L.
" *pectinatus* L.
Zannichellia palustris L. (Horned Pondweed)

ALISMACEÆ (Water-plantain Family)
Sagittaria latifolia Willd. (Arrow-head)
" *lancifolia* L.
Alisma plantago-aquatica L. (Water Plantain)

HYDROCHARITACEÆ (Frog's Bit Family)
Elodea canadensis Michx. (Water-weed)
Vallisneria spiralis L. (Tape Grass or Eel Grass)

GRAMINEÆ

Andropogon virginicus L.
Sorghastrum nutans (L.) Nash. (Indian Grass; Wood Grass)
" *halepense* (L.) Pers. (Johnson Grass)
Digitaria sanguinalis (L.) Scop. (Crab Grass)
Paspalum laeve Michx.
Panicum capillare L. (Old Witch Grass)
" *gattingeri* Nash.
" *miliaceum* L. (European Millet)
" *dichotomiflorum* Michx.
" *virgatum* L. (Switch Grass)
" *stipitatum* Nash.
" *linearifolium* Scribn.
" *dichotomum* L.
" *microcarpon* Muhl.
" *tennesseense* Ashe.
" *villosissimum* Nash.
" *ashei* Pearson.
" *clandestinum* L.
Echinochloa crusgalli L(.) Beauv. (Barnyard Grass)
Setaria glauca (L.) Beauv. (Foxtail, Pigeon Grass)
" *viridis* (L.) Beauv. (Green F., Bottle Grass)
" *italica* (L.) Beauv.
Cenchrus carolinianus Walt. (Sand-bur. Bur Grass)
Leersia oryzoides (L.) Sw. (Rice Cut-grass)
Anthoxanthum odoratum L. (Sweet Vernal Grass)
Phleum pratense L. (Timothy, Herd's Grass)
Agrostis alba L. (Fiorin or White Bent Grass, Red Top)
" *hyemalis* (Walt.) BSP. (Hair Grass)
" *canina* L. (Brown Bent Grass)
Calamagrostis canadensis (Michx.) Beauv. (Blue-joint Grass)
Holcus lanatus L. (Velvet Grass)
Deschampsia flexuosa (L.) Trin. (Common Hair Grass)
Avena sativa L. (Cultivated Oat)
Danthonia spicata (L.) Beauv. (Wild Oat Grass)
" *compressa* Aust.
Spartina Michauxiana Hitchc. (Slough Grass)
Cynodon dactylon (L.) Pers. (Bermuda or Scutch Gross)
Eleusine indica Gaertn. (Goose Grass; Yard Grass)
Tridens flava (L.) Hitch. (Tall Red Top)
Eragrostis capillaris (L.) Nees.
Uniola latifolia Michx. (Spike Grass)
Dactylis glomerata L. (Orchard Grass)
Poa annua L. (Low Spear Grass)
" *compressa* L. (Canada Blue Grass)
" *triflora* Gilib. (Fowl Meadow Grass)
" *pratensis* L. (June Grass, Speak Grass, Kent, Blue Grass)
" *autumnalis* Muhl.
" *brachyphylla* Schultes.
Glyceria torreyana (Spreng.) Hitchc. Manna Grass
" nervata (Willd.) Trin. Fowl Meadow Grass
Festuca octoflora Walt.
" *ovina* L. (Sheep's Fescue)
" *elatior* L. (Taller or Meadow Fescue)
Bromus secalinus L. (Cheat or Chess)
" *commutatus* Schrad.
" *incanus* (Shear) Hitchc.

Lolium perenne L. (Common D., Perennial Ray or Rye Grass)
" *multiflorum* Lam. (Italian Rye Grass)
Agropyron repens (L.) Beauv. (Couch, Quitch, or Quick Grass)
Elymus virginicus L. (Wild Rye)

CYPERACEÆ

Cyperus flavescens L.
" *diandrus* Torr.
" *rivularis* Kunth.
" *acuminatus* Torr. & Hook.
" *strigosus* L.
" *lancastriensis* Porter
" *ovularis* (Michx.) Torr.
" *filiculmis* Vahl.
Kyllinga pumila Michx.
Dulichium arundinaceum (L.) Britton.
Eleocharis obtusa (Willd.) Schultes.
" *tenuis* (Willd.) Schultes.
Stenophyllus capillaris (L.) Britton.
Fimbristylis autumnalis (L.) R. & S.
Scirpus calidus Vahl.
" *polyphyllus* Vahl.
" *lineatus* Michx.
" *cyperinus* (L.) Kunth. (Wool Grass)
Eriophorum virginicum L.
Rynchospora glomerata
Carex scoparia Schkuhr.
" *tribuloides* Wahlenb.
" *rosea* Schkuhr.
" *cephalophora* Muhl.
" *sparganioides* Muhl.
" *culpinoidea* Michx.
" *stipata* Muhl.
" *crinita* Lam. var. gynandra (Schwein) Schwein & Torr.
" *torta* Boott.
" *triceps* Michx. var. hirsuta (Willd.) Bailey.
" *virescens* Muhl.
" *shortiana* Dewey.
" *pennsylvanica* Lam.
Carex laxiflora Lam.
" *grisea* Wahlenb.
" *debilis* Michx.
" *frankii* Kunth.
" *squarrosa* L.
" *lurida* Wahlenb.

ARACEÆ (Arum Family)

Arisaema triphyllum (L.) Schott. (Indian Turnip, Jack-in-the-pulpit)
" *Dracontium* (L.) Schott. (Green Dragon, Dragon Root)

Symplocarpus foetidus (L.) Nutt. (Skunk Cabbage)
Orontium aquaticum L. (Golden Club)
Acorus calamus L. (Calamus)

COMMELINACEÆ (Spiderwort Family)
Tradescantia virginiana L.
Commelina communis L. (Day flower)
" *virginica* L.

JUNCACEÆ (Rush Family)
Juncus bufonius L.
" *tenuis* (Willd.)
" *effusus* L. (Common or Soft Rush)
" *brevicaudatus* (Engelm.) Fernald.
" *nodosus* L.
" *acuminatus* Michx.
" *marginatus* Rostk.
" *aristulatus* Michx.
Luzula campestris var. *multiflora* (Ehrh.) Celak.

LILIACEÆ (Lily Family)
Uvularia perfoliata L.
Oakesia puberula (Michx.) Wats.
Allium cernuum Roth. (Wild Onion)
" *canadense* L. (Wild Garlic)
" *vineale* L. (Field Garlic)
Hemerocallis fulva (Common Day Lily)
Lilium superbum L. (Turk's Cap Lily)
Erythronium americanum Ker. (Yellow Adder's tongue)
Ornithogalum umbellatum L.
Yucca filamentosa L. (Adam's Needle)
Asparagus officinalis L. (Garden Asparagus)
Smilacina racemosa (L.) Desf. (False Spikenard)
Maianthemum canadense Desf.
Polygonatum biflorum (Walt.) Ell. (Small Solomon's Seal)
" *commutatum* (R. & S.) Dietr. (Great S. Seal)
Convallaria majalis L. (Lily of the Valley)
Medeola virginiana L. (Indian Cucumber Root)
Trillium erectum L.
" *undulatum* Willd. (Painted Trillium)
Smilax herbacea L. (Carrion-Flower)
" *rotundifolia* L. (Common Green Brier, Horse Brier)
" *glauca* Walt (Saw Brier)
" *hispida* Muhl.

DIOSCOREACEÆ (Yam Family)
Dioscorea villosa (Wild Yam-root)

AMARYLLIDACEÆ (Amaryllis Family)
Hypoxis hirsuta (L) Coville. (Star grass)

IRIDACEÆ (Iris Family)
Iris cristata Ait. (Crested Dwarf Iris)
" *verna* L. (Dwarf Iris)

Sisyrinchium angustifolium Mill.
" *gramineum* Curtis.

ORCHIDACEÆ (Orchis Family)
Cypripedium parviflorum Salisb. (Smaller Yellow Lily)
" " var. *pubescens* (Willd.) Knight.
" *hirsutum* Mill. (Showy Lady Slipper)
" *acaule* Ait. (Stemless Lady Slipper)
Orchis spectabilis L. (Showy Orchid)
Habenaria clavellata (Michx.) Spreng.
" *ciliaris* (L.) R. Br. (Yellow Fringed Orchid)
Pogonia verticillata (Willd.) Nutt.
Calopogon pulchellus (Sw.) R. Br.
Spiranthes Beckii Lindl. (Ladies' Tresses)
" *gracilis* (Bigel). Beck.
Epipactis pubescens (Willd.) A. A. Eaton.

PIPERACEÆ (Pepper Family)
Saururus cernuus L. (Lizard's Tail)

SALICACEÆ (Willow Family)
Salix nigra Marsh (Black Willow)
" *amygdaloides* Anders. (Peach-leaved Willow)
" *alba* L. (White Willow)
" *babylonica* L. (Weeping Willow)
" *longifolia* Muhl. (Sand Bar Willow)
" *discolor* Muhl. (Glaucous Willow)
" *humilis* Marsh. (Prairie Willow)
" *purpurea* L. (Purple Willow)
Populus alba L. (White Poplar)
" *candicans* Ait. (Balm of Gilead)
" *deltoides* Marsh. (Cotton-wood, Necklace P.)

MYRICACEÆ
Myrica asplenifolia L. (Sweet fern)

JUGLANDACEÆ (Walnut Family)
Juglans cinerea L. (Butternut, White Walnut)
" *nigra* L. (Black Walnut)
Carya ovata (Mill.) K. Koch. (Shell-bark or Shag-Bark H.)
" *laciniosa* (Michx. f.) Loud (Big Shell-Bark, King Nut.)
" *alba* (L.) K. Koch. (Mocker Nut, White-Heart H.)
" *glabra* (Mill.) Spach. (Pignut or Broom H.)
" *cordiformis* (Wang.) K. Koch. (Bitter Nut. or Swamp H.)

BETULACEÆ (Birch Family)
Corylus americana Walt. (Hazelnut)
" *rostrata* Ait. (Beaked H.)
Ostrya virginiana Mill.) K. Koch. (American Hop Hornbeam)
Carpinus caroliniana Walt. (American Hornbeam; Blue or Water Beech)
Betula lenta L. (Cherry, Sweet, or Black B.)
" *nigra* L. (River or Red Beech)
Alnus rugosa (Du Roi) Spreng. (Smooth Alder)

FAGACEÆ (Beech Family)
Fagus grandifolia Ehrh.
Castanea dentata (Marsh) Borkh. (Chestnut)
Quercus alba L. (White Oak)
" *stellata* Wang. (Post Oak, Iron Oak.)
" *macrocarpa* Michx. (Bur Oak. Overcup Oak)
" *bicolor* Willd. (Swamp White Oak.)
" *Muhlenbergii* Engelm. (Yellow Oak. Chestnut Oak)
" *prinus* L. (Chestnut Oak.)
" *rubra* L. (Red. Oak.)

Quercus palustris Muench. (Swamp Spanish or Pin Oak)
" *coccinea* Muench. (Scarlet Oak.)
" *velutina* Lam. (Quercitron, Yellow-barked Oak)
" *ilicifolia* Wang. (Bear or Black Scrub Oak.)
" *marilandica* (Muench). Black Jack or Barren Oak.)
" *imbricaria* Michx. (Laurel or Shingel Oak.)

URTICACEÆ
Ulumus fulva Michx. (Slippery or Red Elm)
" *americana* L. (American or White Elm.)
Celtis occidentalis L. (Sugarberry)
Humulus lupulus L. (Common Hop)
Maclura pomifera (Raf.) Schneider. (Osage Orange)
Morus rubra L. (Red. Mulberry)
Urtica gracilis Ait.
Laportea canadensis (L.) Gaud. (Wood Nettle)
Boehmeria cylindrica (L.) Sw. (False Nettle)
Parietaria pennsylvanica Muhl. (Pellitory)

SANTALACEÆ (Sandalwood Family)
Comandra umbellata (L.) Nutt. (Bastard Toad-flax)

LORANTHACEÆ (Mistletoe Family)
Phoradendron flavescens (Pursh). Nutt. (Amer. Mistletoe)

ARISTOLOCHIACEÆ
Asarum canadense L.
" *virginicum* L.
Aristolochia serpentaria L. (Virginia Snakeroot)

POLYGONACEÆ
Rumex crispus L. (Yellow dock)
" *obtusifolius* L. (Bitter dock)
" *acetosella* L. (Field Sorrel)
Polygonum aviculare L.
" *tenue* Michx.
" *pennsylvanicum* L.
" *hydropiper* L. (Common Smartweed or Water Pepper)
" *acre* HBK. (Water Smartweed)
" *persicaria* L. (Lady's Thumb.)
" *virginianum* L.
" *arifolium* L. (Halberd-leaved Tear-thumb)
" *sagittatum* L. (Arrow-leaved Tear-thumb)
" *convolvulus* L. (Black Bindweed)
" *scandens* L. (Climbing False Buckwheat)
" *dumetorum* L.
Fagopyrum esculentum Moench (Buckwheat.)

CHENOPODIACEÆ
Chenopodium ambrosioides L. (Mexican Tea)
" *album* L. (Lamb's Quarters. Pigweed)

AMARANTHASEÆ (Amaranth Family)
Amaranthus retroflexus L. (Green Amaranth, pigweed)
" *hybridus* L. (Green A. Pigweed)
" *graecizans* L. (Tumble Weed)
" *blitoides* Wats.
" *spinosus* L. (Thorny A.)
Celosia argentea L.

PHYTOLACCACEÆ (Pokeweed Family)
Phytolacca decandra L. (Common Poke or Scoke, Garget.)

ILLECEBRACEÆ (Knotwort Family)
Anychia polygonoides Raf.
" *canadensis* (L.) BSP.

AIZOACEÆ
Mollugo verticillata L. (Carpet Weed)
CARYOPHYLLACEÆ (Pink Family)
Arenaria serpyllifolia L. (Thyme-leaved S.)
Stellaria pubera Michx. (Great Chickweed)
" *media* (L) Cyrill (Common Chickweed)
Cerastium vulgatum L. (Common Mouse-ear)
Lychnis coronaria (L.) Desr. (Mullein Pink)
Silene antirrhina L. (Sleepy Catchfly.)
" *noctiflora* L. (Night-flowering catchfly)
" *pennsylvanica* Michx. (Wild Pink)
" *virginica* L. (Fire Pink)
" *stellata* (L.) Ait. f. (Starry Campion)
" *nivea* (Nutt.) Otth.
Saponaria officinalis L. (Soapwort, Bouncing Bet)
Dianthus deltoides L. (Maiden P.)
" *barbatus* L. (Sweet William)
PORTULACACEÆ (Purslane Family)
Claytonia virginica L. (Spring beauty)
" *caroliniana* Michx.
Portulaca oleracea L. (Common Purslane)
NYMPHÆACEÆ (Water Lily Family)
Nymphaea advena Ait. (Cow Lily)
RANUNCULACEÆ (Crowfoot Family)
Ranunculus laxicaulis (T. & G.) Darby. (Water Plantain)
" *abortivus* L. (Small-flowered)
" *acris* L. (Tall Crowfoot)
Thalictrum dioicum L. (Early Meadow Rue)
" *polygamum* Muhl. (Tall Meadow Rue)
Anemonella thalictroides (L.) Spach. (Rue Anemone.)
Hepatica triloba Chaix.
" *acutiloba* DC.
Anemone virginiana L.
" *quinquefolia* L. (Wood Anemone)
Clematis virginiana L. (Virgin's Bower)
" *Viorna* L. (Leather Flower)
Caltha palustris L. (Marsh Marigold)
Aquilegia canadensis L. (Wild Columbine)
Delphinium tricorne Michx. (Dwarf Larkspur)
Cimicifuga racemosa (L.) Nutt. Black Snakeroot, Black Cohosh.)
Actaea alba (L.) Mill. (White Baneberry)
MAGNOLIACEÆ (Magnolia Family)
Magnolia acuminata L. (Cucumber Tree)
Liriodendron tulipifera L. (Tulip Tree)
ANONACEÆ (Custard Apple Family)
Asimina triloba Dunal. (Common Pawpaw)
MENISPERMACEÆ (Moonseed Family)
Menispermum canadense L. (Moonseed)
BERBERIDACEÆ (Barberry Family)
Podophyllum peltatum L. (May apple)
Jeffersonia diphylla (L.) Pers. (Twinleaf)
Caulaphyllum thalictroides (L.) Michx. (Papoose Root)
LAURACEÆ (Laurel Family)
Sassafras variifolium (Salisb.) Ktze. (Sassafras)
Benzoin aestivale (L.) Nees. (Spice Bush, Benjamin Bush)

PAPAVERACEÆ (Poppy Family)
Sanguinaria canadensis L. (Bloodroot)
Chelidonium majus L. (Celandine)
Papaver dubium L. (Common Poppy)
FUMARIACEÆ (Fumitory Family)
Adlumia fungosa (Ait.) Greene (Climbing Fumitory)
Dicentra cucullaria (L.) Bernh. (Dutchman's Breeches)
" *canadensis* (Goldie) Walp. (Squirrel Corn.)
" *eximia* (Ker) Torr.
Corydalis flavula (Raf.) DC.
CRUCIFERÆ (Mustard Family)
Draba verna L. (Whitlow Grass)
Lepidium virginicum L. (Wild Peppergrass)
" *campestre* (L.) R. Br.
Capsella bursa-pastoris (L.) Medic. (Shepherd's Purse)
Camelina sativa (L.) Crantz. (False Flax)
" *microcarpa* Andrz.
Brassica nigra (L.) Koch. (Black Mustard)
" *rapa* L. (Turnip)
Sisymbrium officinale (L.) Scop. (Hedge Mustard)
Radicula nasturtium-aquaticum (L.) Britten & Rendle. (True Water Cress)
" *obtuse* (Nutt.) Greene.
" *palustris* (L.) Moench. (Marsh Cress.)
" *palustris* var. *hispida* (Desv.) Robinson.
" *armoracia* (L.) Robinson (Horseradish)
Barbarea vulgaris R. Br. (Common Winter Cress, Yellow Rocket.)
Dentaria laciniata Muhl. (Toothwort)
Cardamine parviflora L.
" *pennsylvanica* Muhl. (Bitter Cress)
Arabis lyrata L. (Rock Cress)
" *laevigata* (Muhl.) Poir.
" *canadensis* L. (Sickle-Pod)
CRASSULACEÆ (Orpine Family)
Penthorum sedoides L. (Ditch Stonecrop)
Sedum telephioides Mechx. (Stone Crop)
Sempervivum tectorum L. (Hen-and Chickens)
SAXIFRAGACEÆ (Saxifrage Family)
Saxifraga virginensis Michx. (Early Saxifrage)
Heuchera villosa Michx. (Alum root)
" *americana* L. (Common Alum)
" *pubescens* Pursh.
Mitella diphylla L. (Bishop's Cap)
Chrysosplenium americanum Schwein. (Golden Saxifrage)
Philadelphus coronarius L. (Mock Orange or Syringa)
Hydrangea arborescens L. (Wild Hydrangea)
Ribes cynosbati L. (Prickly Gooseberry, Dogberry)
" *nigrum* L. (Black Currant)
" *prostratum* L'Her. (Skunk Currant)
" *vulgare* Lam. (Red Currant)
HAMAMELIDACEÆ (Whitch Hazel Family)
Hamamelis virginiana L. (Whitch Hazel)
PLATANACEÆ (Plane Tree Family)
Platanus occidentalis L. (Sycamore, Buttonwood)
ROSACEÆ (Rose Family)
Physocarpus opulifolius (L). Maxim. (Nine-bark)
Spiraea corymbosa Raf.
Aruncus sylvester Kosteletzsky. (Goat's Beard)

Gillenia trifoliata (L.) Moench. (Bowman's Root)
Pyrus communis L. (Common Pear)
" *coronaria* L. (American Crab.)
" *malus* L. (Apple)
" *arbutifolia* (L.) L. f.
" *melanocarpa* (Michx.) Willd.
" *americana* (Marsh). (American M.)
Amelanchier canadensis (L.) Medic. (Shad Bush, Service Berry)
" *oblongifolia* (T. & G.) Roem.
" *spicata* (Lam.) C. Koch.
" sanguinea.
" *sanguinea.*
Crataegus crus-galli L.
" *punctata* Jacq.
Fragaria virginiana Duchesne (Strawberry)
" *vesca* L. var *americana* Porter.
Waldsteinia fragarioides (Michx). Trattinick. (Barren Strawberry)
Potentilla monspeliensis L. (Five Finger)
" *argentea* L. (Silvery Cinquefoil)
" *canadensis* L.
" " var. *simplex* (Michx.) T. &. G.
Filipendula rubra (Hill). Robinson. (Queen of the Prairie)
Geum canadense Jacq. (Avens)
Rubus odoratus L. (Purple Flowering Rubus)
" *allegheniensis* Porter.
" *hispidus* L.
" *villosus* Ait. (Dewberry)
Agrimonia gryposepala Wallr. (Agrimony)
" *striata* Michx.
" *parviflora* Ait.
Sanguisorba canadensis L. (Canadian Burnet)
Rosa spinosissima L. (Scotch Rose)
" *rubiginosa* L. (Sweetbrier, Eglantine)
" *gallica* L.
" *carolina* L.
" *virginiana* Mill.
Prunus serotina Ehrh. (Wild Black or Rum Cherry)
" *virginiana* L. (Choke Cherry)
" *pennsylvanica* L. f. (Wild Red, Bird, Fire, or Pin Cherry)
" *avium* L. (Sweet Cherry, Mazzard)
" *cerasus* L. (Sour or Morello Cherry)
" *hortulana* Bailey. (Wild Goose Plum)
" *americana* Marsh. (Wild Plum)
" *persica* (L.) Stokes. (Peach)

LEGUMINOSÆ (Pulse Family)
Gleditsia triacanthos L. (Honey Locust)
Cassia marilandica L. (Wild Senna)
" *chamaecrista* L. (Partridge Pea)
" *nictitans* L. (Wild Sensitive Plant)
Cercis canadensis L. (Redbud, Judas Tree)
Baptisia tinctoria (L.) R. Br. (Wild Indigo)
Crotalaria sagittalis M. (Rattle-box)
Lupinus perennis L. (Wild Lupine)
Trifolium arvense L. (Rabbit-foot or Stone Clover)
" *incarnatum* L. (Crimson or Italian Clover)
" *pratense* L. (Red Clover)
" *virginicum* Small

Trifolium repens L. (White Clover)
" *repens* L. (White Clover)
" *hybridum* L. (Alsike Clover)
" *agrarium* L. (Yellow or Hop Clover)
" *procumbens* L. (Hop Clover, Low)
Melilotus officinalis (L.) Lam. (Yellow Melilote)
" *alba* Desr. (White Melilote)
Medicago sativa L. (Lucerne, Alfalfa)
" *falcata* L.
" *lupulina* L. (Black Medick, Nonesuch)
Robinia pseudo-acacia L. (Common Locust, False Acacia)
Desmodium canescens (L.) DC.
" *bracteosum* (Michx.) DC.
" " var.*longifolium* (T. & G. Robinson)
" *laevigatum* (Nutt). DC.
" *viridiflorum* (L.) Beck.
" *Dillenii* Darl.
" *paniculatum* (L.) DC.
" *canadense* (L.) DC.
" *marilandicum* (L.) DC.
Lespedeza procumbens Michx. (Bush Clover)
" *repens* (L.) Bart.
" *violacea* (L.) Pers.
" *sericea* Mig.
" *harbin*
" *virginica* (L.) Britton
" *frutescens* (L.) Britton
" *hirta* (L.) Hornem.
" *capitata* Michx.
" *striata* (Thumb.) H. & A.
Stylosanthes bilfora (L.) BSP.
Vicia angustifolia var. *segetalis* (Thuillier) Koch.
" *caroliniana* Walt.
" *villosa* Roth. (Hairy or Winter Vetch)
Lathyrus venosus Muhl. (Everlasting Pea)
Apios tuberosa Moench. (Groundnut, Wild Bean)
Clitoria mariana L. (Butterfly Pea)
Amphicarpa monoica (L.) Ell. (Hog Peanut)
" *pitcheri* T. & G.

LINACEÆ (Flax Family)
Linum virginianum L. (Flax)
" *medium* (Planch.) Britton.

OXALIDACEÆ (Wood Sorrel Family)
Oxalis violacea L. (Violet Wood Sorrel)
" *grandis* Smill.
" *stricta* L.
" *filipes* Small.
" *corniculata* L. (Lady's Sorrel)

GERANIACEÆ (Geranium Family)
Geranium maculatum L. (Wild Cranesbill)
" *robertianum* L. (Herb Robert)
" *carolinianum* L.
" *columbinum* L. (Long-stalked Cranesbill)

RUTACEÆ (Rue Family)
Ptelea trifoliata L.
Ruta graveolens L. (Common Rue)

SIMARUBACEÆ (Quassia Family)
Ailanthus glandulosa Desf. (Tree of Heaven)

POLYGALACEÆ (Milkwort Family)
Polygala paucifolia Willd. (Fringed Polygala, Flowering Winter-Green)
" *polygama* Walt.
" *senega* L. (Seneca Snakeroot)
" *sanguinea* L.
" *verticillata* L.

EUPHORBIACEÆ (Spruge Family)
Acalypha virginica L. (Three seeded Mercury)
Phyllanthus caroliniensis Walt.
Euphorbia Preslii Guss.
" *hirsuta* (Torr.) Wiegand.
" *maculata* L. (Milk Purslane)
" *humistrata* Engelm.
" *marginata* Pursh. (Snow-on-the-Mountain)
" *corollata* L. (Flowering Spurge)
" *dentata* Michx.
" *obtusata* Pursh.
" *lathyrus* L. (Caper Spurge, Mole Plant)

ANACARDIACEÆ (Cashew Family)
Rhus typhina L. (Staghorn Sumach)
" *glabra* L. (Smooth Sumach)
" *copallina* L. (Dwarf Sumach)
" *toxicodendron* L. (Poison Ivy, Poison Oak)
" *canadensis* Marsh.

AQUIFOLIACEÆ (Holly Family)
Ilex opaca Ait. (American Holly)
" *monticola* Gray.
" *verticillata* (L.) Gray (Black Alder, Winterberry)

CELASTRACEÆ (Staff Tree Family)
Euonymus atropurpureus Jacq. (Burning Bush, Waahoo)
" *americanus* L. (Strawberry Bush)
celastrus scandens L. (Waxwork, Climbing Bitter-sweet)

STAPHYLEACEÆ (Bladder Nut Family)
Staphylea trifolia L. (American Bladder Nut)

ACERACEÆ (Maple Family)
Acer pennsylvanicum L. (Striped Moose, Moosewood)
" *spicatum* Lam. (Mountain Maple)
" *saccharum* Marsh. (Sugar or Rock Maple)
" *nigrum* (Michx. f.) Britton (Black Sugar Maple)
" *rubrum* L. (Red or Swamp Maple)
" *negundo* L. (Box Elder)

SAPINDACEÆ (Soapberry Family)
Aesculus octandra (Sweet Buckeye)

BALSAMINACEÆ (Touch-me-not Family)
Impatiens pallida Nutt. (Pale Touch-me not)
" *biflora* Walt. (Spotted Touch-me-not)

RHAMNACEÆ (Buckthorn Family)
Rhamnus cathartica L. (Common Buckthorn)
" *lanceolata* Pursh.
Ceanothus americanus L. (New Jersey Tea)

VITACEÆ (Vine family)
Psedera quinquefolia (L.) Greene.
Vitis labrusca L. (Northern Fox Grape)
" *aestivalis* Michx. (Summer or Pigeon Grape)
" *bicolor* Le Conte (Summer Grape)
" *cordifolia* Michx. (Frost or Chicken Grape)
" *vulpina* L. (River-bank or Frost Grape)

TILIACEÆ (Linden Family)
Tilia americana L. (Basswood)
" *heterophylla* Vent (White Basswood)
MALVACEÆ (Mallow Family)
Abutilon theophrasti Medic. (Velvet Leaf)
Sida spinosa L.
Althaea rosea Cav. (Hollyhock)
Malva rotundifolia L. (Common Mallow, Cheeses)
Hibiscus syriacus L. (Shrubby Althæa of gardens)
" *trionum* L. (Flower-of-an-hour)
HYPERICACEÆ (St. John's-wort Family)
Ascyrum hypericoides L. (St. Andrew's Cross)
Hypericum perforatum L. (Common St. John's Wort)
" *prolificum* L. (Shrubby St. John's Wort)
" *densiflorum* Pursh.
" *boreale* (Britton) Bicknell.
" *mutilum* L.
" *gentianoides* (L.) BSP. (Osage Grass, Pineweed)
CISTACEÆ (Rockrose Family)
Helianthemum canadense (L.?) Michx. (Frostweed)
Lechea minor L.
VIOLACEÆ (Violet Family)
Viola pedata L. (Bird-foot Violet)
" *papilionacea* Prush.
" *sagittata* Ait.
" *lanceolata* L. (Lance-leaved Violet)
" *primulifolia* L. (Primrose-leaved Violet)
" *blanda* Willd.
" *rotundifolia* Michx. (Round-leaved or Early Yellow Violet)
" *hastata* Michx. (Halberd-leaved Violet)
" *canadensis* L. (Canada Violet)
" *striata* Ait.
" *Rafinesquii* Greene (Wild Pansy)
THYMELÆACEÆ (Mezereum Family)
Dirca palustris L. (Wicopy)
LYTHRACEÆ (Loose-strife Family)
Cuphea petiolata (L.) Koehne (Clammy Cuphea)
ONAGRACEÆ (Evening Primrose Family)
Ludvigia alternifolia L. (Seedbox)
" *palustris* (L.) Ell. (Water Purslane)
Epilobium angustifolium L. (Great Willow-herb, Fireweed)
" *densum* Raf.
" *adenocaulon* Haussk.
Oenothera argillicola Mackenzie.
" *muricata* L.
" *biennis* L. (Common Evening Primrose)
" *pumila* L.
" *fruticosa* L. (Sundrops)
Gaura biennis L.
Circaea lutetiana L. (Enchanter's Nightshade)
HALORAGIDACEÆ (Water Milfoil Family)
Proserpinaca palustris L.
ARALIACEÆ (Ginseng Family)
Aralia racemosa L. (Spikenard)
" *nudicaulis* L. (Wild Sarsaparilla)
Panax quinquefolium L. (Ginseng)

UMBELLIFERÆ (Parsley Family)
Sanicula marilandica L.
" *canadensis* L.
Osmorhiza claytoni (Michx.) Clarke.
Conium maculatum L.
Cicuta maculata L. (Spotted Cowbane)
Petroselinum hortense Hoffm. (Common Parsley)
Sium cicutaefolium Schrank. (Water Parsnip)
Cryptotaenia canadensis (L.) DC.
Zizia aurea (L.) Koch. (Golden Alexanders)
" *bebbii* (Coult. & Ross). Britton
" *cordata* (Walt.) DC.
Foeniculum vulgare Hill. (Fennel)
Pseudotaenidia montana Mackenzie.
Pastinaca sativa L. (Parsnip)
Oxypolis rigidior (L.) (Coult. & Rose). (Cowbane)
Angelica villosa (Walt.) BSP. (Angelica)
Daucus carota L. (Carrot)
CORNACEÆ (Dogwood Family)
Cornus canadensis L. (Dwarf Cornus, Bunchberry)
" *florida* L. (Flowering Dogwood)
" *amomum* Mill. (Silky Cornus Kinnikinnik)
" *atolonifera* Michx. (Red-osier Dogwood)
" *paniculata* L'Her.
" *alternifolia* L. f.
Nyssa sylvatica Marsh. (Black Gum)
ERICACEÆ (Heath Family)
Chimaphila umbellata (L.) Nutt. (Prince's Pine, Pipsissewa)
" *maculata* (L.) Pursh. (Spotted Wintergreen)
Pyrola elliptica Nutt. (Shin Leaf)
" *americana* Sweet
Monotropa uniflora L. (Indian Pipe, Corpse Plant)
Rhododendron viscosum (L.) Torr. (Clammy Azalea, White Swamp Honeysuckle)
" *nudiflorum* (L.) Torr. (Purple Azalea, Pinxter Flower)
" *calendulaceum* (Michx.) Torr. (Flame-colored A.)
" *Maximum* L. (Great Laurel)
Menziesia pilosa (Michx.) Pers.
Kalmia latifolia L. (Mountain Laurel, Calico Bush, Spoon-wood)
Lyonia ligustrina (L.) DC. (Male Berry)
" " var. *foliosiflora* (Michx.) Fernald
Epigaea repens L. (Mayflower, Ground Laurel, Trailing Arbutus)
Gaultheria procumbens L. (Teaberry, Checkerberry)
Gaylussacia frondosa (L.) T. & G. (Blue Tangle, Dangleberry)
" *baccata* (Wang) C. Koch. (Black Huckleberry)
Vaccinium stamineum L. (Deerberry, Squaw Huckleberry)
" *pennsylvanicum* Lam. (Low Sweet Blueberry, Early Sweet Blueberry)
" " var.nigrum Wood. (Low Black. B.)
" *canadense* Kalm. (Sour-top or Velvet-leaf B.)
" *vacillans* Kalm. (Late Low Blueberry)
" *corymbosum* L. (High or Swamp Blueberry)
DIAPENSIACEÆ (Diapensia Family)
Galax aphylla L.
PRIMULACEÆ (Primrose Family)
Lysimachia quadrifolia L. (Loosestrife)
" *terrestris* (L.) BSP.
Steironema ciliatum (L.) Raf.
Anagallis arvensis L. (Common Pimpernel)
Dodecatheon meadia L. (Shooting Star)

EBENACEÆ (Ebony Family)
Diospyros virginiana L. (Common Persimmon)
OLEACEÆ (Olive Family)
Frainus americana L. (White ash)
" *nigra* Marsh (Black Ash)
Syringa vulgaris L. (Common lilac)
Chionanthus virginica L. (Old Man's Beard)
Ligustrum vulgare L. (Privet or Prim.)
GENTIANACEÆ (Gentian Family)
Sabatia angularis (L.) Pursh.
Gentiana andrewsii Griseb. (Closed Gentian)
Bartonia virginica (L.) BSP.
APOCYNACEÆ (Dogbane Family)
Vincia minor L. (Common Periwinkle, "Myrtle")
Apocynum androsaemifolium L. (Spreading Dogbane)
" *cannabinum* L. (Indian Hemp)
ASCLEPIADACEÆ (Milkweed Family)
Asclepias tuberosa L. (Butterfly-weed, Pleurisy-root)
" *purpurascens* L. (Purple Milkweed)
" *incarnata* L. (Swamp Milkweed)
" *syriaca* L. (Common Milkweed, or Silkweed)
" *amplexicaulis* Sm.
" *phytolaccoides* Pursh. (Poke Milkweed)
" *variegata* L.
" *ovalifolia* Dcne.
" *quadrifolia* Jacq.
" *verticillata* L.
Vincetoxicum carolinense (Jacq.) Britton.
CONVOLVULACEÆ (Convolvulus Family)
Ipomoea coccinea L. (Morning Glory)
" *hederacea* Jacq.
" *pandurata* (L.) G. F. W. Mey. (Wild Potato-Vine, Man-of-the-earth)
" *purpurea* (L.) Roth. (Common Morning Glory)
Convolvulus spithamaeus L.
" *sepium* L. (Hedge Bindweed)
" *pubescens* (Gray) Fernald.
Cuscuta gronovii Willd.
POLEMONIACEÆ (Polemonium Family)
Phlox paniculata L.
" *maculata* L. (Wild Sweet William)
" *ovata* L.
" *glaberrima* L.
" *divaricata* L. (Blue Phlox)
" *subulata* L. (Ground or Moss Pink)
Polemonium reptans L. (Green Valerian)
HYDROPHYLLUM (Water leaf Family)
Hydrophyllum macrophyllum Nutt.
" *virginianum* L.
BORAGINACEÆ (Borage Family)
Cynoglossum officinale L. (Common Hound's Tongue)
Lappula virginiana (L.) Greene (Beggar's Lice)
Myosotis laxa Lehm.
Mertensia virginia (L.) Link. (Virginian Cowslip) Bluebells
Lithospermum canescens (Michx.) Lehm.
Echium vulgare L. (Blue-weed, Blue Devil)
VERBENACEÆ (Vervain Family)
Verbena urticaefolia L. (White Vervain)
" *angustifolia* Michx.
" *hastata* L. (Blue Vervain)
Lippia lanceolata Michx. (Fog-fruit)

LABIATÆ (Mint Family)
Teucrium canadensis L. (American Germander, Wood Sage)
Isanthus brachiatus (L.) BSP.
Trichostema dichotomum L. (Bastard Pennyroyal)
Scutellaria lateriflora L. (Mad-dog Skullcap)
" *versicolor* Nutt.
" *pilosa* Michx.
" *serrata* Andr.
" *integrifolia* L.
" *parvula* Michx.
Marrubium vulgare L. (Common Horehound)
Agastache nepetoides (L.) Ktze.
Nepeta cataria L. (Catnip)
" *hederacea* (L.) Trevisan. (Ground Ivy, Gill-over the Ground)
Prunella vulgaris (Heal-all, Carpenter-Weed)
Physostegia virginiana Nutt.
Galeopsis tetrahit L. (Common Hemp Nettle)
Lamium amplexicaule L. (Henbit)
" *album* L.
Leonurus cardiaca L. (Common Motherwort)
Salvia lyrata L. (Lyre-leaved Sage)
Monarda didyma L. (Oswego Tea, Bee Balm)
" *clinopodia* L.
" *fistulosa* L. (Wild Bergamot)
" *punctata* L. (Horse Mint)
Blephila ciliata (L.) Raf.
Hedeoma pulegioides (L.) Rers. (American Pennyroyal)
Satureja vulgaris (L.) Fritsch. (Basil)
Pycnanthemum flexuosum (Walt.) BSP.
" *virginianum* (L.) Durand & Jackson
Cunila origanoides (L.) Britton. (Common Dittany)
Lycopus virginicus L. (Bugle Weed)
Mentha piperita L. (Peppermint)
" *spicata* L. (Spearmint)
" *arvensis* L.
" " var. *canadensis* (L.) Briquet.
Collinsonia canadensis L. (Rich-weed, Stone-root)
SOLANACEÆ (Nightshade Family)
Solanum dulcamara L. (Bittersweet)
" *nigrum* L. (Common Nightshade)
" *carolinense* L. (Horse Nettle)
Physalis ixocarpa Brotero (Tomatillo)
" *heterophylla* Nees.
Lycium halmifolium Mill. (Common Matrimony Vine)
Datura stramonium L. (Stramonium)
SCROPHULARIACEÆ (Figwort Family)
Verbascum thapsus L. (Common Mullein)
" *phlomoides* L.
" *blattaria* L. (Moth Mullein)
Linaria vulgaris Hill. (Ramsted, Butter and Eggs)
Antirrhinum majus L.
Scrophularia marilandica L.
Pentstemon canadense Britton.
" *laevigatus* Ait.
Chelone glabra L. (Balmony)
Mimulus ringens L. (Monkey flower)
" *alatus* Ait.
" *moschatus* Dougl. (Musk Flower)
Ilysanthes dubia (L.) Barnhart. (False Pimpernel)

Digitalis purpurea L. (Foxglove)
Veronica virginica L. (Culver's-Root, Culver's Physic)
" *officinalis* L. (Common Speedwell)
" *serpyllifolia* L. (Thyme-leaved Speedwell)
" *peregrina* L. (Neckweed, Purslane Speedwell)
" *arvensis* L. (Corn Speedwell)
Gerardia pedicularia L. (Gerardia)
" *laevigata* Raf.
" *tenuifolia* Vahl. (Slender Gerardia)
Castilleja coccinea (L.) Spreng. (Scarlet Painted Cup)
Melampyrum lineare Lam.
Pedicularis canadensis L. (Common Lousewort, Wood Betony)

OROBANCHACEÆ (Broom-rape Family)
Epifagus virginiana (L.) Bart.
Conopholis americana (L. f.) Wallr.
Orobanche uniflora L. (One-flowered Cancer-root)

MARTYNIACEÆ (Martynia Family)
Tecoma radicans (L.) Juss. (Trumpet Creeper)
Catalpa bignonioides Walt. (Indian Bean)

ACANTHACEÆ (Acanthus Family)
Dianthera americana L. (Water Willow)

PHRYMACEÆ (Lopseed Family)
Phryma leptostachya L. (Lopseed)

PLANTAGINACEÆ (Plantain Family)
Plantago major L. (Common Plantain)
" *rugelii* Deen.
" *lanceolata* L. (Rib Grass, Ripple Grass, English Plantain)
" *aristata* Michx.
" *virginica* L.

RUBIACEÆ (Madder Family)
Galium pilosum Ait.
" *circaezans* Michx. (Wild Liquorice)
" *lanceolatum* Torr (Wild Liquorice)
" *latifolium* Michx.
" *claytoni* Michx.
" *concinnum* T. & G.
" *asprellum* Michx. (Rough Bedstraw)
" *triflorum* Michx. (Sweet-scented Bedstraw)
Diodia teres Walt.
Mitchella repens L. (Partridge Berry)
Cephalanthus occidentalis L. (Buttonbush)
Houstonia caerulea L. (Bluets, Innocence)
" *longifolia* Gaertn.

CAPRIFOLIACEÆ (Honeysuckle Family)
Diervilla lonicera Mill. (Bush Honeysuckle)
Lonicera tatarica L. (Tartarian Honeysuckle)
" *japonica* Thunb. (Japanese Honeysuckle)
Symphoricarpos orbiculatus Moench. (Indian Currant, Corral berry)
" *racemosus* Michx. (Snowberry)
" " var. *laevigatus* Fernald. (Snowberry of the Gardens)
Linnaea borealis L. var. *americana* (Forbes) Rehder. (Twin-flower)
" *perfoliatum* L. (Tinker's Weed, Wild Coffee)
Viburnum acerifolium L. (Dockmackie, Arrow-wood)
" *scabrellum* (T. & G.) Chapm.
" *dentatum* L. (Arrow-wood)
" *cassinoides* L. (Wild Raisin)
" *prunifolium* L. (Black Haw)
Sambucus canadensis L. (Common Elder)
" *racemosa* L. (Red-berried Elder)

DIPSACACEÆ (Teasel Family)
Dipsacus sylvestris Huds. (Wild Teasel)
CUCURBITACEÆ (Gourd Family)
Cucurbita pepo L. (Pumpkin)
" *sativus* L. (Cucumber)
" var. *citrullus vulgaris* Schrad. (Watermelon)
Sicyos angulatus L. (One-seeded Bur Cucumber)
Echinocystis lobata (Michx. T. & G.) (Wild Balsam-apple)
CAMPANULACEÆ (Bluebell Family)
Specularia perfoliata (L.) A. DC. (Venus's Looking-glass)
Campanula glomerata L. (Clustered Bellflower)
" *aparinoides* Pursh. (Marsh Bellflower)
" *divaricata* Michx.
LOBELIACEÆ (Lobelia Family)
Lobelia cardinalis (Cardinal Flower)
" *siphilitica* L. (Great Lobelia)
" *spicata* Lam.
" *inflata* L. (Indian Tobacco)
COMPOSITÆ (Composite Family)
Vernonia altissima Nutt.
Eupatorium purpureum L. (Joe-pye Weed, Trumpet Weed)
" *pubescens* Muhl.
" *perfoliatum* L. (Thoroughwort, Boneset)
" *urticaefolium* Reichard. (White Snakeroot)
Kuhnia eupatorioides L.
Chrysospis mariana (L.) Nutt. (Golden Aster)
Solidago caesia L.
" *curtisii* T. & G.
" *bicolor* L.
" *erecta* Pursh.
" *monticola* T. & G.
" *arguta* Ait.
" *juncea* Ait.
" *uniligulata* (DC.) Porter.
" *nemoralis* Ait.
" *serotina* Ait.
Aster divaricatus L.
" *schreberi* Nees.
" *macrophyllus* L.
" *novae-angliae* L.
" *patens* Ait.
" *undulatus* L.
" *multiflorus* Ait.
" *prenanthoides* Muhl.
" *infirmus* Michx.
Erigeron pulchellus Michx. (Robin's Plantain)
" *annuus* (L.) Pers. (Daisy Fleabane, Sweet Scabius)
" *ramosus* (Walt.) BSP. (Daisy Fleabane)
" *canadensis* L. (Horse-weed, Butter-weed)
Sericocarpus asteroides (L.) BSP.
" *linifolius* (L.) BSP. (White-topped aster)
Antennaria parlinii Fernald. (Everlasting, Ladies' Tobacco)
" *dioica* (L.) Gaertn.
" *canadensis* Greene.
" *plantaginifolia* (L.) Richards. (Plantain-leaved Everlasting)
" *fallax* Greene.
" *occidentalis* Greene.
" *brainerdii* Fernald.
" *argillicola* Stebbins.
" *virginica* Stebbins.

Antennaria neodioica Greene
" " var. *gradis* Fernald.
" *solitaria* Rydb.
" *neglecta* Greene
" *petaloidea* Fernald.
Gnaphalium polycephalum Michx. (CommonEverlasting)
" *uliginosum* L. (Low Cudweed)
" *purpureum* L. (Purplish Cudweed)
Polymnia canadensis L. (Leafcup)
Chrysogonum virginianum L.
Parthenium integrifolium L.
Ambrosia trifida (Great Ragweed)
" *trifida* var. *integrifolia* (Muhl.) T. & G.
" *artemisiifolia* L. (Roman Wormwood, Hogweed, Bitter-weed)
Xanthium spinosum L. (Cocklebur, Clotbur)
" *canadense* Mill.
" *commune* Britton.
Rudbeckia hirta L. (Yellow Daisy, Black-eyed Susan, Nigger Head)
" *laciniata* L.
Heliathus giganteus L. (Sunflower)
" *strumosus* L.
" *decapetalus* L.
Actinomeris alternifolia (L.) DC.
Coreopsis major Walt.
" *verticillata* L.
Bidens frondosa L. (Beggar Ticks)
" *vulgata* Greene. (Beggar-ticks, Stick-tight)
" *comosa* (Gray). Wiegand.
" *connata* Muhl. (Swamp Beggar-tick)
" *cernua* L. (Stick-tight)
" *bipinnata* L. (Spanish Needles)
Galinsoga parviflora Cav.
Helenium nudiflorum Nutt. (Sneeze weed)
" *autumnale* L.
Achillea millefolium L. (Common Yarrow, Milfoil)
Anthemis cotula L. (May-weed, Dog Fennel)
" *arvensis* L. (Corn Chamomile)
Chrysanthemum leucanthemum var. *pinnatifidum* Lecoq & Lamotte.
" *parthenium* (L.) Bernh. (Feverfew)
Tanacetum vulgare L. (Common tansy)
Erechtites hieracifolia (L.) Raf. (Fire-weed)
Cacalia reniformis Muhl. (Great Indian Plantain)
" *atriplicifolia* L. (Pale Indian Plantain)
Senecio vulgaris L. (Common Groundsel)
" *obovatus* Muhl.
Arctium minus Bernh. (Common Burdock)
Cirsium lanceolatum (L.) Hill. (Common or Bull Thistle)
" *discolor* (Muhl). Spreng.
" *altissimum* (L) Spreng.
" *muticum* Michx. (Swamp Thistle)
" *pumilum* (Nutt). Spreng. (Pasture or Bull Thistle)
" *arvense* (L.) Scop. (Canada Thistle)
Silybum marianum (L.) Gaertn. (Lady's Thistle)
Centaurea maculosa Lam.
Cichorium intybus L. (Succory or Chicory)
Krigia virginica (L.) Willd. (Dwarf Dandelion)
Leontodon autumnalis L.
Tragopogon porrifolius L. (Salsify, Oyster-plant)

COMPOSITAE (Composite Family) (Con't).
Chondrilla juncea L. (Skeleton-weed)
Taraxacum officinale Weber. (Common Dandelion)
" *erythrospermum* Andrz. (Red-seeded Dandelion)
Sonchus arvensis L. (Field Sow Thistle)
" *oleraceus* L. (Common Sow Thistle)
Lactuca scariola L. (Prickly Lettuce)
" " var. *integrata* Gren. & Godr.
" *saligna* L.
" *canadensis* L. (Wild Lettuce, Horse-weed)
" *sagittifolia* Ell.
Prenanthes alba L. (White Lettuce, Rattlesnake-root)
" *trifoliolata* (Cass.) Fernald. (Gall-of-the-earth)
" *altissima* L.
Hieracium pilosella L. (Mouse-ear)
" *aurantiacum* L. (Orange Hawkweed, Devil's Paint-Brust, Grim the Collier)
" *pratense* Tausch. (King Devil)
" *venosum* L. (Rattlesnake-weed, Poor Robin's Plantain)
" *scabrum* Michx.
" *gronovii* L.

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CONTRIBUTIONS OF CHARLES FREDERICK MILLSPAUGH to the BOTANY OF WEST VIRGINIA

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ON JULY 1, 1933, when the departments of botany and zoology of West Virginia University were merged with the department of plant pathology to form the new department of biology, the priceless Millspaugh collection of West Virginia plants was incorporated into the general Herbarium. This group of plants is historically of prime importance to West Virginia botanists, being cited in the check-list of the state's flora and hence constituting the foundation on which succeeding students have built. It was thought that it might be of interest at this time to present to the public a short account of the work of Dr. Millspaugh during the period of his brief stay in West Virginia.

Charles Frederick Millspaugh was born in Ithaca, New York, in 1854, and early developed a strong interest in the outdoors. He met the great Louis Agassiz when the latter was on a fishing trip near Ithaca and the chance acquaintance developed into a lasting friendship. He was a nephew of Ezra Cornell, the founder of Cornell University, where he spent the years 1872-75 as a student. He later attended the New York Homeopathic Medical College, receiving the degree of Doctor of Medicine in 1881. During the next nine years he practised medicine in Binghamton, N. Y.,

but became increasingly interested in plants, publishing in 1887 his "American Medicinal Plants". This monumental work was issued in ten volumnes, with 180 full-page colored plates prepared by himself.

Dr. Millspaugh came to West Virginia in the summer of 1889, when the University was, as he said, located "on one of the main roads leading into Morgantown".[1] His official title was Botanist and Microscopist and his work was entirely in the field of research with the State Agricultural Experiment Station.

Before 1889 only the most fragmentary investigations had been conducted into the flora of West Virginia, largely by "a few transient botanists who have worked over, for their own personal pleasure, the neighborhood of some vacation resort."[2] In addition to these, there need be mentioned only the work of Dr. A. S. Todd, who published in his "Medicinal Plants of West Virginia" (1867, 1871), a list of 86 species; Mr. Diss DeBarr, who included in his "Handbook of West Virginia" (1870) a list of 64 woody plants; Prof. Fontaine, who listed in "The Resources of West Virginia" (1876) 69 trees and 16 shrubs; and Profs. H. N. Mertz and G. Guttenberg, who published in 1878 a check-list of the "Flora of West Virginia", enumerating 59 trees, 37 shrubs, and 494 herbs.

Dr. Millspaugh was, therefore, forced at once to the conclusion that the prime requisite was a "full knowledge of what species of vegetation might be found in this state; where each species best grew, and what were its characteristics in the localities naturally chosen. To a thorough knowledge of this point, three special duties devolved upon me: first, to travel and observe, meantime taking copious notes; second, to obtain specimens of each species of herb, shrub, or tree, and preserve the same for future reference at the station; and, third, to note by the natural inhabitants of the soil what cultivated plants might best succeed in the various sections of the state. It will readily be seen by this that the work laid out for this department for the first year was purely of a foundational type, tending toward a knowledge of the vegetable and soil resources of the State."[3]

The winter of 1889-90 was spent largely in getting together his apparatus and laying plans for the work of the next season. He was an excellent photographer and "fitted up a photographic developing room with every convenience for work, obtained a camera with lenses, together with all the necessary chemicals and apparatus for developing, printing, and toning the pictures taken. . . . Thus fitted out, I have taken this season a large number of negatives of such views, objects, and things, as I desired in my own department, or other members of the staff wished to preserve in theirs."[4] His interest in photography led to the publication of a highly detailed and well-illustrated paper entitled, "Photography: Its Application to Station Work,"[5] giving an account of a complete outfit together with a full method of using it. Several plates illustrating the Third Annual Report of the Experiment Station are from his photographs.

By the end of this period he found the microspic "section of the Station . . . . well equipped with all the accessories for scientific work upon minute forms of life and matter," although "so far I have only had time to measure and tabulate the eye-

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[1]W. Va. Agr. Exp. Sta. Rept. 3: 103. 1891.
[2]W. Va. Agr. Exp. Sta. Bul. 24: 315. 1892.
[3]W. Va. Agr. Exp. Sta. Rept. 3: 89. 1891.
[4]Ibid. 3: 102.
[5]Ibid. 3: 122-144.

pieces and lenses, arrange the apparatus for whatever work may fall to me in aiding other departments . . . . and mounting several results of experiments.''[6]

''On the 16th of April, 1890, we received in excellent condition from the Department of Agriculture at Washington, thirteen bundles of cuttings of Austrian Basket Osiers, for the purpose of experimentation, to determine whether this locality was or was not suitable to their growth for the purpose of willow-ware manufacture.''[7] These were planted in a plat on the University Campus.

With the opening of spring he was ready to undertake his botanical survey of the state. ''In entering upon botanical investigation in this state, I found the field almost a virgin one, so nearly so indeed that I deemed collecting an important branch of the primary work in this department, and therefore began immediately the task of placing in my laboratory a typical specimen of each tree, shrub, and herb in the state.''[8]

''Beginning the first of April, trips about Monongalia county were made, for the purpose of observation and collection of specimens upon the plan usually adopted in explorations of this kind, and a list of all the species collected was begun under arbitrary numbers, and continued from this date until the period of late frosts. So much time was spent in this county on account of its nearness to the laboratory. In collecting, everything met with was taken when found in typical condition, special care being employed in searching for natural grasses, forage plants, weeds, and medicinal herbs. In connection with this work as conducted in Monongalia county, two trips of more extensive nature were made as follows:

''In company with the Station entomologist, I began at noon on the second of July, a trip by team and wagon, from Parkersburg on the Ohio, east to the valley of Tygart's River in Randolph County, thence south-west to the Gauley River, westerly along the Great Kanawha River to Charleston, and north to the starting point. This trip covered 376 miles of road, led us through twelve counties, and consumed 27 days.

''Our route in Wood county led along the south bank of the Little Kanawha River to the county line beyond Leachtown. Here 68 species not before met with this season were added to the collection, and many valuable notes were taken for future reference. Entering Wirt county still upon the south bank of the river, we proceeded to Elizabeth, where the north bank was gained, which we kept substantially to Glenville, the county seat of Gilmer. In Wirt 45 species were added, and in Calhoun 16 more. Leaving Glenville by the principal pike, we passed up Leading creek, a tributary to the Little Kanawha, crossed a dividing ridge to a small tributary of the Monongahela, along which our route led to Weston, the county seat of Lewis. Here our first Sunday was spent in rest, and our route continued the following day, along another; tributary to the same river, across another divide to a branch of the Buckhannon River, thence to Buckhannon, the county seat of Upshur. The similarity of the flora of all the counties so far crossed, give me but three additional species in Gilmer and eleven in Lewis counties; though my notes increased in value and number.

''From Buckhannon our route upon the famous Staunton Pike now led us away from the courses of streams, and by easy grades to the deep gap in Rich Mountain which formed one of the earliest fields of battle during the war. From here, a side trip afoot to Lone Sugar Knob was made; after which we proceeded down the mountain to Beverly, the county seat of Randolph. One day was lost at Beverly on account of sickness, and the following two occupied in leisurely ascending Tygart's River Valley through its broad bottom and rugged road for ten miles to the summit of Point Mountain, where our second Sunday was spent. Upshur county yielded

[6]Ibid. 3: 101.
[7]Ibid. 3: 113.
[8]Ibid. 3: 90.

me 40 species—many of which were of great interest, and the trip along the valley and over the mountain in Randolph 108 more.

"Here upon Point Mountain at an elevation of 3,700 feet above the sea level lie the most wonderful hardwood forests it was ever my pleasure to visit ,the majestic specimens of cherry, *(Prunus serotina)* rising 60 feet without a limb, and full 60 more in foliage, while the "poplar" (*Liriodendron tulipifera*) here attains great size. The oaks of different species *(Quercus rubra* and *nigra)* magnolias *(Magnolia acuminata, umbrella,* and *frazeri),* maples *(Acer saccharinum,* Marsh, not L., and its variety *nigra)* and chestnut *(Castanea vesca.* var. *americana)* form forests of thousands of acres, in which, strange to say, at this altitude and distance from water, there is a large amount of black walnut *(Juglans nigra).* It was along the road through this great forest for a number of miles after leaving the summit, and proceeding toward Alderson, that great quantities of curled maple attracted my attention where the foresters had cut down the trees along the road that the sun's rays might reach it and dry its almost impassable ruts.

"Upon the highest pinnacle of Point Mountain, I saw the first growth of Canada thistle I have met with since my residence in this state. It grew where, should the seed have developed, they might readily have been blown by the slightest wind into three counties. This growth I took care to thoroughly destroy before leaving the spot. The seed from which it grew was probably brought there with that of some grain, as the field in which it stood showed evidence of stubble two years old. Had we accomplished nothing further during this whole trip than to identify and destroy this one patch of that vilest of weeds, its cost in time and money would be repaid many fold.

"From Point Mountain our route lay along the ridge of Buffalo Bull range, through a continuation of the forest mentioned, and then down a romantic but somewhat perilous mountain road, for ten miles, into Addison, the county seat of Webster. We had passed since leaving Valley Head, from the headwaters of the Monongahela system of rivers to that of the Great Elk. Addison, looking flat enough upon our map, was found to lie deep in the mountain fastness, from which next day we were extricated by making an ascent of 700 feet in less than a mile of road.

"The next point of interest upon the route was the Glade Region between the headwaters of the Elk and Gauley rivers. These glades having an altitude of 2,350 feet are evidently the beds of ancient sphagnum ponds, which have now however lost their waters, leaving only ditches mostly deepened by attempts to reclaim the land. In one of these glades, "Long Glade", there still remains about 100 acres of marshy tract, in which cranberries still grow in sufficient quantity to enable one person to pick from 2 to 4 bushels per diem during the season. "Upper", "Middle", "Welch", and "Long Glades" yield 56 species new to my collection, though visited too late in the season to see them in their best floral condition.

"Passing from here into Nicholas county we strike Peter and Elk Creeks tributary to the Gauley River, and follow the windings of the latter through grand forests of hardwood, in which the Hemlock becomes for the first time plentiful and the Sweet Gum *(Liquidambar styraciflua,* which continued as far as Jackson county) is first met in the state. Reaching the Gauley we followed its course, skirting the beautiful Gauley Mountains, to its junction on the great Kanawha; thence along the fertile bottoms of the latter stream, to the city of Charleston, where our third Sunday was spent. On this portion of the trip Nicholas county yielded me twelve and Fayette a like number of interesting species.

"Leaving Charleston on the morning of the 24th of July upon the Charleston, Ripley, and Parkersburg pike, we passed through the Pocotalico country, over the great limestone ridge to Jackson C. H., thence along the fertile hills of that and Wirt counties, to our starting point. Kanawha yielded me 24, and Jackson 17 further species.

"This trip, while placing a diversified collection of 412 species among those already in the Station herbarium, gave me a knowledge of this portion of the state that will assist me materially in all the work falling to my department.

"While in the neighborhood of this great forest range upon the trip just related, we learned that the valuable forests of spruce there were being destroyed by some insect or disease, the extension of which was reported to threaten their utter ruin. Placing this matter before the director of the Station upon our return, we were bade make a special trip to these forests, for the purpose of determining, if possible, the cause, and find a remedy should one suggest itself to us. Accordingly on the 25th of August, we left Morgantown by the B. & O. R. R. for Piedmont, where we changed to the West Virginia Central; which carried us over 80 miles through wild mountain forests to Elkins, near the county seat of Randolph, where we arrived late in the evening. Having decided to advance as far as possible southward along the Cheat range, we took the stage for Huttonsville the next afternoon. Although I had already worked over the 21 miles to this point upon our previous trip, through the kindness of the obliging driver who made several halts for the purpose, I was enabled to add quite a number of new specimens to my collections. Huttonsville was reached at 6:30 p. m. in driving rain, which threatened our expedition with delay. The morning of the 27th was so stormy that, with the rains of the previous night, the roads soon became too bad to attempt further progress, and the morning was spent in gaining further particulars concerning the trouble in the forests. Men were sought and found who had been intimately acquainted with the mountain wilds for years, and through their kindness and deep interest in the object of our trip, we gained most of the knowledge that is here represented in figures. Most of these gentlemen had either been surveyors or assistants, hunters or lumbermen purchasers, or buyers' agents, so that the points given were very exact and reliable. To Col. E. Hutton, whose large experience in this region renders him an authority upon the forest, I am under special obligations; not only for figures and facts, but also for kindly hospitality. The afternoon was spent in gathering plants in the neighborhood, and gleaning information concerning the weeds of that locality.

"The morning of the 28th opened bright and auspicious, enabling an early start. Our road for four miles lay along the broad valley of Tygart's River, and easterly along a tributary stream, to the base of the mountain, where the ascent was begun upon the continuation of the old Staunton pike, made so famous through this region first by those bright sketches of Porte Crayon, and later by the Civil War. Traversing the beautiful grades and windings of this road, the flora became more boreal the higher we ascended, until at an elevation of 3,425 feet we reached the "spruce line" eleven miles from Huttonsville. The entomologist's first view of the dead trees suggested, and his investigations soon after proved, that the cause of the trouble lay entirely within the province of his department; thus leaving me free to the study of the living vegetation, the novelty and profusion of which had already deeply interested me. Two miles further on we gained the summit of Old White Top, the scene of the battle of Cheat Mountain; from which the view spread before us, first in clear, then hazy distances, of rugged and densely wooded mountain spurs and ranges. As far as the eye could distinguish to the east and south, the deep olive green of the spruce, here and there dotted with the early changing foliage of the cherry, clothed the earth. On turning, however, in our seats, what a change! the vast forests of the western ranges were brown in death, the gaunt trees stood like types of desolation, extending their bare arms as if in grim mockery from their ruined neighbors, toward their rich leafy brothers, across the black waters of Cheat.

"From this summit, 3,650 feet above the sea level, the road drops at a heavy grade down to the river, which has an altitude at this point of 3,310 feet, and is about 2,500 feet above its mouth in southwestern Pennsylvania. Crossing the bridge our stage draws up the entrance of the only hotel, which, with the postoffice and the lumber camp, constitutes the village of Winchester."[9]

At the close of this season, he writes[10] that "from my present knowledge of the

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[9]Ibid 3: 93-97. I have taken the liberty of quoting at length from Dr. Millspaugh's account of his field work, because of the inimitable charm and freshness that attaches to the original.

topography of the state, and its character of soil, I estimate that we should have here at least of:

Flowering plants	1650	species
Ferns, club mosses, etc.	60	"
Mosses, liverworts, etc.	300	"
Fungi, lichens, etc.	2000	"
Minor forms of vegetable life	100	"
Total	4110	"

He had always present in his mind the fact that he was a member of the staff of the Agricultural Experiment Station and that his first duty was to the farmers of the state. In regard to grasses he wrote: "It is our design to have chemical analyses carefully made at this Station of each and every natural grass and forage plant, to determine their nutritive value, and, after this, to analyze the most nutritious species, to determine the character of soil best suited to their full and characteristic growth."[11]

He was especially interested in weeds and in December, 1890, issued the following "Appeal to Farmers": "It is my intention to issue during the coming season a complete account of the weeds of this state. To do so intelligently and honestly, I need the help of every West Virginia agriculturist who reads this article. I am only one man and cannot conscientiously cover the whole state. I therefore ask you, for the benefit of your farms, to assist me by answering the questions here asked, and mailing your answer to the West Virginia Agricultural Experiment Station, Morgantown, W. Va."[12] There followed a list of ten questions.

He laid plans for an Arboretum to be planted on the Campus. "It is my intention to transplant into the University Campus as rapidly as possible, either direct or from raised seedlings, a typical individual of each and every tree and shrub found native in this State; to form an arboretum in which the agricultural students, Station staff, and the agriculturists of the state may examine under their proper names the useful, ornamental, and detrimental large plants of West Virginia."[13] In the Third Annual Report he presents the following summary:[14]

	Now in Arboretum	*To be planted*	*Total*
Native trees	27	48	75
Native shrubs	8	49	57
Cultivated trees	11		11
Cultivated shrubs	14		14
Total	60	97	157

In June, 1891, he wrote: "The work in the botanical department during the past year, with few exceptions, has been confined to systematic botany and the question of the weeds of the state, as I have not yet been supplied with the necessary literature and apparatus for working out original investigations upon plant diseases, which, however, will be done during the present season. When having, as this report will show, worked out the principal problems for the state in systematic botany, the matter of original investigations upon diseases of crops will constitute the object of this department.

"I have finished and submitted 150 pages of manuscript, comprising a pre-

[10]Ibid. 3: 91.
[11]Ibid. 3: 117.
[12]Ibid. 3: 120; also in W. Va. Agr. Exp. Sta. Bul. 12. 1890.
[13]W. Va. Agr. Exp. Sta. Rept. 3: 102. 1891.
[14]Ibid 3: 112.

liminary catalogue of the flora of this state, which contains the notes of species observed as well as a compilation of all the work of others, as far as I could determine in this region. . . . The preparatory work necessary to obtain the facts recorded in this catalogue comprises: 63 days spent in the field; 1840 miles of travel by rail; 376 miles by wagon; 37 miles on horseback, and 264 miles on foot. Besides the notes gathered for practical use in the laboratory, I have collected, mounted, and preserved over 1200 specimens, and placed them in shape for reference and exhibit toward explanation in person to farmers and others desiring information upon the vegetation of the state.''[15]

''In connection with this work I had the pleasure of discovering a peculiar blackberry in Randolph Co., one not only new to botany and horticulture, but growing entirely without thorns. I hope to make another trip to its locality next season and procure a quantity for the purpose of cultivation at the Station, as the plant bids fair to develop a new and valuable fruit.''[16] This blackberry was described by Britton under the name *Rubus millspaughii*.[17]

''Contemporary with this work, I have devoted much time to the study of our weed growths, and have also filed, tabulated, and answered over 300 communications upon weeds received from our famers, most of which were called forth by my remark in Bulletin 12, issued December last. The results practical and historical of this work will appear in four bulletins. . . . . as follows:

Your Weeds and Your Neighbor's

Part 1. Weeds as fertilizers
Part 2. Descriptive list of Weeds
Part 3. Distribution and bad points of weeds
Part 4. General treatment of weedy fields.''[18]

These papers later appeared, Part 1 as Bulletin 19 of the Agricultural Experiment Station, Part 2 as Bulletin 23, and Part 3 as Bulletin 22. Part 4 never was published. Bulletin 23 is a splendid work of 95 pages, with excellent descriptions of 200 weeds, profusely illustrated. It contains references to the medicinal value of various weeds.

Commenting on these papers B. D. Halsted says ''The farmers of West Virginia are fortunate in having such a thorough work upon their weeds placed within easy reach of all.''[19]

''The experiment with Austrian Basket Osiers . . . . has me with quite a serious set-back on account of the ruthless pulling up of over 80 of the rooting cuttings by some vandal. Nevertheless, from the general condition of those remaining, I feel quite certain that we can not expect to successfully grow basket willows within our borders.''[20]

''In the microscopical department I have been engaged principally in the study of a new bacterial disease of the Locust.''[21]

''Since my last report but little has been done towards adding species to the Arboretum.''[22]

He had added 15 species to his list of native shrubs and trees, two being species new to science, namely, *Rubus millspaughii* Britt., and *Spiraea virginiana*

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[15]W. Va. Agri. Exp. Sta. Rept. 4: 41, 42. 1891.
[16]Ibid. 4: 42.
[17]Bul. Torr. Bot. Club 18: 366. 1891; see also Agri. Sci. 6: 66, for a horticultural treatment of the new blackberry.
[18]W. Va. Agri. Exp. Sta. Rept. 4: 42, 43. 1891.
[19]Bul. Torr. Bot. Club 19: 324. 1892.
[20]W. Va. Agri. Exp. Sta. Rept. 4: 44. 1891.
[21]Ibid. 4: 44.
[22]Ibid. 4: 45.

Britt.,[23] which he collected along the Monongahela River below Morgantown on June 20, 1890.

"In assisting at Farmer's Institutes throughout the state . . . . I have spent 29 days away from my laboratory in travel and attendance; have travelled 2102 miles by rail and 16 by wagon, and prepared and delivered 8 lectures upon subjects pertaining to my department." He made "over 150 photographic lantern transparencies."[24]

The summer of 1891, like that of the previous year, was spent in the field. He made a trip to the Eastern Panhandle in June and was in the region about Bayard, Grant county, and Davis, Tucker county, early in July. In August he collected in southern West Virginia, stopping on the 11th for a visit with Lawrence William Nuttall, at Nuttallburg, Fayette County.

Mr. Nuttall, who was later associated with Dr. Millspaugh in the publication of a flora of West Virginia, was at that time a mine owner at Nuttallburg. He was born near Phillipsburg, Pa., Sept. 17, 1857, and went to Nuttallburg in 1875. His spare time he spent in the woods, and in the period from 1890 to 1897 collected about 1000 species of flowering plants in addition to 1400 species of fungi. His manuscript of 700 species was used freely by Millspaugh in the preparation of his preliminary check list. His large private herbarium was presented to the University in 1928 and is now filed in the Herbarium.[25]

Another amateur botanist who assisted Dr. Millspaugh in the collection of material for the check-list was Dr. Hamilton McSparrin Gamble, a physician of Moorefield, who did considerable collecting in the valley of the South Branch of the Potomac River in Hardy, Grant, Mineral, and Hampshire counties from 1889 to 1910. He donated his plant collections of 157 species to the Herbarium in 1891.

In the summer of 1892 there appeared "A Preliminary Catalogue of the Flora of West Virginia", published as Bulletin No. 24 of the West Virginia Agricultural Experiment Station, dated June, 1892. In presenting this paper to the public Dr. Millspaugh stated: "Although I have worked only two seasons among the plants of the State, as a side issue from my duties at the Experiment Station, I can not feel . . . . nothwithstanding the assistance of those who have contributed toward this catalogue — that much more than a beginning has been made toward a knowledge of the plant life within our boundaries. However, this rich field already makes a good showing even when compared with the almost complete work done by many observers combined, in other states."[26]

His "Summary of the Flora" follows:

	Genera	*Species*	*Varieties*	*Forms*	*Total*
Anthophyta	504	1189	109	23	1321
Pteridophyta	15	39	4	1	44
Bryophyta	66	107	6	. .	113
Thallophyta	94	164	. .	3	167
Total	679	1499	119	27	1645
Of these, there are native of the state,					1452
Foreign,					193
Total species, varieties, and forms					1645

[23]Bull. Torr. Bot. Club 17: 314. 1890.
[24]W. Va. Agri. Exp. Sta. Rept. 4: 47. 1891.
[25]See "Former Student Gives Work to University", by Douglas Miller, in The West Virginia Agriculturist for February, 1929. The title is misleading; Mr. Nuttall was never a regularly enrolled student at the University.
[26]W. Va. Agr. Exp. Sta. Bull. 24: 518. 1892.

The work includes original descriptions of four new species of cryptogams, as well as a number of new varieties of seed plants.

Dr. Millspaugh's connection with the West Virginia Agricultural Experiment Station was, unfortunately, terminated June 30, 1892. The Board of Regents of West Virginia University, at its meeting in June, 1892, "deemed it advisable to change the policy of the Station in regard to the botanical work; it being apparent that the efforts of the Station could be more advantageously directed to horticultural work than at present to continue the botanical work. By direction of the Board, the work under way in botany was finished up, and has been published in bulletin form, leaving it fairly well completed as far as it goes and making a good foundation for the horticultural work which was begun Sept. 15th by the appointment of Mr. F. Wm. Rane as horticulturist to the Experiment Station."[27]

That Dr. Millspaugh's work was fully appreciated by his associates in the Experiment Station is indicated by the following comment by John A. Myers, then director of the Station: "In regard to the botanical work done by the Station, I may say that while we were concentrating our energies upon it, no state in the Union did better, or more extensive work, and it resulted in the publication of a preliminary catalogue of the Flora of West Virginia, which, I believe, is the most comprehensive botanical publication issued by any Station in the country."[28]

He appeared on the program of the Botanical Club at the A. A. A. S. meeting in Rochester, Aug. 18-24, 1892, presenting by title "Some noteworthy features of the botany of West Virginia."[29]

In 1894 Dr. Millspaugh was made curator of botany at the Field Museum of Natural History, Chicago, which position he occupied until his death. His interest In West Virginia remained alive and for the next few years, in collaboration with L. W. Nuttall, he continued an investigation of the flora, adding the knowledge of over 1000 species to the preliminary list and detecting many new localities for previously published species. In January, 1896, they published jointly their "Flora of West Virginia".[30] The small edition of the preliminary catalogue having been exhausted within a few months of its issue, and many institutions, libraries, and personal workers being unable to secure copies of the work, it was deemed expedient to include in the new list all the species of the first publication. The repeated species appear in small capitals, the additional species new to the flora in black-faced type. As in the preliminary catalogue, the original descriptions of all species that had been described from known West Virginia types were republished in full.

The greatest number of additional species were among the fungi, and it was to their collection and study that Mr. Nuttall had devoted most of his spare hours from business after 1893. "His field of search for forms in this class of plants has been very limited, being almost wholly the immediate neighborhood of his home at Nuttallburg, in Fayette county, on New River. Even this small area has furnished the major part of the 980 fungi of this flora, and continues to present additional forms as well as unique hosts upon every search, no matter how casual the examination or short the time devoted to the trip. Fully two-thirds of the species collected have passed under the critical examination of Mr. J. B. Ellis, whose care-

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[27] W. Va. Agr. Exp. Sta. Rept. 5: 14. 1897.

[28] "History of West Va. Agricultural Experiment Station", in W. Va. Agr. Exp. Sta. Spec. Bul. 2: 127. 1895.

[29] See Bul. Torr. Bot. Club 19: 324. 1892.

[30] "Flora of West Virginia", by Charles Frederick Millspaugh and Lawrence William Nuttall. Field Columbian Museum Bot. ser. 1, no. 2: 65-276. 1896.

ful consideration of our numbers has been of incalculable assistance in this work.''[31] Thirty-six species of fungi were described in the catalogue for the first time.

The following ''Summary of the Flora''[32] is quite significant when compared with that presented in the preliminary catalogue:

	Genera	*Species*
Fungi, etc	342	980
Lichens	31	115
Thallophyta, etc.	373	1095
Hepaticae	24	32
Musci	42	90
Sphagnae	1	1
Bryophyta	67	123
Equisetae	1	1
Filicinae	14	40
Ophioglossae	2	7
Lycopodae	1	5
Selaginellae	1	1
Pteridophytes	19	57
Gymnospermae	7	13
Monocotyledonae	95	268
Dicotyledonae	412	1028
Anthophyta	514	1309

Total number of species, varieties, and forms detected in the state to the date of this flora 2584

In 1913 there appeared the last and most pretentious work of Dr. Millspaugh on the flora of West Virginia, published as a part of the West Virginia Geological Survey.[33] ''The very exhaustive paper of Dr. Millspaugh which forms Part 1 of this new volume V (A) of the publications of the West Virginia Geological Survey, constitutes an entire revision of the *West Virginia Flora* prepared and published by Dr. Millspaugh in 1896, as a revision of his first publication of a *Preliminary Catalogue of the Flora of West Virginia*, 1891, published by the West Virginia Agricultural Experiment Station when Dr. Millspaugh was connected with that Institution as botanist during the years 1889-1892. The present paper embodies the results of a much wider and later study not only by Dr. Millspaugh through the works and collections of other authors, but also the results of Dr. John L. Sheldon's (professor of botany, W. Va. University) recent studies communicated freely to Dr. Millspaugh for use in this publication, so that a very large addition to the West Virginia flora is thus made known to the world by this labor of love on the part of Dr. Millspaugh, for which all those interested in the botany of the state will be deeply grateful.''[34]

Nearly a thousand new names were added in this list, as shown by the following summary:[35]

	Genera	*Species*
Fungi, etc.	430	1130
Lichens	39	176
Thallopyta, etc.	469	1506

[31]Ibid. 75.
[32]Ibid. 80.
[33]"The Living Flora of West Virginia". W. Va. Geol. Surv. 5 (A): i-xiii, 1-389, 454-487. 1913.
[34]Ibid. vi.
[35]Ibid. 487.

Hepaticæ	48	18
Musci	68	171
Sphagnaceæ	2	8
Bryophyta	118	257
Equisetæ	1	4
Filices	16	43
Ophioglossaceæ	2	7
Lycopodiaceæ	1	6
Selaginellaceæ	1	2
	21	62
Gymnospermæ	8	15
Monocotyledonæ	118	347
Dicotyledonæ	476	1224
	602	1586

Total number of species, varieties, and forms detected in the state to the date of this flora 3411

Toward the close of 1919, in an effort to recuperate his physical strength after a serious operation, he went to the Island of Santa Catalina off the coast of California. He invited to his island home his old West Virginia friend, L. W. Nuttall, who had in that year retired from his mining business. They collected many specimens of plants, took numerous field notes and photographs, and laid the foundation for their "Flora of Santa Catalina Island", published jointly in January, 1923. It was Dr. Millspaugh's last published work. He died on Sept. 15, 1923.

The following appraisal of his character and work, by E. E. Sheriff, of Chicago Normal College, forms a fitting conclusion to this paper: "To the younger generation of American botanists Dr. Millspaugh was known mainly by reputation, for, busied with the many administrative tasks incident to his work, he often had to forego attendance upon conventions of fellow scientists. A full six feet in stature, of erect carriage and decisive manner, he possessed a strong and positive personality not soon to be forgotten by those who knew him. Accurately to appraise his various qualities and powers as a botanist would be well-nigh impossible, nor would the writer, biased with the warm friendship that comes from an acquaintance and close personal contact during the past twelve years, feel equal to the task. True it is, however, that Dr. Millspaugh's death marks the departure of an able taxonomic worker and one of America's most brilliant organizers of museum displays."[36]

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[36]Bot. Gaz. 77: 231. 1924. The article presents a brief biography of Dr. Millspaugh, with a portrait. See also Bul. N. Y. Bot. Gard. 24: 286. 1923, for a short sketch and appraisal.

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THE FLORAL DEVELOPMENT OF THE STAMINATE FLOWER OF THE HONEY ROCK MUSKMELON

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THIS INVESTIGATION has been carried on in order to throw light on the true nature of the staminate flower of *Cucumis melo* by a study of the origin and arrangement of its parts. Some contradictory discussion occurs in the literature regarding the nature of the staminate flowers of the Cucurbitaceæ. Very little is known concerning the development and origin of the structures of the flowers of *Cucumis melo.* By a study of the early stages in the development of the flower it is possible to determine the order in which the floral parts appear.

Payer *(7)* has shown in his studies on the staminate flowers of various members of the Cucurbitaceæ that the first parts to appear are the sepals. He further shows the receptacle at first to be flat, later becoming hollow, and bearing five sepals on its upper edge. The petal lobes appear soon afterward slightly below and alternate with the sepals on the internal side of the hollowed receptacle. The stamen lobes appear next, followed closely by the pistillodium lobes, which appear in the bottom of a cup-shaped receptacle. He points out that in many species of the Cucurbitaceæ five distinct ''mamelons'' appear alternating with the sepals. In other genera, as Cucurbita and Bryonia, four of the ''mamelons'' group themselves two by two and the fifth one stays isolated. This results in two double stamens and one single stamen.

Muller *(6)*, Eichler *(1)*, and Kirkwood *(5)* find in the pistillate flowers of the Cucurbitaceæ the floral parts in the following order: sepal lobes, petal lobes, staminodium lobes, and pistil lobes.

Heimlich *(2)* has reported the developmental succession of the floral organs in the staminate flowers of the cucumbers as follows: perianth tube, stamens, pistillodium, calyx lobes, and corolla lobes.

METHODS AND OBSERVATIONS

Flowers in the earliest stages were placed in a watch glass containing a saturated solution of iodine in 70% alcohol. Drawings were made from observations with a Spencer binocular microscope equipped with 32, 48, and 55-mm. objectives and 6x and 10x oculars. Light was thrown on the flowers from above with a Spencer portable lantern equipped with a 550-watt electric bulb. All light was cut off from underneath.

The account here presented is based entirely upon the study of a variety of the muskmelon, *Cucumis melo*, known as the Honey Rock. This melon was originated by Richardson from crossing the Honey Dew with the Lake Champlain and the offspring with the Benders Surprise. The author has been selecting and developing this variety since it was first originated.

Staminate flowers may be procured from the terminals of the branches of a mature plant in abundance. Staminate flowers appear before the pistillate flowers, and are found as early as the first or second leaf axis of the young plant. A single flower appears first as a blunt protuberance upon the stem in the axil of a leaf (pl. I, fig. 1). It has much the same shape as a Mazda electric-light bulb. As the development takes place, this blunt protuberance becomes flattened on its terminal end. Cell division and elongation take place in the outer margin more rapidly than in the center, which results in a terminal depression surrounded by a slightly elevated ridge. Soon growth takes place at five points on this elevated ridge more rapidly than in other places on the ridge, forming five sepal lobes (pl. I, fig. 2). Division and growth of the cells within the terminal ridge as well as just below the sepal lobes, especially at the outer of the ridge, cause an elevation of the outer border of the receptacle as well as an upward extension of the sepal lobes. The apex of the stem, which is at the center of the terminal depression, grows very slowly, while the outer margin grows to form a cup-shaped receptacle about and above the apex (pl. I, fig. 2). The cup-shaped receptacle tends to be roofed over by the sepal lobes, which curve upward over its center (pl. I, fig. 3). Many fine hairs cover the inner and outer surfaces of the young flowers.

The primordia of the petal lobes appear soon after those of the sepals in a cycle within and alternate with them (pl. I, fig. 2). They appear first as blunt, more or less rounded protuberances (pl. I, fig. 2). As cell division and growth take place they likewise tend to roof over the center of the receptacle, immediately underneath the sepal lobes (pl. I, figs. 1-5).

Growth takes place in the tissues just beneath the bases of the sepal and petal lobes, which increases the depth of the cavity within which the stamens and carpel lobes develop (pl. I, figs. 3-5). This tissue formed beneath the sepal and petal lobes makes the perianth tube. Further cell division and growth occur at the base of the petal lobes, just within the bases of the sepal lobes. This growth forms a corolla tube. The tissues at the base of the petal lobes do not divide into five

separate petals, and the result is the formation of a corolla tube with five lobes, which is attached to the upper extremity of the perianth tube at the level of the attachment of the separate sepal lobes (pl. II, fig. 6). The tissues of the perianth tube fail to become differentiated into two separate structures at their bases; therefore a common tube is formed, which is separated at the upper surface into a corolla tube and five sepal lobes (pl. II, fig. 6). There is no evidence of a separate corolla tube whose basal portion unites or coalesces with a calyx tube.

The primordia of the stamens are laid down directly after those of the petal lobes. There are three stamens, one of them smaller than either of the other two. Two of the stamens have at their upper extremities two conspicuous lobes. The smaller stamen has only one of these lobes. These lobes indicate the double nature of the two large stamens. They are noticeable at all stages in the development of the stamen (pl. I, figs. 3-5; pl. II, fig. 6). Each of the larger stamens stands opposite petal lobes, and the smaller stamen is midway between sepal and petal lobes.

As the primordium of each stamen develops, a broad filament is formed, which supports a broader mass of tissue called the connective (pl. I, fig. 5). Growth takes place in the filaments, and the stamens bend over toward the center of the perianth tube, where their connectives fit closely together (pl. II, fig. 6). Each of the two larger stamens has two S-shaped thecæ or "pollen sacs". The small stamen has just one. As growth takes place in the perianth tube, cell division and elongation become evident below the bases of the stamens, until in the mature flower the stamens appear to branch off from the perianth tube near the median level.

Immediately after the primordia of the stamens appear, three small lobes may be recognized equidistant from one another, near the bottom of the receptacle, and below and within the stamen lobes (pl. I, fig. 4). These lobes are alternate with those of the stamens. They grow toward each other and form a small three-lobed pistillodium in the base of the perianth tube.

DISCUSSION AND SUMMARY

The floral parts of the staminate flowers of many of the Cucurbitaceæ were found by Payer *(7)* to appear in the following order: sepal lobes, petal lobes, stamen lobes, and pistillodium lobes. Kirkwood *(5)* shows that, in the pistillate flowers of various Cucurbitaceæ, among them Bryonopsis, which belongs to the same tribe as the melon, the developmental succession of the floral parts agrees with the contentions of Payer. The writer *(3) (4)* has investigated the development of the floral parts of staminate and pistillate flowers of the cucumber and has found the developmental succession of the floral parts to be in the same order as reported by Payer and Kirkwood in the other Cucurbitaceæ. Eichler *(1)* states that the melon flower is diagrammatically the same as the cucumber.

Heimlich *(2)* found the floral parts in the staminate flower to appear in the following order: perianth tube, stamens, pistillodium, sepal lobes and petal lobes. He further points out that the calyx and corolla tube exhibit both cohesion and adnation.

The present investigation shows that the flower parts of the staminate flower of the muskmelon appear in the same order as reported among the Cucurbitaceæ by Payer and Kirkwood. The sepal lobes appear first, the petal lobes next, followed

closely by the stamen lobes and finally the pistillodium lobes. The perianth tube is formed by the growth of the whole zone at the base of the sepal and petal lobes. There is no evidence of a so-called calyx tube fusing with a corolla tube. The tissues of the perianth tube fail to become differentiated into separate structures at their bases, resulting in the formation of a single tube.

DESCRIPTION OF PLATES

PLATE I

Fig. 1. Three blunt protuberances in the axils of leaf primordia, which are the primordia of three staminate flowers.

Fig. 2. A young staminate flower, showing the primordia of the sepal lobes (S) and the first appearance of the five petal lobes (P).)

Fig. 3. A later stage with a portion of the flower shaved off, showing the location of the sepal lobes (S), the petal lobes (P), and the early appearance of the stamen lobe (St).

Fig. 4. The sepal lobes (S) and the petal lobes (P), which have been separated from their tentlike arrangement. One large stamen lobe, a portion of the other large lobe, and a portion of the small stamen are shown (St), as well as the first appearance of the pistillodium lobes (C).

Fig. 5. A later stage with the young flower torn apart showing the sepals (S), the petals (P), the stamens (St.), and the pistillodium (Pl).

PLATE II

Fig. 6. A mature staminate flower torn apart, showing the petal lobes (P), the corolla tube (Ct), the sepals (S), the stamens (St), the perianth tube (Pt), and the pistillodium (Pl).

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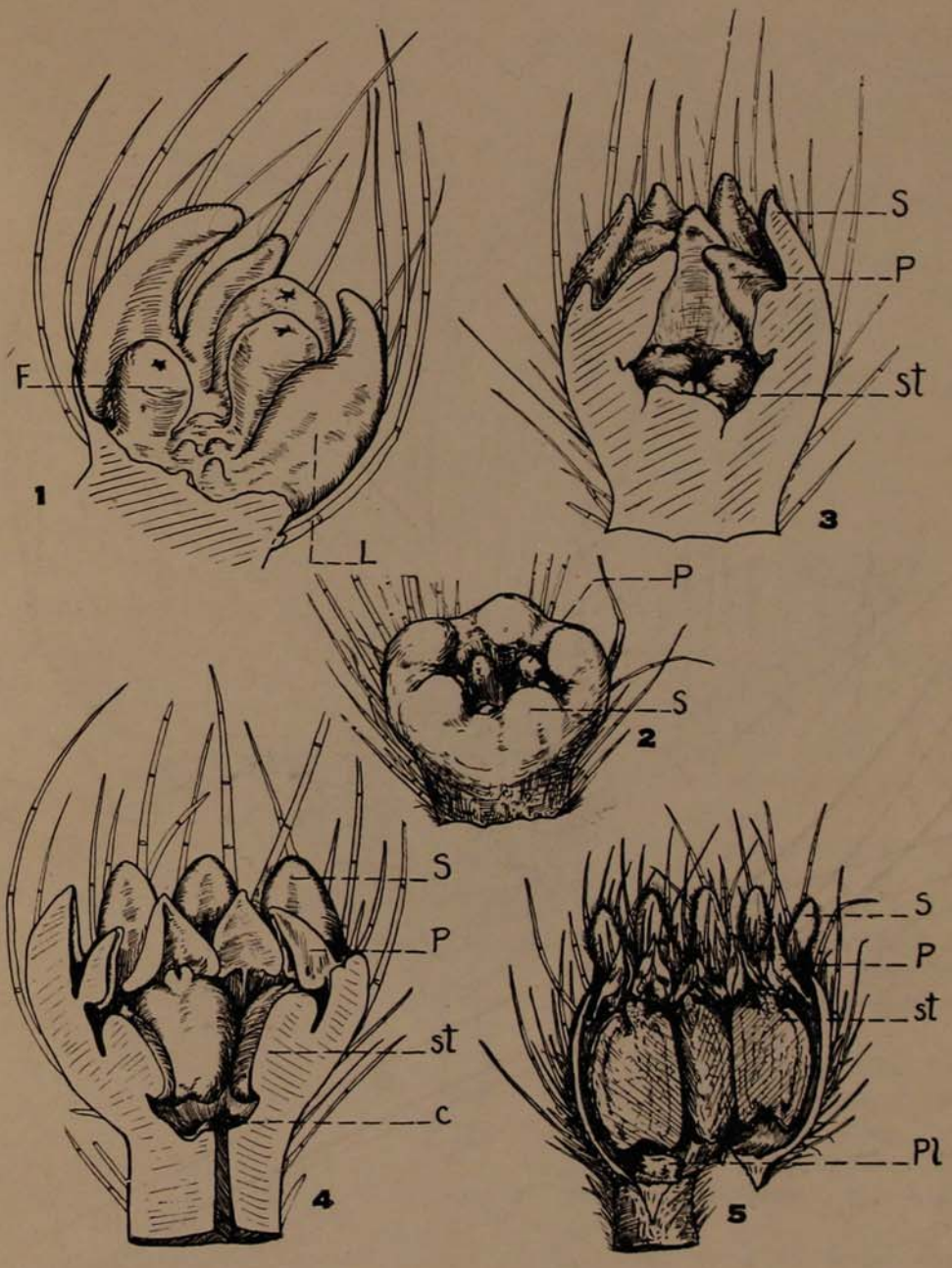

PLATE I

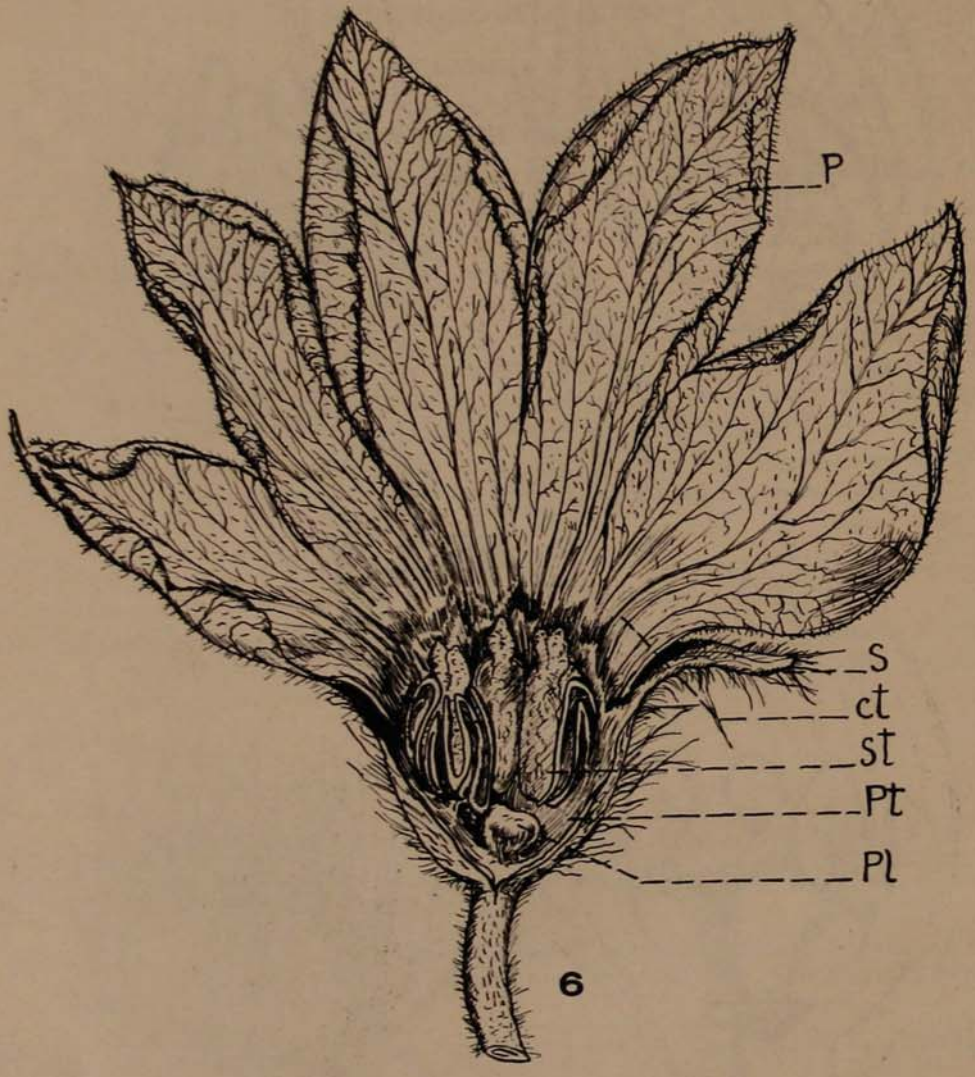

PLATE II

A BOTANICAL SURVEY OF MARION COUNTY, WEST VIRGINIA

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THE PRESENT SURVEY of the vegetation of Marion county, West Virginia, has been undertaken for a number of reasons. Foremost among these are (1) the author has been interested in this region and has collected there for a number of years; (2) the belief that an accurate check-list of the flora of the county would be valuable to students and to the residents of the state alike, and (3) to create more interest in the county flora in order to carry out the statewide campaign in behalf of the preservation of the flora of the state.

The nomenclature used throughout is that of Gray's New Manual of Botany, 7th edition, with modifications. Common names have been derived from Schaffner's Field Manual of the Flora of Ohio.

Marion county is situated in the north-central portion of West Virginia, constituting a part of the Morgantown area, which is composed of Monongalia, Marion, and Taylor counties. The land area of the county is roughly 350 square miles.

Marion county has the prevailing steeply-broken topography characteristic of this portion of the Allegheny Plateau. The surface is deeply dissected by weathering and erosion, extending through a long period of time. The plateau surface is the general level of the surrounding uplands. The elevation towards the south-central part of the county in Grant district is slightly above 800 feet, while on the southeastern part of the Winfield district the elevation is nearly 2000 feet.

In Marion county along the Monongahela River in some places limestones and shales predominate. Their weathering has resulted in a smoother topography, the hilltops being rounded and the slopes smooth, though often quite steep. In the valley of the Monongahela and in other large stream valleys, high terraces of sedimentary materials are found. These were laid down in the valleys when the lower course of the Monongahela was blocked by ice during the ice age.

From the records of the Weather Bureau Station at Fairmont, giving the mean monthly and annual precipitation for the period 1892-1930 inclusive, the mean annual temperature is 53 degrees F., the seasonal mean being 32 degrees F. The average date of the last killing frost of the spring is in the latter part of April and that of the first, in the first week of October. The growing season is about five and one half months. The mean annual rainfall is 42.63 inches. The precipitation varies much from year to year.

The soils found in the county fall into two main groups — residual soils of the upland and transported soils of the stream bottoms and terraces. Exclusive of areas of rough, stony land, ten distinct types of soil have been mapped: Meigs Clay, Dekalb Silty Clay, Dekalb Stony Loam, Tyler Silt Loam, Huntington Silt Loam, Westmoreland Silty Clay, Elk Silt Loam, Holston Silt Loam, Dekalb Silt Loam, Moshannon Silt Loam, and including rough stony land.

Typical floodplain vegetation is well developed only along the larger water courses, especially the Monongahela River and some of its larger tributaries. In the more quiet waters of these streams, the water-willow *(Dianthera americana)* grows in luxuriant beds. If the stream is shallow and is slow-moving, the broad-leaf arrowhead *(Sagittaria latifolia)* will usually be found next as one moves shoreward. Along the margins of these larger streams, immediately at the water's edge,

a well-marked streamside association is frequently found. In this association occur shrubby willows *(Salix interior)*, several characteristic herbs, as jewel-weed *(Impatiens biflora* and *I. pallida)*, bonesets *(Eupatorium spp.)*, and swamp milkweed *(Asclepias incarnata)*. Adjacent to the shrubby willows are tree willows *(Salix alba, S. nigra,* and *S. amygdaloides)*. Next in order on the floodplain appears a mixture of such typical floodplain species as sycamore, linden, ironwood, blue-beech, red maple, sugar maple, tulip, black cherry, beech, box-elder, walnut, and black locust. The trees all vary in their proximity to water.

The characteristic shrubs of the floodplain forests here are elderberry, bladdernut, and sometimes black raspberry. Many species of herbs are to be found in this type of forest; these are divisible into two groups: those that grow and flower in the spring before much shade is produced, and those that flower in summer and autumn — a large number of shade-enduring species. Spring herbs are as follows:

Mertensia virginica
Arisaema triphyllum
Arisaema dracontium
Anemone quinquefolia
Anemonella thalictroides
Ranunculus hispidus
Ranunculus abortivus
Erigenia bulbosa
Trillium sessile
Trillium grandiflorum
Erythronium americanum
Erythronium albidum
Jeffersonia diphylla
Viola eriocarpa
Viola rostrata
Viola pubescens
Viola striata
Cardamine bulbosa
Cardamine douglasi
Claytonia virginica
Bicucula cucullaria
Bicucula canadensis
Filis fragilis
Sanguinaria canadensis
Hepatica triloba
Hepatica acutiloba

A smaller group is to be found in summer and fall, this probably being due to the intense shade produced during these seasons.

Hystrix hystrix
Asclepias incarnata
Tovara virginiana
Monarda fistulosa
Thalictrum polygamum
Osmunda cinnamomea
Elymus canadensis
Elymus virginicus
Galium cercaezans
Galium aparine
Aster sagittifolius
Aster puniceus
Aster ericoides
Solidago canadensis
Solidago serotina
Lobelia cardinalis
Lobelia syphilitica
Eupatorium perfoliatum
Eupatorium purpureum
Helianthus decapetalus

Certain vines, such as poison-ivy *(Rhus toxico-dendron)*, wild grape *(Vitis spp.)*, clematis *(Atragene)*, passionflower *(Passiflora lutea)*, and bittersweet *(celastrus scandens)*, are characteristic species and are always present in large numbers.

Quite often willows will be lacking altogether along a stream, their place being taken by smooth alder *(Alnus rugosa)*, cottonwood *(Populus deltoides)*, or, in some cases, by balm-of-gilead *(Populus candicans)*. The latter species is rare in this portion of West Virginia, however, and was seen along streams only twice.

After floodplain forests have been cut, either because of the landowners' desire to increase the acreage for cultivation or grazing, or to secure timber and firewood, the vegetation will go through a number of stages, and will again revert back to a forest similar in composition to the original one. First there will be a series of herb stages, then thickets, and eventually climax forests. The streamside associa-

tion comes back first; the willows sprout, and due to the great amount of light present, a large number of composites, consisting of goldenrods, asters, fleabane, bouncing-bet, oxe-eye daisy, along with sunflowers, iron-weed, burdock, Canada thistle, virginia thistle, mullein, and bluegrass will be dominant. If not disturbed by too much grazing or by cultivation, such shrubs and trees as hawthorn, sassafras, spicebush, black-haw, elderberry, and pawpaw will appear. Next to appear, in order, are sycamore, red maple, tulip, black locust, box-elder, linden, ironwood, and sugar maple.

Reversion to climax floodplain forest takes place rapidly due to soil moisture and probably also to the high humidity of the atmosphere.

The climax forest on the floodplains of this region is mixed, consisting of red, white, and chestnut-oak, beech, red and sugar maple, black walnut, sycamore, linden, tulip, chestnut, box-elder, black locust, ironwood, blue-beech, magnolia, and others, none of which is dominant of the aspect. Most of the floodplains observed varied in composition. Black maple was prominent in some instances but not to the extent of dominance. Birch is not found along the larger streams, but is confined to rocky ravines and gorges.

Some of the most interesting plants of this region are to be found in rocky crevices and on out-croppings of the bedrock, at Valley Falls and along the rivers. The plants in different localities differ so much in their occurrence and numbers that a definite association for such habitats does not exist. Therefore, it seems better to consider these plants, especially those that are pioneers on rock, as individuals rather than collectively.

A large proportion of the plants existing on rock or in rocky crevices come from neighboring associations, and are merely chance seedlings which are able to withstand the occasional droughts. Some of the rock plants, however, are very characteristic of this type of situation, and are found nowhere else.

At Valley Falls the river has cut downward through the massive sandstone bedrock and in so doing has produced numerous pockets and crevices in which many rare and interesting plants are to be found. The rocks are exposed to full sunlight all day long and to the spray of the falls nearby. Most of the rock species are shrubs, which are able to exist in the moist crevices with very little soil around their roots. There is practically no competition between plants here, since only scattered individuals occur. One large blueberry bush was adjoined on each side by seedlings ranging in height from two to eight inches, growing in the same crevice.

Close to the water's edge the following species are characteristic of the rocky wall:

Spiraea tomentosa
Kalmia latifolia
Amelanchier canadensis
Gaylussacia baccata
Rhus toxicodendron
Ptelea trifoliata
Azalea nudiflora
Smilax glauca
Vaccinium pennsylvanicum

In crevices on the flatter portions of the bedrock these species were found:

Chrysopogon nutans
Andropogon virginicus
Andropogon scoparius
Juncus marginatus?
Eupatorium purpureum
Eupatorium sessilifolium
Viburnum dentatum
Hypericum prolificum
Cornus paniculata
Lysimachia quadrifolia
Panicum spp.

In small pockets containing water or moist soil the following were found:

Juncus marginatus
Juncus effusus
Juncus tenuis
Thalictrum polygamum
Coreopsis tripteris
Lobelia syphilitica
Salix discolor
Salix longifolia
Cephalanthus occidentalis
Alnus rugosa

After a scanty residual soil has accumulated other herbs, shrubs, and trees rapidly come in. Characteristic of the herbs are nettle, stoneroot *(Collinsonia virginiana)*, *Oxalis* spp., and boneset. These are succeeded by Virginia creeper, poison ivy, hoptree, wild grape, alder, raspberry and blackberry, and box elder, which in turn are succeeded by red maple, sycamore, black willow, black cherry, and black locust. Farther back beech, Linden, various oaks, sugar maple, etc., make up the Mixed Mesophytic climax.

Hemlock does not occur along the rivers but is to be found on north-facing bluffs near Bacter, and in certain rocky ravines, such as at Rock Lake forge, along Glady Creek, and along Piney Run in the Winfield District. The species is decidedly not common in the county.

SOCIETIES IN ROCKY RAVINES AND GORGES. ROCK LAKE

A departure from the severe conditions of the Valley Falls region may be found in the deep gorges and ravines at Rock Lake and at Hammond. Here, because of the constant moisture supply, the rocks are covered with mosses and lichens, in which are growing small seedlings of mountain laurel and rhododendron, common polypody fern, and partridgeberry. Overhanging these are large masses of *Rhododendron maximum, Hydrangea arborescens,* and *Kalmia latifolia.* At the very edge of the water, characteristic species are:

Alnus rugosa
Hamamelis virginiana
Aruncus aruncus
Tsuga canadensis
Aster schreberi
Sambucus racemosus
Betula lutea

Farther back from the streamside, on the moist lower slopes, a mixture of trees is to be found, consisting chiefly of beech, tulip, cucumber, sourwood, linden, hemlock, umbrella magnolia *(Magnolia tripetala)*, hop-hornbeam, and red maple. Characteristic of the herbs of this moist forest are:

Clintonia umbellulata
Orchis spectabilis
Viola pallens
Viola rostrata
Viola blanda
Viola papilionacea
Actaea alba
Tiarella cordifolia
Arisaema triphyllum
Polystichum acrostichoides
Cypripedium acaule
Medeola virginica
Aspidium noveboracense
Botrychium dissectum
Aspidium spinulosum
Cimicifuga racemosa
Mitella diphylla
Aralia racemosa
Aralia nudicaulis

Such shrubs as flowering dogwood and maple-leaved viburnum occur in abundance.

Higher up on the slopes, in a much drier situation, the forest is of the typical mesophytic type. At Rock Lake as well as at Hammond there is a tendency for beech-hemlock-tulip to occupy the gorges, with rhododendron and mountain laurel the dominant shrubs.

Still another group of rock-dwelling plants are found on steep cliffs and bluffs. The situation used for a typical description of this type of vegetation occurs along the highway at the village of Baxter. The walls of this sandstone-shale bluff are somewhat vertical to a height of about twelve feet, where a more sloping topography begins. At the base of the bluff the vegetation is very similar to that of other roadsides in the county — mostly common barnyard weeds. In the crevices of the sandstone are alum root *(Heuchera americana)*, sedum *(Sedum ternatum)*, juneberry *(Amelanchier canadensis)*, redbud, hydrangea, several stunted sycamores, and abundant black locust saplings. The black locust frequently forms pure stands on these steep bluffs, particularly on shale outcrops. Some sassafras and much smooth sumac were also present of this bluff. Bindweed *(Convolvulus spithamaeus)*, wild grape, dewberry *(Rubus procumbens)*, and smilax *(Smilax glauca)* also occurred here in varying amounts.

Other bluffs observed in the county were very similar to the above.

The vegetation of Marion county as a whole is Mixed Mesophytic in character. In the Mixed Mesophytic Association instead of two or three dominant forest trees there are a number of species to be found, none of which could be described as dominant, although a few species are frequently more numerous than others.

On observing the vegetation one is constantly confronted by a general mixture of tree species. The forested areas are covered with chestnut, chestnut-oak, tulip, red maple, white oak, beech, and black locust. These species are the most characteristic, but other common species occur in varying quantities: cucumber, white ash, pignut, black walnut, butternut, sycamore, dogwood, black cherry, choke cherry, shagbark, basswood, black birch, mockernut, red mulberry, red oak, sourwood, sourgum, hemlock, black maple, and sugar maple.

This community is similar to the one described by Sampson *(16)* in northeastern Ohio. Besides the trees mentioned by Sampson, the black locust is also present in profusion.

Probably the best example of practically untouched climax mesophytic forest community was observed on a west-facing slope near Granttown. Along the roadside, where more light was present, were the following shrubs and herbs:

Cercis canadensis
Azalea lutea
Azalea nudiflora
Vaccinium pennsylvanicum
Hydrangea arborescens
Hamamelis virginiana
Mitchella repens
Nabalus albus
Viburnum acerifolium
Geranium maculatum
Amphicarpa monoica
Gaylussacia baccata
Polycodium stamineum
Vaccinium vacillans
Kalmia latifolia
Smilax hispida
Smilax glauca
Smilax herbacea
Panicum clandestinum
Panicum dichotomiflorum
Amelanchier canadensis

The most abundant shrubs and vines in this typical forest were *Azalea* spp. *Viburnum prunifolium*, and *Smilax herbacea*. Along the roadsides azalea, blueberries, and the hispid greenbrier were more abundant.

In the forest proper occurred the following species:

Quercus rubra
Quercus alba
Kalmia latifolia
Magnolia acuminata

Castanea dentata
Fagus grandifolia
Acer rubrum
Sassafras sassafras
Nyssa sylvatica
Liriodendron tulipifera
Fraxinus americana
Juglans nigra
Carya ovata
Carya alba
Carya cordiformis
Viburnum acerfolium
Oxydendrum arboreum
Viburnum prunifolium
Smilax herbacea
Vitis cordifolia
Psedera quinquefolia
Mitchella repens
Polygonatum biflorum
Smilacina racemosa
Aspidium noveboracense
Trillium erectum
Polystichum acrostichoides
Galium spp.

In this forest, beech made up about 30% of the total trees present. The remainder consisted of white oak, red oak, and chestnut. No large trees of shagbark, cucumber, or black walnut were present, but a number of 3 to 5 year seedlings were seen. The giant trees of this forest were spaced widely, and in these openings such shrubs as Azelea, *Viburnum acerifolium,* and sassafras thrived. A large number of seedling beeches, red oaks, red maples, and tulip were interspersed with the shrubs. Herbs were widely scattered, only *Mitchella repens* being really abundant. The dominant shrub is *Viburnum acerifolium*, the most abundant lianas, *Smilax herbacea* and *Vitis cordifolia*.

As one climbs up to the higher slopes the composition changes somewhat, and more white oak, hickory, cherry, sassafras, white ash, and scarlet oak are found. Large red maples occur here and uncommonly large sassafras.

At elevations of 800-900 feet the Mixed Mesophytic forest frequently covers the ridges. In these forests white oak, scarlet oak, and hickory are present, along with red maple and some beech. However, there is not enough hickory and oak present to warrant this being called an oak-hickory association.

The largest and tallest trees are white oak, making up approximately 18% of all the trees. The most common species is beech, which constitutes about 30%; the remaining 52% consisting chiefly of white and red oak, tulip, red maple, linden, shagbark, mockernut, searwood, black maple, sugar maple, black locust, cucumber, pignut hickory, choke cherry, black walnut, butternut, sycamore, dogwood, black cherry, red mulberry, and hemlock.

After a Mixed Mesophytic forest on the slopes is cut, the secondary ensuing successions are very similar to those occurring in old fields which have been abandoned after cultivation. The first stages contain chiefly herbs — *Desmodium* spp. and *Andropogon scoparius*, with some vines, and such shrubs as blueberry and huckleberry. The glaucus greenbrier *(milax glauca)* forms dense tangles, which are frequently impenetrable. Usually a few of the original trees are left standing, and as conditions of moisture and shade are developed, seedlings from these trees spring up everywhere, gradually forming a thicket in which sassafras, hawthorn, raspberry, blackberry, poison-ivy, smooth, and staghorn sumac, grape, and dewberry predominate.

These pioneer shrubs soon are followed by black locust, black cherry, sour gum, butternut, black maple, white ash, red maple, shagbark, butternut, and mockernut, and chestnut oak. Eventually beech and sugar maple come into the forest, completing the mixed mesophytic community. Apparently forests which were formerly of the Mixed Mesophytic type will always go back to this kind of forest after cutting or burning. No exceptions to this rule were discovered.

A large acreage in Marion county is now apparently worthless for agricultural purposes, due to erosion and leaching out of the scanty soil. In these worn-out fields, mostly occupying the slopes, a somewhat definite secondary association has developed. On the bare and well-lighted areas in the old field association the fruticose lichen *Cladonia cristatella* as well as many crustose lichens form a thick mat. Among the lichen patches is a variety of perennial herbs, some of which are characteristic of dry prairies:

Andropogon scoparius
Danthonia spicata
Lysimachia quadrifolia
Lithospermum canescens
Oenothera biannis
Ascyrum hypericoides
Cirsium lanceolatum
Rudbeckia hirta
Chrysanthemum leucanthemum
Potentilla canadensis
Aster spp.
Solidago nemoralis
Solidago canadensis
Hypericum punctatum
Hypericum prolificum
Daucus carota
Euphorbia carollata
Asclepias tuberosa
Lespedeza frutescens
Pycnanthemum flexuosa

The dominant plants in this associes are *Danthonia spicata* and *Andropogon scoparius. Chrysopogon nutans* was found in an old field on occasion, but in all these fields the most abundant grass was *A. scoparius.*

During the later stages of this lichen-herb association, shrubs such as *Vaccinium* spp., *Rhus glabra,* etc. come in an abundance. Associated with these pioneer shrubs are:

Rhus toxicodendron
Prunus americana
Smilax glauca
Smilax hispida
Rosa virginiana
Rubus procumbens
Rubus allegheniensis

This group in turn is followed by secondary forest trees, among which the first comers seem to be, in the order of their abundance:

Sassafras sassafras
Prunus americana
Quercus marilandica
Crataegus punctata
Crataegus macrosperma

A dense thicket is then formed which is made up of numerous sassafras of all sizes, a few hawthorns, black locust, wild plum, and perhaps red maple and white or red oak or both. The undergrowth at this stage is still composed chiefly of the two grasses already mentioned, with *Pycnanthemum flexuosa, Euphorbia corollata,* and goldenrods *(Solidago* spp.).

This condition is followed by the typical Mixed Mesophytic forest community. In addition to the above-mentioned trees others such as shagbark, mockernut, tulip, flowering dogwood, and sorrel-tree will almost always be present, depending on the altitude of the slope and the direction in which it faces. Various differences in the successions in old fields are noticeable as the conditions of moisture, wind direction, and elevation vary. In the old fields, as elsewhere in the county, the Mixed Mesophytic community is the climax.

In the valleys the old-field communities are developed in much the same manner as on the slopes, except for the presence of certain herbs which seem to require more

moisture. As on the slopes, *Andropogon scoparius* and *A. virginicus*, along with goldenrods and asters, are dominant, but in addition there are such interesting species as meadowbeauty *(Rhexia virginica)*, purple milkwort *(Polygala viridescens)*, and shrubby St. Johnswort *(Hypericum prolificum)*. Bergamot *(Monardo fistulosa)*, and Indian-grass (*Chrysopogon nutans*) are also present in this type of habitat.

Blueberries *(Vaccinium* spp.) and greenbrier *(Smilax glauca)* were abundant here, and where moist spots occurred in these valley fields, dense thickets of smooth alder were to be found. The climax forest here is eventually of the Mixed Mesophytic type, as found on the slopes, except for the addition of such tree species as box-elder, sycamore, and linden.

Other variations in the old-field communities occur on the higher slopes and on the hilltops at high elevations. On the higher, drier slopes there is a succession from Andropogon-Composite Association through hawthorn and sassafras to climax forest of oak-hickory-chestnut. At elevations of 1500-1800 feet, chestnut-chestnut oak will frequently be the ultimate stage in succession.

In Marion county the chestnut-chestnut oak association is to be found only on the hilltops at elevations of from 1600 to 1800 feet. In the field it was exceedingly difficult to find forests that had not been modified by cutting.

These forests are dominated by chestnut and rock chestnut-oak *(Quercus prinus)*. At present practically all the chestnuts are dead, due to the ravages of the chestnut-blight fungus *(Endothia parasitica)*.

Associated with chestnut and chestnut-oak such species as white, red, and black oak, shagbark, mockernut, and some butternut hickory are to be found. Chestnut-chestnut Oak forests are of the dry type, being extremely well-drained, situated as they are, only on hilltops and on the tops of sandstone ridges.

Characteristic understory vegetation consists of *Viburnum scabrellum, Azalea nudiflora*, great mats of mosses, chiefly *Polytrichum juniperinum and Dicranum scoparium*, lichens *(Cladonia* spp.), shrubs such as *Vaccinium* spp., *Kalmia latifolia*, and *Polycodium stamineum*. Herbs are few in number:

Hieracium venosum
Hieracium gronovii
Asplenium platyneuron
Isotria verticillata
Mitchella repens
Andropogon scoparius

Plants such as bluestem, blueberry, deerberry, mosses, and lichens mentioned above occur mostly in dry, open situations, exposed to much sunlight.

Chestnut-chestnut oak forests after being cut over return to the original condition again, due to the habitat conditions. Since most of the hilltops are not suited for grazing or for agricultural purposes, the forests originally there are either left without disturbing, or are only thinned out for lumber or firewood.

On the higher slopes and on hilltops at lower elevations (1000-1500 feet), a forest made up of chestnut, shagbark, bitternut, and mockernut hickories and red, white, scarlet, chestnut, and black oak will be found. This forest type is very similar to the chestnut-chestnut oak forest previously described except for the preponderance of the various species of hickories.

The undercover is much the same as that in the chestnut-chestnut oak forest, consisting of the following:

Sassafras sassafras
Crataegus spp.
Amelanchier canadensis
Vaccinium vacillans
Vaccinium pennsylvanicum
Azalea lutea
Azalea nudiflora
Polycodium stamineum
Prunus virginiana
Cornus florida
Polystichum acrostichoides
Hieracium venosum
Asplenium platyneuron
Smilax hispida
Smilax glauca

The open spots, especially where bedrock is exposed, are covered with mats of mosses and lichens, together with tufts of *Andropogon scoparius, Euphorbia corollata, Baptisia tinctoria,* bushclovers *(Desmodium* spp.), and *Commandra umbellata. Anychia canadensis* and *Ascyrum hypericoides* are very abundant on the scanty sandy soil. Goldenrods *(Solidago nemoralis)* and asters *(Aster* spp.) give the rocks a mantle of color in autumn.

As this type of forest is cut over, sassafras, cherry, hawthorn, and greenbrier come in, but these are later replaced by oaks and hickories. Since the chestnut is about to disappear, these forests will be of the oak-hickory type eventually.

At one place in the eastern section of the county, near Smithtown, a relatively high ridge (elevation 1400 feet) is occupied by a stand of white pine and white oak, with some chestnut-oak and chestnut. This is the only native white pine still standing in the county as far as can be ascertained. However, there are several plantings of white pine, loblolly, and scotch pine near Fairmont. These trees are making excellent growth, and in the past few years have grown to a height of nearly twelve feet or more. Undoubtedly the original forests of the county contained more pine than at present, especially on the ridges. Although many people were questioned concerning the whereabouts of native pine, this was the only original stand that could be discovered. A number of natives referred to the hemlock as "pine".

Characteristic plants of the pine forest are *Chimaphila maculata* and *Cypripedium acaule. Mitchella repens* is common, as well as *Hieracium venosum, Smilax hispida,* and *Smilax glauca.*

Eventually this pine forest will be replaced by a forest dominated by oaks and, possibly, hickories.

The following catalog of plants of Marion county is a brief list of the plants identified and located. Taken from catalog of plants, which lists location found and gives corresponding reference to the Herbarium of author. The original catalog is filed in the Botany library at Ohio State University.

A CATALOG OF THE VASCULAR PLANTS OF MARION COUNTY, WEST VIRGINIA

OPHIOGLOSSACEÆ—Botrychium *(3)*
OSMUNDACEÆ—Osmunda *(3)*
POLYPODIACEÆ—Polypodium, Phegopteris, Adiantum, Pteris, Asplenium *(7)*, Camptosorus, Polystichum *(2)*, Aspidium *(4)*, Cystopteris *(2)*, Woodsia, Dicksonia, Onoclea
EQUISETACEÆ—Equisetum *(2)*
LYCOPODIACEÆ—Lycopodium *(3)*

PINACEÆ—Tsuga, Pinus, Juniperus
TAXACEÆ—Taxus
TYPHACEÆ—Typha
SPARGANIACEÆ—Sparganium
ALISMACEÆ—Sagittaria, Alisma
GRAMINEÆ—Andropogon *(3)*, Sorghastrum, Paspalum *(2)*, Panicum *(12)*, Echinochloa *(2)*, Chætochloa *(2)*, Sphenopholis *(2)*, Brachyeletrum, Phleum, Arrhenatherum, Agrostis *(2)*, Avena *(2)*, Dactyloctenium, Danthonia *(2)*, Digitaria, Eleusine, Tridens, Eragrostis *(5)*, Phalaris, Dactylis, Aristida, Poa *(5)*, Anthoxanthum, Glyceria, Festuca *(3)*, Sporobolus, Holcus, Bromus *(7)*, Lolium, Agropyron, Hordeum *(2)*, Elymus *(2)*, Hystrix, Muhlenbergia *(2)*
CYPERACEÆ—Carex *(11)*, Cyperus *(3)*, Kyllinga, Elocharis *(5)*, Fimbristylis, Soirpus *(4)*, Rynchospora
ARACEÆ—Arisæma *(2)*, Peltandra, Symplocarpus, Acorus
LEMNACEÆ—Lemna *(2)*, Spirodela
PONTEDERIACEÆ—Pontederia
JUNCACEÆ—Juncus *(4)*, Luzula
LILIACEÆ—Clintonia, Smilacina, Maianthemum, Polygonatum *(2)*, Medeola, Allium *(4)*, Hemerocallis, Lilium, Erythronium *(2)*, Camassia, Ornithogalum, Yucca, Asparagus, Oakesia, Uvularia *(2)*, Trillium *(4)*, Smilax *(4)*
DIOSCOREACEÆ—Dioscorea
AMARYLLIDACEÆ—Hypoxis
IRIDACEÆ—Iris *(2)*, Sisyrinchium
ORCHIDACEÆ—Cypripedium *(3)*, Orchis, Ibidium, Epipactis, Liparis
SALICACEÆ—Salix *(8)*, Populus *(4)*
JUGLANDACEÆ—Juglans *(2)*, Carya *(4)*
BETULACEÆ—Corylus, Ostrya, Carpinus, Betula *(2)*
FAGACEÆ—Fagus, Castanea, Quercus *(7)*
URTICACEÆ—Ulmus *(2)*, Celtis, Cannabis, Humulus, Maclura, Morus *(2)*, Urtica *(2)*, Laportia, Bœhmeria
SANTALACEÆ—Comandra
ARISTOLOCHIACEÆ—Asarum *(2)*, Aristolochia *(2)*
POLYGONACEÆ—Rumex *(4)*, Polygonum *(12)*, Fagopyrum
CHENOPODIACEÆ—Chenopodium *(3)*, Atriolex
AMARANTHACEÆ—Amaranthus *(3)*
PHYTOLACCEÆ—Phytolacca
ILLECEBRACEÆ—Anychia, Mollugo
CAROPHYLLACEÆ—Stellaria, Cerestium *(2)*, Agrostemma, Lychnis, Silene *(4)*, Dianthus, Saponaria
PORTULACCACEÆ—Claytonia, Portulaca
RANUNCULACEÆ—Ranunculus *(4)*, Thalictrum *(3)*, Anemonella, Hepatica *(2)*, Anemone *(3)*, Clematis *(2)*, Aquilegia, Delphinium, Cimicifuga, Actæa
MAGNOLIACEÆ—Magnolia *(2)*, Leriodendron
ANNONACEÆ—Asimina
MENISPERMACEÆ—Menispermum
BERBERIDACEÆ—Podophyllum, Jeffersonia, Caulophyllum, Berberis
LAURACEÆ—Sassafras, Benzoin
PAPAVERACEÆ—Sanguinaria, Stylophorum
FUMARIACEÆ—Dicentra *(2)*, Corydalis
CRUCIFERÆ—Thlaspi, Lepidium *(2)*, Capsella, Brassica *(2)*, Sisymbrium, Radicula, Barbarea *(2)*, Iodanthus, Dentaria, Cardamine *(2)*, Arabis *(3)*
CRASSULACEÆ—Penthorum, Sedum
SAXIFRAGACEÆ—Saxifrago, Tearella, Heuchera, Mitella, Hydrangea, Ribes
HAMAMELIDACEÆ—Hamamelis
PLATANACEÆ—Platanus
ROSACEÆ—Physocarpus, Spiræa, Aruncus, Pyrus *(2)*, Fragarica *(2)*, Waldsteinia, Potentilla *(3)*, Geum *(2)*, Rubus *(5)*, Agrimonia *(2)*, Rosa *(2)*, Prunus *(3)*

LEGUMINOSEÆ—Cassia *(2)*, Cercis, Baptisia, Trifolium *(5)*, Melilotus *(2)*, Medicago, Robinia, Desmodium *(5)*, Lespedeza *(4)*, Vicia *(2)*, Apios, Amphicara, Astragalus
LINACEÆ—Linum
OXALIDACEÆ—Oxalis *(5)*
GERANIACEÆ—Geranium
RUTACEÆ—Xanthoxylum, Ptelea
SIMARUBACEÆ—Ailanthus
EUPHORBIACEÆ—Acalypha, Euphorbia *(4)*
ANACARDIACEÆ—Rhus *(4)*
AQUILIFOLIACEÆ—Ilex, Nemopanthus
CELASTRACEÆ—Euonymus *(3)*, Celastrus
STRAPHYLEACEÆ—Staphylea
ACERACEÆ—Acer *(7)*
SAPINDACEÆ—Aesculus *(2)*
BALSAMINACEÆ—Impatiens *(2)*
RHAMNACEÆ—Ceanothus
VITACEÆ—Psedera, Vitis *(2)*
MALVACEÆ—Abutilon, Malva, Sida, Hibiscus
HYPERICACEÆ—Ascyrum, Hypericum *(6)*
VIOLACEÆ—Viola *(11)*, Hybanthus
PASSIFLORACEÆ—Passiflora
MELASTOMACEÆ—Rhexia
ONAGRACEÆ—Oenothera, Keiffia, Gaura, Circæa
ARALIACEÆ—Aralia *(3)*, Panax
UMBELLIFERÆ—Sanicula *(4)*, Erigenia, Chærophyllum, Osmorhiza *(2)*, Conium, Aegopodium, Cicuta, Sium, Crypototænia, Zizia, Fœniculum, Tænidia, Thaspium, Pastinaca, Angelica, Daucus
CORNACEÆ—Cornus *(5)*, Nyssa
ERICACEÆ—Chimaphila, Monotropa, Rhododendron, Azalea *(3)*, Kalmia *(2)*, Oxydendrum, Epigæa, Gaultheria, Gaylussacia, Vaccinium *(3)*
LYTHRACEÆ—Cuphea
PRIMULACEÆ—Lysimachia *(2)*, Steironema *(2)*
EBENACEÆ—Fraxinus *(3)*
APOCYNACEÆ—Apocynum *(2)*
ASCLEPIADACEÆ—Asclepias *(3)*, Gonoblus
CONVOLVULACEÆ—Ipomea *(2)*, Convolvulus *(3)*, Cuscuta *(2)*
POLEMONIACEÆ—Phlox *(5)*, Polemonium
HYDROPHYLLACEÆ—Hydrophyllum *(3)*, Phacelia
BORAGINACEÆ—Lappula, Cynoglossum, Lithospermum *(2)*, Echium, Mertensia
VERBENACEÆ—Verbena *(2)*, Lippia
LABIATÆ—Teucrium, Scutelleria, Marrubium, Mentha *(3)*, Lycopus, Collinsonia, Pycnanthemum, Agastache, Nepeta, Glecoma, Physostegia, Stachys, Leonurus, Lamium, Prunella, Monarda *(2)*, Bleiphilla
SOLANACEÆ—Solanum *(2)*, Physalis, Lycium, Datura
SCROPHULARIACEÆ—Verbsacum *(2)*, Linaria, Scrophularia, Pentstemon *(2)*, Chelone, Mimulus, Gratiola, Veronica *(3)*, Pedicularis
OROBANCHACEÆ—Epifagus, Conopholis
BIGNONIACEÆ—Tecoma, Catalpa
AGANTHACEÆ—Dianthera, Ruellia *(2)*
PHRYMACEÆ—Phryma
PLANTAGINACEÆ—Plantago *(5)*
RUBIOCEÆ—Galium *(5)*, Mitchella, Cepholanthus, Houstonia *(2)*
CAPRIFOLIACEÆ—Diervilla, Triosteum, Viburnum *(5)*, Sambucus *(2)*
VALERIANACEÆ—Valerianella
DIPSACEÆ—Dipsacus
CUCURBITACEÆ—Sicyos
CAMPANULACEÆ—Specularia, Campanula

LOBELIACEÆ—Lobelia
COMPOSITÆ—Vernonia, Eupatorium *(5)*, Solidago *(6)*, Bellis, Aster *(12)*, Erigeron *(3)*, Sericocarpus, Antennaria, Gnaphalium *(2)*, Inula, Silphium *(2)*, Ambrosia *(2)*, Xanthium, Heliopsis, Rudbeckia *(3)*, Helianthus *(4)*, Coreopsis, Bidens *(4)*, Galinsoga, Helenium, Achillea, Anthemis, Chrysanthemum, Tanacetum, Cacalia, Senecio *(2)*, Arctium, Cirsium *(4)*, Cichorcium, Leontodon, Sonchus, Lactuca *(3)*, Prenanthes *(2)*, Hieracium *(2)*

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The Chemistry Section

INTRODUCING THE STUDENT TO ORGANIC CHEMISTRY

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EVER SINCE undergraduate days the author has heard much of the dangers and pitfalls of organic chemistry. Even in graduate work — particularly while pursuing the study of physiological chemistry in Rush Medical School of the University of Chicago — this note was sounded loudly by classmates who were primarily interested in medicine. The continued expression of such an opinion has led to a careful study of the proper approach to the subject. When one presents a friend to another by formal or informal introduction, it is courteous and tactful to give the new acquaintances a point of contact. Should not this be the motive in the mind of the teacher as he makes the student acquainted with organic chemistry or any other subject? But what is this point of contact — this common ground — in the case of organic chemistry?

A very casual excursion into this fascinating realm gives immediately the impression of beauty of organization. The thousands of organic compounds fall into comparatively few classes, and in each of these we find many generalizations in methods of preparation and in physical and chemical characteristics. There are just enough exceptions to prevent monotony and to make the subject more interesting. Organic chemistry thus resembles a carefully planned city, with all the avenues going in one direction and the streets in another, with commercial and residential districts sharply defined, with all business establishments of each type in the same section, constructed of the same material, fashioned according to the same style of architecture, and with just enough dissimilarity to give beauty and charm to the entire surroundings. Is not this a fact that should be emphasized throughout the introductory course in organic chemistry?

Being convinced of the wisdom of such a procedure, the author has followed this plan for some time. As a result of twelve years of teaching elementary organic chemistry, he has worked out an architectural design which he believes to be of value to the student and the instructor. In the same spirit in which results of laboratory research are reported, the experiences and products of teaching itself may be given. The design referred to above is an outline of elementary organic chemistry and it has the proportions of a text-book. The finished product contains 374 mimeographed pages, constituting a very definite outline of the material covered in an average ten-semester-hour course. Generalizations are featured throughout, and much purely descriptive matter is omitted. The classification, nomenclature, general methods of preparation, general physical properties, and general chemical properties of each group of compounds are given, and reactions are illustrated by general equations. Following each general discussion, a few typical members of the class are briefly considered, exceptional properties are noted, and the student is given the opportunity of seeing that in many respects the compound follows the general requirements of the class. Problems are introduced at critical points, and the student is encouraged to apply rules of general behavior to specific compounds. Whenever feastible, types of compounds are discussed in tabular form by comparison and contrast. This is true of such classes as paraffin, olefine, and acetylene hydrocarbons; aldehydes and ketones; primary, secondary, and tertiary aliphatic

amines; primary, secondary, and tertiary aromatic amines; aromatic compounds with halogen attached to carbon of the benzene ring, and aromatic halogen compounds with halogen attached to carbon of the side chain, etc. There is given, also, a concise summary of the common substitution reactions involving elements or radicals attached to carbon of the benzene ring. Twenty-one types of substitution are listed in the summary, as, hydrogen by halogen, halogen by hydrogen, hydrogen by hydrocarbon radical, hydrocarbon radical by hydrogen, etc., and in each instance the proper cross reference is made so that the student can swiftly and easily locate a more complete discussion of the particular reaction. Furthermore, the outline contains a brief statement of the theories generally discussed in an elementary course, namely, electronic concept of valence in organic chemistry, partial valence, stereoisomerism, and color production. Specific compounds of wide interest in the fields of medicine, chemical warfare, etc., are listed and briefly discussed. In short, the book endeavors to meet the need of the student by giving in very concise form and logical style a definite outline of the general principles of organic chemistry, by emphasizing the marvelous organization shown in this realm of natural science, and by suggesting an easy way of applying the few generalizations to hosts of specific instances.

The use of such an outline may be criticized because of the supposed monotony of series of facts presented in a coldly logical manner. On the contrary, it has been the experience of the author that many students and some instructors lack the power of organizing material around a few major issues so that the facts can be presented effectively and mastered easily. One cannot reason in any field until he has definite information, and it is certainly infinitely easier to acquire the necessary data if they are presented in outline form. Such a treatment of organic chemistry should be supplemented by parallel reading from several sources so that the student may get many points of view. When this method is followed, the instructor can take the outline as a guide and, by proper enthusiasm in his lectures, make the material vibrant with life and charm, and the student will catch more fully the spirit of the subject since he does not have to bother about the mechanics of taking voluminous class notes.

Will the method work? This is the sure test of any procedure. From his experience the author has discovered that the plan produces excellent results. Far more material has been covered in the same length of time, and the average proficiency attained by the class since adoption of the outline has been considerably higher than it had been previously.

Glenn Frank has said: "The future of America is in the hands of two men — the investigator and the interpreter. The practical value of every social invention or material discovery depends upon its being adequately interpreted to the masses." Mr. Frank names the interpreters "salesmen of knowledge". Is not this a challenge to the teacher? He it is who must continue to master the great discoveries of those who blaze the trails in the realm of research, and then he it is who must open up the highways of truth by translating these new facts into the language of the growing student. What better way can this be accomplished than by presenting the subject matter in a logical, forceful manner? Great is the responsibility of teaching! Great is the dignity of imparting instruction! Let the teachers be true salesmen of knowledge, stimulating and inspiring the student to master truth and to take his place in applying truth in the solution of human problems.

COAL FLOWERS*

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COAL FLOWERS have been grown by many people in West Virginia. For this purpose pieces of coal have been grouped in a dish and treated with equal volumes of solid table salt, water, liquid bluing, and household ammonia. Colors have been obtained by the further addition of mercurichrome or other colored solutions.

As early as 1705 the French chemist, Nicholas Lemery, told the French Academy how to make somewhat similar "vegetations" by the spontaneous evaporation of salts of iron. However, no one seems to have offered an explanation for their growth. In the colloid chemistry laboratory at West Virginia University we have discovered how and why such growth takes place. The technique has been so simplified and improved that a good crop of "coal flowers" can unfailingly be obtained with reagents found in every chemical laboratory. Such flowers should add to the interest of any chemistry exhibit and their growth prove a welcome supplement to the activities of high-school science clubs.

Photographs, photomicrographs, and selected portions of motion pictures of these growths are shown elsewhere,[1] and a detailed study has been made of the physical chemistry underlying the phenomenon. At this time we need only give the principal conclusions.

Laboratory Directions for Growing Salt Flowers—Use a low, wide dish such as a 6-inch (diameter) x 3-inch crystallizing dish. In its center place pieces of coal, red brick, cinder, unglazed porcelain, soft rough wood, or even broken glass. This solid material will serve as a support for the salt flowers. Fill the dish about one-third full of a saturated solution of ordinary technical sodium chloride. During the next two or more weeks, occasionally (every three or four days) add more saturated solution up to the original level. Finally, allow it to completely evaporate and from then on use a saturated sodium chloride solution which is also saturated with potassium ferrocyanide (less than 2%).

Blossoming will follow the inauguration of the potassium ferrocyanide treatment. Growth will continue for many days and may be readily observed even with the unaided eye.

In this laboratory a sample of satisfactory commercial liquid bluing was found to be essentially ferric ferrocyanide (commonly known as Prussian blue). Treated with ammonium hydroxide it gave a precipitate of ferric hydroxide and a solution of ammonium ferrocyanide according to the equation

$$Fe_4(Fe(CN)_6)_3 + 12NH_4OH = 4Fe(OH)_3 + 3(NH_4)_4Fe(CN)_6$$

Blue and green shades of color result when the blossoming mixture contains some acid such as sulphuric, citric, or tartaric. Colors may also be made by adding dyes or inks. After good blossoms have formed and evaporation is complete, a blue or green color may be obtained by treating the saturated sodium chloride with suf-

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*Contribution No. 105 of the department of industrial sciences of West Virginia University.

[1]Journal of Chemical Education, July 1934. Twenty slides were shown at the New River State College meeting of the West Virginia Academy of Science.

ficient ferric chloride to react with the potassium ferrocyanide, distributed among the blossoms, giving Prussian blue. A similar treatment with ferric sulphate gives yellow blossoms over a background of green and blue.

Observe with low-power microscope the evaporation on a glass slide of droplets of solutions of NaCl, of $K_4Fe(CN)_6$, and of a mixture of these.[2]

Explanation of the Growth of Salt Flowers—Creeping of a saturated solution is common, and results from adsorption of the solution by the solid surface. As evaporation progresses the crust formed leaves a thin opening between it and the solid wall, thus aiding further rise due to capillarity, in much the same way as water rises in a tree.

Sodium chloride crystallizes in cubes, but in the presence of potassium ferrocyanide these are metastable, redissolve, and with the potassium ferrocyanide form an elastic skin which expands and elongates as new solution swells it. The wall of this skin ruptures, a drop of mixed solution bursts out, but at the air interface forms a new skin, thereby producing branches analogous to those of a tree. Therefore branches become smaller and smaller until so fragile that they break off. Finally, as they are isolated or when the solution is allowed completely to evaporate, the salt contained within them will at last solidify and give the blossoms their final, solid appearance. Suprisingly few combinations of solutions will give coal flowers.

SOME MODIFIED EXTRACTION APPARATUS (ABSTRACT)

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A SIMPLIFIED APPARATUS for the determination of crude fat in feed was described and illustrated with lantern slides. It consists of a large-size test tube with a smaller tube used for a condenser inserted in the top. The sample is placed between two asbestos pads in a special flared filter tube which rests on a small lipped receiving flask. This flask holds the ether and catches the fat. The advantages of this set-up over a soxhlet apparatus are economy of ether, ruggedness, ease of manipulation, and small space required for a large number of extractors.

A steam heating bath to take the place of electric hot plates for heating soxhlet extraction apparatus was described and illustrated.

A modified Bailey-Walker apparatus used for extraction of rat and chicken bones was described and illustrated. The ordinary Bailey-Walker flask is replaced by a special flask with a neck of sufficient length to take a fritted-bottom Jena crucible and glass syphon tube. The material to be extracted is placed in the crucible and the moisture, extractable material and ash are determined without transfer of the sample.

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[2]At the New River State College meeting this was demonstrated with a Bausch and Lamb Optical Company microprojector. The projection of an evaporating droplet serves as a good substitute for a motion picture.

SOURCES OF MATERIAL FOR JUNIOR ACADEMY PROGRAMS

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THE WEST VIRGINIA ACADEMY OF SCIENCE has offered to affiliate high-school science clubs as branches of a State Junior Academy. Whether the high-school science clubs avail themselves of this proposal or not, we may be called upon as individual Academy members to render assistance as speakers and advisers in connection with such work.

In response to a request of Wallace Smith, who heads a committee in charge of Junior Academy activities, I set about to prepare a bibliography of journal articles, carefully selecting only those articles which I thought would be adaptable as high-school club material. The reference list which I submit is made up from the back files of School Science and Mathematics, Science Education, the Scientific American, and the Journal of Chemical Education. The articles selected pertain more to chemistry than to other fields. The list anyhow is merely a suggestion of the possibilities of the use of periodical literature as a source of club program material. Any one interested in science will be impressed with the wealth of material available which is not too technical and which in many instances is written in an appealing, fascinating style. As we read the current issues of our journals, card references to suitable articles made out and filed away will give us an up-to-date reference list which will prove of great personal use as well as for student reference readings, essay material, high-school club material, etc. We have not attempted here to give any book references, though there is an increasing number of excellent books since the publication of Slosson's Creative Chemistry.

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The Tree Bark of a Hundred Uses. Sc. Am. Nov., 1930, p. 344.
Where not to Look for Oil and Gas.—Sc. Am., Nov. 1931, p. 321.
Chemistry in Industry—Sci. American, Feb. 1930, p. 156.
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Caricatures of Chemists.—J. C. Ed. Nov. '31, 2138.
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Francis Wm. Aston, Sep. '31, p. 1677.
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The Following are from Hygeia, pub. by Am. Med. Assoc.
Pioneers of Medicine, a series: Walter Reed Jan. '32 p. 49.
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An Assembly Program: A Pageant—Edison Our Foremost Inventor.—Sc .Ed. Vol. 14, p. 456.
Illustrating the Black Art.—Jr. Chem. Ed. August '26, p. 897.
The Fraternity Initiation—A One-Act Burlesque.—Jr. Chem. Ed. p. 2254.
A Memory Trick.—Scientific American, p. 62.
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Lecture Demonstration, Artificial Silk.—Jr. Chem. Ed. Vol. 5, p. 96.
Osmotic Pressure Experiment.—Jr. Chem. Ed. May 1928, p. 530.
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The Science Classroom—Monthly, except July and August—20c. Popular Science Publishing Co., 250 Fourth Ave., N. Y. C.

Hygeia—Monthly—$3.00, American Medical Assoc., 535 North Dearborn Street, Chicago, Ill.

Nature Magazine—Monthly—$3.00. American Nature Association, 1214 Sixteenth St.,N. W. Washington, D. C.

The American Botanist—Quarterly—$2.00, William N. Clute, Editor Butler Univ., Indianapolis, Ind.

American Forests and Forest Life—Monthly—$4.00. Am. Forest Assoc., 1523 L. St., N. W., Washington, D. C.

Bird Lore—Bi-monthly—$1.50. Official Organ, of Audubon Society, Harrisburg, Pa.

The Guide to Nature—Monthly—$1.50. Agassiz Assoc., South Bend, Conn.

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STUDIES OF MORGANTOWN WATER SUPPLIES, ESPECIALLY THEIR VARIATIONS IN MINERAL CONTENT

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IN THE FALL of 1921 the administrative officers of West Virginia University requested the writers to make a thorough investigation as to the quality and quantity of the available water supplies in Morgantown and vicinity. At that time the water in the city mains of Morgantown was pumped from the Monongahela River above U. S. Government Dam and Lock No. 10. During those years for nine or ten months of each year the water had a very disagreeable taste. People would not drink very much of such a bad-tasting water and it even had a deleterious effect on tea, coffee, and food stuffs cooked in it. Because of the large increase in the quantities of industrial wastes and of mine waters flowing into the Monongahela River, the city water had also become corrosive in its action. The galvanized-iron water pipes put in Woman's Hall, the girls' dormitory at the University, had to be replaced after only about three years of service because of the excessive rate of corrosion. The tubes in the experimental boiler in Mechanical Hall had continually to be replaced because of rusting out or pitting and finally the boiler plate itself became so badly corroded that the entire boiler was cut into pieces with an oxyacetylene torch and sold as scrap iron. Red (rusty) water often flowed from the hot-water faucets in the kitchens and bathrooms of our Morgantown homes and in our University laboratories. Under such conditions of city water supply the State Board of Control began considering the advisability of securing a separate and better water supply for the University students, buildings, and heating plant. Hence the request to make a thorough investigation of the water supplies which could be made available for University uses. About one year later the West Virginia Utilities Company, at that time owners of the Morgantown city water system, requested our assistance in their efforts to ascertain the cause of and a method for removing the bad taste in the

city water and to improve in other ways the quality of water furnished to the people of Morgantown.

A survey of possible available sources of water in or near Morgantown led to the conclusion that there were four sources, each of which might supply a sufficient quantity of water for the city's and the University's needs. These sources were The Cheat River, Tibbs Run, deep wells, and the Monongahela River. The cost of laying a pipe line some nine or ten miles to the Cheat River and pumping the water over the hills eliminated this source from serious consideration. Samples of water were obtained from each of the other sources, and series of physical and bacteriological tests and of chemical analyses were carried out. This paper deals largely with the results obtained in the chemical analyses of the waters.

The methods used in making the chemical analyses were those given in Stillman's Engineering Chemistry *(1)*, Standard Methods of Water Analysis *(2)*, and in Mason's book, Examination of Water *(3)*. A general outline of the procedure is as follows on page 120.

The data in these tables and two analyses of deep well water show clearly that the Tibbs Run water from the standpoint of its chemical content is the best of the three samples analyzed. Also while the deep well water contained more total solids than the Monongahela River water the nature of these solids was not so objectionable as those in the river water. The Monongahela River water was highest of the three in parts per million of iron, aluminum, calcium, and magnesium salts, the compounds which cause incrustations and scale in boilers and tea kettles and consume to no useful purposes large quantities of soap in household cleansing operations and laundry work. Also the river water, as previously stated during those years, often had a very disagreeable taste.

On the basis of the above findings further conferences were held with the geologists of the State Geological Survey, the owners of the three deep wells (over 600 ft. in depth) in Morgantown, and the representatives of the West Virginia Utilities Company. Geological investigations combined with the results of pumping tests on the three deep wells led to the conclusion that there would not be a sufficient quantity of water in that underground source to supply the city and University needs. Studies of annual rainfall, also weir readings of the flow of water over several months, indicated that, as regards Tibbs Run the reservoir constructed some years earlier on this stream would have to be greatly enlarged in order to impound a sufficient quantity of water during the spring months to supply the city's needs during the drier summer months. Also to supply the city's water requirements a new and larger-diameter, seven-mile pipe line would have to be laid from the Tibbs Run reservoir (also called Field's Lake). The Utilities Company agreed to replace the old Tibbs Run pipe line with new and larger pipe. This would supply Morgantown with the excellent-quality mountain water shown in the above analyses during several months of each year. However, the other big problem on hand at that time was to find and remove the causes of the bad taste in the Monongahela River water and improve the methods of treating the raw river water before it was pumped into the city mains.

Since the results of the author's investigations as to the cause of the bad tastes in the river water have been published *(4)* they are only very briefly referred to here: in cooperation with representatives of the West Virginia Utilities Company and of the South Pittsburgh Water Company, the writer collected samples from all

OUTLINE OF ANALYTICAL PROCEDURE FOR DETERMINING THE USUAL MINERAL CONSTITUENTS IN NATURAL WATERS (1)

Evaporate on a steam bath 1000 g. of water in a 1-liter Pyrex beaker to about 50 cc., then pour it into a weighed porcelain dish and continue evaporation to dryness. Transfer dish and contents to a hot-air oven and dry to constant weight at 105° C. Total wt.(2)—minus—wt. of dish (1) = Total Solids.

Place dish and contents in an electric furnace, ignite at dull-red heat to constant wt. (3). This wt. (3)—minus—wt. of dish (1) = Fixed Mineral Matter.

The loss in wt., or Total Solids—minus—Fixed Mineral Matter = Volatile Matter; organic, CO_2 and water of crystallization.

To the contents of the dish add 20 cc. distd. H_2O and 10 to 15 cc. HCl; heat to boiling, avoid any spattering. Filter into a 100 cc. volumetric flask, wash free from chlorides adding washings to flask — make contents to 100 cc. mark, mix thoroughly.

Residue

Dry and ignite in Pt. cruc. to const. wt. (4). This wt. (4) minus wt. of cruc. = Insoluble Matter.

Volatilize SiO_2 with HF and weigh (5). This wt. (5) is insol. clayey material, i.e., Al_2O_3 and $CaSO_4$.

Filtrate

Divide into two portions.

75 cc.

Ppt. Al and Fe with NH_4OH. Boil, filter, wash thoroughly.

Residue: $Al(OH)_3$ + $Fe(OH)_3$. Dry, ignite to const. wt. (6). This wt. (6) × 4/3 = $Al_2O_3 + Fe_2O_3$.

Filtrate plus washings.

Ppt. Ca with $(NH_4)_2C_2O_4$ — filter, wash thoroughly.

Residue, CaC_2O_4. Dry, ignite to const. wt. (7). This wt. (7) × 4/3 = CaO.

25 cc.

Ppt. SO_4 with $BaCl_2$. Filter wash, ignite to const. wt. (13). This wt. (13) × $\frac{SO_3}{BaSO_4}$ × 4 = SO_3

Filtrate plus washings:

Acidify with H_2SO_4. Evap. to dryness in weighed dish. Drive off ammonium salts at low heat and ignite to const. wt. (8). This wt. (8) is $MgSO_4 + Na_2SO_4 + K_2SO_4$. Dissolve residue

in 75 to 100 cc. hot distd. H_2O. Add a few drops NH_4OH, then make slightly acid with HCL. Add 20 cc. satd. soln. of NH_4NaHPO_4. Cool, make slightly but distinctly alkaline by adding NH_4OH very slowly. Allow to stand for four hours. Filter, wash thoroughly with 3% | NH_4OH.

Residue, $MgNH_4PO_4$. — Filtrate

Dry, ignite to const. wt. as $Mg_2P_2O_7$ (9). — Discard

This wt. (9) $\times \frac{2\ MgO}{Mg_2P_2O_7} \times 4/3 = \underline{MgO.}$

This wt. (9) $\times \frac{2\ MgSO_4}{Mg_2P_2O_7} = \underline{MgSO_4}$ (10),

and wt. (8) ($MgSO_4 + Na_2SO_4 + K_2SO_4$) — wt. (10) $MgSO_4 = (Na_2SO_4 + K_2SO_4)$ (11), these latter two compounds in our analyses are reported as Na_2O, since the quantity of potassium usually present is very small. This wt. (11) $\times \frac{Na_2O}{Na_2SO_4} \times 4/3 = \underline{Na_2O.}$

The chloride (14) content of each water was determined volumetrically in 50 cc. samples of water, by titration with standard $AgNO_3$ solution, using K_2CrO_4 indicator. If the chloride content was very small 250 cc. of the water was evaporated to 50 cc. volume, if chloride content was excessively high 25 cc. of the water was diluted with 25 cc. of distilled water.

The results of some of our analyses of Morgantown City Water when it was obtained from the Monongahela River made during the years 1921 to 1924 inclusive are given in Table 1; collected during the years 1925 to 1933 inclusive in Table 2; Analyses of city water obtained from Tibbs Run are given in Table 3, Parts I and 2.

TABLE 1—*Analyses of Morgantown city water from Monongahela River (Analytical data are in parts per million)**

Date sample was collected	Total solids	Volatile matter	Insol. matter	Iron and Aluminum oxides	Calcium oxide	Magnesium oxide	Alkalies as Na_2O	Sulfates as SO_3	Chlorides	Soap hardness		
										Total	Permanent	Temporary
Nov. 14, 1921	100.3			12.4	11.1	2.0	12.2	40.6	3.5	38.0	36.5	1.5
Feb. 9, 1922	116.4	10.3	10.7	8.4	23.6	8.0	20.7	35.1	4.0	44.5	38.3	6.2
Feb. 8, 1923	115.5	10.2	10.5	9.8	22.4	0.5	28.6	36.0	4.5			
Sept. 20, 1923	163.2	21.6	10.2	7.8	26.4	50.9		63.5	6.8	63.7	51.5	8.9
Sept. 20, 1923	189.9	36.6	11.0		25.4	41.5		71.1	7.5			
Sept. 25, 1924	126.0	22.5	1.3	3.2	22.1	6.9	16.6	52.2				
Sept. 25, 1924	122.1	4.2		4.6	20.6	6.1	20.2	52.4	10.0	87.5	35.8	51.7

*Several of these analyses were made by senior and graduate students in the courses in chemical engineering and in sanitary engineering in West Virginia University. The other analyses were made by the authors.

TABLE 2—*Analyses of Morgantown city water from Monongahela River (Analytical data are in parts per million)*

Date sample was collected	Total solids	Volatile matter	Insol. matter	Iron and Aluminum oxides	Calcium oxide	Magnesium oxide	Alkalies as Na_2O	Sulfates as SO_3	Chlorides	Acidity to methyl Orange	Alkalinity to methyl orange	Soap hardness		
												Total	Permanent	Temporary
Sept. 25, 1925	250.0	22.2	6.5	2.1	32.8	6.2	41.3	118.0	2.6			111.5	111.5	0.0
Sept. 23, 1926	148.0	18.3	8.7	0.7	23.3	4.2	29.5	71.4	5.6			78.7	73.5	5.2
Sept. 23, 1926	149.6	16.7	3.5	0.8	23.1	3.2	27.1	69.1	5.6		8.0	70.0	70.0	0.0
Sept. 24, 1927	102.6	13.5	2.2	3.3	17.3		21.1	42.4	3.2		15.4	31.2	30.0	1.2
Sept. 22, 1928	175.1	24.1	4.4	5.1	4.4	9.8	25.4	87.5	4.2		16.0	68.6	68.0	0.6
Sept. 21, 1929	447.1	38.8	4.1	4.2	110.2	18.6	40.8	198.7	20.4	0.0	6.0	174.2	170.3	3.9
Sept. 21, 1929	441.1	4.1	4.5	4.7	98.0	38.7	40.2	210.0	15.2	0.0	7.0			
Jan. 28, 1930	105.7	2.5	10.0	4.7	25.3	5.9	25.3	49.0	5.9			45.7	41.6	4.1
Sept. 18, 1930	399.0	33.4	6.3	10.7	112.0	21.5	35.8	214.0	10.2	1.0		140.0	132.8	7.2
Sept. 15, 1931	186.8	17.1	3.2	4.0	55.5	11.2	20.3	94.5	5.7			75.7	74.3	1.4
Sept. 15, 1932	362.8	47.1	2.9	4.9	86.8	18.7	48.1	171.0	10.7		10.8	149.5	149.5	0.0
Sept. 16, 1933	143.1	16.0	0.3	0.9	39.7	9.5	23.4	55.0	4.2		8.5	80.9	80.6	0.3

TABLE 3 (Part 1)—*Analyses of Morgantown city Water from Tibbs Run (Analytical data are in parts per million)*

Date sample was collected	Total solids	Volatile matter	Insol. matter	Iron and aluminum oxides	Calcium oxide	Magnesium oxide	Alkalies as Na_2O	Sulphates as SO_4	Chlorides
Nov. 28, 1923									
Feb. 10, 1925	23.0	7.9	4.9	3.5	3.5	1.2	6.2	7.5	
Sept. 25, 1925	36.5	17.5	5.4	1.5	1.6	2.1	0.6	1.7	0.4
Sept. 23, 1926	29.2	8.3	1.5	0.4	1.6	2.7	5.1	7.0	0.5
Sept. 23, 1926	37.6	6.7	1.7	7.0		7.7	7.9		4.0
Sept. 22, 1928	24.6	3.4	1.7		3.7	3.8	4.0	6.4	1.4
Sept. 22, 1928	24.7	4.0	2.0		5.3	4.6	9.3	5.8	1.5
Jan. 28, 1930	19.3	4.7	1.8	0.3	2.7	0.3	5.5	5.7	3.6
Jan. 30, 1933	23.0	3.5	4.8	0.9	2.9	4.8	6.1	4.1	1.9
Jan. 30, 1933	26.0	3.6	4.1	0.8	3.1	5.9	5.8	8.8	1.9
Sept. 27, 1933	29.0	8.8	3.0	3.1	3.7	5.4		7.9	3.3
Sept. 27, 1933	29.1	8.8	3.3	3.5	4.1			9.0	3.3

TABLE 3 (Part 2)—*Analyses of Morgantown city water from Tibbs Run (Analytical data are in parts per million)*

Acidity to phenolphthalein	Free carbon dioxide	Alkalinity to methyl Orange	Soap hardness			Free NH_3	Albuminoid	Nitrite	Nitrate	Dissolved oxygen
			Total	Permanent	Temporary	Nitrogen				
*	3.0	14.0	19.3	15.3	4.3	0.005	0.055	None	1.2	
	2.3		20.0							
2.4			10.7							
		8.2	54.3	50.0	4.3	0.0	0.016	Tr.	0.2	5.2
		2.1	3.8	0.4	3.4	0.024	0.015	0.0	0.2	5.4
		3.5	8.3	3.5	4.8	0.028	0.021	0.0	0.01	7.8
0.0		1.0	14.9	11.4	3.5	0.034	0.033	0.02	0.03	10.4
12.2	10.2	2.2	4.8	4.8	0.0	0.015	0.028	0.0	Tr.	
12.2	10.2	2.2	4.8	4.8	0.0	0.01	0.087	0.001	0.01	
2.5	10.2	5.5	12.7	4.8	7.9	0.01	0.072	0.001	0.01	
2.5	10.2	6.0	12.7	4.8	7.9					7.0

*60 alkalinity to phenolphthalein.

streams, both natural and of industrial wastes, emptying into the Monongahela River between Government Dam No. 10 at Morgantown and upstream some 20 miles to the big concrete bridge in Fairmont. The seniors in chemical engineering at West Virginia University volunteered as a tasting squad. None of the samples collected could even be detected by taste in dilution greater than about 1:100 except the waste liquor from the by-product coke plant in Fairmont. This phenolic waste liquor could be tasted in dilutions of 1:10,000 and sometimes in even greater dilutions. After a conference between representatives of the Domestic Coke Corporation of Fairmont, the sanitary engineering division of the State Health Department, the chemical engineering department of West Virginia University, and the West Virginia Utilities Company, the Coke Corporation readily agreed to cooperate in every possible way to reduce the quantity of objectionable phenolic wastes being emptied into the Monongahela River. The Domestic Coke Corporation constructed a phenol absorption plant *(5)* and now recover approximately 97% of the phenols which were formerly run with their other wastes into the river. It is only very seldom now that we in Morgantown notice any of that disagreeable chloro-phenol taste in our water. A somewhat similar problem *(6)* came up some three years ago in the disposal of by-product coke-plant waste liquors from a large chemical plant near Charleston. This problem was also solved by the company constructing a waste-treating plant *(7)* such that a minimum of deleterious waste products would be discharged into the river. This attitude of the manufacturers to cooperate in keeping the pollution of streams as low as possible is certainly commendable.

In addition to the wastes from manufacturing plants and city sewage emptied into the Monongahela, large quantities of acid mine waters run into this river. Carpenter and Herndon *(8)* have called attention to the great quantities of sulphuric acid from mine waters which flow into the West Virginia rivers every year. It is hoped that the work now being done in sealing abandoned coal mines will appreciably reduce the load of acid and of iron sulphate in this river.

In spite of the heavy pollution load, the quality of river water delivered to the Morgantown city mains has been improved by applying more accurate chemical treatments to the raw water. A new and larger sedimentation tank was constructed which gave the suspended matter, including the "floc", more time to settle. The old rapid sand filters were repaired and some new ones built; thus the efficiency of filtration has been greatly increased. Also a new chlorinator was installed and this last line of protection to a city water supply was brought up to date. Many of the chemical analyses given in Table 2 were made on this carefully treated Monongahela River water as delivered from the faucets in our chemical engineering laboratory. Some analyses of the Morgantown city water have been made each year since 1921.

From a further study of the data in Tables 1, 2, and 3, several conclusions are indicated:

1. There are very large variations in the quantities of the different chemical compounds carried by the city water when it is obtained from a large industrial wastes river such as the Monongahela River.

2. The data from chemical analyses of the total solids in the water may furnish evidence as to (a) the nature of waste products being carried by the river; (b) the geological and perhaps also biological nature of the watershed; (c) the type of chemical treatment applied to the water in its purification for city uses.

3. There is a close relation existing between the results obtained in a water analysis and the recent weather and meteorological conditions. Heavy rains may result in a larger amount of suspended solids in the water, but the p. p. m. of dissolved solids will be less than usual as a result of the dilution with rain water.

These conclusions will be more apparent if some of the more important data in the tables are plotted. The following six sets of curves show graphically the variations found in the samples of water analyzed each year since November 1921. The first four sets of curves are drawn from analyses of Morgantown city water obtained from the Monongahela River.

Set No. 1—assembles the data for total solids, volatile matter, and alkalies as sodium oxide.

Set No. 2—for insoluble matter, sulphates, and chlorides.

Set No. 3—for insoluble matter, calcium oxide, magnesium oxide, and permanent hardness.

Set No. 4—for total, permanent, and temporary hardness.

Set No. 5—data plotted are from analyses of Morgantown city water when it was obtained from Tibbs Run; — for total solids, calcium oxide, alkalies as Na_2O, and total hardness.

Set No. 6—a comparison of the city water when obtained from Monongahela River and from Tibbs Run; — for total solids, and total hardness at the times tested during 1925 to 1933.

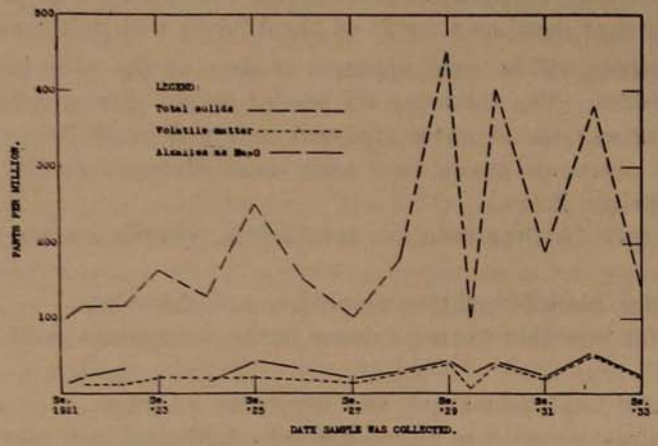
These sets of curves show clearly the wide variations in quantities of dissolved compounds which occur in a city water supply when it is obtained from a large river such as the Monongahela, into which flow many industrial wastes, acid mine waters, and much city sewage. Also, the curves show the small quantities of dissolved solids and slight variations in the amounts present when the city water supply is obtained from a protected, wooded watershed such as the sources from which flows the Tibbs Run water. These differences have many lines of significance and practical application; we will refer to only five of them.

1. The first requirement of a city water supply is that it shall be a safe, clear, pleasantly potable water. By our modern methods of treatment, settling, coagulation, sedimentation, filtration, and chlorination a skilled water plant operator can clarify and render bacteriologically safe almost any kind of water even though it be grossly polluted. However, it often happens that certain disagreeable tastes and odors and sometimes harmful dissolved compounds are not so easily removed or neutralized. Morgantown is fortunate in having for eight or nine months of each year the clear, soft, Tibbs Run water which contains no sewage, acid mine water, or industrial wastes. Occasionally the clarity of the water would be improved if it could be filtered, but chlorination is the only treatment this supply requires in order to give Morgantown a safe water, excellent for all purposes. However, when the supply of this fine mountain water gets low and the Morgantown Water Company has to pump the Monongahela River water into the city mains, the changes in certain properties of the water are so marked that complaints are often registered even though this river water, after the modern treatment it receives, is a safe and comparatively good city water.

2. The large variations in mineral content of the Monongahela River water make it clear that any system of softening or other treatment in order to be efficacious must be calculated on the results of daily tests of the water. Some com-

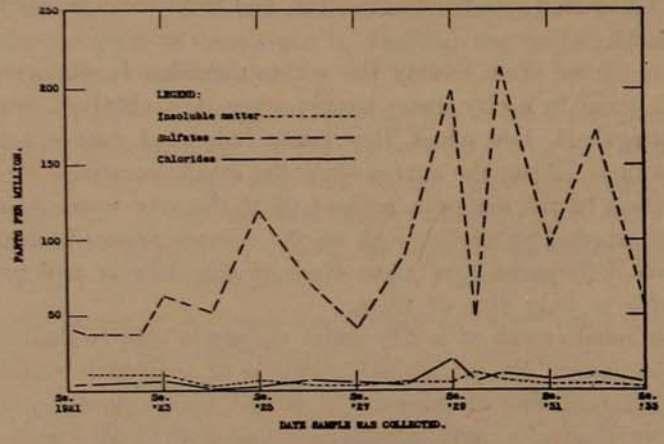
No. 1.

FROM ANALYSES OF MORGANTOWN CITY WATER FROM MONONGAHELA RIVER SHOWING THE VARIATIONS IN P.p.m. OF TOTAL SOLIDS, VOLATILE MATTER AND ALKALINE.



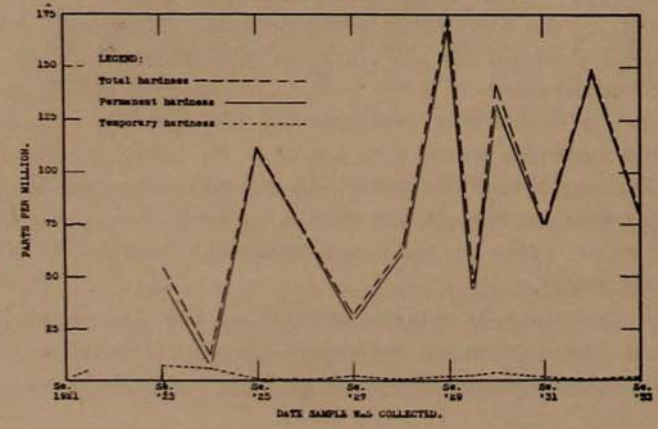
No. 2.

FROM ANALYSES OF MORGANTOWN CITY WATER FROM MONONGAHELA RIVER SHOWING THE VARIATIONS IN P.p.m. OF INSOLUBLE MATTER, SULFATES AND CHLORIDES.



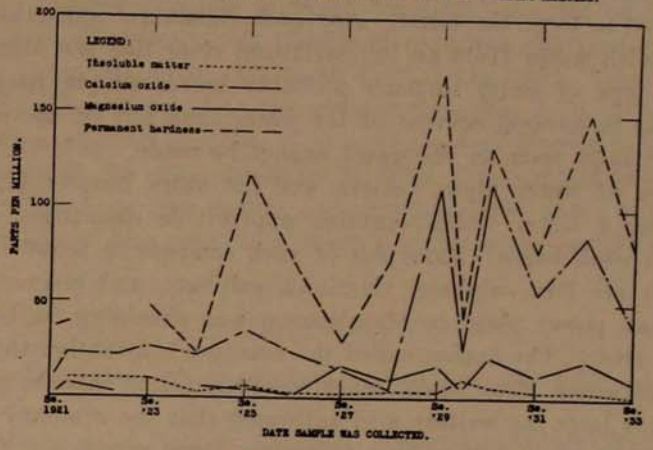
No. 3.

FROM ANALYSES OF MORGANTOWN CITY WATER FROM MONONGAHELA RIVER SHOWING THE VARIATIONS IN P.p.m. OF TOTAL, PERMANENT AND TEMPORARY HARDNESS.



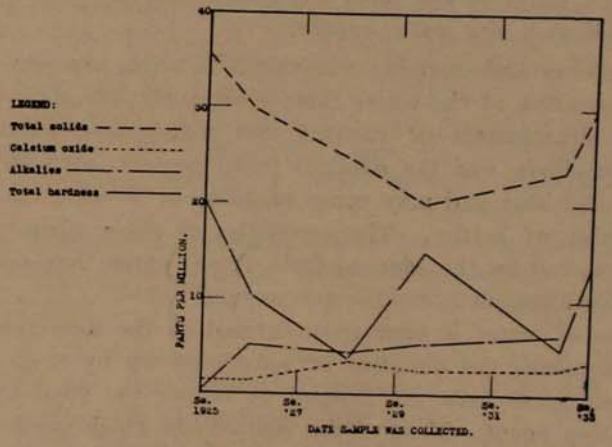
No. 4.

FROM ANALYSES OF MORGANTOWN CITY WATER FROM MONONGAHELA RIVER SHOWING THE VARIATIONS IN P.p.m. OF INSOLUBLE MATTER, CALCIUM OXIDE, MAGNESIUM OXIDE AND PERMANENT HARDNESS.



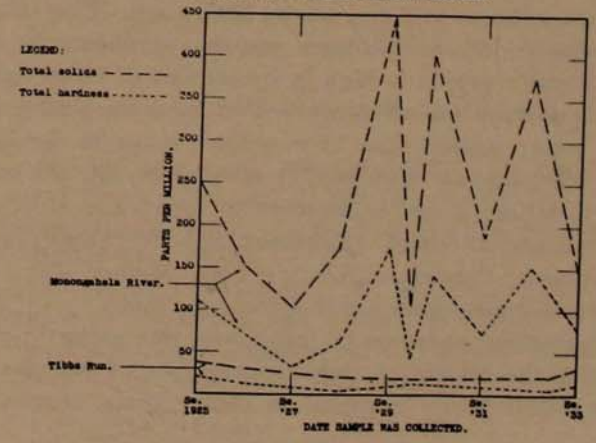
No. 5.

FROM ANALYSES OF MORGANTOWN CITY WATER FROM TIBBS RUN SHOWING THE VARIATIONS IN P.p.m. OF TOTAL SOLIDS, CALCIUM OXIDE, ALKALIES AND TOTAL HARDNESS.



No. 6.

FROM ANALYSES OF MORGANTOWN CITY WATER FROM MONONGAHELA RIVER AND TIBBS RUN SHOWING THE VARIATIONS IN P.p.m. OF TOTAL SOLIDS AND TOTAL HARDNESS.



mercial companies advertise that they will make a single test on a sample of your city water, then tell you the correct amount of their patent washing powder or boiler compound required to treat the water. Any such claims are apparently false if your city is supplied with water from an industrialized river like the Monongahela. The exchange-zeolite type of water softener probably better adapts itself automatically to wide variations in mineral content of the water than any of the other systems of treatment, where daily tests on the water cannot be made.

3. Corrosion of water pipes, boilers, and hot-water heaters *(9)* is much more rapid when using a water which contains appreciable quantities of the salts of strong acids and weak bases. Examples of such compounds found in the Monongahela River water are iron sulphate, aluminum sulphate, and magnesium chloride or sulphate. A small power plant in Morgantown was obtaining its boiler feed water from a polluted river. The author called the manager's attention to the fine quality of the Tibbs Run water. The power plant was changed to this source for the boiler water. Two years later the writers were informed that the company had saved from $5,000 to $6,000 in cost of boiler tubes to replace those rusted out or pitted through and in time lost by shut downs and labor costs for replacing the tubes. Similarly for hot-water heaters and for piping in homes and public buildings, real savings result from having a water of low total solids and mineral content and of the proper alkalinity available as a city water supply.

4. Incrustants or scale-forming compounds in water are very objectionable. On heating and evaporation of the water these compounds such as calcium sulphate, the carbonates and bicarbonates of calcium and magnesium, sulphates of iron and aluminum on hydrolysis, and the silicates leave deposits of scale which greatly retard the transfer of heat and may cause buckling or burning out of boiler tubes or plates and cracking of kettles. The quantities of these compounds in Tibbs Run water is very low, but in the Monongahela River water they occur in considerable and quite variable amounts.

5. Hardness of water is sometimes defined as the soap-consuming capacity of the water. This means the quantity of soap used up by a given quantity of the water before permanent suds are formed or before the soap can do any effective work as a cleansing agent. Most of the compounds which cause corrosion and scale formation are also large consumers of soap. Not only do these substances waste expensive soap, but the insoluble soaps formed cause the dirty, smeary films which tend to form on the surfaces of the wash bowls and tubs and often "spot" the clothes. Tibbs Run water is soft and wastes little soap. The water from the Monongahela River varies widely in hardness content as shown in the tables and the graphs. If a city water supply is high in its content of compounds causing hardness it would be much cheaper for all concerned to have the water softened with cheap chemicals at the water station than by expensive soaps in the homes. One laundry company *(9)* in Morgantown calculated it saved over $50 per week on cost of soap and labor after installing a zeolite softener to soften the Monongahela River water they used. A number of cities (Fairmont and Wellsburg) now have municipal water softening plants; Columbus, Wis., *(10)* and Quincy, Ill., *(11)* are cities which have recently installed municipal water softening plants.

The writer had three purposes in presenting this paper to the Academy of Science: first to give the results of chemical analyses of samples of water from the same source but collected over a period of twelve years. Second, to note the great

variations in the quantity of dissolved solids carried by the Monongahela River, a large industrialized stream. Third, to arouse interest in the problem as to the chemical nature of water supplies in West Virginia. As far as the writer is informed there are comparatively few published complete analyses of West Virginia waters such as are available in Arkansas *(12)*, Ohio *(13)*, Virginia *(14)*, North Dakota *(15)*, and other states. At the present time Mr. J. D. Sisler, director, and Mr. H. A. Hoskins, chemist for the W. Va. Geological Survey, are making an extended investigation of the mineral springs in West Virginia and the chemical nature of these waters. We hope that future investigations may make available abundant chemical and geological data regarding West Virginia water supplies.

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The Geology and Mining Section

WHY THE TYGART RIVER FLOWS THROUGH LAUREL HILL

CLAUDE W. MAXWELL, Elkins

AGES AGO when the mountain-folding took place that made the western part of the Appalachian Mountains, a very large fold occurred in what is now the Tygart Valley.

This fold or mountain was 16 miles wide. The highest part of this fold, beginning in Pocahontas county and extending to Bedford, Pennsylvania, was near the City of Elkins.

At this time the erosion has progressed until the Devonian shales are exposed down to and including the Genesee. This is within 1500 feet of the Oriskany Sandstone, the top of the Lower Devonian. (Note: It is not commonly held by geologists that the Appalachian uplift took place suddenly, but rather in a prolonged series of uplifts. Erosion was going on at the same time. For this reason the maximum height of any uplifted area is difficult to estimate.)

This is the lowest formation of any rock that is exposed west of the top of the mountains in the state. This great phantom mountain, for it is gone, except the rims of the arch, was at least 7000 feet high. This high elevation has been eroded down to 2000 feet at this time, and Laurel Hill on the west and Shavers Mountain on the east are all that remains. The erosion is about ten miles wide and in this area today there is the Tygart River and Shavers Fork of Cheat. The Tygart River flows for many miles almost along the top of this vast mountain fold. The river has conquered the mountain and is now the master of the rocks.

The Tygart River flows through the present Laurel Hill about four miles west of Elkins and at or near the south side of the phantom mountain. This is the only place where the river has eroded a passageway through the mountain for more than fifty miles.

It was the erosion through the mountain and the easy way from the Tygart Valley to the west that made the City of Elkins. This gateway east and west made transportation easy and the moving of people and freight made the city.

Since this gateway through the mountain has made a city and is a great passageway for people and freight, let use see what has happened in ages passed. Why would the river make a passage through the mountain at this particular place when there are dozens of other places to the north and the south?

An examination of the mountain range shows many deep erosions on the west side and several of these places came near getting the precious passageway. But the reason was working all the time and as there was more water at this particular place than any other, the wearing down of the sandstones of the New River coal formation was going on all the time.

When the phantom mountain was standing, a very large volume of water came from the west side and this side being steeper than the east side, the erosion was faster. The largest volume of water flowing the fastest of any other part of the mountain, wore the rocks away faster, and the streams getting into the red shales and limestones worked very fast.

The old river beds high on the ridges and hills show that in former ages there

were three and probably four streams flowing into this one larger stream that was cutting the mountain to water-level. One was from the south and another from the north and along the level of the limestone. The other two were from the east and the different streams cut down channels to such an extent that at this day there are two very high hills on the south side of the present gap that are isolated.

So the phantom mountain was the cause of the present river way through the mountain, and since the mountain is gone, it is hard to believe that, long ago, this very high mountain started several small streams that finally met at a common place on the south side, and had enough power to wear away the rocks.

When you travel this way think, when you cross Leading Creek, two miles west of Elkins, that over your head ages ago was a mountain a mile high, and that the mountain now known as Laurel Hill is the side of this mountain about two miles from the ancient top; that the rocks along the road are the Genesee shale, and the oldest rocks west of the mountains in the state.

If there is any truth in the theory that gas and oil rise to the highest place in the rock where they are located, this being the highest elevation of the Oriskany sandstone and other sandstones away from their outcrops, much oil and gas must have worked up the sides of this vast dome. Possibly some day this high eroded mountain will yield its secret of oil and gas deposits and in addition to having the finest coal, limestone, and shales, will produce oil and gas.

It seems strange to a person who has never known of this phantom mountain that today there are thousands of acres of level land, producing clovers, grains, and a home for a happy people, at one time a mile below the surface.

In this erosion is the horizon of fossil trees, discovered by David B. Reger a few years ago, which has proved to us that trees were growing in this section half a billion years ago. These trees are large and well preserved and would never have been found if our long ago phantom mountain had not been worn away.

This very high mountain was a treasure house, as it was all covered near the surface with a seam of Sewell Coal. This very fine coal, that is in such demand today, was over all this mountain and was carried away by the water and the wind a little at a time. And so much was carried away that more than 60% of this very valuable coal is gone.

And while our phantom mountain is gone and is reduced to a few small fringes of hills, and a broad valley of fertile land now remains, and this mountain was the cause of the river making a passageway through the mountain to the more level lands to the west, the loss of the best and finest coal that ever was formed by nature at any time or any place, was vast. I have estimated that there has been lost by erosion more than 150,000 acres of Sewell coal averaging four feet in thickness.

However, much of this priceless fuel is left and if it had all been here, this coal might not be so valuable.

Those who love the hills and valleys of West Virginia should study the story of the present mountains and rivers, for while the story is long and the life history of a mountain or a river extends over millions of years, still each one has a story that is interesting and worth knowing.

We invite the stranger to come and see where our phantom mountain stood, and to help find the treasures of oil and gas that may remain hidden in the unexposed rocks.

THE ORIGIN OF THE GREEN BANK BASIN IN POCAHONTAS COUNTY, WEST VIRGINIA

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EXTENSIVE LEVEL AREAS in east central West Virginia are very rare and it is somewhat surprising to find a tract of land embracing several thousand acres, surrounded by mountains and situated away from large streams. The first thought likely to enter one's mind is that a large river at one time has crossed this area and has been the important agent in the formation of the Green Bank basin. Stream boulders are found embedded in the alluvium which covers the area. However, evidence of the existence of a former large stream is lacking. In fact, it appears that the drainage area has been increased rather than decreased.

Since it is improbable that a large stream has been responsible for the development of the basin it is necessary to look for other causes. It is apparent that the rocks upon which the various terraces in the area have been formed are weaker than the surrounding strata. The formations in the area are Devonian shales and thin-bedded sandstones, and, with the exception of a small area of Oriskany sandstone, are easily eroded. The Brown's Mountain anticline plunges to the northeast and disappears only a few miles from the town of Green Bank.

It is evident that drainage conditions in eastern Pocahontas county are closely related to the various periods of base-leveling. The streams owe their present locations to the fact that they were entrenched, irrespective of the kind of underlying rock, as soon as uplift began after peneplanation. Two well-defined peneplains are recognized in Pocahontas county. The oldest (variously called the Upland,[1] Schooley, or Kittatinny) has an elevation of about 4600 feet. The other peneplain, commonly called the Harrisburg, may be clearly seen in the vicinity of Marlinton at an elevation of about 2500 feet.[2]

The author has recognized an intermediate level at an elevation of about 3500 feet in northeastern Pocahontas county. This surface may be correlated with the Weverton in northeastern West Virginia and the Allegheny in the western part of the state. With the uplift following the formation of this peneplain, the Greenbrier River was entrenched in the Chemung and Catskill rocks. In places the river has migrated westward with the dip of the rock until it has embedded itself in the Pocono sandstone and conglomerate. However, in no place in Pocahontas county has it reached the Greenbrier limestone in the last cycle of erosion.

During the formation of the Harrisburg peneplain the Devonian shales were leveled much faster than the massive sandstones. This was especially true in the Green Bank area where the strata had been made still weaker by the formation of the Brown's Mountain anticline. As these rocks were being worn down, the Greenbrier River remained at practically the same elevation above sea level, thus forming a local base-level. The highest terrace in the basin is at an elevation of 2750 feet which is 250 feet above the Harrisburg level at Marlinton. This slope, approximately

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[1]J. F. Wright, The Physiography of the Upper James River Basin in Virginia, Bul. no. XI, Virginia Geol. Surv., 1925.

[2]Paul H. Price, Pocahontas County Report, W. Va. Geol. Survey, pp. 25-26, 1929.

Map of the Green Bank basin. The shaded area represents the highest terrace

nine feet per mile, is about the slope to be expected from Green Bank to Marlinton, since the uplift has been greater in northern than in southern Pocahontas county.

There are three distinct terraces above the flood plain of Deer Creek, separated by intervals varying from 15 to 40 feet. The highest terrace at 2750 feet shows almost perfect truncation of the shales and thin-bedded sandstones. On each terrace the alluvium is several feet in thickness and the rounded boulders are usually found just above the solid rock. The boulders, for the most part, show the effects of stream action but in places where road cuts expose the mantle it has the appearance of glacial till. While no part of the terrace material can be considered till, it is not unlikely that an enormous amount of debris was brought down by small local glaciers or snow slides during Pleistocene times. There is no doubt that precipitation was heavy enough during the ice age to account for the numerous boulders which have been strewn over the various terraces. The material found on the lower terraces has been let down from the highest terrace. It is found that the boulders are larger on the 2750 terraces east of Green Bank than west of this place. Also those of the highest terraces are, in general, larger than those on the lower terraces.

There are three distinct terraces above the flood plain of Deer Creek, separated basin along the tributaries of the Greenbrier River. These correspond very closely in elevation with the Green Bank area, thus affording further proof of the long period of time during which the Greenbrier River remained at the same level.

From the study of this region the conclusion of the writer is that the formation of the Green Bank basin is a part of the development of the Harrisburg peneplain.

THE FIRE CLAY HORIZONS OF WEST VIRGINIA

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UNDERCLAYS occur below many of the coal beds and to a considerable extent at other horizons throughout the coal measures in West Virginia. They are popularly referred to as "fire clays" without regard to the technical limitations of the term. Those known to have P. C. E. of 19 or better are few, and limited to the strata of the Allegheny series plus 100 feet of the Pottsville below, and 200 feet of the Conemaugh above. Thus the known fire clays of the state occur within a vertical stratigraphic range of not much over 600 feet.

Published information regarding these clays is confined largely to reports of the West Virginia Geological Survey. Volume III, "Clays, Limestones, and Cements," 1905, gives descriptions of the deposits known at that time together with chemical analyses and some physical tests of most of the fire clays then in use. Subsequent county reports provide additional data. Unfortunately no additional physical tests are included in the county reports, although many chemical analyses of clays and shales are given. Most of the material given here was obtained from these reports.

Thick underclays are frequently found below the Washington, Pittsburgh, Little Clarksburg, and Elk Lick coal beds, but no information found would indicate that any of these clays is sufficiently refractory to be called fire clay.

A yellowish massive clay, resembling the flint clays in appearance, but not so hard, has been described by Galpin and Noelting. (The Bulletin of the American Ceramic Society, Vol. 13, June, 1934.) This clay occurs near the base of the Pitts-

burgh Red Shale in Monongalia, Preston, Taylor, and Tucker counties and probably elsewhere. Only one sample of this material has been tested for refractoriness. The test indicated a no. 2 fire clay of rather high fire shrinkage. This is the highest horizon proved to be fire clay to date.

The Bakerstown Underclay

This clay, found some 30 to 50 feet lower in the Conemaugh than the aforementioned clay, is rather persistent, but as it has not been tested it can not definitely be said to contain any fire clay. This clay is usually plastic. Its presence is noted in Monongalia, Preston, Taylor, and Kanawha counties. The MacDonald farm clay (Kanawha county) tested by Grimsley and referred by him to this horizon, is reported by Krebs to be not Bakerstown, but considerably lower (possibly Middle Kittanning, S. L. G.).

The Brush Creek Underclay

This is one of the more persistent underclays of the state and often one of the thickest. It is usually apparently impure, there being much iron stain on most outcrops. Nodular limestone also is commonly present.

The Elk Clay (of Kanawha county)

This clay may be Brush Creek, although Grimsley suggested Thornton as its equivalent. It has been used in fire brick, face brick, and paving block manufacture. Grimsley reports the results of tests from two plants near Charleston which indicate that the flint clay is a high grade no. 2 fire clay. The plastic clay associated with the flint clay is not so refractory, but still ranks as a no. 3 fire clay.

The Mahoning Underclay; Thornton Clay

This is an important fire-clay horizon. It has furnished much firebrick material at Thornton, Taylor county, where Reger measured the following section:

Sandstone, massive, Mahoning	22′
Fire Clay, Shale, brown	16′
Fire Clay, Shale, gray, plastic and flinty (Thornton Fire Clay)	36′
Coal, Upper Freeport	

(Marion, Monongalia, Taylor Report p. 154)

Grimsley (pp. 223-225, vol. 3), speaking of the Thornton Fire Brick Company mine, says: "The mine shows 18 feet of flint and soft clay, and one place reaches 22 feet. The distribution of the flint clay and soft plastic clay is irregular. In some parts of the mine the soft plastic clay cuts out the flint clay entirely. The soft clay is sometimes above and sometimes below the flint. The roof and floor of the mine are sandstone, and the mine is dry." Analyses and physical tests reported by Grimsley show a marked difference between the flint and plastic clays. The flint clay reaches vitrification at cone 30 with no shrinkage, while the plastic clay overfires at cone 5.

The Thorton clay is best developed in the vicinity of Thornton and in southwestern Preston county. The horizon carries fairly thick clay at places in Monongalia, Tucker, Upshur, Barbour, and Braxton counties, but lack of tests leaves the quality in doubt.

The Elk clay of Kanawha county is correlated with the Thornton by Grimsley. It has been discussed with the Brush Creek clay.

The Upper Freeport Underclay; The Bolivar Clay

Altho the presence of one or both of these clays in workable thickness has been reported for several localities, they have been worked for fire clay only near New Cumberland, Hancock county, and Thornton. The operation at New Cumberland is active, producing flint and plastic clay which is sold to steel mills. The flint clay is said to have a P. C. E. of 28-29. The Thornton operation (in the Upper Freeport clay) produced some fire brick, but has long since ceased. Grimsley (vol. 3, W. Va. Geol. Survey) reports the Bolivar occurring in Hancock county as a flinty clay, from 6 to 16 feet thick, coming directly below the Upper Freeport limestone. Later county reports by Hennen and Reger indicate the presence of clay beds of workable thickness below the Upper Freeport coal in Preston, Monongalia, and Taylor counties; and to some extent in Barbour, Upshur, and Braxton. Chemical analyses given in these reports indicate a fairly refractory clay, often of rather high silica content. No physical tests are reported.

The Upper Freeport and Bolivar clays show a relationship which is common to many underclays. When the members are all present the sequence is:

Coal, Upper Freeport.
Clay, usually plastic, but often flinty.
Limestone, nodular to solid, non-marine.
Clay, flint, semiflint, or plastic (Bolivar).
Shale or sandstone.

When, as often happens, the limestone is wanting it is difficult to distinguish the two clays. The Bolivar clay is reported at intervals of from 0 to 40 feet below the Upper Freeport coal.

The Lower Freeport Underclay

No published data indicate fire clay at this horizon except the Ruffner Fire Clay reported by C. E. Krebs in Kanawha county. The Ruffner clay is said to have been used in fire-brick manufacture, but no tests or analyses are given to indicate its refractoriness. Underclays, usually shaley, but at some outcrops massive or flinty, are reported from Monongalia, Taylor, and Tucker counties.

The Upper Kittanning Underclay; the Hardman Clay

Clays below the Upper Kittanning coal have their best development in eastern Monongalia and western Preston counties. The generalized section for this region is as follows:

Coal, or dark shale, Upper Kittanning.
Clay, plastic or flinty, Upper Kittanning.
Limestone, Johnstown Cement.
Clay, flint or plastic, Hardman.

The Hardman clay was once mined at a point about one mile north of Hardman, Preston county. It is reported that the plastic clay was used at Clarksburg in stoneware, and that some of the flint clay was made into satisfactory coke-oven blocks. No physical tests are reported, but chemical analyses of the flint clay indicate a no. 2, or possibly more refractory fire clay. These clays vary in thickness form 0 to 24 feet. The proportion of flint to plastic clay is also variable. Both flint and plastic clays have been reported from Taylor, Barbour, and Upshur counties at this horizon.

The Middle Kittanning Underclay

This clay is not of general occurrence in West Virginia. It is reported in Hancock county and a few other sections, but is not a promising source of fire clay.

The Lower Kittanning Underclay

This clay, one of the most persistent of the underclays, has been extensively mined near New Cumberland, Hancock county. It was first reported as Middle Kittanning clay by Grimsley, who later changed his correlation to Lower Kittanning upon discovery of marine fossils (Vanport) some distance below the clay. The New Cumberland section is as follows:

Sandstone	
Coal, Lower Kittanning	2½′
Flint clay	6′
Gray shale clay	4′
Blue Shale clay	12′

Only the flint clay (so called) is refractory. It is reported by Grimsley to become viscous at about cone 28, with 2% fire shrink. Other clays at this horizon are reported from Monongalia, Preston, Mineral, Marion, Tucker, and Upshur counties. The reported analyses of these clays indicate low-grade fire clays at best. Krebs reports the analysis of a 5-foot plastic clay bed near Ft. Gay, Wayne county (Cabell, Wayne, and Lincoln report) which may be the Lower Kittanning clay, and which indicates a silicious fire clay of possibly no. 2 grade.

The Clarion Underclay

This clay is spotty in occurrence, and the information at hand gives little promise of true fire clay in it.

The Brookville Underclay has not been recognized as such in the reports of the West Virginia Geological Survey.

The Mt. Savage Fire Clay; the Hammond Fire Clay

The Mt. Savage Fire Clay is given in county reports as present in Monongalia, Marion, Preston, Grant, and Mineral counties. It has been utilized in the manufacture of fire brick and refractory cement at Piedmont, Mineral county, but elsewhere little is known of its character or extent.

At Piedmont the clay is of decidedly variable character. The thickness ranges from 2 to 15 feet. The relation of flint to plastic clay is not definite either as regards proportion or position. Thin coal beds appear in, above, and below the clay in one section or another. Whether these coal layers represent splits of a single coal bed or not is speculative.

According to the tests reported in volume 3 of the West Virginia Geological Survey, the flint clay of the Mt. Savage horizon at Piedmont shows little change at cone 30. This would indicate a no. 1 fire clay, and apparently the most refractory clay, so far tested, in the state.

The Hammond Fire Clay

At Hammond, Marion county, a clay has been extensively mined and used in the manufacture of fire brick. In Grimsley's report (vol. 3) this clay was listed as Lower Kittanning, but the later work of Hennen and Reger indicates that the clay lies between the Homewood and the Upper Connoquenessing sandstones. Quoting

from the Marion, Monongalia, Taylor report—"By reference to the Powell (Marion Co.) section it may be seen that this (Hammond) fire clay is separated from the Mt. Savage fire clay by a small seam of coal, a fact that proves conclusively that this is a separate horizon.—It will be styled the Hammond Fire Clay".

Several clays are exposed in the present mine workings at Hammond. Apparently only the flint clay, which varies from little to as much as 6 feet in thickness, deserves the designation fire clay. Grimsley reports (vol. 3) that the flint clay vitrifies at cone 30 with very little shrinkage.

The Hammond clay seems to be limited to a comparatively small area, although it would doubtless be difficult to distinguish it from the Mt. Savage clay if the separating coal were absent.

Thin or impure fire clays (underclays) are reported from many horizons lower in the series than any specifically mentioned above, but reported information does not indicate the probable existence of commercial fire clays at horizons below the Mercer group.

MINERAL PRODUCTION IN WEST VIRGINIA

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THE MINERAL RESOURCES of any geographical unit are inseparably intertwined with its political condition and today with the existing economic crisis. It is admitted that the civilization of the twentieth century is based in large measure upon the product of the mine and the smelter. Therefore in discussing the causes underlying the current economic disturbances, and possible ameliorative measures, it is necessary that a knowledge of the trends in utilization of mineral products be taken into consideration as one of the major factors, perhaps the most basic one.

In order to show more clearly the position of the mining industries in the existing economic order, a few statistics are not amiss. Mining and railway transportation employ in this country about 1,700,000 persons each,[1] and mining alone more than any single manufacturing industry[1]. In Great Britain one man in ten is employed underground in the mines, while in the United States the proportion is one those engaged in fabricating, transporting, and merchandising the manufactured mineral products; nor their enormous tonnage.

TABLE 1[3]—*Percentage increase from 1899 to 1929*

Percentage increase from 1899 to 1929	
Population	62
Agricultural production	48
Manufacturing (physical volume)	210
Mineral production	286
Consumption of raw energy	230
Installed horse power	536

[1] F. G. Tryon and F. E. Berquist, Mineral Economics. An outline of the field. Ch. i, Mineral Economics, A. I. M. E. series, McGraw-Hill Book Company, 1932, 4-5.

in 40[1]. More than one-half of the railway tonnage of the United States is composed of raw materials from the mines, and it would be fully three-fourths if smelter and refinery products were included.[2] These figures, large as they are, do not include

[2] M. K. Hubbert, Future Ore Supply and Geophysical Prospecting. Eng. & Min. Jour., January, 1934.

[3] Data adapted from Tryon and Schoenfield, Recent Economic Trends, 1933, 60.

Table 1 shows the increase in population, agriculture, mineral production, manufacturing, and the use of energy in the United States during the last three decades. It has been estimated that the energy consumed in this country has increased, within the last 100 years, from less than 5,000 kilogram calories per capita per day to 153,000.[4] Nearly all the extraneous energy is derived from the combination of mineral fuels.

TABLE 2[5]

	Capital invested	Production or service value
Steam railways	$24,000,000,000	$ 6,000,000,000
Mines	12-15,000,000,000	6,600,000,000
Agriculture		13,000,000,000
Added by manufacture of raw materials from mines		26,500,000,000

Table 2 shows the relative importance of investment and production in mining, agriculture, and steam railway transportation. It is notable that the value of the mineral products after manufacture is almost double that of the agricultural products and the railway services combined. This indicates the commanding position assumed by the mineral industries in modern civilization .

TABLE 3[7]

	Pig-iron production					
	Production in 1,000,000 tons					
1880	8	1898	21.5	1916	78.5	
1881	8	1899	28	1917	78.5	
1882	10	1900	31	1918	78	
1883	10	1901	32	1919	68	
1884	8.5	1902	40	1920	76	
1885	8.5	1903	39.5	1921	33	
1886	11.5	1904	32	1922	52	
1887	12.5	1905	48	1923	77.5	
1888	13.5	1906	50.3	1924	61	
1889	16	1907	58	1925	79.5	
1890	18	1908	40	1926	76	
1891	16	1909	57	1927	69	
1892	18	1910	64	1928	69.5	
1893	13	1911	49	1929	82	
1894	13	1912	62	1930	62	
1895	18	1913	69.5	1931	34	
1896	18	1914	46	1932	15	
1897	20	1915	64			

Table 3 shows the oscillations which have taken place in the iron industry (whose condition is frequently used as an index of the general health of business) since 1870, a date which perhaps marks the real beginning of the high energy consumption civilization in the United States. It shows that in 1894, the decrease in pig-iron

[4] M. K. Hubbert, An historical review of social phenomena as a function of resources, science, and technology. National Technological Congress, 1933, I, in press. Man consumes on the average about 2,000 kilogram calories per day in food. Prior to about 1825, installed horse power is estimated to have been almost negligible and the energy derived from domestic animals not more per capita than that of the food consumed by man.

[5] Data adapted from Tryon and Berquist, *idem*.

[7] Data from the Mineral Resources of the United States.

production was about 19%; in 1907, about 39%; in 1921, about 55%; and in 1930 about 80%.[8] If an increase in amplitude of the same order of magnitude takes place in the next depression, provided there should be one, this industry will completely shut down.

With this background and introduction, attention is directed to mineral production in West Virginia for the decade or more immediately preceding the current financial depression. It is possible that a partial answer to some of the perplexing questions of taxation might be found in a careful consideration of the figures presented.

West Virginia produces a number of mineral products; coal, petroleum, and their by-products being the most important, both from the point of view of the present financial set-up, and from that of utility to civilization. In view of the fact that there are important implications connected with the fuel production curves, it seems wise to examine the minor products before considering the sources of energy.

TABLE 4[9]—*Carbon Black Production (W. Va.)*

	Number of plants	Production in 1,000,000 pounds	Value in $1,000,000	Gas used in 1,000,000 ft.
1921*	12	25	2	15
1922	18	20	1.7	12
1923	20	20	1.9	14
1924	18	15	1.1	9.6
1925	14	11	.8	7
1926	10	4	.3	7
1927	6	3	.2	2
1928	2	.7	.05	.5
1929	2	.6	.04	.3
1930	2	too small to record		
1931		ceases altogether to produce		
1932		" " "		

*Not reported earlier.

Carbon black is used in the manufacture of ink (11%) in 1932, rubber goods (81%), paint and varnish (5), and a number of relatively unimportant articles.

A steady decline in carbon black production (Table 4), has taken place since 1921, and in the number of plants since 1923. It is to be supposed that the number of employees in the industry has decreased in proportion, as well as the taxable value of the industry.

The decrease in clay production in this state in 1921 (Table 5) is a reflection of a similar decline in activity in metallurgy, as a large proportion of West Virginia fire clay is used in the furnaces of that industry. The clay industry had not entirely recovered from the financial difficulties following the close of the World War (1914-18) by 1929. In fact, a second decline has been noticeable since 1923, 1929 being the only year since that time which has approached the immediate post-war level of production.

While lime production rose in West Virginia (Table 6) from 1905 to 1929, the number of plants showed a fluctuating decline. The production curve indicates, to some extent at least, the trend in metallurgical activity, as is evidenced by the severe decline in West Virginia lime production in 1921 which accompanied the shut down of many of the large metallurgical plants.

[8] Steel production had fallen off 69% by 1930. Minerals Yearbook, 1932-3, 635.
[9] Mineral Resources of the U. S., and its successor, Mineral Yearbook of the U. S., are the sources for all statistics unless otherwise stated.

TABLE 5—*Clay Production**

	W. Va. prod. in 1,000 tons	Value in $1,000	Pa. prod. in 1,000 tons
1920**	86	211	603
1921	25	43	254
1922	25	43	381
1923	76	154	517
1924	63	129	662
1925	69	136	759
1926	63	113	855
1927	48	85	898
1928	42	67	971
1929	61	99	1054
1930	46	68	801
1931	not reported	not reported	not reported
1932	12	16	238

*Excluding that used in ordinary building brick.
**Not reported earlier as a separate item.

Clay is used in the manufacture of china, porcelain, and paper (24.6%), tile and stoneware (3.1%), fire brick (55.5%) of the national and nearly all of the West Virginia production), ball clay (3.1%), and a number of minor products.

TABLE 6—*Lime Production*

	Number of plants	W. Va. prod. in 1,000 tons	Value in $1,000,000	Pa. prod. in 1,000 tons	Ohio prod. in 1,000 tons
1905	Not reported	104	.3	620	327
1906	"	98	.3	624	331
1907	34	107	.3	655	327
1908	41	91	.2	582	279
1909	46	90	.3	881	343
1910	37	90	.3	877	415
1911	27	179	.5	842	405
1912	30	232	.7	849	464
1913	31	282	.8	852	497
1914	28	192	.7	850	480
1915	30	250	.9	901	507
1916	25	278	1.0	972	571
1917	23	246	1.3	936	480
1918	10	168	1.2	801	489
1919	8	174	1.3	780	513
1920	10	193	1.8	784	558
1921	13	119	1	509	471
1922	15	219	1.6	719	752
1923	11	241	2	773	868
1924	10	239	1.9	700	934
1925	9	270	1.9	795	1089
1926	9	267	1.7	794	1056
1927	12	244	1.6	813	987
1928	12	280	1.8	834	1013
1929	13	309	1.9	782	962
1930	13	228	1.4	634	736
1931		170	1	497	656
1932		85	.5	374	477

Lime is used in building (32.2%), agriculture (11.2%), paper manufacturing (5%), metallurgy (54.5%), and a few minor industries.

The Great Kanawha Valley has produced salt from very early times, and it is believed[10] that the Americans carried on a brisk trade in this commodity. The settlers produced about 150 pounds per day in 1797; 789,000 bushels were produced in 1827; 2,690,087 in 1847; and 1,321,066 in 1867. By 1880 there were fifteen salt operations in the state.

[10]Oral communication.

TABLE 7—*Salt Production*

	W. Va. prod. in 1,000 tons	Value in $1,000	Mich. prod. in 1,000,000 tons	N. Y. prod. in 1,000,000 tons
1880	910	Not reported	2.1	2.3
1883	320	211	2.9	1.6
1884	310	195	3.2	1.8
1885	223	145	3.3	2.3
1886	250	162	3.7	2.4
1887	225	135	3.9	2.4
1888	220	143	3.9	2.3
1889	200	130	3.9	2.3
1890	230	134	3.8	2.5
1891	Not reported	Not reported	4.0	2.9
1892	" "	"	3.9	3.5
1893	544	209	3.0	5.7
1898	247	88	5.3	6.8
1899	221	108	7.1	7.5
1900	244	118	7.2	7.9
1901	231	95	7.7	7.3
1902	208	98	8.1	8.5
1903	244	96	4.3	8.2
1904	575	66	5.4	8.6
1905	202	74	9.5	8.3
1906	200	56	9.9	8.9
1907	156	77	10.8	9.6
1908	145	70	10.2	9.1
1909	150	76	9.9	10.9
1910	155	63	9.5	11.6
1911	183	78	10.3	11.2
1912	139	66	10.9	10.5
1913	15	63	1.6	1.5
1914	20	78	1.6	1.5
1915	32	115	1.8	1.6
1916	33	123	2.0	1.9
1917	24	191	2.3	2.2
1918	26	251	2.4	2.1
1919	18	168	2.5	1.9
1920	29	384	2.3	1.9
1921	27	320	1.4	1.5
1922	25	283	1.4	1.5
1923	32	284	2.1	2.0
1924	38	258	1.9	1.9
1925	26	180	2.2	2.
1926	23	171	2.3	2.
1927	22.6	167	2.3	2.
1928	18.7	149	2.4	2.
1929	20	153	2.6	2.2
1930	29	184	2.0	1.8
1931	35	219	2.6	2.0
1932	49	243	1.7	1.5

Salt production (Table 7), although far from being up to the all-time high of 1904, has shown a steady increase since the onset of the depression (1929), while its dollar value has increased in proportion. The writer has been informed by an employee of one of the producing operations near Charleston that employment has not been kept at the 1928 level. No elaboration of this statement was made, but it is evident that the productivity of the worker in the salt works must have increased rapidly during the depression years; provided, of course, that the statement can be accepted at its face value.

Activity in the building trades, highway construction, and bottle manufacture greatly influences sand gravel production in West Virginia. Fully nine-tenths of these materials produced in this state is used in construction or glass manufacture. It is notable that production increased even after the onset of the depression (1929). (Table 8.)

TABLE 8—*Sand and Gravel Production*

	W. Va. prod. in 1,000,000 tons	Value in $1,000,000	Mich. prod. in 1,000,000 tons	Ill. prod. in 1,000,000 tons
1911	1.1	.3	2.2	8.5
1912	.8	.5	2.7	6.9
1913	1.0	.9	6.4	8.0
1914	1.1	.6	3.8	7.7
1915	.7	.5	3.7	7.7
1916	1.	.8	4.4	8.4
1917	.9	1.0	3.8	9.1
1918	.9	1.4	2.8	6.4
1919	1.2	1.8	3.8	7.0
1920	1.5	2.5	4.4	7.7
1921	1.4	2	5.5	6.3
1922	1.5	2	5.9	8.8
1923	2.4	3.2	9.6	11.9
1924	2	2.9	11.4	12.3
1925	2.4	3	10.8	14.9
1926	2.6	3	14.3	17.7
1927	2.5	2.9	15.4	19.3
1928	2.4	2.8	15.9	20.9
1929	2.7	2.1	16.8	18.2
1930	2.7	2.8	11.3	17.4
1931	Not reported	Not reported	Not reported	Not reported
1932	"	"	"	"

Gravel is used in building (19.9%), paving (68.8%), railway ballast (1.14%), and a few other activities.

Sand is used in glass manufacture (3.67% of the national and about one-third of the West Virginia production), molding (1.2%), building (31% of the national production and about one-third of that of West Virginia), engines (3.5%), paving (47%), and a few other industries.

TABLE 9—*Stone Production*

	Number of plants	Prod. in 1,000,000 tons	Value in $1,000,000	Pa. prod. in 1,000,000 tons
1912	Not reported	Not reported	1.0	
1913	" "	" "	1.0	
1914	" "	" "	.8	
1915	71	" "	1.0	
1916	60	" "	1.5	
1917	51	" "	1.8	
1918	40	" "	2.0	
1919	35	2	2.3	13
1920	37	2	3.0	14
1921	35	1.6	1.7	9
1922	33	2.1	2.1	12.7
1923	32	2.5	2.6	15.7
1924	37	2.6	3	14.6
1925	62	3.3	3.4	16
1926	40	3.2	3.4	17
1927	38	3.0	3	16
1928	25	3.0	3	16.5
1929	30	3.4	3	18.2
1930	42	3.0	2.7	15.1
1932	Not reported	Not reported		
1933	" "	" "		

Crushed stone is not always included under this item.

Stone is subdivided for statistical purposes into granite, basalt, marble, serpentine, limestone (fully 90% of the West Virginia production), and sandstone (nearly 10% of West Virginia's production).

Crushed stone is used in concrete and road materials, and railway ballast.

Cut stone is used in paving and building construction.

Stone production (Table 9) increased, with minor oscillations, until 1925, while the number of plants remained almost constant. Peaks in production and the number of plants were reached in 1925. It is notable that forty plants produced as much in 1926 as 62 had the previous year. It is not shown whether employment in the industry was lowered during the same period. However, a decrease in employment is usually a sequence of centralization with its consequent mechanization and increased efficiency.

West Virginia's most important commodities are the mineral fuels and their by-products, and their employment is greater than all other mining enterprises within the state combined. The material prosperity of the state and its people depends in large measure upon the financial condition of the fuel operations. Therefore a care-

TABLE 10—*Natural Gas Production*

	W. Va.	Texas	Okla.	La.	Calif.
	All in 1,000,000 ft.³				
1906	119		4		.1
1907	123		5		.2
1908	112		12		.5
1909	116		28		2
1910	191		50		3
1911	207	6	67		6
1912	239	7	74		9
1913	246	12	75		11
1914	236	13	78		18
1915	244	13	88	26	22
1916	299	16	124	32	32
1917	309	17	137	31	49
1918	265	13	124	36	38
1919	234	23	163	47	55
1920	240	37	154	58	66
1921	175	45	124	58	76
1922	195	48	141	70	85
1923	204	75	203	112	131
1924	182	107	214	161	190
1925	180	135	249	153	188
1926	180	175	286	157	212
1927	162	254	327	187	212
1928	163	302	321	228	246
1929	167	465	358	261	342
1930	144	518	348	278	335
1931	Not reported	Not reported	Not reported	226	Not reported
1932	" "	" "	" "	194	277

TABLE 11—*Natural-Gas Gasoline Production*

	*W. Va.	Oklahoma	Texas	California
	All in 1,000,000 gallons			
1918	52	190	9	40
1919	52	190	9	40
1920	59	179	33	48
1921	55	185	77	58
1922	57	189	95	67
1923	63	270	178	173
1924	62	301	187	333
1925	58	391	214	303
1926	64	476	243	389
1927	64	548	321	498
1928	69	620	325	584
1929	73	676	419	840
1930	63	591	491	829
1931	53	455	427	670
1932	46**	378	353	545

**Largest production in the Appalachians and fourth largest nationally.
*Louisiana and Wyoming are next below West Virginia in production (1928).

TABLE 12—*Production — Oil*

	W. Va.	Texas	Okla.	Calif.
		In 1,000,000 bbls.		
1876	.1			
1877	.2			
1878	.2			
1879	.2			
1880	.2			
1881	.15			
1882	.1			
1883	.1			
1884	.1			
1885	.1			
1886	.1			
1887	.15			
1888	.1			
1889	.5			
1890	.5			
1891	2			
1892	4			
1893	8.5			
1894	8.5			
1895	8			
1896	10			
1897	13			
1898	14			
1899	14			
1900	16			
1901	14			
1902	13			
1903	13			
1904	13			
1905	11.5			
1906	10			
1907	9			
1908	9.5			
1909	11	9	52	73
1910	12	9.5	56	81
1911	10	12	51	87
1912	12	15	64	98
1913	11.5	20	73	100
1914	10	25	98	87
1915	9	28	107	91
1916	9	32	107.5	94
1917	8	39	103	98
1918	8	79	87	101
1919	8	97	106	103
1920	8	106	115	113
1921	8	119	150	138
1922	7	131	160	263
1923	6	134	174	229
1924	6	145	177	232
1925	6	167	179	224
1926	6	217	278	231
1927	6	257	250	231
1928	6	297	255	292
1929	5.5	290	216	227
1930	5	332	180	189
1931	4.5	311	153	178
1932	3.8			

Kansas, Louisiana, and Pennsylvania have productions larger than that of West Virginia, while Kentucky is about the same (1928).

West Virginia has a production greater than Poland, Japan, Canada, Italy, Germany, Egypt, Sarawak, Algeria, Ecuador, France, England, Czechoslovakia, Sakhalin (Russia), Iraq (which has about one-fourth of the reserves of the world); and a production about equal to India, Argentina, and Trinidad — 1928.

ful consideration of statistics dealing with these industries is of more vital interest than of those which so far have been developed.

West Virginia reached the peak of its gas production (Table 10) in 1917, while national production has increased since that time. Few, if any, new gas fields are likely to be discovered in the future, so that a further decline in production must be forecast for this state. The taxable income from gas properties has been decreasing also during the same period, although at a slower rate. The explanation why the taxable value remained higher than expected may be found in Table 11.

The production of gasoline from natural gas (Table 11) has increased during the last decade and a half. This is surprising when the production curve for natural gas is considered, and it is to be explained by the rapid expansion in the use of the internal combustion engine, particularly the automobile. Production bids fair to increase for years, possibly throughout the next decade. However, the increase in West Virginia production is almost negligible compared to the rapidly accelerated production in California, Oklahoma, and Texas.

West Virginia reached its maximum production of oil about 1900 (Table 12). Since then production has fallen off, and it is to be assumed that employment and taxation income from the industry have also been on the decline. The price of West Virginia oils is still high; Cabin Creek crude, for example, is bringing a remarkably high price.

TABLE 13—*Coal Production*

	W. Va. Prod. in 1,000,000 tons	Value in $1,000,000	U. S.	Pa.	O.	Ill.	Ky.
1909	52	45	380	138	28	51	11
1910	62	57	417	151	34	46	15
1911	60	54	406	145	31	54	14
1912	67	63	450	162	36	60	15
1913	71	72	479	174	36	62	20
1914	72	71	514	148	19	58	20
1915	77	75	532	158	22	59	21
1916	86	102	590	170	35	66	25
1917	86	196.5	552	172	41	86	28
1918	90	230.5	579	178	45	90	32
1919	79	...	466	150	36	61	30
1920	90	390	567	170	46	89	36
1921	73	207	416	116	32	70	32
1922	80	236	422	113	26	58	42
1923	108	285	658	171	40	79	44
1924	101	175	571	130	30	68	45
1925	122	210	581	137	28	67	55
1926	143	264	658	153	28	69	62
1927	145	250	598	272	30	47	69
1928	132	211	576	131	16	56	61
1929	139	c. 200	535	144	24	61	60
1930	121	182	468	124	23	54	51
1931	101	not reported	382	98	20	44	40
1932	84	" "	305	76	13	32	35

Coal production (Table 13) rose in this state until 1927, with the exception of a slight decline in the year following the world war, and a 19% drop in the 1921 depression. It is worthy of note that all other leading coal-producing states suffered more severely in that depression than West Virginia, with the sole exception of Kentucky, whose loss in production was only 11.5%. This state has suffered a smaller decline since 1929 than has the nation as a whole,[11] and its loss in 1932 was less than that of the nation. About the middle of the war, national production (Table 13) be-

[11]Minerals Yearbook, 1932-3.

gan to show signs of reaching a constant level.[12] Had industry realized the significance of this production curve at that time, much of the distress of the last decade might have been avoided.

TABLE 14—*Coal Production in West Virginia by Counties (1921)*

	1,000,000 tons	1000 men employed
McDowell	16.8	17
Logan	10.6	10
Fayette	9	12
Raleigh	7.8	9
Kanawha	6.4	6
Harrison	6	8
Marion	5.7	6
Monongalia	3.8	4
Mercer	2.7	3
Preston	2	2

Table 14 shows the production by counties in West Virginia, together with the number of men employed in each, for the year 1921.

TABLE 15—*Production of Light Oil and Benzol*

	Light oil in 1,000,000 gal.		Benzol in 1,000,000 gal.	
	W. Va.	U. S.	W. Va.	U. S.
1921	1	76	5	48
1922	3	101	1.9	67
1923	5	105	2.6	96
1924	5	101	2.1	91
1925	5.4	146	2.1	98
1926	5.6	164	Not reported	113
1927	6.3	129	"	109
1928	6.2	189	"	125
1929	6.5	200	"	121
1930	6.3	145	"	120
1931	Not reported	...	"	Not reported
1932	"	74	"	10.5

TABLE 16—*Coke Production*

	Coal burned to coke in 1,000,000 tons	Coke (W. Va.) Prod. in 1,000,000 tons	Value in $1,000,000	Coke (U. S.) Prod. in 1,000,000 tons
1912	.3	1.4	....	..
1913	.2	..	....	45
1914	.06	..	....	34
1915	.2	3.4	....	40
1916	.2	2.5	....	53
1917	..	3.0	....	54
1918	.5	3.2	16.7	55
1919	.5	1.4	22.01	43
1920	.6	1.8	16.8	51
1921	.4	.4	.4	25
1922	1.4	.9	6	37
1923	2.2	1.7	11	56
1924	2	1.3	6	44
1925	2.3	1.5	6.6	51
1926	2.6	1.7	6.9	57
1927	2.4	1.9	6.8	51
1928	1.4	1.8	5.3	52
1929	2.9	1.9	5.3	60
1930	2.8	1.9	5.0	48
1931	Not reported	..	Not reported	..
1932	1.4	.95	2.0	22

[12] H. W. Straley, III. The mineral resources of North America as compared with the rest of the world. National Technological Congress, 1933, in press.

TABLE 17—*Production of Ammonia Compounds and Tar*

	Ammonia Compounds in 1,000,000 gal.		Tar in 1,000,000 gal.	
	W. Va.	U. S.	W. Va.	U. S.
1920	14.6	657	6.0	...
1921	6.8	...	3	...
1922	18.8	...	6.7	...
1923	27	1151	15	441
1924	36.8	1089	16.7	422
1925	36.9	1278	15.6	481
1926	42	1381	16.5	529
1927	46.8	1435	20.5	547
1928	46.7	1598	20	632
1929	48.8	1712	20.8	681
1930	Not reported	1538	17.8	290
1931	"	Not reported	Not reported	
1932	"	708	"	303

TABLE 18—*Employment and Productivity in Coal Mining*

	Employees in 1,000 men		Tons per man day	
	W. Va.	U. S.	W. Va.	U. S.
1890	...	192	...	2.56
1891	...	206	...	2.57
1892	...	213	...	2.72
1893	...	230	...	2.73
1894	...	245	...	2.84
1895	...	240	...	2.90
1896	...	244	...	2.94
1897	...	248	...	3.04
1898	...	256	...	3.09
1899	...	271	...	3.05
1900	...	304	...	2.98
1901	...	340	...	2.94
1902	...	370	...	3.06
1903	...	416	...	3.02
1904	...	438	...	3.15
1905	...	461	...	3.24
1906	...	478	...	3.36
1907	...	513	...	3.29
1908	57	516	...	3.24
1909	...	...	...	...
1910	69	556	...	3.46
1911	68	550	...	3.50
1912	68	549	...	3.68
1913	75	571	...	3.61
1914	79	584	4.52	3.71
1915	76	557	4.89	3.91
1916	78	561	4.68	3.90
1917	88	603	4.35	3.77
1918	90	762	4.22	3.78
1919	95	777	4.18	3.84
1920	103	785	4.39	4.00
1921	102	823	4.79	4.20
1922	110	688	5.10	4.28
1923	117	863	5.44	4.47
1924	102	780	5.48	4.56
1925	110	748	4.95	4.52
1926	118	759	4.90	4.50
1927	120	759	5.15	4.55
1928	112	683	5.35	4.73
1929	105	654	5.34	4.85
1930	106	644	5.61	5.06
1931	...	...	...	...
1932	...	...	...	...

Tables 15 to 17 show the production of the larger groups of coal by-products. It is notable that by-product quantity has increased more rapidly than the amount of coal burned to coke. This is due to the extended use of by-product ovens, a tendency which will persist for the next few decades. Tar peculiarly enough is one of the few commodities which was not materially affected by the hard times of 1921. National coke production (Table 16) shows the same tendency toward becoming constant, which is evident in national bituminous coal production.

TABLE 19—*Machine Production*

	United States			West Virginia			
	%	1,000,000 tons	No. machines	Ave. per mach.	Tons	%	No. mach.
1891	...	6	545	11,398	...	...	....
1896	...	16	1,446	11,373	...	...	....
1897	...	23	1,956	11,579	...	...	....
1898	...	32	2,622	12,362	...	...	....
1899	...	44	3,125	14,068	...	...	....
1900	...	53	3,907	13,510	...	...	....
1901	...	58	4,341	13,325	...	...	....
1902	...	70	5,418	12,848	...	...	....
1903	...	78	6,658	11,712	...	...	....
1904	...	79	7,663	10,258	...	...	....
1905	...	103	9,184	11,258	...	...	....
1906	...	119	10,212	11,638	...	...	....
1907	...	139	11,144	12,432	...	...	....
1908	...	123	11,569	10,648	...	...	....
1909	...	142	13,049	10,920	...	...	....
1910	...	174	13,254	13,127	...	...	....
1911	...	178	13,829	12,854	...	...	....
1912	...	211	15,298	13,763	...	...	....
1913	...	242	16,379	14,801	...	...	....
1914	...	218	16,507	13,237	...	...	....
1915	...	243	15,692	15,501	...	...	....
1916	...	284	16,198	17,514	...	...	....
1917	...	306	17,235	17,514	...	...	....
1918	...	324	18,463	17,545	61	67.5	3,281
1919	...	276	18,959	14,559	56	70.3	3,136
1920	59.8	340	19,103	17,788	65	72.2	3,626
1921	65.6	273	19,618	13,901	56	77.2	3,229
1922	63.2	267	20,436	13,067	61	76.7	3,809
1923	66.9	377	21,229	17,799	85	78.0	3,936
1924	69.5	336	18,660	18,201	83	82.0	3,312
1925	70.6	367	17,551	20,895	100	82.4	3,381
1926	71.7	411	17,466	23,526	118	82.4	3,341
1927	72.2	314	17,388	21,511	122	83.5	3,397
1928	73.8	370	15,262	24,224	112	84.8	2,989
1929	78.4	403	14,731	43,710	118	85.8	2,718
1930	81.0	362	14,237	40,886	106	87.1	2,626
1931	...	...	.....	.....	...	...	....
1932	...	...	.....	.....	...	...	....

Table 18 shows employment in bituminous coal mining for the decade preceding the current depression. It is notable that national employment has fallen since 1923, while production did not reach its peak until 1926. An explanation may be found in productivity (Table 18), which has remained constantly high throughout the last decade. Further enlightenment as to the cause of both may be found in statistics of machine-mined coal (Table 19), which increased during the same period.

CONCLUSIONS

It is evident that production of many of West Virginia's minerals is nearing or has reached its peak. The major mineral products are among those which are apparently on the decline. Petroleum is long past its peak, and coal statistics indicated, in the last decade, that it was approaching a point where production may become essentially constant.

Jones[13] has pointed out that a constant or declining production cannot long support an increasing debt structure. Taxation is a sort of debt claim of the government against industry and those supported thereby. If his contentions are valid and the tax load is permitted to increase indefinitely, disaster of some kind is imminent.

The writer[14] has mentioned elsewhere the close relationship between mineral production and the financial structure as examplified by banking and insurance. A study is now in progress[15] which indicates far-reaching changes in these institutions within the next decade and a half.

While it is not the purpose of this paper to discuss national problems, suffice it to say that in a society as well integrated as that of this country it is necessary to take into consideration national and even continental conditions in order to solve problems which, a generation ago, would have appeared to affect solely the people of this state.

As to the solution of the many problems raised by the mineral-financial hook-up, predictions are unsafe. However, it seems certain that drastic revision of the taxation system of this state, as well as of the nation, must be undertaken. Perhaps drastic governmental control of raw material and other heavy industries is "just around the corner". It is even possible that such left-wing measures as government ownership and operation will be necessary before many years.

Whatever may be in store, it is incumbent upon scientific groups to throw their weight upon the scales in favor of technical control being placed in the hands of trained and competent personnel under rigid civil-service regulations.

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[13]Bassett Jones, Debt and Production. John Day. 1933.
[14]H. W. Straley, III, *idem.*
[15]F. J. Pettijohn and the writer.

The Mathematics Section

NOTES ON A CERTAIN SYMMETRIC DETERMINANT

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IN A RECENT number of the American Mathematical Monthly, Mr. Raphael Robinson proposed for solution the n-rowed determinant

$$D = |a_{ij}| \quad \text{where} \quad a_{ij} = |i - j| .$$

It is the purpose of the present paper to give the solution of, and to set forth several theorems in connection with, this determinant.

1. THE DETERMINANT AND ITS SOLUTION. Setting up the determinant we find it to be a zero-diagonal, symmetric array, with the elements of each row forming an arithmetic progression to the left and to the right of the principal diagonal.

$$D = \begin{vmatrix} 0 & 1 & 2 & 3 & \cdots & n-2 & n-1 \\ 1 & 0 & 1 & 2 & \cdots & n-3 & n-2 \\ 2 & 1 & 0 & 1 & \cdots & n-4 & n-3 \\ 3 & 2 & 1 & 0 & \cdots & n-5 & n-4 \\ \cdot & \cdot & \cdot & \cdot & & \cdot & \cdot \\ n-2 & n-3 & n-4 & n-5 & \cdots & 0 & 1 \\ n-1 & n-2 & n-3 & n-4 & \cdots & 1 & 0 \end{vmatrix}$$

The general solution of the determinant is readily obtained by making a number of elementary transformations. By first adding the first column to each succeeding column, and then subtracting each row, except the first, from the preceding row, the determinant is reduced to the form

$$D = \begin{vmatrix} -1 & 0 & 0 & 0 & \cdots & 0 & 0 \\ -1 & -2 & 0 & 0 & \cdots & 0 & 0 \\ -1 & -2 & -2 & 0 & \cdots & 0 & 0 \\ -1 & -2 & -2 & -2 & \cdots & 0 & 0 \\ \cdot & \cdot & \cdot & \cdot & & \cdot & \cdot \\ -1 & -2 & -2 & -2 & \cdots & -2 & 0 \\ n-1 & 2n-3 & 2n-4 & 2n-5 & \cdots & n & n-1 \end{vmatrix}$$

in which the value of the determinant is at once obtained as the product of the terms in the principal diagonal; that is

$$D = (-1)^{n-1}(n-1)2^{n-2}.$$

2. CONDITION FOR A PERFECT SQUARE. The determinant being symmetric with respect to the center of the square formed by its elements, it is possible to reduce it to the product of two other determinants. This was

done for both odd and even orders of the determinant. For the case of odd order, n was set equal to $2r+1$; then, adding the last column to the first, the last but one to the second, the $(r+2)$nd to the rth, and then subtracting the first row from the last, the second from the last but one, the rth from the $(r+2)$nd, the determinant is reduced to the form

$$\begin{vmatrix}
2r & 2r & \dots & 2r & 2r & r & r+1 & r+2 & \dots & 2r-1 & 2r \\
2r & 2r-2 & \dots & 2r-2 & 2r-2 & r-1 & r & r+1 & \dots & 2r-2 & 2r-1 \\
\cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\
2r & 2r-2 & \dots & 4 & 4 & 2 & 3 & 4 & \dots & r+1 & r+2 \\
2r & 2r-2 & \dots & 4 & 2 & 1 & 2 & 3 & \dots & r & r+1 \\
2r & 2r-2 & \dots & 4 & 2 & 0 & 1 & 2 & \dots & r-1 & r \\
0 & 0 & \dots & 0 & 0 & 0 & -2 & -2 & \dots & -2 & -2 \\
0 & 0 & \dots & 0 & 0 & 0 & -2 & -4 & \dots & -4 & -4 \\
\cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\
0 & 0 & \dots & 0 & 0 & 0 & -2 & -4 & \dots & -2r+2 & -2r+2 \\
0 & 0 & \dots & 0 & 0 & 0 & -2 & -4 & \dots & -2r+2 & -2r
\end{vmatrix}$$

Evaluating the $(r+1)$-rowed determinant in the upper left of this determinant and the r-rowed determinant in the lower right, the value of the determinant of order $2r+1$ is found to be the product of determinants whose values are $r2^r$ and 2^r, i. e., $r2^r \times 2^r = r2^{2r}$.

Setting n equal to 2r and following the same process, it is found that the determinant, when of even order, can be reduced to the product of determinants whose values are $(2r-1)2^{r-1}$ and $(-2)^{r-1}$, i. e., $(2r-1)2^{r-1} \times (-2)^{r-1} = -(2r-1)2^{2r-2}$

While the second result is not of special interest, from the first there follows at once the

THEOREM: If the order n of the determinant is such that it can be stated in the form $n = 2r+1$, where r is a perfect square, then the value of D is also a perfect square.

3. THE PRINCIPAL MINORS. With respect to the principal minors of the elements of the determinant D, it was found that the following theorem could be stated:

THEOREM: Of the n^2 elements of the determinant D, only 3n have principal minors with values other than zero. Moreover, these 3n elements can be classed in four groups as follows:

(a), the first and last elements of the principal diagonal, each of whose principal minors has the value $(-1)^{n-2}(n-2)2^{n-3}$, i. e., differs from the value of the determinant by the factor $-2(n-1)/(n-2)$;

(b), the n-2 elements of the principal diagonal other than the first and last, each of whose principal minors has the value of $(-1)^{n-2}(n-1)2^{n-2}$, i. e., differs from the value of the determinant only in sign;

(c), the 2n–2 elements of the obliques immediately to the left

and to the right of the principal diagonal, each of whose principal minors has the value $(-1)^{n-2}(n-1)2^{n-3}$, i. e., differs from the value of the determinant by the factor -2;

(d), the element at the upper right and that at the lower left of the determinant, each of whose principal minors has the value $(-1)^{n-2}2^{n-3}$, i. e., differs from the value of the determinant by the factor $-2(n-1)$.

The existence of this theorem is established by the following considerations. In the first place, upon calculating the value of the determinant by the method of first minors, the three first minors, which exist for each row as set forth in the theorem, are exactly sufficient to give the value of the determinant as previously determined. Moreover, a process of random sampling, in which the values of the first minors of a large number of elements were calculated, indicates the value of all other principal minors to be zero.

4. RECIPROCAL ARRAYS. The first minors of the elements being known, the reciprocal array whose elements are the first minors of the corresponding elements of D was set up. By the process of mathematical induction, and the use of the relationships for arithmetical series, the following theorem was established:

THEOREM: The value of the reciprocal determinant whose elements are the first minors of the corresponding elements of D is zero when the order of D is odd; moreover, whether the order of the determinant be odd or even, the sum of the terms of the reciprocal array is $-2(n-1)$ times the value of D.

It may also be remarked that the sum of the terms in the first row (or column) and of those in the nth row (or column) each differ from the value of D only in sign.

The determinant whose elements are the co-factors of the corresponding elements of the original determinant was next set up. By the methods used in the preceding work it was found possible to state the following

THEOREM: The value of the determinant whose elements are the co-factors of the corresponding elements of D, as well as the sum of the elements, is zero when the order of D is odd; further, when the order of D is even, the sum of its terms is $(-2)^{n-1}$.

The Social Sciences Section

OUR FUNDAMENTAL SOCIAL PROBLEM

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IN 1858 LINCOLN made the famous speech in which he said, "A house divided against itself cannot stand! I believe this government cannot endure permanently half slave and half free. . . . It will become all one thing or all the other." The same sort of assertion could be made today with regard to the United States. In those days it was a sectional issue between the North and South over the question of slavery. Today we have, or have had until lately, between political democracy and economic autocracy a conflict which extends into every community of the country. Can a government thus divided permanently endure?

To understand our problem it is necessary to know some of the changes which have taken place since the middle of the past century. Everybody knows that a great Civil War occurred early in the sixties which resulted in the defeat of the South and the abolition of slavery. The deep significance of that struggle, however, has become apparent only of late. The plantation-slave capitalistic system, which was agricultural and which had done so much to keep northern industrialism in check, was annihilated — without compensation. Not only that, but while the South was trying to establish a government which would make it possible for her to determine her own destiny, our federal government was in the hands of a sectional party—the Republican—which managed affairs in the interest of nothern capitalism. Consider such Republican measures as the high tariff, a national banking system, the legalization of contract labor (later repealed), gold payment to the bondholders, repeal of the excise taxes and of the income tax (while the tariff remained high), government support of the railroads, and the legislation in favor of the Union veterans. Is not this class legislation? And when, after the humiliating reconstruction days, the southern delegates were again admitted to congress "the South had become merely an appanage of New York and the Ohio Valley".

Another movement which we must understand is the so-called "economic revolution" which has taken place since 1850. Being so much less spectacular than the Civil War it escaped the attention of American historians until about fifteen years ago. Then Prof. William E. Dodd of Chicago (now American ambassador to Germany) and Arthur M. Schlesinger of Harvard (then of Iowa) began to appreciate how this movement has revolutionized American Life. Various forces caused the economic life of the country to develop by leaps and bounds. The amount of capital invested in manufacturing, for instance, increased from approximately half a billion dollars to ten billions between 1850 and 1900. In agriculture, transportation, communication, finance, and mining similar developments took place. Along with the expansion of the volume of business there went a development in business organization. "Big Business" took the place of little business. The directors of a large "trust" or a "holding corporation" or an "absorbing corporation" became economic barons and dictators. One fundamental result of the economic revolution has been that it

has divided American society sharply into two classes: a small group of employers and a large laboring population.

That our national wealth is very unevenly distributed everybody knows. The Federal Trade Commission found in 1926 that in thirteen representative states 2.2% of the population owned 50.9% of the wealth. A few hundred men own or control about one half of the corporate wealth of the nation, while a majority of the people have practically nothing which they can call their own.

When it comes to the distribution of the national income, the story is similar. Paul H. Douglass has shown (World Tomorrow, December 28, 1932) that the relative amount of wages between 1926 and 1932 went down from 100 to 40, while the total interest and dividend payments by American corporations went up from 100 to 160 during the same time—having been as high as 196 in 1930. This would seem to indicate that we have in this "land of the free" a small privileged class and a large class that is little better off (if any) than slaves.

We need not here re-argue the proposition as to whether it is possible for an honest man to accumulate a large fortune. Students of existing American fortunes tell us that practically all of them have been amassed, in part, by unethical methods, many by illegal methods, and some by downright criminal methods. But that is all forgotten—if not forgiven—by the masses if the devotee of the god Success has worshipped successfully enough.

To me it seems doubtful whether any man in one brief lifetime could acquire great material riches without some form of government privilege. Such privileges may assume a variety of forms, such as tariffs, low taxes, freedom from restraint or regulation, franchises, government loans, subsidies, monopolies. This fact makes it unavoidable that Big Business should everywhere be in politics and everywhere corrupt government. First there is the necessity of obtaining the privilege, and once the privilege has been obtained, it must be protected or extended. This is particularly true of the public utilities corporations in the cities.

If anyone still fails to see the connection between large business interests and government, let him turn to the writings of the "muckrakers" who began to flourish some 30 years ago. What was ture in this respect at the turn of the century is still true — with modification. Writers like Lincoln Steffens, Ida M. Tarbell, Upton Sinclair, Charles Edward Russell, C. P. Connolly, Ray Stannard Baker, Thomas W. Lawson, David Graham Philips, and others revealed in hundreds of articles the close connection between business and politics. Many of our large cities, including New York, Chicago, Philadelphia, St. Louis, Minneapolis, Pittsburgh, Cincinnati, and San Francisco were honeycombed with corruption. Everywhere the business interests, the bribe-givers, corrupted government. What was true of the cities was also true of the states, and, in measure, of the federal government. Lincoln Steffen, the prince of the muckrakers, stated in the introduction to his series on state government — *Enemies of the Republic*—that every time he attempted to trace to its source the political corruption of a city ring, the stream of pollution branched off in the most unexpected directions and spread out in a network of veins and arteries so complex that hardly any part of the body politic seemed clear of it. Corruption was not confined to politics, but extended into finance and industry. The source of sustenance of our bad government was not the politicians, the bribe-takers, but the bribe-givers, the captains of industry. "The highway of corruption", he wrote, "is the road to success."

In his article on Missouri he explained what he meant by the "System." It was corruption settled into a "custom of the country"; the betrayal of trust established as the form of government. A few bribes, or even a hundred bribes, might not be so bad, but in Missouri—as elsewhere—there was a system of bribery—"corruption installed as the motive, the purpose, the spirit of a state government." The "combine" was composed of dishonest legislators of both parties who were usually in the pay of big business interests and were controlled by the lobby. The lobby also controlled the honest legislators, for they represented the corporations and big business which contributed to the campaign funds. Such contributions were everywhere the first step toward corruption. It was wholesale bribery which bought also the honest legislator. The lobby served both the party and business.*

That our national government was not free from the taint of corruption may be seen from the articles by David Graham Phillips on "The Treason of the Senate," which appeared in the *Cosmopolitan* in 1906; and that it is not now free from that taint may be inferred from the Senate investigations into the elections of Frank L. Smith of Illinois and of William S. Vare of Pennsylvania, and from the reports of the "Nye Committee". This committee reported that in the senatorial campaign of 1930 the sum of $4,898,121 was expended in eighteen states, ranging in amounts from $63,375 to $2,005,033. The report states that "the use of such large sums is incompatible with a free and uncontrolled expression of the will of the people and with the maintenance of even a semblance of that equality of opportunity for citizens to seek public office, which is the very foundation of genuine democracy."

An interesting sidelight on the relation between money and our federal government is the fact that in the seventeen presidential elections since the Civil War the political party with the larger campaign fund has elected the president fifteen times. The only exceptions took place in 1916 and 1932, and in neither of these cases was the relative difference in the size of the funds very large. This does not necessarily mean that the size of the campaign chest is the determining factor in an election, but the above-stated fact is, nevertheless, an interesting commentary on our form of government.

What difference does it make, somebody may ask, if business does occasionally meddle in politics, provided we get, on the whole, a decent and efficient system of government and economics? But there is the crux of the matter. How can anybody call a system of economics decent that throws ten millions of laborers out of employment? And how can a government be called decent that does not take care of its needy and destitute citizens. Our government cannot even take care of crimes of violence, let alone the administration of social justice. Or how can the government atone for the sins of our economic system? It produces none of the necessities of life; how, then, can it supply them? How long can the government go on borrowing billions of dollars and distributing them among the victims of our economic system without running into bankruptcy? The government is supposed to protect us against criminals; but is there no connection between criminality and racketeering on one side and an economic system that makes decent living impossible for millions of people on the other? Is there not something radically wrong with a system under which there is an "overproduction" of nearly every basic commodity of our civiliza-

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*Regier, *The Era of the Muckrakers* p. 84.

tion (including food) and under which the federal government has to carry 25% of the population of this state (West Virginia) on its relief rolls? In reality there has been an overproduction of goods only to the extent that they could not all be sold at a profit. We have never produced more than our people could and would gladly consume if they had the purchasing power.

We find ourselves compelled to look into our economic system—the capitalistic system. This system is based on private profits and rugged individualism, and flourished under a regime of laissez-faire. It does very well in a new country which has natural resources, a large farming population, and a limited labor supply—as was the case in this country until recently. When, however, the industrial class exceeds the rural population in numbers, when labor becomes plentiful and cheap, and when technological developments make it possible for employers to lay off more and more workers—then the system breaks down. When fewer and fewer people receive wages, who will buy the products of industry? The consuming power is then destroyed. Is not this precisely what we are suffering from today? We can hardly call the present depression merely another panic, such as the many we have had in the past. It is a technological depression. We have reduced wages so much that the purchasing power has been destroyed. There is little hope of getting the capitalistic machine to function again as it formerly did. Capitalism has concentrated on production to such an extent that that problem has been pretty well solved. We can not turn out the same volume of commodities that were produced in 1926 with about 70% of the labor and little more than 50% of the wages. This means that capitalism in its pure form is unnatural and self-terminating.

Stuart Chase claims that in order to raise our industrial production to the level of 1923-1925 and employ all our workers, it will be necessary to cut the work-week to 26 hours. Most of the NRA codes provide for a 40-hour week. But with such a work week we shall continue to have an unemployed army of twelve million. In other words, the "technocrats" are fundamentally right in their contention, even though the capitalists have been trying to laugh them out of court.

The question arises, is it impossible to work out a system under which a man—any man—may work as long as he pleases and receive full returns for his labor? To answer that question in the affirmative is to admit bankruptcy to the human mind and human character. We *must* work out a social and democratic system of distribution. To do this will require an open mind and a courageous heart. Not to do it will probably lead to calamity, chaos, or violent revolution.

What is our choice? What courses are open to us? The fundamental alternative is clear enough. It is either autocracy or democracy. There are those who claim that the economic dictators should be given a free hand to manage the government as well as business and industry. Even Lincoln Steffens, the man who has worked so hard for clean government, has come to the conclusion that it is useless to oppose the economic powers; that the large-scale business men *must* be in politics, and that it is for the common good that they should be. Others see in the lobby, which is composed of the representatives of occupational groups, a sort of "third house" of the legislature, which, they claim, will ultimately dominate the whole government.

But why should we turn the government over to the advocates of an economic system which so clearly is breaking down? The financial and industrial wizards of our age have suffered a distinct loss of prestige during the last few years. We no longer look up to them as to the saviors of our civilization.

The true democrats hold that our whole system, economic as well as political, must be thoroughly democratized. The demoralizing conflict between business and government must be eliminated. The government must be made to represent the people truly by abolishing the profit system and by taking over all the basic industries and managing them in the interest of society. It makes no difference whether we call such a system socialistic, communistic, or an extention of the NRA. The point is that this is the logical alternative to the capitalistic system. Socialism and communism agree in their aim. which is a prosperous, classless, co-operative society; but they differ in method or tactics. The former depends upon suasion and majority rule, while the latter may use violence and set up a dictatorship of a minority. Both claim to be Marxian socialists. Which of the two methods is to be employed in a given country depends largely upon the popular support which the movement toward democratization receives and upon the resistance which it encounters. If the privileged classes assume a Tory attitude and refuse to make any concessions, violence may become unavoidable.

It is safe to say that the merits of socialism and communism would be much better understood in the United States were it not for the fact that all the public-opinion-forming agencies—the school, the church, the press, the radio, the cinema—are capitalistically owned and controlled. This situation makes it necessary for thinking people to turn to the liberal and radical press for information.

Aside from these two fundamental alternatives—capitalism and socialism—several compromises are being tried in various countries at present, notably Fascism and our "New Deal". Under both, the capitalistic system with its profit motive is left in-tact but in a modified form. Fascism, in order to be successful, depends upon an aggressive party, headed by able and ruthless leaders who do not hesitate at acts of coercion and violence. Such a party develops at a time of national distress and is, therefore, highly emotional. It appeals especially to the middle class, and brings powerful pressure to bear on the nationalistic sentiment—the spirit of patriotism. Once in power it lays a heavy hand on big business but especially on little business and on labor. It seeks to regulate every phase of civilization in the interest of the common good. Minorities are ruthlessly supressed, the press is rigorously censored, and personal liberties limited. Whether such a system is a permanent solution of a nation's problems is not yet determined. It would seem doubtful when we consider that it is based on emotionalism, and that the means of production are left in private hands.

Our own Rooseveltian compromise is likewise too young to be appraised fully. It aims to bring about social justice and economic security at the same time that it maintains the benefits of private enterprise and democratic liberty. It definitely breaks with the doctrine of laissez-faire, but leaves the capitalistic system intact. How a benevolent government can permanently counteract the evils of a vicious economic system, it is hard to see. Then, too, what assurance have we that even these relatively mild beginnings which have been made can be maintained, remembering that the electorate has never yet had an opportunity to register its approval or disapproval at the polls. When Roosevelt came into office he had on his hands a thoroughly scared country that was willing to follow in any direction which he might choose. In our next election, our privileged classes will probably put up a strenuous struggle to maintain their privileges. The battle royal in American politics is still to be fought.

As it is we have a dualism that extends into every sphere. We should like to promote the interests of the common people, but everywhere and always we are obliged to preserve property rights. This dualism extends into politics, government, economics, education, religion, and every other phase of life. What a simplification it would be if we could centralize our whole system around the single objective of promoting the common wealth! It would simplify government and economics, vitalize religion and education, and eliminate a lot of social snobbery and hypocrisy.

When once we have our fundamental problem clearly in mind and once we know the alternatives from which we may choose we may be able to determine our policy. We can create in this country any system we choose to create, provided we have the will to do so.

THE ECONOMIC BACKGROUND OF THE AGRICULTURAL STORY OF THE OLDER NORTHWEST, 1865-1880

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THE AREA embraced by this study comprises the five states of the "Old Northwest"—Ohio, Indiana, Illinois, Michigan, and Wisconsin—plus the three states immediately west of them—Missouri, Iowa, and Minnesota. Compared with our last "Great West" of the period, 1860-1890, we may call it the "Older West". Turner calls it "the economic and political centre of the republic", with "the Populism of the prairies" at one edge, and "the capitalism that is typical of Pittsburgh" at the other. *(1)* It has been a politically important area, for it has furnished the nation with a president or a vice-president in every election from 1860 to 1924 inclusive *(2)*; and during the Civil War it furnished such leaders as Lincoln and Chase in Washington; and Grant and Sherman in the field; as well as over one-third of the troops of the Union armies *(3)*. For this section the war was a struggle between King Cotton and King Wheat *(4)*.

Fundamentally an agricultural region *(5)*, it drew its population chiefly from New England, New York, the South, and even from Germany *(6)*. Once opened to settlement, it saw a rapid increase of population. In the decade prior to the Civil War, four of these states more than doubled their population. Minnesota led with an increase of approximately 273%; while Iowa came next with approximately 450% *(7)*. By 1870 this area comprised over one-third of the farm population of the United States, and double that of the North Atlantic region *(8)*. In this same period of the sixties, the farmers of this area were the nation's chief wheat producers *(9)*.

The rapid occupation of this area during and after the war may be attributed to several reasons. The Homestead Act of 1862 had made land more easily obtainable than ever before. The next year no less than a million acres were occupied, both in this area and further west. A second cause was the use of machinery in agriculture, which enabled farming on a large scale *(10)*. A third cause was the coming of a large surplus industrial population, due to the three-fold causes of demobilization of the armies *(11)*, cessation of war industries, and immigration *(10)*. All this resulted in a record-breaking corn and wheat output. Two other causes for this enormous output were the war demands for feeding troops *(12)* and a crop failure

in England. During the war period, wheat and flour exports to that country increased 43% *(13)*. Farm acreage increased during the 'sixties from 5% in Ohio to 137% in Minnesota *(14)*. In 1865 the states of Illinois, Indiana, Ohio, Iowa, and Kentucky led the nation in the corn crop yield with a total output of more than a half billion bushels *(15)*. Five years later the output of Iowa alone increased 50%. Wheat output also showed an increase of 50% in Iowa, 54% in Indiana, 131% in Missouri, and about 371% in Minnesota *(16)*. The nation as a whole increased its output in wheat by 221% and corn by 98% *(17)*. It is interesting to read in an Illinois newspaper the complaint that drouth had damaged the corn crop beyond help *(18)*; yet the official figures show that the corn output for that state for that year exceeded 109,000,000 bushels, or a falling off of 46,000,000 bushels from the previous year *(16)*.

Taking the nation as a whole, the corn acreage in the five years since the end of the Civil War more than doubled while the wheat acreage increased by more than half *(19)*; and the population engaged in agriculture had increased over half *(20)*. In the area of our study alone the acreage of improved land had increased nearly 50% *(21)*.

Living in a day of limited social and educational advantages for rural people, the farmer remained an extreme individualist who failed to understand the rest of the world about him *(22)*. When depression hit him, he failed to realize that his own lack of progress and his inertia were partly to blame *(23)*.

In this area wheat, a frontier crop *(24)*, had spread rapidly due to favorable soil, also to the open prairies *(25)*. In Wisconsin, for example, it had a tendency to become the single crop, due to a labor shortage, lack of capital, abundant and cheap fertile land, and its high prices during the war, plus the inertia of the farmer *(26)*. The farmer failed to realize that soil, climate, and market conditions would demand a change *(27)*; also that wheat was traveling west with the frontier. For example, in 1848 5% of America's wheat came from west of the Mississippi and in 1876, 40% *(28)*.

One fundamental cause of the agrarian unrest of later days in this region lay not only in the excessive cultivation of wheat, but also in the too rapid opening of this part of the country *(29)*. According to Charles Francis Adams, Jr., "They have gone too far west" *(30)*. In Iowa the rapid increase of population took up not only the best lands but also the untimbered prairies, far from streams and exposed to the evils of drouth, prairie fires, grasshoppers, wintery storms, and tornadoes; and as the settlers came in by rail and not by covered wagon, they placed their chief reliance upon the railroads and were willing to make any sacrifice to aid the expansion of the latter *(31)*.

During the whole period of our study, the corn acreage of the nation at large more than trebled; and so did the wheat acreage; but the prices of both crops fluctuated. From 46c a bushel in 1865, corn rose to 79½c in 1867, when it began to fluctuate. By 1872 it stood at 39.8. In 1874 it was 64.7c; then it fell to 31.8c in 1878. After that it began to rise. Wheat likewise fluctuated. From $1.468 a bushel it rose to $2.064 in 1866; then fell to 94.1c in 1869. Two years later it stood at $1.258, then fell to 94.1c in 1874. For the remainder of our period, it fluctuated, standing at 77.7c in 1878, then rising to $1.108 the next year *(19)*.

Among other causes for these price fluctuations may be listed the close of the

Civil War, with the demobilization of the Union armies *(32)*. The fall in prices in foreign and eastern markets *(33)* came in 1868, two years after the close of the Austro-Prussian War. The price rise shortly after 1870 can be attributed to the Franco-Prussian War *(34)*; and the rise in prices after 1878 can be attributed to the crop failures in Europe after 1875 and to the Russo-Turkish War, which closed the Russian ports *(35)*. The export figures for this period bear out this fact *(16)*.

Closely linked with the fluctuating prices was the currency situation. The defeats of the federal troops during the early period of the war, the danger of war with Great Britain, and the inadequate financial program of Secretary of the Treasury Chase, caused many to doubt the ability of the Lincoln administration to weather the storm. As a result, people began to hoard their specie, and this led to a suspension of specie payments *(36)*. This in turn led to fluctuation of the dollar. In 1865 it fell to 49½c. Between 1866 and 1870, it remained between 71c and 73c. This rise in price was due to the Act of 1866 for gradual retirement of the greenbacks *(38)*. By 1872 the currency was worth 89.4c on the dollar; and it remained between that figure and 87.8 until after 1876, after which it rose steadily until it reached par in 1879 with the operation of the Resumption Act *(37)*.

During this period of our study the burning question of the day was whether or not the great volume of paper currency called forth by the war should be contracted in order to enable resumption of specie payments. These currency fluctuations became the principal cause of high interest rates *(39)*, some of them rising as high as 15 to 20% *(40)*. As we have noticed, much of this region was settled during the period of the war and shortly thereafter, at a time of high prices; and the settlers incurred many debts. Some were due to need of timber when they settled treeless areas *(41)*; others due to purchase of lands from grants to railways, schools, or soldiers *(41)*; others due to investing in stocks of railway lines to be built through their respective communities *(42)*; others for the purchase of farm machinery, such as reapers at $200- 225, and mowers at $100-125 *(43)*.

Prices of other goods bought by farmers either remained high or slowly increased. For example in Ohio flour rose from $5.75 a barrel in 1861 to $6.50 in 1878; sugar from 9c to 12½c; and coffee from 16c to 28c *(44)*. Most of these supplies were bought on credit and with the expectation of increased farm values and high crop prices due to the war-time boom prices. When Hessian flies destroyed the wheat crop, or corn crop prices were low, the farmer would have to sign another note. The result was that his debts, contracted in days of inflated currency, must be paid with specie worth 20 to 30% above the original value of the debt. As many farmers could not meet such obligations, mortgages and foreclosures resulted *(45)*. Such a situation as this caused the West to press upon Congress to check the contraction program of Secretary McCulloch. Thus arose a sectional issue between the money-lending East and the money-borrowing West *(46)*. True, Congress did yield temporarily by the Act of February 1868, which prohibited further greenback retirement, and authorized a reissue of $44,000,000; but after the panic of 1873, Grant, dominated by the big business men of the East, vetoed a bill to force a permanent reissue of greenbacks to the amount of $400,000,000 *(47)*.

National bank currency was likewise unpopular with the inflationists. They brought up typically Jacksonian arguments to the effect that these banks were making from 15% to 40% profit upon the capital invested; also that they intensi-

fied the concentration of financial control in the Northeast — about New York, Philadelphia, and Boston *(48)*.

Likewise there grew the popular demand in this region that the national debt be paid in greenbacks *(48)*. Such a plan was opposed by the *Illinois State Journal* in 1867 *(49)*, but inflation was supported by the Chicago *Tribune* of ten years later *(50)*, for this whole decade by all the Chicago Congressmen except Long John Wentworth *(51)*.

The middleman also must share part of the responsibility for the plight of the farmer. He fixed the prices farmers received for their crops and paid for their goods; and in many cases he took unfair advantage of the farmer's ignorance of market conditions *(52)*. Easily able to prevent competition, he often induced the farmer to buy materials he did not need *(53)*. Agents were yet another type of middleman. One class of agents often sold on credit to the farmer, and charged high prices in order to get a larger commission for themselves *(53)*. Another class of agents began to infest the prairie regions, too. This included the man who would get large sums from eastern capitalists to lend to the western farmers on high interest terms, and often charged commissions at both ends *(54)*.

One cause of the high prices of farm machinery happened to be that many of these machines were under the protection of unexpired patents. Often when a patent did expire, it would be renewed either by political influence or by making some slight improvements. The Patent office did not always make a careful investigation of all applications *(55)*.

The railroads likewise expanded rapidly into this region. Due to the need of railway transportation, a mania of railway construction hit this region in full force. For the country as a whole, railway mileage increased 87½% from 1867 to 1873 *(56)*; but in six Granger states — Illinois, Wisconsin, Iowa, Minnesota, Nebraska, and Kansas — the mileage increased 254% *(57)*. Prior to 1865, from 2,000 to 3,000 miles of railway were built each year. But this rapid expansion after 1865 brought the average yearly construction up to 7,379 miles in 1871 which in turn led to an increased demand for iron, steel, and labor. This increased the construction costs, which in turn led to such evils as overbonding and excessive fixed charges *(58)*; also to the rise of a new class of promoters, namely men able to build railways entirely at the expense of other people. The desire for railways led towns, counties, states and even the Federal Government to contribute to construction expenses by loans, bonds, stock purchases, and land grants *(59)*. For example, in Iowa it was estimated that in the period 1865-1871, one acre out of every 8½ had been thus donated *(60)*. Promoters even induced farmers along the right of way to buy railway stock, both to aid the building of the line and in the expectation of dividends later *(61)*. In six years following the war fully $500,000,000 was thus invested *(62)*.

Naturally every railroad sought a profit. Three results followed, namely, high freight rates, cut-throat competition with discriminations between places, and fraudulent practices of dishonest directors. The latter two of these items *(63)*, plus poor business in the Northwest, caused a decline in railway earnings and no dividends for the farmer stockholders *(59)*. The railways and the elevators combined to take advantage of the farmer. For example, in 1867 it was shown that the cost of shipping shelled corn from Iowa to Liverpool was ten times what the farmer received for his grain at the elevator; and to carry one bushel of grain from the

Mississippi River to the Atlantic Seaboard cost 52½c, and from Dubuque to Chicago, 20c *(64)*. Parton in his intended expose of scandal connected with the Chicago and Northwestern writes:

> "It costs 3 bushels of corn to send one to market a distance of 100 miles; to get a pair of boots, 100 bushels; 1,000 bushels to get a suit of clothes; and two tons of corn for a ton of coal. A farmer of Waterloo, Iowa, was actually brought $5 in debt by a shipment of barley to Chicago." *(65)*

From 1871 on, people began to recognize the railroads no longer as "the pioneers of a driving civilization or the harbingers of an increasing prosperity", but as tools of extortion in the hands of capitalists *(66)*. The railroads were now clearly not in sympathy with the patrons and openly sought to intimidate the public. One railway official announced that regardless of right or wrong, his company was determined to make it terrible for the public to fight it *(67)*.

With the rise of competing lines the railroads either absorbed them or cut the rates sharply *(68)*. For example, in 1876 the rate on cattle from Chicago to Boston was a dollar a carload *(69)*. The loss on such low rates was partly made up by increasing the rates to and from non-competing points; hence, the rise of discriminations not only between places *(70)* but even between persons. Passes were given prominent public officials; and secret rates and rebates to certain shippers *(71)*.

The period of our study is the day of such men as Jay Gould, Cornelius Vanderbilt, Daniel Drew, and Jamee Fisk; also of the famous Credit Mobilier; of "Black Friday"; and of Gould's operations connected with the Erie. The system of railway construction of that day was wasteful and corrupt *(72)*; and stock-watering was frequently practised. In 1867-8-9, 28 railways increased their capital by 40% *(73)*; and control of the railways passed gradually into hands of a few men in the East *(74)*. Men like Drew and Fisk used such a situation for their own profit by deliberately creating a "money panic" in 1868 in order to get into their hands all of some newly-issued stock of the Erie. Such a step caused a money shortage in the banks of New York City at a time when cash was needed by the farmers to move their crops. This caused mortgage foreclosures for many farmers *(75)*. It is also interesting to notice that within the next four years following this maneuver, the stock of the Erie was watered from $17,000,000 to $78,000,000 in market speculations *(76)*. Such practices were held to be one great cause for the panic of 1873. Investigations showed that the railroads of the country, with an actual investment of $2,400,000,000, had a total capitalization of $6,200,000,000 *(77)*.

Taxes played a part in this situation. During the war internal revenue taxes were put upon all goods used by the rural people; and taxes were heavy upon real and personal property *(78)*. More than half the customs receipts came from duties upon sugar, molasses, wool, and cotton goods; and internal revenue duties were heavy upon liquor and tobacco *(79)*. The real cause for unrest, however, seemed to be the inequalities, rather than the size of the burden. Large amounts of wealth were invested in government bonds, tax-exempt securities; while the farmer's land and the mechanic's house paid heavy taxes. The bondholders bought in days of depreciated currency, and with resumption, would be paid in gold *(80)*. Railways were dodging their share of the taxes, and the farmer was being taxed to pay for railway stock bought by his county or township *(81)*.

The tariff also contributed to the unrest in this region. The Morrill Tariff of 1864, passed at the behest of the manufacturing interests, meant for the farmer high prices for goods he constantly used, from sugar to plowshares *(82)*. The manufacturer benefited thereby *(83)*. Mr. Burchard of the Illinois legislature well expressed the feeling of the farmer in 1866:

> "Educated as a protectionist, since 1847 a constant reader of the New York *Tribune*, all my proclivities and sympathies have been toward that school. But during the past summer, considering what is for the interest of the people of Illinois and the western agricultural states, every examination drives me further and further from my early views. Upon every pound of iron used the farmer must pay a bonus. He must sell or pay the price of one bushel of oats *to pay the extra cost imposed by tariff*, when he has a horse shod. Illinois must be an agricultural state. Fifty million bushels of wheat — shipped as grain or flour — from Chicago annually are not to decrease. Let us get in exchange for it as cheaply as we can the products of other regions, and if the English importer will sell us in New York more iron or other commodities for it than the manufacturers of the East, let us buy of him" *(84)*.

In this, Congressman Henderson of Missouri *(85)*, Senator Trumbull of Illinois, Congressman Grimes of Iowa, and other leading men of this area backed him *(86)*. So did the Chicago *Times* and the Chicago *Tribune (86)*.

The tariff bill of 1866, while it made a few revisions, was likewise unpopular with this area. The northern protectionists backed it, but the western Republicans rejected it regardless of appeal to party loyalty *(87)*. Had President Johnson in his famous "Swing-around-the-Circle" trip of 1866 appealed to the western feeling of magnanimity, or of fair play, he might have gained support from this region; and had he based his policies upon economic issues, he might have stirred the Northwest to its depths and strengthened his cause tremendously *(88)*. Johnson clubs were appearing here during the spring and early summer of 1866, all opposing the tariff *(89)*; and the Chicago *Tribune* practically called upon him to veto the bill if it should pass Congress *(90)*. So intense was the opposition in 1866 that the leaders in Congress became alarmed and postponed further consideration until after the Congressional elections of 1866 *(91)*.

A geographical analysis of the votes upon the tariff bill the next year shows the East generally for it by substantial majorities in each house; the northwest against it 28 to 39 in the House and 8 to 7 in the Senate; but if we exclude Ohio and Michigan, the Northwest vote stood 9 to 36 against in the House and 3 to 8 in the Senate. Ohio and Michigan voted aye 19 to 3 in the House and unanimously in the Senate *(92)*.

The tariff acts of 1870 and 1872 sought to remedy the situation in the West with some reductions *(93)*; but evidently failed to do so, when we find Mr. Cyrus McCormick, the famous manufacturer, holding the tariff rates responsible for the high cost of the reapers he sold the farmers, and encouraging them to fight for free trade *(94)*. However, these reductions were removed in 1875 due to the panic of 1873 and the need of increased revenue *(95)*.

The people of this area, despite their strong Jeffersonian and Jacksonian background, were steadily going Hamiltonian. The Republican party of this area had drawn its strength from the Whigs, the Democrats, and the Liberty Party of antebellum days *(96)*. Yet, by 1872 the Republicans are led by such men as Grant and

Logan, both of whom were Democrats prior to the war. Of the original pre-war members of the Republican party in Illinois, only two were still in the party fold by 1872. Lincoln was dead and his most intimate friends had left the party; and in Wisconsin, of eight leaders of the party prior to 1860, only two were left. The others had either died or left the party *(97)*. Clearly a new group of men had taken over control of the party. Its outlook was changed. The intemperate character of the controversy between President Johnson and Congress also did much to force various leading statesmen of this area from backing Lincoln's policies into the Radical camp led by such men as the Gettysburg ironmaster, Thaddeus Stevens of Pennsylvania, and his fellow-Easterners *(98)*.

It was clear that the Jeffersonian-Jacksonian frontier and rural elements had lost their grip upon the party in the West. They were also losing their grip upon the government. In the 43rd Congress, elected in 1874, 61% of the members were lawyers, 16% merchants and manufacturers, and only 7% were farmers *(99)*. In the Illinois state legislature, for example, predominantly Republican *(100)*, out of a total of 204 members we find but 48 farmers *(101)*; and Illinois had more than half of her people engaged in agriculture *(101)*.

Fundamentally the frontier was going west and with it much of the old frontier spirit; and with it also wheat-growing. King Wheat was forced to vacate this realm in favor of other types of agriculture, and eventually to urban and industrial life. It is true that the old cry of copperheadism and the war-hatred propaganda of the Radicals held this old Northwest in the Republican column in 1866 *(102)*; but other forces were at work. Areas near Chicago and Milwaukee began to develop into dairy farming *(103)*; and states like Michigan and Ohio had gone into sheep-raising. Due to the war cutting off southern cotton, also developing a strong demand for woolen clothing and blankets for soldiers, wool-production received an unusual stimulus. Raw wool prices rose 67% *(104)*. Stationary during the pre-war decade, the sheep industry now grew rapidly. Mutton prices rose 62% as compared with 22% for beef and 9% for pork *(105)*. For the nation at large wool production nearly doubled during the war and gained 40,000,000 pounds within the next three years. Imported wool very nearly doubled between 1860 and 1866 *(16)*. Due to competition with other farm enterprises, the continued increase in wool-production in the rest of the world, and continued development of transportation facilities *(104)*, the number of sheep in each of the northwestern states east of the Mississippi fell off *(16)* but there was a decided increase in the number in the other states of this area *(16)*. This showed that sheep-raising, like wheat, was moving west. Due to competition with southern cotton, and with foreign wool, plus the sale of unused army stores, and large increase of flocks, the price of wool declined *(107)*. On the proposed tariff on wool in 1867, the Ohio and Michigan senators voted unanimously aye; while the rest of the northwestern senators voted no, 10 to 3 *(108)*. This bill won more favor than the bill of 1866-67. By means of it the Radicals won over Congressman Bingham of Ohio *(109)*; the Wisconsin legislature called upon Wisconsin congressmen to support it *(110)* and the Illinois State Journal rejoiced over its passage *(111)*.

Not only was the passing of the frontier to areas farther west a fundamental item here; another item of equal importance was the rapid industrialization of this area. Before the war the southern planter had ably represented the agricultural

interests in Washington; but in this period of carpetbaggers, negroes, and scalawags, allied with the industrial and urban easterners, the city was in the saddle *(112)*. In Ohio, for example, the urban areas became the dominant factor in determining the attitude of the state toward national issues. The interests of Cleveland became ultimately identified with the financial and industrial interests of the State *(113)*. In 1868 Cleveland's 14 rolling mills were turning out 400 tons of iron daily. In Lucas county, including Toledo, capital invested in manufacturing had increased more than 3½-fold during the 'sixties; and in the same period Toledo's factory employees increased 75% *(113)*. The census reports show that capital invested in manufacturing in Ohio increased from $29,000,000 in 1850 to $57,000,000 in 1860; and to about $189,000,000 by 1880, or three times the amount for 1860 *(114)*. By 1880 Ohio stood fourth in rank in this respect with only New York, Pennsylvania, and Massachusetts ahead of her *(114)*.

Stimulated by war prices, factories rose elsewhere in this area. In Illinois, for example, nearly every town of any size wanted a woolen mill; and within ten years after 1860 the number in the State trebled *(115)*. Capital invested in manufacturing increased from $27,500,000 in 1860 to more than $140,000,000 in 1880 *(114)*. In Michigan the value of factory output increased 275% in the decade 1860-1870. Iron manufacturing alone increased from a negligible amount in 1860 to more than $3,500,000 in 1870 *(113)*. In other states, capital invested in manufacturing increased during the period 1850 to 1880 as follows: ninefold in Indiana; 33-fold in Iowa; 15-fold in Michigan; ninefold in Missouri; more than sixfold in Wisconsin; and more than 310-fold in Minnesota *(114)*.

The woolen and the manufacturing interests were a valuable ally to the Radicals in the Northwest. Alone, each of these could only weaken opposition to the tariff in 1866; but allied together, and aided by a Radical bloody-shirt and anti-southern propaganda, they became a potent factor *(116)*.

The attempts of the farmer to remedy his undesirable situation by means of Grangerism and Greenbackerism are only too well known to call for comment here. These agitations died out with the return of prosperity for the farmer after the European crop failures of 1875 and the Russo-Turkish War of 1877-1878. Both of these created a market and better prices for his goods *(117)*.

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SOME SOCIOLOGICAL AND ECONOMIC EXPERIMENTS

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THE STATEMENT has been frequently made, and with some justification, that the whole field of human relations can never be scientifically understood or effectively controlled because we can not carry on experimentation with human beings or in the realm of social institutions and processes. Events of the last few years are more and more destroying whatever of truth there has been in this statement.

If we speak in *relative* terms, it is true and will probably continue to be true that we can not experiment with people and their inter-relationship problems to the degree of exactness that we can with guinea-pigs, fruitflies, and electric currents in the laboratories of the respective biological and physical sciences. After we have granted this much, however, there still remains a vast field for experimentation in dealing with *social* problems.

It is the purpose of this paper to give brief descriptions and evaluations of some sociological and economic experiments now going on in certain countries of the civilized world.

THE SOCIOLOGICAL FIELD

I. *Marriage Clinics.* Until very recently, the generally held idea concerning success in marriage has been that success in this vital human relation was due entirely either just to good luck or to the handing down of precept and practice by parents to their children. The thought of even *attempting* to apply science and reason and experimentation to an improvement of these delicate relationships, or to a possible solution of any of the difficult problems constantly arising in family life, had not occurred to any one, so far as our records go.

In the last three decades a great variety of new and experimental techniques along these lines have come into existence. Many of these have been partial or complete failures, but there are some residues of constructive results that encourage us to expect still more definite results in the future. The writer of this paper holds no brief for any of the fads or freaks that always flourish when new types of dealing with emotional and social problems crop up. It is hard to distinguish between the genuine and the fakes. Nevertheless it must be admitted that out of the work of Freud and Jung and others of the somewhat discredited Psycho-analysis School, out of the somewhat more scientific efforts of the psychiatrists, psychologists, social workers, and sociologists, there is in process of formation a new understanding of family interactions which are vital for personality development.

One important reason why a more consciously and, we might say, *artificially* developed knowledge and technique have become necessary in family case-work problems is the fact that, contrary to the economic and social conditions of earlier generations, recent years have brought such vast changes that even the most intelligent and the best intentioned of parents sometimes can not give adequate help, information, or advice to their sons and daughters about to be married.

The rapid growth of cities, the great mobility of modern populations, the large migrations of young people from the farms into the cities have, in thousands of cases, put young people into a set of social and economic circumstances never experienced by their parents, even if their parents were available for advice, which in city life is very often *not* the case. Our social environment today is distinctly dynamic and we must inevitably adopt, to a considerable extent, an experimental or scientific attitude toward it instead of a merely traditional *attitude* as in the past.

A specific example of a new and successful experiment in this field is the Institute of Family Relations, organized in Los Angeles, California, in 1929. Dr. Paul Popenoe, a well-known writer and worker in the field of eugenics, is director of this Institute and has a staff of several assistants. The major objective is to help *prevent* marriage misfits. Dr. Popenoe does not believe in the old saying that "love is blind," provided he has an opportunity to contact young men and women *before* they are head over heels in love with *particular* persons of the opposite sex.

The "pre-marital conference" is a part of the program which, through a series of experimental processes, has been made one of the key-notes of the Institute's work. An unusual combination of sympathetic personality and scientific knowledge of young peoples' physiological and emotional make-up, have been and are the foundations for the very large degree of success of the Institute. Personal and family history are studied; traits of character and personality attitudes, both of individuals and of prospective couples, are analyzed and interpreted to those who voluntarily come to the clinic because they realize their own inadequacy. This inadequacy refers both to knowledge of facts and to the way in which they may develop the best prospect of being able to cultivate the cooperative emotional attitudes so essential in wholesome family life. As we might surmise, Dr. Popenoe finds one of his greatest problems that of helping young people who have spent several years in the individualistic type of living to realize the necessity of the give-and-take attitude in marriage. He finds that three main sources of difficulty in modern marriage are: (1) ignorance of even the most elementary facts of the physiology and psychology of sex; (2) financial difficulties and worries; (3) lack of sufficient recreational and social life for the husband and wife together. He also finds that, with long married couples who have developed frictions, a frequent cause is impatience. They want and expect Dr. Popenoe to cure in a ten-minute conference difficulties that have been developing for ten years.

Other features of this successful experiment in a field formerly given over to tradition and the emotions are: courses of educational lectures for parents and prospective parents, as well as adolescent youth, also wide use of the services of medical consultants where diseased bodily conditions are involved. This marriage clinic has demonstrated its usefulness to a large number of clients and its services are constantly widening. An increasing proportion of new clients are referred to the clinic by men and women who themselves have been helped to develop more successful family life as a result of its information, advice, and friendly sympathy; all based on as much of an experimentally scientific technique as possible under the circumstances.

II. A second sociological experiment that is actually going on is *companionate marriage.* As is well known, this type of marriage is one in which it is definitely planned and agreed that there shall be no children. Thought of by many persons

as only a practice to be condemned, by others it is approved. At any rate, the companionate marriage has grown out of present-day economic and social conditions and should be studied and judged in that light. The limits of this paper preclude further analysis of this experiment. Those who are interested may get the pros and cons of the sociological desirabilities of this new type of marriage from Judge Lindsey's book on the subject and from numerous criticisms of the book and its ideas.

III. *The Socialization of Medical, Surgical and Hospital Services.* Twenty-five years ago if a physician or layman had dared to predict that before 1934 one of the largest nations of the world would have a completely socialized medical and health service and that several other leading countries (the United States among them) would have taken long strides in the same direction, this doctor or layman would have been thought a harmless visionary. Yet all these things and more have come to pass. The critics still call it a foolish, even dangerous experiment, predicting many different and dire consequences, from the ruining of the medical profession to the drastic lowering of the *quality* of medical service rendered to the people. An old ghost has been revived—the belief that no professional or business man will really do his best work unless he, personally, gets or *believes* he *will* get definite and substantial monetary reward. This idea or belief *may* have been true in 1776, when Adam Smith founded the science of economics by writing his "Wealth of Nations;" but the ghost has long since been laid to rest with his ancestors.

For doctors, nurses, public-health officers, and hospital workers have proved in thousands of cases that, with a modest living assured, they will devote themselves unselfishly and wholeheartedly to stemming the ravages of disease among their fellow-men.

And so this sociological experiment of the socialization of medicine goes merrily on, and daily piles up convincing evidence that it likely is actually to succeed. This phase of the Russian program is probably the most generally satisfactory and beneficial of all the elements of the program. The valuable and extensive work of the clinics, large hospitals, and children's day nurseries which the writer observed in Russia in 1932 tends to support this conclusion.

But let us consider a few facts about our American situation. In the Survey Graphic for April, 1934, we find the following editorial statement on page 163: "A year ago the American Medical Association dubbed proposals for organized medical service socialism and communism. Yet medical societies themselves, ignoring the outspoken and indirect opposition of their National Association, are (now) leading or sharing in . . . constructive developments (along this line) in many states and cities." In this same issue of the Survey Graphic is found an account of the following projects now going on:

1. In the states of Washington and Oregon, in Seattle, Tacoma, Portland, Yakima, and a few smaller places county medical societies have organized "service bureaus" which are furnishing services to substantial numbers of people under annual payment agreements. In Seattle the "service bureau" consists of a group of 300 doctors who furnish services to more than 8,000 subscribers.

2. Several towns in the Middle West are carrying on similar projects. "These plans are experiments. They have the defects of newness and the possibility of commercialization. But they are the considered attempts of medical men to find solutions for economic and professional problems in their localities."

3. The Michigan State Medical Society at its own expense prepared and published, in 1933, a careful study of the costs and needs of medical care in the state. It also authorized a committee to prepare practical plans for establishing demonstrations of sickness insurance in Michigan communities. In cooperation with the American College of Dentists the Michigan Medical Society sent two representatives to England to get a first-hand report on British sickness insurance.

In Los Angeles, California, two doctors in 1929 established a clinic to furnish medical care to the employees of the city water and power department. The clinical staff has grown in 1934 to 55 doctors who serve 15,000 subscribers for a fee of $2 a month. The service comprises medical care and a certain amount of hospitalization for each subscriber and his family.

We all know of the relatively rapid spread of public health services and free hospitalization during the last 15 to 20 years in the United States. The health-center work of the Red Cross during and just after the war period undoubtedly gave a great stimulus toward the development of public interest in the possibilities and values of more socialized types of medical and health work.

SOME ECONOMIC EXPERIMENTS

I. The first economic experiment we shall consider is the present trend toward government control of banking and foreign trade. We place these two together because they cannot be considered independently. The whole process of modern industrialism in all nations until recently has gone forward with only relatively slight limitations, on the premise that laissez-faire individualism is basically sound and best for both individuals and society as a whole. In the last few years, however, the repercussions of the greatest and most destructive war in human history have given drastic jolts to many cherished ideas, traditions, and practices, among them laissez-faire. The world-wide depression which began in the fall of 1929 and the Russian revolution which began in October, 1917, have played havoc with long-established and seemingly generally accepted theories and practices in government, business, religion, and other vital phases of life. We do not yet know how rapid or how enduring these changes will be. One of these phases of economic revolution (not in Russia alone) has been the growth of economic and political nationalism, and an important aspect of this modern form of nationalism is the increasing assumption by government of control of foreign trade and, logically, the *financing* of foreign trade.

The State Bank of Moscow, the Amtorg Trading Corporation in New York City, and the subsidiary corporations thereof are in complete control of all trade between Russia and the United States; that is, of the Russian side of that trade. When in 1930 Russia concluded she had about 100,000,000 bushels of wheat to export, she just set a price for her wheat on the world market that enabled her to underbid her competitors, especially the United States. A tragic decline in American wheat prices followed.

On this side of the water, the Export-Import bank has been set up by our government to finance our trade with Russia. Another similar bank has been created to control and finance our trade with Cuba; and a third bank to finance and direct, as far as our government thinks advisable, all the rest of our foreign trade.

Italy, Germany, Japan, and England for several years have given government support and direction to their foreign trade, especially with Russia.

This new experiment is advancing rapidly, with little effective opposition. How permanent it will be no one knows. At present it promises a large degree of success, at least so long as the present world-wide wave of nationalistic self-protection continues. Also there is valid support for the experiment in the feeling (widespread now in the United States) that investments and other financial dealings with the people or governments of foreign powers are matters too delicate and too far-reaching in their political, economic, and social consequences to be left in private hands, where personal profit is the chief motive. Our billions of dollars of defaulted foreign debts, both commercial and governmental, have made us willing, for a time at least, to approve the experimental idea of government responsibility in this complicated field of foreign trade and finance. The Securities Act, passed by Congress in 1933, is one specific evidence of this new policy. It is interesting to note that not a dollar of its foreign obligations has been defaulted by Russia since the present regime took control in 1918; that is, obligations *created* by the present regime and for which it holds itself responsible.

The United States now seems to be moving rather rapidly toward a large degree of government control in the foreign-trade field.

II. The second economic experiment to which we shall give attention is the new and experimental policy and practice usually referred to as a "managed currency." For several generations the prevailing thought and practice of economists, statesmen, and businessmen as to a medium of exchange has been that the gold standard is the one and only really satisfactory national and international monetary base. Only backward countries like China and Mexico have held on to silver or depreciated and unstable paper currencies. But the world-wide economic crisis out of which we are only now slowly emerging brought a drastic challenge to the validity of the old concept of the gold standard. Many competent critics have gone so far as to say that rigid adherence to the gold standard and certain manipulations of currencies for private profit have been among most potent causes of the extremely unfortunate social and economic conditions which have brought untold sufferings to millions of innocent people. Be that as it may, several important countries have deliberately entered upon the experiment of managed currencies, with the main objectives of securing more stability of commodity prices and of industry in general. The gold standard, in part at least, has been thrown overboard.

We shall state a few significant facts concerning the nations most definitely participating in this economic and financial experiment.

Revolutionary Russia after a few years of tinkering with barter, etc., settled down to a deliberate policy of paper currency, backed, *nominally*, by a gold reserve. In actual practice, however, Russia simply uses her gold, when necessary, to pay her international trade balances; and goes on accumulating as large a supply as possible, both for the economic power it gives her and for the exigencies of war. In the sense that gold was a real standard and medium of exchange in the United States from 1879 to 1933, revolutionary Russia has *never* been on the gold standard. The government controls the issue of paper money according to the degree of purchasing power it wants its citizens to have, and for other reasons. The nominal value of the gold rouble is 51 cents of United States money before dollar devalua-

tion. In the summer of 1932, when the writer was in Russia, the actual exchange value of the paper rouble was eleven or twelve cents.

On the whole, Russia's system of managed currency has worked remarkably well. If it were not, however, for the fact that she is now one of the largest gold-producing nations and can keep her foreign trade on an internationally acceptable basis, by gold payments when necessary, she probably would have had more difficulties. It is possible that the relative success of Russia with her managed currency, and the undeniable fact that she has come through the depression remarkably well, have been large factors in encouraging other countries to try out their own brands of managed currencies.

England, hard hit by loss of foreign markets, unemployment, and mounting taxation, took the plunge in the fall of 1931 and left the gold standard. Almost immediately the downward curve of English business began to straighten out. Whether leaving the gold standard did it or not, in 2½ years since that event England has made substantial progress; has reduced unemployment materially, stabilized commodity prices, increased her foreign trade, and in the last few weeks has even balanced her budget with a good surplus, and is now planning to reduce taxation. The elaborate and intricate processes which the Bank and England and business-financial leaders have worked out in connection with their huge stabilization fund to steady the pound sterling on the international market have been, on the whole, exceedingly helpful to the English people.

Sweden, about the same time that England did, or a little earlier, went on the managed-currency basis; and the results there have been even more favorable than in England. Many foreign economists and government officials have gone to Sweden to find out what they did, and how.

Australia was in bad straits even before the depression. Some of her governmental units had defaulted on their bonds, and unemployment was widespread. About 1930, Australia began to operate on what soon came to be a *non*-gold standard basis, or a managed currency. She applied the Swedish and English principles in her own way, experimentally at first, then on a larger scale. The government has kept strict control of the currency situation, in a way to maintain the international price structure, improve her foreign trade, and stimulate employment. The whole country is now in a relatively prosperous condition.

Last, but not least, the United States, after many bickerings and arguments, in and out of Congress, was taken off the gold standard by President Roosevelt early in 1933. It is still too early to evaluate the results of the managed-currency experiment in the United States. The policy has strong and impressive exponents and strong and impressive opponents. Probably one main fact that has caused congressmen, the president, and citizens generally to favor the move has been the belief that the so-called international bankers of New York City ("Wall Street") *wanted* the country to stay on the gold standard. That is, in the minds of many Americans, whatever Wall Street approves of is the very thing that citizens in general should oppose. It is alleged, for example, that many Wall Street bankers have made large profits out of manipulating the fluctuations of foreign exchange based on the gold standard. At any rate the United States now seems committed for indefinite period to the experiments connected with a managed currency.

We shall now merely list a few more socio-economic experiments, especially in the United States. These experiments have all been and now are more or less integral parts of the "New Deal," whose chief objective as stated by President Roosevelt is to bring about a more equitable and more stable distribution of economic and social welfare among all the people.

(a) The subsistence homestead project, with $25,000,000 of government money; intended to aid stranded industrial and agricultural families to make their living on the land instead of living upon government charity.

(b) Governmental control of agricultural production, including already the great staple products of cotton, wheat, corn, hogs, and tobacco. The purpose of this experiment is to reduce production sufficiently to enable farmers to get a fair price for their products; the present economic surplus of cereals and cotton being due to heavy losses, since the World War, of our foreign markets for these products. The newest wrinkle is the Bankhead Law, which puts cotton production on a compulsory basis and levies heavy penalties on farmers who exceed their quota. It should be said that Secretary of Agriculture Wallace is opposed to this compulsory form of crop control.

(c) Regional planning by the national government, the most outstanding example of which is the creation of the Tennessee Valley Authority for the comprehensive development of water power (to produce electric curtent), and flood control in the Tennessee River Basin. This project includes vast objectives for raising the economic and social standards of several milions of people; and it is already openly announced that, if it is a success, similar projects will be undertaken in other parts of the country, particularly in the Columbia River Basin in the far West and the Missouri River Basin in the Middle West. The electric utilities groups already see their profits threatened.

(d) The substitution of state and federal relief measures for the former private and local agencies dealing with destitution and relief. In 1932, this problem became so great that there was no other way out, because the national government was the only agency with sufficient means or credit to do the job. There are already many signs in the offing that this experiment will result in a great extension of federal control of unemployment and unemployment relief as a permanent policy.

All the sociological and economic experiments discussed in this paper are governmental or public in nature; and in the United States they are practically all in the field of the *federal* or *national* government, even though states, counties, and cities are indispensable units in the administration or carrying out of the experiments. (There are many sociological and economic experiments being carried on by *private* agencies, especially by the great philanthropic foundations; but we can not discuss them here.) The tendency toward the relative obliteration of local boundary lines (of states, provinces, etc.,) is a world-wide phenomenon for civilized countries. The process is a natural and inevitable one and is bound to go farther.

Whether we consider Hitler's doing away with the German states, (except for administrative purposes), or Mussolini's concept of the corporative, totalitarian state, or the overwhelming power of Moscow in the Soviet State, or the *almost* overwhelming power of Washington in our American nation, the tendency toward centralization of authority and political power is developing with irresistible force. The plain reason for this tendency is the tremendous development of modern means of communication and transportation, the relative ease of central control and, in most cases, the greater efficiency and better quality of such control. The Russian revo-

lution probably would have failed without the aid of the high-powered broadcasting stations at Moscow and the fleet of airplanes to protect the far-flung Russian borders, especially in the Far East. The New Deal experiments and the great power and influence of President Roosevelt would have been much less effective, if the administration had not had at its command the modern devices of propaganda and education, especially the radio.

As intelligent, forward-looking citizens of the present-day world, and especially as students and teachers of the social sciences, it is a definite part of our responsibility to go as far as we can in analyzing and understanding the sociological and economic experiments going on all about us. And our responsibility has not ceased when we have obtained a fair degree of understanding for *ourselves*. By all the skill and earnestness of which we are capable, we owe to our students and associates to do what we can to help them separate the sound from the unsound in these experiments, and then give our hearty support to the proposals for action that lead forward rather than backward, that lead to a more humanized social order rather than to a more selfish and animal-like civilization. Under present conditions of the machine age, social evolution does not proceed at the snail's pace that it did in the days of our medival ancestors. Experiments of all kinds move more swiftly to and through the testing period. If successful, they may give our whole culture a strong boost forward; if selfish, ill-conceived, and unsuccessful, we all pay the price in no small and trifling measure.

AN OPPORTUNITY-THEORY OF PROFITS

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PROFITS are said to arise as a reward for risk bearing. In this first of three theories, risk takes on a sort of psychological nature. The business man is compared with the wage worker. At the close of the day the wage worker takes his hat and goes home, planning, as a rule, not to think again of the shop or of the business with its turmoil. The business man is not as fortunate, for he must bear the risks of the business. Not only are his days full of occasions when he must decide about the uncertainties of the future, but his time spent away from the place of business is occupied largely with tossing over the problems of the enterprise. Never is the business man free from his business and its uncertainties and risks. It is assumed in this respect that the man can earn a salary as an employee of some other business man, but by being in business for himself he is able to get something more than a mere salary. This extra compensation is a reward for the nervous strain which his business inflicts upon him as a result of its uncertainties and risks.

The second theory regarding the effect of risk appears to be more objective as contrasted with the subjectivity of the first one. Risks in this case come upon the business man as the dragons upon Saint George, threatening to wipe out his profits unless they are overcome. As the risks present themselves the clever business man proceeds to down them. If he does not succeed in downing the risk, his profits will suffer to that etxent. In this view two equally objective things are raised in opposition to each other—risk and profits.

In the third current aspect of the relation of risk to profits it is found that profits are the reward for the ability to meet risk. In this case profits are a pay-

ment for ability—in a sense, for managerial ability. In this theory the business man is contrasted with other business men; all are making profits but some are making more than others because of superior ability. The greater the ability the greater will be the amount of profits accruing to the business man or to his enterprise.

Complete reliance upon the risk explanation of business is not above criticism, particularly since it proves to be inadequate under many conditions. Risk is a term which means a chance or possibility. In business, risk represents the chance of failure or the possibility of disaster. According to the accepted conception this existence of the possibility of failure arises from the uncertainties which beset the way of the business man. If the possibilities materialize then the business suffers, its sufferings being reflected in an emaciated profits account. But risk is a contingent circumstance, dependent upon other circumstances, and unless one sets out to perform some act, he is in no danger of not succeeding in his pursuit, so that the risk arises only when some act is attempted. Every part of life and activity is fraught with risk; we live at the risk of death, we ride to work at the risk of not getting there, in fact, everything connected with existence is associated with the element of risk. The important thing to note about risk is that it arises only because of another circumstance. The risk of death can exist only for those who are living and is hence dependent upon life itself; the risk of not arriving at work can come only to those who set out for work. By its definition risk is a chance of failure, but this is not a complete thought, for to that must be added,—failure to do what? When the thought is completed by a statement of the nature of the failure, the idea of the dependency of risk becomes clearer.

The risk explanation assumes that the business is normally entitled to profits and will receive them if it incurs no risk. This throws out entirely the question whether or not the business is justified. It likewise shuts its eyes to the motivation of all business, which is the quest for profits. Business men engage in business purely in order to make profits. When a new project presents itself for the business man to accept, the first test which it must stand is: will it be profitable? The picture of the business world as a steady quest after profits has been portrayed in a clear manner by Messrs. Foster and Catchings in their book entitled *Profits*. They accept, however, the conclusion that profits are the result of a wise selection of risks.

The total risk which any company can possibly bear, particularly those of the limited liability type, is to be wiped completely out of existence. Further than annihilation risk cannot go; when all that has been risked in the project is absorbed in the losses, risk has done all that it is possible for it to do. The inadequacy of this explanation becomes more evident when it attempts to explain the unusual growth which many of the business enterprises enjoy and particularly when this growth exceeds many times the original size of the company. If a business man risks a few dollars and makes millions, the risk explanation has difficulty being a satisfactory theory.

Profits represent a growth in capital. A business man invests his capital in the productive process. If at the end of his period his income has exceeded the amount of the investment for the period, this excess or surplus represents profits, which are the equivalent to an increase of capital. The increase of capital accrues to the company itself and also to the community which is benefited to a like degree. The business man receives immediately greater claims upon capital in return for his

contribution to the community's capital. If he decides to spend the surplus, other industries in the community will prosper to the extent of the spending; if he decides to accumulate the amount, he reserves it for his own company, but the community is not benefited or injured by this decision.

It was mentioned above that profits were not determined by risk but were the result of an accomplishment. The nature of these accomplishments has not yet been stated. They present themselves to the business man first in the form of opportunities. The business world is in constant pursuit of profits and when an opportunity to invest capital profitably presents itself, it is taken by the alert business man. New products, new uses for old products, new uses for existing plant and materials, new territories to be developed, new mines to be opened up, new forest lands to be made into timber or paper, and new discoveries of oil trickling through the earth's surface are but a few of the countless opportunities which await the man in business. Any one of these means that a few thousand dollars invested in them may in time yield capital to the value of millions.

If the opportunity does not prove to be as profitable as it promised in the beginning: i. e., if the capital so invested fails to increase in value but returns only an equal amount, there are no profits, and capital is not increased; neither is capital lost. But if the project returns less than the amount invested, capital is lost not only to the business but to the community as well. Business men may make a false estimate of an opportunity, and in fact they do this frequently both in under-estimation and in overestimation. Mute testimony to overestimation of opportunities is found in the vacant factories which were built in 1929 just before the break in prices; Henry Ford can testify to the underestimation of opportunities which he took 25 years ago. The idle factories, many of them modern in every respect, represent a loss of capital to the community.

To the accountant, profits represent the difference between income and outgo, and deeper into the accounting aspect than this we need not go, although many good problems arise as to what should be considered as outgo or expenses of production. Since profits represent the difference between income and expenses, it follows logically that an opportunity to increase profits may present itself in the form of an opportunity to reduce expenses. Business men frequently take advantage of this sort of opportunity by introducing better equipment or by improving their organizations. A step toward increasing income and one toward decreasing expenses are both the equivalent to taking an opportunity to increase profits. The function of the business man is not then to judge risks, but to estimate opportunities. These opportunities are ever present in an active business community. He will probably not be able to take all the opportunities which he can see, but will chose only those which give the promise of greatest profits. Profits then depend upon the opportunities; and the greater the opportunity taken, the larger will be the profits which result.

Unquestionably risk exists for all business, and if the risk materializes into a reality and failure ensues there will be no profits, and so far there has been no denial of this aspect of risk. This explanation, however, places the emphasis on the wrong side of the problem and shows only why profits may not be made, and it neglects the demonstration of how profits can be made. This theory does not picture the world in active pursuit of profits, seizing upon every opportunity to increase capital and show a profit. The aspect of risk does not arise until the oppor-

tunity has been taken, and then it has a limited scope. The risk incurred is equal only to the investment and cannot exceed this amount, while the opportunity may prove to be worth many times the original investment.

There is no such a thing as a normal rate of profits, or normal profits. In the first place no one or no collective body could ever estimate what the line of normalcy is; the world is different from what it was ten or more years ago, but whether it is normal now or whether it was normal then cannot be told. There are a few businesses which have a fairly predictable line of growth, as, for example, the telephone industry, in which it is possible to forecast the size of the business ten years in advance. These forecasts from time to time must be revised, but if the industry actually follows the line of growth laid out for it by the statisticians, it can be said to be following a normal trend of growth, but beyond this sort of normalcy the term has practically no meaning to the man of business.

The business world is a day-to-day fight for profits against competition. Opportunities present themselves, and more than one business man tries to take them, and in most cases the most successful one makes a profit, but this he does not know until the end of the fiscal period. At that time he closes up his books and looks at the profit account with a sigh; sometimes it is a sigh of satisfaction, sometimes it is a sigh of disappointment, and sometimes it is simply a sigh of relief that the affairs were not worse than he had believed them to be. Whether or not the results of the year's activities were normal is not a factor in the minds of the business men whose sole questionnaire is why the profits were not larger this year and how can they be made larger next year.

To summarize: We took a point of departure in this case from the orthodox theory on the question of the relation of risk to profits. It was shown that risk is a contingency and is present in nearly every aspect of life; it was shown to be contingent upon an accomplishment. It is only as one sets out to accomplish a purpose, that one runs the risk of not succeeding. Profits result not from risk-bearing but from successfully taking an opportunity or opportunities which are presented to the business man from day to day. Profits are related to the increase in capital described in the previous chapter and are the equivalent; the business man invests his claims upon capital in his enterprise and if it returns to him a larger amount than he invested he makes a profit and also increases the community's capital. It is through successful enterprise that the capital of a community grows and that profits are made.

A ROMAN WHO REFUSED TO BECOME EMPEROR — LUCIUS VERGINIUS RUFUS (14-97 A. D.)

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THE WORLD IS WONT to admire great men whether they be engaged in conquests of nations or in the peaceful pursuits of science and art. Most of the great soldiers and statesmen, however, have been and are men of unbounded ambition and love of power. But to withstand temptation even in small things is praiseworthy; to withstand temptation in great things is more praiseworthy still, while to withstand the temptation for donning the purple deserves the highest praise and admiration, inasmuch as the temptation has been strong and the allurements too

great even for the greatest minds of all times. And yet, Cincinnatus left the dictatorship and hurried back to the plough; Sulla surrendered his tyranny of his own accord; of his own free will did Diocletian abdicate from his imperial throne. But they had tasted of the power and the glory thereof and satisfied their ambitions, especially the last two; for Cincinnatus did not seem to care much for power. But to be called to become king of one's country, and refuse it, fell to the lot of George Washington in this country and of Lucius Verginius Rufus in Rome. Washington might well reject such a proposal, coming as it did in a country full of democratic ideals and fresh from the hatred of the name of king due to its unpleasant experiences with King George III *(1)*. As to Verginius, however, the case was entirely different. He lived in a country that worshipped the emperors—a far cry from the days of the sturdy Roman republic that hated the name of king and had carried its legions to the four corners of the earth—not with kins but with consuls. But during the time of Verginius eleven emperors had come and gone from the throne, four of them in one fateful year, that of 68 A. D. This was a trying year for Verginius Rufus as well, and it was possible it seems only for Verginius to keep his head cool and put his name unsullied in the annals of the bleeding Roman Empire. Being a successful commander, the idol of a powerful *(2)* and victorious army, in a year when vieing for the purple ran amuck, he refused to become an emperor even though he knew that by refusing he would displease his soldiers; for the Roman soldiers of his time, once having found out the fatal secret of the empire, that an emperor could be made elsewhere than at Rome *(3)*, made and unmade emperors. But Verginius refused the purple more than once, at one time even when his soldiers, after Otho's death, had tried to force him at the point of the sword. He had a powerful influence, an eminent talent as a soldier, a wonderful self-mastery and moderation and, above all, a conspicuous lack of ambition for power and aggrandizement. Moreover he was honorable and fair, and whatever he did was done with a clear and free conscience. Pliny in one of his Epistles tells us that when Cluvius Rufus, a Roman historian *(4)*, in a conversation said to Verginius, "You know, Verginius, what fidelity is required of history; therefore I beg of you to forgive me if you should read in my history things written otherwise than you would desire them;" Verginius answered, "O Cluvius, do you not know that I acted as I did, that any one might be free to write about me whatever he pleases?"

Such was the character of the man Verginius, about whom few facts are known, but all of which breathe the purity and noble-mindedness of the man.

Lucius Verginius Rufus, that "Nestor of his time" *(5)*, was born either at or near Comum *(6)*, the birthplacee of the younger Pliny, in 14 A. D., the year of death of Augustus. Of his education and training we know nothing. From his ward Pliny we learn that Verginius was something of a literary man and that like other great men of his nation he wrote poems, a practice which Pliny tells us was not unbecoming to the dignity of "such personages as M. Tullius Cicero, G. Calvus, Asinius Polio, M. Messala, Quintus Hortensius, M. Brutus, L. Sulla, Q. Catullus, Q. Scaevola, Servius Sulpicius, Varro, the Turquati, G. Memmius, Lentulus Gaetulicus, Annaeus Seneca. . . . divus Julius Augustus, Nerva Tiberius Caesar. . . . *(7)*" He read both poems and histories. From Pliny we learn also that Verginius wrote his own epitaph, a very modest one indeed *(8)*. We are indebted to the same Pliny for the account that Verginius met his death while preparing his speech which he

meant to deliver to the emperor Nerva thanking him for the consulship *(9)*. Verginius must have been persuasive to win such popularity with his soldiers. Dio Cassius, for instance, tells us that, after the defeat of Vindex, his soldiers took down and broke the images of Nero and saluted him as Caesar and Augustus. But when he did not accept the title one of the soldiers wrote these terms quickly on one of the standards. But Verginius erased them and, although with difficulty, brought them to order and persuaded them to act according to the Senate and the people *(10)* —a far different thing from the princes and commanders of the Vitellius and Valens type. Verginius was also the guardian of Pliny *(11)*, as was mentioned above. Being of an equestrian family *(12)*, Verginius was promoted to senatorial rank, but when, we do not know. In 63 A. D., under Nero, he became consul for the first time with C. Memmius Regulus as his colleague *(13)* When the rebellion of Vindex *(14)* took place, V. Rufus was governor of Upper Germany *(15)*. He hastened to Gaul with all his Rhine legions and some Gallic auxiliaries *(16)* consisting of Belgians. The Batavian cavalry had been brought there from Britain for the first time. The forces of Vindex were supported by the Aeduans and Avernians; Civilis says that "it was the Batavian cavalry that crushed the Aeduans and Avernians; the Belgians had formed part of the Army of Verginius . . . . it was the Gallic armies that had subdued Gaul *(17)*." After reaching Gaul Verginius laid siege to Vesontio (modern Besancon), Dio says, "for the pretext that it had not received him. Vindex having come against him, to help the city, pitched camp not far from him and both of them sent to each other messages and finally they held a conference, no one else being present, and made a mutual agreement with each other, against Nero *(18)*, it was thought. But afterwards Vindex started with his army with the apparent purpose of taking the town; and when the soldiers of Rufus perceived them coming near and thinking they went straight against them, they started against the latter of their own accord, and falling on them they cut down very many of them *(19)*." Vindex killed himself over his slain Gauls. But Verginius did not wish to accept the principate. "Verginius being the leader of very strong troops *(20)* which many times declared him emperor and urged him to accept the office said neither he himself would get it nor would he allow any one else to get it except the person whom the senate would choose. This annoyed Galba at first a great deal. . . . Vindex having killed himself over his 20,000 slain Gauls, there spread a report that all were willing that Verginius take the principate after so great a victory, or else they would turn to Nero again, then indeed Galba becoming alarmed very much wrote to Verginius beseeching him to take concerted action and preserve both the empire and the liberty of the Romans *(21)* . . . . Verginius being yet uncertain gave worry to Galba . . . . lest he listen to those who were urging him for the principate. For no one's name was greater, nor did any one have as much glory as Verginius as affecting the deliverance of the Roman affairs both from a grievous tyranny and the Gallic wars, affairs of the highest importance. But he, adhering to his former resolution, kept the choice of an emperor for the Senate. Although when the death of Nero became known, both the multitude importuned Verginius and one of the tribunes present in the tent, drawing forth his sword, bade Verginius accept the empire or receive *(22)* the death blow by the sword. But since Fabius Valens *(23)*, commander of one legion, was the first to administer the oath for Galba, and letters arrived from Rome conveying the vote

of the Senate, he persuaded the soldiers barely and with difficulty *(24)*. Galba recalled Verginius. And when he (Galba) sent there Hordeonius Flaccus as his successor he received him, and having handed over to him the forces, he himself met Galba *(25)* on his way and he remained in Galba's retinue, being favored neither with anger nor yet with any remarkable honor. Galba himself was the cause for the first because he revered the man; for the second Galba's friends and especially Titus Vinius thinking he was hindering Verginius, but he did not know that he was working in unison with Verginius' good angel already putting the man outside of wars and evils which got hold of other commanders, into a calm life and an old age full of peace and tranquillity *(26)*."

Thus did Galba recall Verginius from Germany. But the army was left without a leader *(27)*, since Flaccus was an old and incompetent man. This was resented by the sturdy legionaries who were deprived of their beloved commander. Later on, when opportunity offered, they turned to Vitellius and revolted from Galba, but Galba did not live to see much of this consequence, for he was laid low by the murderous hands of the soldiers Otho had sent for this purpose.

After the death of Galba and the accession of Otho, Verginius became consul for the second time on the first of March. Otho himself in the Senate made it a matter of pride. Otho and his brother did not enter the office till the 26th of January, according to the Arval Brothers inscription *(28)*. They ended their consulship in favor of Verginius and Vopiscus on the end of February. Verginius and Vopiscus yielded the office on the first of May to the two Sabini, who in turn gave up the office at the end of June. It was a year of consuls, no fewer than 15 within one year, 69 A. D.

After the disaster of Otho's army at Bedriacum, on the 15th of April, the eve of Otho's death, Verginius, whom Otho had taken with him when he left Rome for the front, was besieged in his quarters. What the reason was, we do not know. Tacitus says the generals had offered to depart a thing which angered the soldiers. Otho at that time was resting, having dismissed the senators and other people for their destination of safety. "And while he (Otho) was now resolving in his mind the thoughts about his end, a sudden tumult turned his thoughts aside when he learned of a wild outbreak and the wantonness of the soldiers; for they were threatening death to those who were departing and whose most savage violence was directed against Verginius, whom they besieged at his home which he had closed. Otho, after calming the soldiers by rebuking the authors of the disorder, went to his quarters *(30)*."

Later on, after the death of Otho, the soldiers came again to Verginius entreating him with threats now to receive the empire, now to undertake an embassy to Caecina and Valens. But Verginius slipped out the back door of his house and avoided the angry soldiers when the latter burst into it *(31)*.

This marks the close of Verginius' chance for the purple. Thrice it was offered him, thrice did he refuse it with a firmness truly Roman. But it was fated for Verginius to see in his life altogether "eleven wearers of the purple, which he prudently refused for himself in the terrible year of four emperors *(32)*." But the dangers of Verginius were not yet over, nor had the time "full of peace and tranquillity" *(33)* arrived for him. Even in the time of Flavian emperors there were dangers which "he escaped" as also he escaped "the resentment of those

emperors to whom his virtues had rendered him suspect and even odious *(34)*."

While Verginius was dining with the emperor Vitellius, the only man of that century who was scarcely redeemed by any virtue *(35)* at Ticinum, the soldiery of Vitellius this time, who had been once his trusty legions, began to demand the life of Virginius on a very poor pretext common to all times, especially during periods of stress: viz., accusation for treason against the emperor—treacherous intention against his life! "Meanwhile," says Tacitus, "a slave of Verginius who was met by chance was accused as a would-be murderer of Vitellius; and the soldiery was rushing into the banquet demanding the death of Verginius Rufus. But not even Vitellius, though he was prone to fear any whisper of suspicion, doubted his innocence. But those who were urging the death of the consular, once their leader, were restrained with difficulty" *(36)* by Vitellius. And the historian adds, "the admiration for the man and his good reputation remained, but they hated him as having spurned them *(37)*." As we have said, he was suspected and hated by some of the emperors, but he escaped them through his virtues.

Thus did Lucius Verginius Rufus "escape" the fury of fortune to enjoy his felicitous old age "full of peace and tranquillity *(37a)*." Already he had been consul twice. He retired into his Villa Alsium on the Etruscan coast near Caere. But 28 years later, after that memorable year 69, when his second consulship of two months had taken place, during the time of happy Nerva, in the "rare felicity of times when one could think what he chose and speak what he thought *(38)*," he was called upon by Nerva to become his own fellow-consul, in 97 A. D., a rare opportunity for Verginius to reach the highest place as a subject since he was unwilling to become an emperor. For "Nerva did not hesitate to make him consul together with himself, though Verginius had been called emperor many times *(39)*." But while rehearsing his speech of thanks for the emperor, he slipped, fell on the ground, and broke his hip, and after some time he passed out from life quietly and with honors. His burial was a public concern. The "grand old man," who was 83 years at his death, had the "eloquent" Tacitus pronounce his funeral oration, a rare privilege accorded to a rare man. And throughout the histories Tacitus speaks with admiration for Verginius. Juvenal *(40)* mentions Verginius in passing, mentioning also his great services in suppressing the revolt of Vindex *(41)*.

In this connection of Verginius' death and burial, as well as the estimate of the man, it is well to let Pliny, his ward, speak; for Verginius had no son *(43)*.

"Rome," says he, "has not for many years beheld so striking and memorable a spectacle as was lately exhibited in the public funeral of Verginius Rufus, one of her greatest citizens and no less fortunate than illustrious. For he lived 30 years after achieving fame, he read his actions on the pages of poets and historians, and thus made one among his survivors. He was thrice raised to the dignity of Consul, that he who refused to be the first of princes might at least be the highest of subjects. He escaped the resentment of those emperors to whom his virtues had rendered him suspect, and even odious, and left the best, the most amicable of princes firmly seated on the throne, as if providence had purposely preserved him to receive the honor of this public funeral. He arrived, in full tranquillity and universally revered, to the 84th year of his age, still enjoying robust health, excepting only a paralytic disorder in his hands, which however was attended with no pain. His passage to death, alone, was severe and tedious; but even this was matter for praise *(43a)*.

"The funeral obsequies paid to the memory of this great man have done honor to the emperor, to the present age, and also to Eloquence herself. The consul Cornelius Tacitus pronounced his funeral oration: for the series of his felicities was crowned by the applause of the most eloquent of orators. He died full of years and of glory, as illustrious by the honors he refused as by those he accepted. Still, however, he will be missed and lamented by us, as the bright model of a bygone age; especially by myself, who not only admired him as a patriot, but loved him as a friend. We were not only natives of the same province, and of neighbouring towns. but our estates were contiguous. Besides, he was also left guardian to me, and treated me with the affection of a parent. . . .

"Thus I am constrained to lament his death, as if it were immature, and pour out the fullness of my grief in the bosom of my friend; if indeed it be permissible to grieve at all upon this occasion, or to call that event death, which to such a man is rather to be looked upon as the period of his mortality than of his life. For he lives. and will continue to live forever; and his fame will be spread farther by the recollection and the tongues of men now that he is removed from their sight. . . .

" . . . There are, perhaps, and possibly hereafter will be, some few Romans who may rival him in virtue, but not one, I am persuaded, that will ever equal him in glory *(42)*."

But even thus Verginius was begun to be forgotten soon after his death. Pliny complains of the neglect of the heirs of Verginius against his memory. His monument, a modest tomb, was not yet finished in 107! He evidently had no children, and certainly no son, and his other relations must have been very remiss *(43)*. "That place," writes the same Pliny after a visit to Alsium, where Verginius had an estate, a calm and reposeful "retreat he was extremely fond and used to call it 'the nest of his old age,' renewed even painfully my regrets for that great and excellent man . . . . Wherever I turned, my heart, my eyes, ached to behold my vanished friend. I even had an inclination to view his monument; but I repented the visit, for I found it still unfinished, and this not from any difficulty in erecting a work of such modest, indeed, small dimensions, but through the neglect of him (i. e., one of the heirs) to whose charge it was committed. I could not see without a concern mixed with indignation, the remains of a man, whose fame filled the whole world, lie for ten years after his death without an inscription, or a name. Yet he had directed that the divine and immortal action of his life should be recorded upon his tomb in the following lines:

'Here Rufus lies, who raised in victory's hour
His country, not himself, to sovran power.'

But a faithful friend is so rare to be found, and the dead are so soon forgotten, that we shall be obliged to build even our very tombs, and anticipate every office of our heirs. For what man can feel himself secure from undergoing the same fate as Verginius, whose shining worth makes the wrong to his memory more cruel, and more conspicuous?" . . . . *(44)*

This monument, however, must have been finished later, for Dio Cassius, speaking of Verginius, says that the above inscription was placed upon the tomb when it was finished. *(45)* Nor did Verginius escape the captious critics as he escaped "the resentment of those emperors". He was blamed for aspiring to have on his

modest tomb a still more modest epitaph. For a man named Ruso *(46)* blamed him for it, adding, according to Pliny, "that Frontinus *(47)* acted much more worthily in forbidding any monument whatsoever to be erected to his memory . . . . I confess," adds Pliny, "I admired him most whom you condemn; and to such a degree, that so far from imagining I ever should have occasion to rise up in his defence, I thought he could never be sufficiently applauded. In my opinion, every man who has acted a great and memorable part deserves not only to be excused but extolled, if he pursues that glorious immortality of fame he has merited and endeavors to perpetuate an everlasting remembrance of himself, even by an epitaph.

"Yet hardly could I name a man, who has performed such great achievements, so modestly reserved upon the subject of his own actions, as Verginius was . . . .

"But let us compare Frontinus with him in that very instance wherein you think the former is more modest and reserved. He forbade a monument to be erected to him, it is true; but in what words? 'The expense of a monument', says he, 'is superfluous; my memory will endure if my actions deserve it.' Is there less vanity, do you think, thus to put on record for all the world to read that his memory would endure; than to mark upon a single tombstone, in two lines, the actions one has performed . . . . In my own opinion, indeed, neither of them is blameworthy, since they both pursued glory with equal passion but by different roads: the former in desiring those monumental honours he had merited; the latter in rather choosing the appearance of despising them *(48)*."

Thus did Pliny deem it necessary to defend Verginius Rufus than whom perhaps there was none more modest and reasonable, more impervious to the ambition for power and even glory, but who despite his lack of ambition, lives and will live always, and his name will be more widely used both in the memory and conversation of men. *(49)* Others may have equalled Verginius in excellence, but none in glory *(50)*.

NOTES

(1) Colonel Lewis Nicola, of Fishkill, N. Y., wrote to Washington in May 22, 1782, suggesting that he become king. A brief abstract of Nicola's letter is contained in the *Calendar of the Correspondence of George Washington . . .* With Officers, compiled by J. C. Fitzpatrick, Government Printing Office, 1915, vol. III, p. 2125. Washington's reply to this suggestion of Nicola is printed in full in *The Writings of Washington*, by Jared Sparks, Boston, Russell, Odiorne, and Metcalf, 1835, vol. VIII, pp. 300-301. It runs as follows:

> With a mixture of great surprise and astonishment, I have read with attention the sentiments you have submitted to my perusal. Be assured, Sir, no occurrence in the course of the war has given me more painful sensations, than your information of there being such ideas existing in the army, as you have expressed, and I must view with abhorrence and reprehend with severity. For the present the communication of them will rest in my own bosom, unless some further agitation shall make a disclosure necessary.
>
> I am much at loss to conceive what part of my conduct could have given encouragement to an address, which to me seems big with the greatest mischiefs, that can befall my country. If I am not deceived in the knowledge of myself, you could not have found a person to whom your schemes are more disagreeable. At the same time, in justice to my own feelings, I must add, that no man possesses a more sincere wish to see ample justice done to the army than I do; and, as far as my powers and influence, in a constitutional way, extend, they shall be employed to the utmost of my abilities to effect it,

should there be any occasion. Let me conjure you, then, if you have any regard for your country, concern for yourself or posterity, or respect for me, to banish these thoughts from your mind, and never communicate, as from yourself or anyone else, a sentiment of the like nature.

Apparently Nicola's letter was so couched as to suggest the title of king indirectly. Sparks, *ibid*, p. 302, in a footnote, gives an excerpt of Nicola's letter. The editor remarks that "there was unquestionably at this time, and for some time afterwards, a party in the army, neither small in number, nor insignificant in character, prepared to second and sustain a measure of this kind, which they conceived necessary to strengthen the civil power, draw out the resources of the country, and establish a durable government." See also H. W. Elson, *History of the United States of America*, N. Y. Macmillan, 1914, p. 325, Note 1.

(2) See Dio Cassius, 43, 25, 1. The army of Verginius was composed of Romans and auxiliaries. V. Duruy, *History of Rome*, translated by M. M. Ripley and W. F. Clarke, edited by J. P. Mahaffy, Boston, Jewett and Co., 1883, vol. V, p. 44, states that the troops of Verginius Rufus were "composed entirely of Romans." But Tacitus, Histories, 4, 17, expressly says that there were Batavians and Belgians. Civilis sorrowfully remarks: "*Batavo equite protritos Aeduos Avernosque; fuisse inter Vergini auxilia Belgas, vereque reputantibus, Galliam suismet viribus concidisse.*" Legions from other places were called to quell the revolt of Vindex, but these were not used. Verginius had with him, when he met his foe, the fourth, Macedonica, the 22nd, Primigenia, both of which were in Metz, and the 21st, Rapax, which was in Vindonissa. See L. Paul in *Reinisches Museum*, 54 (1899), p. 606, and also B. W. Henderson, The Life and Principate of the Emperor Nero, London, Methuen, 1903, p. 403. The number of Verginius' army is given by Henderson at 30,000. With the army of Upper Germany Verginius probably joined part of that of Lower Germany, which was composed of the legion called Germanica. See Paul, *op. cit.* p. 610.

The army of Vindex must have been even less than 25,000. Plutarch, Galba, 4, states that when Vindex wrote to Galba asking him to become emperor, he offered to bring to the field 100,000 armed men, adding that he had other thousands that he could equip if need be. See also Suetonius, *Galba*, 9, where it is stated that Galba accepted this offer of Vindex. The latter's statement of the number of the troops was exaggerated. See Paul, *op. cit.*, and authorities cited there. The Gallic army, as eventually it transpired, was not much over 20,000, at the most, 25,000.

(3) Tacitus, *Histories*, 1, 4: *evulgato imperii arcano, posse principem alibi quam Romae fieri.* It is said Verginius feared this very thing when he refused to listen to his army. See Note 24, below.

(4) Pliny, *Letters* 9, 19, 5: *Tune ignoras Cluvi, ideo me fecisse quod feci, ut esset liberum vobis scribere quae libuisset?* Tacitus, Histories 1, 8, considers Cluvius as eloquent, but as having no experience in war: *vir facundus et pacis artibus, bellis inexpertus.* Cf. also *ibid.* 4, 43, where Cluvius is *perinde dives et eloquentia clarus.* He was consul under Nero, and when Vindex revolted (69-70 A. D.), governor of Spain. He is said to have written an account of the lives of Galba and Otto which Plutarch used, according to H. Peter, *Die Quellen Plutarch's*, 40ff., cited by L. Paul,*op. cit.*, 618, and a history of his own times; cf. Paul, *ibid.*, p. 626. Cf. also Tacitus, *Annals*, XIII, 20. During Vitellius' time, he was accused of treason, Tacitus *Histories*, II, 65, but Vitellius forgave him. When Nero announced that he was going to sing in Rome, he did it through Cluvius. See Suetonius, *Nero*, 21.

(5) W. M. L. Hutchinson, *Pliny Letters*, Loeb Library, London; W. Heinemann, New York, G. P. Putnam's Sons, 1924, vol. II, p. 439, *Index* under Verginius Rufus. Pliny, Letters II, 1, 8, tells us that Verginius was his neighbor in Comum! *Utique eadem regio, municipia finitima, agri etiam possessionesque coniunctae.*

(6) Pliny II, 1. Rohden and Dessau, *Prosopographia Imperii Romani Saec. I-III*, vol. III, 1898, p. 403, suggest that tablets of inscriptions mentioning L. Verginius have been found between Milan and Comum and that in Milan are mentioned many L. Verginii as in the *Corpus Inscriptiorum Latinarum*, vol. V., 397, 5702, 6118. According to Tacitus, Histories, I, 52, Valens remarks scathingly to Vitellius that Verginius' father, of an equestrian family, lived and died in obscurity, *ignoto patre.*

(7) Letters V, 3.

(8) Letters VI, 10. Dio LXVIII, 2.

(9) *Ibid.*, II, 1.

(10) Dio Cassius, LXIII, 25.

(11) Pliny, *Letters*, II, 18.

(12) Tacitus, *Histories*, I, 52. See note 6, above.

(13) Tacitus, *Annals*, XV, 23. C. I. L., V. 397. C. Memmius Regulus was son of the person mentioned by Tacitus in *Annals*, XIV, 47, 1-2, who died in the year his son became consul. Martial XII, 36, 8, mentions this colleague of Rufus as belonging among the great good men, such as Seneca, Piso, and Crispus. See H. M. Stephenson, *Selected Epigrams of Martial*, Macmillan, 1887, p. 421, *ad locum;* Edwin Post, *Selected Epigrams of Martial*, Ginn and Co., 1908, pp. 303-4; A. Draeger, *Die Annalen des Tacitus* (3), Leipzig, Teubner, 1882, p. 184, on*Annals* XV, 23; H. Pitmann, *Tacitus Annals*, XIII-XVI, based on Furneuex, Oxford University Press, 1904, p. 99.

(14) Julius Vindex had intended to make Galba emperor. According to Dio Cassius, 63, 22, Vindex had sprung from a kingly line in the Gaulic province, Aquitania. He had a powerful body and a clever mind. In 68 he was propraetor of Gallia Lugdunensis. Suetonius, *Nero*, 40; Plutarch, *Galba* 4, states that Vindex offered the emperorship to Galba (see below). Zonaras, *Histories* XI, 13, reports that when Nero set a price on the head of Vindex, the latter, upon hearing it, said, "Whoever brings me the head of Nero, let him get mine in return." The same historian says that when Vindex saw the Gauls eager for a revolution, he incited them to it. L. Paul, *op. cit.*, 604, maintains that Vindex planned to free both Gaul and the entire empire from Nero.

Cf. Tacitus, *Histories*, I, 65. Besancon, besieged later by Verginius, was the capital of the Sequani

From Tacitus,*Annals* XV, 74, we learn that when Nero found out that a conspiracy was formed against himself, he dedicated a dagger that Scaevinus brought out from the temple of Salus, in the capital and inscribed it to Jupiter Vindex. This action of Nero some people, after the death of Vindex, took as an omen of presage of future vengeance *(ibid.)*

Galba considered Vindex not as a rebel or a would-be liberator of Gaul, but as a representative who wanted to free all the oppressed people from Nero's tyranny. Plutarch, Galba XXII, reports that Galba felt grateful to Vindex and honored him when killed on the ground that he was proclaimed emperor by him. Because of the efforts of the latter, Plutarch reports, Galba is said even to have punished those Gauls who abstained from the revolt of Vindex and rewarded those who took part in it. Tacitus, *Histories*, I, 51, states that the Gauls who took part on the side of Vindex boasted that they had obtained from Galba the lessening of one fourth of their tribute: *qui remissam sibi, a Galba quartam tributorum partem et publice donatas in ignomumam exercitus iactabant.* Duruy, *op. cit.*, vol. V, p. 44, thinks that Vindex had become "too much of a Roman to conceive anything beyond a change of administration or sovereign; his whole conduct shows this; he made his followers swear to be faithful to the Senate and to the Roman people." The same author, p. 47, declares that Verginius and Vindex in a conference before Besancon "soon came to an agreement in favor of a restoration of the Republic." But the soldiers of Verginius evidently thought otherwise. Zonaras XI, 13, likewise thinks that the Gauls were ready for a revolution and Vindex goaded them on. B. Henderson, *op. cit.*, p. 403, believes that at

that time "in actual fact the integrity of the empire was at stake, and Verginius remained proudly and steadfastly its champion." That Vindex at first was planning for a revolution and liberation of Gaul may be gathered from Suetonius, Nero, 40, and Verginius himself who seems to think so in his epitaph, boasting that he defeated the Vindex and saved his country. Pliny Letters, VI, 10.

(15) Plutarch, *Galba* 6, Dio Cassius, 63, 24; Tacitus, Histories I, 1. H. Goelzer, *Oevres de Tacite*, Paris, 1920, vol. I, p. 20, note 1, 8, line 12, incorrectly says that Verginius commanded Lower Germany. His own words are: "*commandait l'armée de la Basse-Germanie a l'avénement de Galba.*" With him agrees Charles Marivale, *History of the Romans*, D. Appleton, 1896, vol. VI, p. 280. But the commander who succeeded Verginius was Hordeonius Flaccus. Suetonius, *Galba* XVI, espressly states that Verginius was commanding Upper Germany: "*Fremebat Superioris Germaniae exercitus fraudari se praemiis,*" which cannot be interpreted in any other way but that this was the army of Verginius. Rohden and Dessau, *Prosopograph. Imp. Rom.* etc. vol. III (1898), pp. 403-4, take the same view: "*Superioris provinciae legatum fuisse (SC. Verginium) et ex aliis rebus colligitur, et inde quod successor eius Hordeonius Flaccus superiorem provinciam rexit.*" Cf. also L. Paul, *op. cit.*, 610, 621; F. G. Moore, *The Histories of Tacitus*, Books I and II, Macmillan, 1910, p. 115, on Book I, 1, 8; B. W. Henderson, *The Life and Principate, etc.*, p. 396, 399. Duruy, *op. cit.*, V, p. 47. It is difficult to know the exact ideas of Vindex. The Gallic uprising took place first in Aquitania and spread over the provinces of the Arverni, Sequani, Haedui, with its headquarters at Vienna.

(16) Tacitus, *Histories*, IV, 17; I, 9. See also note 2 above for further details of Verginius' army.

(17) *Ibid.*

(18) Dio Cassius, 62, 47, tells us that "when Nero heard that Galba was hailed emperor and that Verginius forsook him, he was thrown into great fear and was both himself getting ready at Rome and also sent against them Rubrius Gaelus and some others. Suetonius, Nero, 40-49, graphically relates the moods through which Nero passed from the beginning of the revolt to his miserable end. *Inter alia* he is reported to have uttered, "*Qualis artifex perio*" *(ibid.*, 49).

(19) Dio Cassius, 62, 27. Dr. H. B. Foster in his Index to vol. IV, p. 312, of his translation of Dio, calls Vindex governor of Greece! Plutarch, Galba 6, states that Vindex slew himself. Dio accepts this account, but the inference is that Vindex was slain by his soldiers. Zonaras 11, 13, relates that Vindex felt remorse for exposing his people to danger and also was angry against his luck.

(20) Merivale,*History of the Romans*, N. Y. D. Appleton, 1896, vol. VI, p. 281, says that the Gaelic legions after the death of Vindex were united with the Germanic.

(21) Plutarch, Galba 6. Galba must have been either double-faced or alarmed at the magnitude of the Gaelic revolt. See note 14 above. He treated Verginius with suspicion, perhaps owing to his fear of his popularity. See also notes 23 and 24, below.

(22) Plutarch, *Galba* 10, "*Ton chiliarchon tis ton en te skene spasamenos to xiphos ekeleue ton Ouerginion dechesthai ten hegemonian e ton sideron.*" Cf. also Dio Cassius 62, 25. It is interesting in this connection to recall the words of Julian to the Emperor Constantius after he accepted the throne: "Conquered at last and reflecting that if I were struck down some other perhaps would gladly see himself proclaimed emperor in my stead, I yielded to the hope of appeasing their violence." D. Brooke, Private Letters, Pagan and Christian, Dutton's 1930, p. 116. See also Zonaras 15, 18, of the ascension of Leo to the purple.

(23) Fabius Valens was a greedy man. He was so avaricious that he killed for a thousand denarii (ordinarily about $200) the decurion who had once saved his

life. See Tacitus Histories I, 52; *"profusa cupidine et insigni temeritate legati legionum Alienus Caecina et Fabius Valens."* See also Dio Cassius, 64, 10. Valens tried to make Verginius revolt against Galba and later defamed him to the latter. Tacitus, Histories I, 52, 55; III, 62. Even the Illyrian legions which were brought to Italy by Nero tried to induce Verginius to become emperor. See Tacitus, Histories I, 9; 31.

(24) Tacitus, Histories, I, 8, tells us that Verginius turned away slowly from Nero and delayed declaring for Galba *"an imperare voluisset dubium"*. This may have aroused the suspicions of Galba, who treats him coldly. See notes 21-23 above. Duruy, *op. cit.* V, p. 47, thinks that Verginius was alarmed at the ideas that the evils would fall upon the empire if the provinces and the armies should discover that an emperor could be created outside of Rome — a thing that actually happened. See Tacitus, Histories I, 4; *"evulgato imperii arcano, posse principem alibi quam Romae fieri."*

(25) Galba was going over the Pyrenees and by way of Narbo to the Maritime Alps. See E. G. Hardy's edition of Plutarch's *Galba,* Macmillan Co., on chapter 10.

(26) Plutarch, *Galba,* 10.

(27) Tacitus, *History* I, 8, says that after the recall of Verginius there was no general in the army. Indeed Hordeoneus Flaccus was an old man and of no importance. Tacitus, History I, 9, describes him as a man *"senecta ac debilitate pedum invalidum, sine constantia, sine auctoritate.*

(28) C. I. L. vol. VI, 2051, p. 499.

(29) Tacitus, *Histories* I, 77, and cf. F. G. Moore, *op. cit. ad loc.,* p. 166-167. Plutarch, Otho I. *Tacitus, ibid.,* I, 76, says that Otho did it to soothe the feelings of the German army.

(30) Tacitus, *Histories* II, 49. W. A. Spooner, The Histories of Tacitus, Macmillan, 1891, Index, p. 512, lists incorrectly. The reference to Vitellius should be to II, 68, instead of to II, 49, which he gives. It is thought by some that the soldiers suspected Verginius of treachery, and Tacitus lends partly countenance to it when he says the men were mistrusting the officers *(miles ducibus infensus).* Cf. also F. J. Wells and R. H. Barrows, A Short History of the Roman Empire, New York Dial Press, 1931, p. 137.

(31) Tacitus, *Histories* II, 51; Plutarch, Otho, 18.

(32) W. M. L. Hutchinson,*op. cit.,* vol II, p. 439, Index.

(33) Plutarch, *Galba* 10.

(34) Pliny,*Letters* II, 1, translated by W. Melmoth; edited by W. M. L. Hutchinson *(See Note 5).*

(35) See Tacitus, *Histories* I, 52, 62; II, 31, 62, 95; III, 36, 67. For some of his virtues, see Tacitus, Histories I, 70. He ruled Africa well when he was proconsul. See also Suetonius, Vitellius, 5, who reports that a great change for the worse came to Vitellius after he became an emperor. In Rome he even stole the gifts and ornaments of the temples and changed other precious gifts of gold and silver, substituting tin and copper.

(36) Tacitus, *Histories,* II, 68.

(37) *Ibid.* Perhaps this was the better reason for the action of the soldiers, than the one suggested in note 30.

(37a) This villa was sold afterwards to Pliny's mother-in-law, Pompeia Celerina (Pliny VI, 10). Verginius was buried in the villa. He used to call it his little nest in old age, *"senectutis suae nidulum."* See E. T. Merrill, Selected Letters of Pliny, Macmillan, 1910, p. 333, *ad locum,* who cites a parallel in Ausonius, Moselle 449, *"nidum senectae."* Cf. also Horace, *Carmina,* II, 6, 6. *"Tibur . . . sit meae sedes utinam senectae;"* cf. also Carmen Saeculare, 46.

(38) Tacitus, *Histories,* I, 1.

(38a) Pliny, II, 1. *"Ut summum fastigium privati hominis impleret, cum principis noluisset.*

(39) Dio Cassius 68, 2, *". . . . kaiper pollakis autocratora onomasthenta, ouk oknesen hypateusas synarchonta proslabein . . . ."*

(40) Satires VIII, 221. *"Quid enim Verginius armis debuit ulcisci magis aut cum Vindice Galba"* etc.

(41) According to Plutarch, Galba respected Verginius; and Otho made it a matter of pride to tell the Senate that he elected Verginius as consul. See Plutarch, Galba, 10, Otho, 1. All men respected Verginius. Cf. Dio, 64, 4.

(42) Pliny, *Letters* II, 1.

(43) Pliny, II, 1, 9. *"Etiam si filium haberem, tibi mandarem,"* he told Pliny, when he chose him in his stead to present his excuse for not accepting the office of quinquivir for reducing the public expense.

(43a) See p. 8 above.

(44) Pliny, Letters VI, 10.

(45) Dio Cassius, 68, 2, 4.

(46) Probably Cremutius Ruso, whom Pliny mentions in VI, 23, as his junior counsel in a law case. See E. T. Merrill, *Selected Letters of the Younger Pliny*, Macmillan, 1908, p. 392 ad IX, 19. Of Triarius, Pliny says he was of good family and "excessive affection" for him. The writer adds that Ruso was "of the best disposition imaginable."

(47) Sextus Julius Frontinus, Pliny's friend (V, 1, 5) governor of Britain in 76-78 (Tacitus, *Agric.* 17). See Merrill, *op. cit., ibid.*

(48) Pliny, IX, 19.

(49) Pliny II, 1, 11. *"Vivet enim vivetque semper atque etiam latius in memoria hominum et sermone versabitur postquam ab orculis recessit."* In this connection it is well to remember the words of Ennius. *"Nemo me lacrimis decoret nec funera fletu faxit. Cur? Volito vivus per ora virum."*

(50) *Ibid*, II, 1, 12: *"Cui fortasse aliquos cives virtutibus pares et habemus at habebimus, gloria neminem."* See also Plutarch Galba, 10.

THE LINGUISTIC QUESTION IN EPISTEMOLOGY

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EPISTEMOLOGY asks: how far can man's knowledge really go? What from one point of view appears one way, appears different from another. Conditions and circumstances greatly change our ideas of things; when we are thinking practically, they look different than when we think æsthetically, for instance. There is a difference of opinion on almost every subject. Then there is the final question, if we may not all make the same mistake, after we have compared our results and come to an agreement. Perhaps we are all looking as through green or blue or red glasses, due to the nature of our senses and of our thought. In my last paper at the Academy I suggested that there might be different planes of truth: things were true, as we find them every day, in a certain context, from a certain point of view, or when viewed with a certain purpose. I have since sought to define and to classify these planes of truth, as I perhaps may call them, and I found that I already had done so some ten years ago in my dissertation.[1] I shall, therefore give you only the briefest outline now.

There are three main divisions. There is the bodily feeling which has no object common to several of us. We find it in the tooth-ache, the stomach-ache. We make but few differentiations here and have but few words to specify them; we cannot exactly describe these feelings to each other, since we have no common object to which to refer them. The second group, broadly speaking, is the group of the senses,

[1] *Die Mittel der sprachlichen Mitteilung*, Freiburg im Brsg., 1924.

although these shade into the first group and give us the clearest common object by way of sight, that is, in the thing all of us can see. From these two groups we derive the third, the abstractions. These are but parts of things as they exist in the phenomenal world, parts which we gather together from different objects to determine their similarity. From these abstractions we can derive further abstractions; we can combine them and separate them in thought; we can unite them with objects of sense and with feelings in all sorts of combinations. If we think of each of our three main groups as level planes, these combinations will give us transverse plans cutting across one or more of the three. These transverse planes we set up in various areas and at all angels, constantly, in our practical life as we supply our bodily needs, go after our business, make our scientific investigations. The possibilities of such transverse planes seem infinite; fortunately it is unnecessary to investigate them further now. In this connection the epistemological question arises: in how far are these arbitrary transverse planes permissible?

As we think, we think in wholes and parts. These wholes and parts, of course, may be abstract or concrete. When we combine wholes, we make new wholes, and the former wholes become the parts of the new. When we divide wholes into parts, these parts by their isolation become wholes. Wholes and parts are ways of thinking. As we can divide the spectrum into as many colors as we choose, we divide the rest of the world into such parts as suit our purpose. The world, however, is continuous and divisible only on certain principles which thought supplies. We find a certain affirmation of our divisions in the phenomenal world, but there are two epistemological questions: How far are these affirmations justified beyond the practical purpose which they serve? and: In the infinite possibilities of division and combination, of parts and wholes, which we make constantly for our practical purposes, what chance have we to keep in mind the planes on which they apply and to escape the confusion of shifting from one plane to another inadvertently and unjustifiedly?

Our thoughts are mainly in words. Words are the symbols of ideas, that is, of the units of our thought. Here we can combine and divide to please our fancy *ad infinitum* and are molested only when we transfer them to the phenomenal plane or the combinations and divisions of another's thought. As soon as we forget the possibilities of contradiction by phenomena and other men, we are moving on that arbitrary plane of truth, the truth of our own poetry. Within itself it is as true and real as any other. But its findings are not completely corroborated by the truth on other planes. So it is, more or less, on all planes, for who can keep in mind all the jarring possibilities of the phenomenal world and of others' thought? The difficulty with language as the chief vehicle of our thought, quite apart from any difficulties of communication, is that it provides symbols to represent wholes and parts on all sorts of planes of truth without indicating in any way on which plane they properly apply and thus warning us in our thoughts that we are making improper transgressions. Words representing bodily feelings, objects of the senses, abstractions, and a thousand practical combinations all have the same form and can be used in the same ways. They beguile us to suppose that the truths we find on one practical plane will fit as well on another, in fact, that there are no planes of truth, that all truths are equally true everywhere and, once established, can be applied anywhere indifferently. We think in symbols that imply unconditional truth, but we find otherwise that our truths are limited by conditions in phenomena and others' thought, and yet these

symbols are almost the only means of thought that we have. Parts become wholes in our thoughts, and our language does little or nothing to remind us that these are only our own divisions made for our purposes; in fact, it leads us to suppose through the common acceptance of the linguistic symbol that the thing symbolized is unquestionably an independent whole, because it is thought separately by others. The epistemological question, then, concerning language is: In how far can we work with symbols implying absolute truth — symbols which, however, represent only conditional truths?

A METHOD FOR STUDYING THE FINANCIAL SUPPORT OF EDUCATION IN A COUNTY, AS AFFECTED BY THE ASSESSMENT POLICY AND THE FLUCTUATIONS OF THE DOLLAR

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A METHOD FOR STUDY

Public education must be supported by taxation. The amount of money that can be raised by taxation is determined by the taxing limit of the community and is dependent upon it. The taxing limit of a community is determined by the assessed valuation, which is, at least in theory, supposed to bear a fixed relation to the true wealth of the taxing unit. That taxing units usually do not assess at full value, even when required by law, is evident from the numerous studies and from common observation. The close relationship of school support, assessed valuation, and real valuation, together with the fact that the assessed valuation as placed by the assessors seldom agrees with the real valuation, as shown by actual transfers, gives rise to a demand for a technique or method whereby trends in community wealth may be studied.

Numerous studies in various localities bear out the common observation that school costs are constantly rising. On the whole, the American people have responded nobly to this urgent need, but of late there has been a tendency to ask the question, Can this constantly rising cost continue to be met? It has even been suggested by some of our leeaders that we might be approaching a point where the pupil must bear a greater part in the cost of his education.

Every year brings new demands upon the school, such as new subjects, better trained teachers, and room for more students who will remain longer. The schools have become the "dumping ground" for all the worthwhile things that other agencies are failing to do, and these all cost money. The schools apparently are approaching the "point of saturation" financially, with no evident slacking of the increasing demands upon it. If the numerous school surveys have taught anything, it is that more and more money will be needed to care for the demands of instruction, building, and maintenance. Some method is needed to enable the school administrator to compare the trends of the community's school costs and its wealth, which is the purpose of this paper.

Two methods could be used for studying school costs. The first is the amount of "taxes raised" for school purposes; this, for reasons to be discussed later in this

paper, seems to be the better. The second method is that of the "school expenditures."

Upon first observation it would seem that "school expenditures" and "school taxes" for a given area should approximately equal each other. This probably is not true. There are several considerations which may cause the two to differ. For the most part the fiscal year for schools ends in June, whereas that for taxation ends in December. There seems to be no adequate method to render these sets of data comparable in temporal relation. In some localities at least, "school expenditures" are kept in a poorer manner than the tax receipts. School bonds and short-time borrowing by the boards of education will render the "school expenditure" higher than the taxes raised unless these items are carefully separated, since they will enter into the accounting as money paid out twice. For these reasons the curves or trend lines for "school expenditure" will probably run higher than "school taxes" and will be subject to more fluctuations. A $200,000 school building would show immediately in "school expenditures" but would be spread over a period of from five to 20 years when using the "taxes raised" basis for computing school costs. However, both will give fairly similar results.

Satisfactory results will be obtained if these data are gathered in five-year periods for a period of 50 or more years. This will give fairly accurate trends. Using the first year's datum as a base year and dividing it into the data for each of the succeeding years will give the percentage index, or the percentage each succeeding year is of the first or base year. Plotted on arithmetic paper these percentage indices will give a trend line for either school taxes or school expenditures.

It is obvious that anything unusual that causes the base year to deviate widely from the normal condition of affairs would in turn affect the entire trend line. To check upon this possibility the logarithmic index could be used. Instead of being a percentage that each period is of the first, the logarithmic index shows the average periodic rate of increase or decrease and can then be compared with other index numbers or their trend lines. It must however be borne constantly in mind that this is not an increase over the first year, but rather an average percentage of increase by periods, and will give when projected a curvilinear line as in "compound interest." The percentage index described will give a straight-line graph if plotted. The one is a geometric increase, while the other is an arithmetic increase. Both may increase in a positive, negative, or zero manner. The logarithmic index line will give a more rapid rate of increase.

The following procedure is necessary in order to compute this average periodic rate of increase. Divide the first number in the series into the second number. This gives the percentage that the second number is of the first in the series. Then divide the second number into the third, thus getting the percentage the third number is of the second. Continue in this manner until each periodic percentage of increase or decrease has been computed. In order to get the average rate of increase or decrease it is necessary to find the logarithms of these numbers and average them. The anti-log of this average logarithm will be the average periodic rate of increase or decrease in the series and is the logarithmic index. Any factor that might have caused the first year in the series to be in error will not be eliminated by this manner, but its effect will be averaged throughout and will not continue to cumulate throughout as in the case of the percentage index described earlier.

The investigator will collect data showing the "assessed valuations" and "actual-transfer values" of the property in the district. The variations in the assessment policy and the almost universal tendency by the assessors to under-assess the property renders the use of what is known as the "sales technique" necessary in order that the "assessment ratio" may be computed. This is the percentage the "assessed value" of a piece of property is of the "true value" as shown by transfers in the market.

The use of the "assessment ratio" is based upon the assumption that the ratio as found by a large sampling of property transfers will represent the policy for the entire district. For the data used in this study all the transfers were used for each period. Sampling would have been sufficiently accurate for practical results. This was evidenced by the fact that, when the ratio was computed for all the cases and compared with the ratio of the chance grouping of odds and evens, the ratio was in each case approximately the same. The greatest deviation in this study was eight points.

From such a study of the assessment policy of a community one may learn the average assessment policy, the variability of practices, the fluctuations of policy, and the trend of the policy over the period studied. Such information is of value to the administrator who is faced with approaching "point of saturation," or with the fact the layman believes that it is approaching.

The "assessment ratio" may be determined in two ways. In one case the first problem is to find the "assessment ratio" for each piece of property transferred. Grouping these by years and taking the average gives the average "assessment ratio." The presence among the individual transfers of many cases with wide divergence from the usual custom will cause the mean to be an unreliable index of the "assessor's error" or "assessment ratio." The median, which is a counting average and does not take into account the distance each case is above or below the middle case is the better measure to use.

The other method is to find the sum of all the "transfer values" of property, and the sum of all the "assessed values" of the property transferred, and compute a ratio from these sums. The accuracy of data may be tested by summating for the odds and evens of a chance grouping of all cases studied, and comparing the ratio obtained from the totals.

It would seem that either method would be correct; however, the two methods do not give the same results. Which of the two is the better is debatable; hence the two ratios might be averaged, and this average "assessment ratio" used. Such was the procedure used in this study. For practical purposes the ratio derived from the totals probably is sufficiently accurate, and the ease of computation is decidedly in its favor.

The total "assessed valuation" of the community or district can then be corrected with this "assessment ratio," giving an "estimated true valuation." For example, if a piece of property is valued at $100 and the "assessment ratio" 25, the property probably is valued at $400. Similarly, the treatment of the total valuation of the county is possible. It becomes necessary only to multiply by 100 and divide by the "assessment ratio" expressed as a whole number. Reduced to a formula the procedure would be as follows:

$$\frac{\text{``Assessed value''}}{\text{``Sales value''}} \quad \text{equals ``assessment ratio''}$$

$$\frac{\text{``Assessed value''}}{\text{``Assessment ratio''}} \quad \text{equals the ``estimated true value''}$$

Often the consideration found upon the recorder's records is manifestly untrue. Such considerations as ''love and other valuable considerations'' or ''$1 and other considerations'' cannot be used without being a greater source of error than if they were left out of the investigation. In the years when the federal revenue act was in force, it was a simple matter to correct these fictitious considerations, since these acts required a stamp of 50c for each $500 or fractions thereof for which the property was transferred In such cases the mid-point should be used: e. g., a 50c stamp would be assumed as a transfer of $250. In case a mortgage is involved it will be necessary to add the mortgage value, as the stamp covered only the monetary consideration,

These data may be found in the recorder's office or treasurer's office in the court house. A short-cut is possible in communities in which an old and well-established firm of abstractors is located, as they usually have such data on record. An intelligent stenographer can secure these data in a reasonably short time. These values can then be treated as school costs were, and a ''percentage index'' and ''logarithmic index'' computed. These figures are now comparable because they are reduced to percentages, cover the same period, and the ''assessed valuations'' have been corrected for the assessor's error. One other source of error remains since there has been a steady decline in the value of the dollar since 1900. These dollars must be reduced to comparable values.

The Bureau of Labor Statistics in the *Monthly Bulletin* maintains what purports to be a continuing index of wholesale price levels which, while not entirely comparable, are probably the best and most accurate of the price indices. In this series all indices are in terms of the 1913 dollar. These indices may be found in Vol. XXI (July 1925, p. 47); or in Magee, J. D., ''An Introduction to Money and Credit'', T. S. Crofts, New York.

Whether or not the administrator will care to make a correction for the declining dollar value will depend upon the use to be made of the data. ''Assessed valuation'', ''taxing limit'', and ''taxes raised'' unfortunately are in terms of dollars and not in purchasing power of those dollars. Hence if the administrator is collecting data merely to aid him in the formulation of his future fiscal program, the data had better not be corrected by the dollar index. On the other hand, if these figures are not to be used in publicity for increased school support in a community amply able to make such increase, and where there is a feeling that schools are increasing in cost too rapidly, the correction for the dollar value will serve a good purpose because it is easily shown thereby that much of the increased school costs is really only the reflection of the declining value of the dollar.

THE METHOD APPLIED

Even in localities required by law to assess at market value practically no attempt is made to do so, and the almost uniform policy of under-assessment prevails. This of itself would not be so bad if the policy followed were or even approximated an uniform one. A situation shown by the following figures probably can be duplicated anywhere the study is repeated:

TABLE 1

Case	Description	Consid.	Stamp	Ass'd Val.	Prob. Val.	Enc.
1	Lots 18, 19, 20, Block 23 R. R. Add. & N 66 ft. L 17-SW¼ Sec. 7-95-12 Town A	5500	5.50	2864	5500	
2	Lot 1 Block 15 Original Plat Town B	1	3.00	3060	8750	6000

Legend for Table 1

Case means the transfer.
Description is the legal description of the property transferred.
Stamp is the amount of revenue stamp placed upon record.
Ass'd Val. is the assessed valuation of the property transferred, and may not be the same as the consideration; in fact, usually is not.
Prob. Val. is the probable value of property. This may be more than the consideration as in case 2 above. In this case a mortgage of $6000 must be added to the consideration.
Encumbrance is the mortgage, if any, upon the property. The stamp is unaffected by the mortgages; hence they must be added to value shown by consideration and stamp.

When the individual "assessment ratio" for each transfer is figured and then placed in a distribution table and the median and quartiles figured, results shown in table 2 were obtained from data collected in total over an entire county by the writer.

TABLE 2—*The "Assessment Ratio" in County "C"*

Year	Group	Highest Ratio	Third Quartile	Median	First Quartile	Lowest Ratio	Number of Cases
1925	Urban	508.8	63.9	43.0	15.6	16.0	140
	Rural	225.9	74.5	58.6	44.8	12.2	155
1920	Urban	640.0	59.0	42.4	31.0	4.2	172
	Rural	501.9	67.5	47.3	37.9	4.7	560
1915	Urban	544.0	60.9	45.9	33.3	1.7	162
	Rural	628.5	60.8	49.6	40.7	6.2	246
1910	Urban	400.0	68.3	52.0	37.9	11.4	105
	Rural	200.0	63.1	53.4	45.8	3.0	236
1905	Urban	292.0	67.7	53.8	40.9	10.1	101
	Rural	480.0	76.2	64.4	53.8	10.0	227
1900	Urban	600.0	92.3	73.1	48.8	4.5	112
	Rural	1206.4	89.7	71.7	61.1	8.0	364
1895	Urban	375.0	40.2	21.1	11.7	1.2	135
	Rural	600.0	35.6	22.9	18.1	1.2	332
1890	Urban	423.0	44.6	26.7	16.3	1.3	142
	Rural	238.5	50.8	35.2	27.1	3.2	345
1885	Urban	2375.0	45.6	33.7	25.3	2.6	126
	Rural	1824.0	57.7	42.8	32.7	3.2	263
1880	Urban	550.0	46.3	26.6	16.3	1.2	117
	Rural	2664.0	67.4	48.4	32.3	3.3	287
1875	Urban	400.0	42.3	26.4	16.4	2.5	135
	Rural	240.0	61.8	44.9	29.3	0.18	441
						Total —	4903

The "assessment ratio" obtained by the summation of "transfer value" and "assessed value" of all properties transferred is shown in Table 3. This table also shows the average "assessment ratio" obtained by averaging the median method and the total method. The rural and urban ratio obtained by this averaging is then averaged to obtain the best single figure for the entire county.

TABLE 3—*The Assessment Ratio in County "C"*

Year	Group	Ass't ratio total cases	Ass't ratio odd numbers	Ass't ratio even numbers	Average total & median ratio	Average rural & urban ass't ratio
1925	Urban	51.3	48.0	55.8	47.2	53.0
	Rural	59.0	59.5	59.7	58.8	
1920	Urban	38.3	37.6	37.9	40.4	44.2
	Rural	48.8	51.0	47.6	48.0	
1915	Urban	43.2	33.4	32.8	44.6	47.7
	Rural	51.7	54.0	49.3	50.7	
1910	Urban	54.3	51.2	57.8	53.2	52.9
	Rural	51.6	53.7	50.2	52.5	
1905	Urban	46.4	43.6	51.2	50.1	57.5
	Rural	65.4	62.6	68.6	64.9	
1900	Urban	65.5	64.5	66.5	69.3	71.0
	Rural	73.4	72.1	75.2	72.6	
1895	Urban	20.3	22.7	17.6	20.7	21.9
	Rural	23.0	22.9	23.1	23.0	
1890	Urban	26.3	27.4	25.2	26.5	30.4
	Rural	33.3	33.5	35.9	34.3	
1885	Urban	34.8	37.4	32.7	34.3	38.6
	Rural	43.0	48.1	42.3	42.9	
1880	Urban	21.7	22.1	21.3	24.2	35.4
	Rural	44.6	43.0	48.2	46.5	
1875	Urban	24.3	26.0	22.5	25.4	34.4
	Rural	40.9	41.7	40.0	42.9	

The close similarity of the "median" and the "total method" indicates that the total method is accurate enough for all practical purposes.

A study of Tables 2 and 3 shows wide variations in the "assessment policy" of this county. This is true within a given period as well as for different periods. Not only was the variation noticeable within the county among different assessors, but even with the same assessor a wide variation existed. Property ranging from $200 to $500 was assessed at the same value. The "assessment ratio" for the individual cases ranged from 0.18 to 2640.0 for the period from 1875 to 1925. The extreme variation for any year was among the rural transfers for 1880. In that year the highest "assessment ratio" was 2640 and the lowest was 3.3, making a difference of 2636.7. It is hard to believe that such a variation could exist in one county. The highest and the lowest "assessment ratio" may represent the operation of unknown factors, but a casual inspection of the upper and lower quartiles shows a decided variation among the middle 50% of the cases. In this case the range was from 13.7 to 92.3, with the extreme variation in the urban property transfers of 1925, which varied from 63.9 to 15.6, making a difference of 48.3.

These tables show a decided tendency for the "assessment ratio" to drop for both rural and urban areas. For both there was an uninterrupted decline in the "assessment ratio" from 1875 to 1900. Here the ratio for both urban and rural property rose suddenly to 73.1 for urban and 71.1 for rural. Since then the fall has been continuous with the exception of the rural property in 1925. In this case

the recent land boom probably was influencing the assessor after the deflation had caused a drop in value. The consistent lowering of the assessment probably is a function of the close relationship of the local assessor and his constituents. He is under constant pressure to lower their assessments, and there are certain advantages in having the entire district assessed at a low figure, because by so doing a partial exemption is secured from the state levies. This in turn necessitates a high mill levy for the expenditures of government. The reason for the abrupt rise in 1900 was the change in the code of 1897 in the state where these data were collected, in which property was to be taxed upon 25% of its assessed value. This had the effect of raising the assessment and causing more property to be listed. The old tendency soon reasserted itself, and since that time the ratio steadily declined.

In these days of unrest among the farmers and their clamor for reduced taxes, the statement is often made that the farmer pays more than his share of the taxes. These statements are based for the most part upon an opinion, and not upon any scientific evidence: thus, this study throws some light upon the controversy. A study of Tables 2 and 3 shows that there is a consistent tendency to assess rural property at a value more nearly that which it actually will sell for on the market. The only exception was in 1900, when the two were nearly equal. It seems evident that this will force the rural property to pay a higher tax in proportion to "real value" than that of urban property. Stated another way, this policy leaves a larger percentage of urban property untaxed than rural, which, added to the tendency to conceal monies and credits probably more plentiful in urban areas, indicates that the farmers do pay a larger percentage of the taxes as compared with their "real wealth."

The reason for this under-assessment of urban property lies in the assessment system itself. The assessors for the most part are men with little ability along financial lines and but slightly trained along lines of property values. It probably is true that to the average assessor, the 160-acre farm looks more valuable than the small lot on Main Street in the business district of a city, whereas the reverse is probably true.

This decreasing "assessment ratio" is of interest to the school administrator, for to the layman an increase in mill levy means an increased tax, which is not necessarily true. A high mill levy may be caused by a low "assessed valuation," and the continual lowering of the assessment then means a continual raising mill levy, or the curtailment of governmental functions, which creates a growing discontent among the taxpayers and patrons.

THE TRENDS OF WEALTH AND SCHOOL COSTS FROM 1875 TO 1925

Continuing the use of the method set forth earlier in this paper, we may find the trends of the wealth and school costs in the county under investigation. Percentage indices and logarithmic indices are given below for both the "assessed valuation", "school taxes," and " school expenditures" in the raw figures, which are then corrected by the use of the "assessment ratio" and the "price levels" of the Bureau of Labor Statistics.

An interesting sidelight is shown when the "percentage index" and "logarithmic index" is figured for average daily attendance, population, and school enrollment.

These figures show that for County "C" the matter of population, enrollment, and attendance was practically static for the entire period of the investigation, which would indicate that another set of variables had been checked out of the investigation.

Table 4 shows the correction indices used in this part of the study. Tables 5, 6, 7, 8, 9, and 10 show the "raw figures," "corrected figures," and the "percentage indices" for both the "raw" and "corrected figures." Table 11 shows the figures and percentage indices for the school enrollment, school attendance, and total population.

TABLE 4—*Correction Indices*

Year	Price Levels	Ass't Ratio County	Ass't Ratio Urban	Ass't Ratio Rural
1925	158.0	53.0	47.2	58.8
1920	226.2	44.2	40.4	48.0
1915	100.8	47.7	44.6	50.7
1910	100.9	52.9	53.2	52.5
1905	86.2	57.5	50.1	64.9
1900	80.5	71.0	69.3	72.6
1895	70.0	21.9	20.7	23.0
1890	80.5	30.4	26.5	34.3
1885	82.0	38.6	34.3	42.9
1880	94.0	35.4	24.2	46.5
1875	112.0	34.4	no data	no data

TABLE 5—*Assessed value and "estimated true value" of property in County "C" and the "percentage-index" or increase over 1875*

Year	Ass'd val.	Est. true val.	Ass'd val. index	Est. true val. index
1925	29,184,092	34,850,837	1,225.6	558.9
1920	33,337,781	33,344,316	1,400.1	534.8
1915	28,494,031	59,261,819	1,196.6	950.5
1910	18,421,600	34,512,824	773.6	553.7
1905	17,729,200	35,769,595	744.5	573.7
1900	15,063,600	26,355,699	632.6	422.7
1895	3,315,050	21,624,591	139.2	346.8
1890	2,998,598	12,253,178	125.9	196.5
1885	3,183,557	10,054,836	133.6	161.2
1880	2,282,361	6,858,879	95.8	110.0
1875	2,381,092	6,234,530	100.0	100.0

TABLE 6—*School taxes and the "estimated true value" of school taxes in County "C" and the "percentage-index" or increase over 1875*

Year	Taxes	Est. val. taxes	Tax index	Est. val. tax index
1925	201,020	127,227	571.9	405.4
1920	211,552	93,524	601.8	298.0
1915	107,625	106,770	306.1	340.2
1910	95,133	94,284	270.6	300.4
1905	50,585	58,683	143.9	187.0
1900	45,425	56,428	129.2	179.8
1895	42,799	61,141	121.7	194.8
1890	31,750	39,440	90.3	125.6
1885	37,837	43,142	107.6	147.0
1880	19,103	20,322	54.3	64.7
1875	35,149	31,378	100.0	100.0

TABLE 7—*School expenditures and the "estimated true value" of the school expenditures in County "C" and the "percentage index" or increase over 1875*

Year	Sch. expend.	Est. val. sch. expend.	Expend. index	Est. true val. expend.
1925	141,402	89,494	715.3	508.4
1920	188,264	83,229	952.3	847.8
1915	172,183	170,816	871.0	970.5
1910	67,634	67,030	342.1	380.8
1905	65,135	75,562	329.4	429.3
1900	57,639	71,601	291.5	406.8
1895	54,130	77,328	273.8	439.3
1890	46,732	58,052	236.4	329.8
1885	45,410	55,378	229.7	314.6
1880	36,100	38,404	182.6	218.2
1875	19,768	17,600	100.0	100.0

TABLE 8—*Assessed value and "estimated true value" of urban property in County "C" and the "percentage index or increase over 1880* (Data for 1875 not available)*

Year	Ass'd val.	Est. true value	Ass'd val. index	Est. true ass'd val. index
1925	8,256,260	11,070,934	1,641.9	500.8
1920	8,484,659	9,284,540	1,687.3	420.0
1915	6,622,611	14,731,054	1,317.0	666.4
1910	4,536,000	8,450,262	902.0	382.2
1905	3,752,000	8,687,957	746.1	393.0
1900	4,088,658	7,229,116	813.1	331.5
1895	787,658	5,435,872	156.6	245.9
1890	682,376	3,198,761	135.7	144.7
1885	659,413	2,344,495	131.1	106.0
1880	502,847	2,210,510	100.0	100.0

*Due to the fact that data were missing, it was impossible to make a similar table for school expenditures for rural and urban areas.

TABLE 9—*School taxes and the "estimated true value" of the school taxes raised on urban property in County "C" and the "percentage index" or increase over 1880 (Data for 1875 not available)*

Year	School taxes	Est. true val. school taxes	Sch. tax. index	Est. true val. sch. tax. ind.
1925	94,535	59,832	1,226.1	729.4
1920	98,634	43,604	1,279.2	531.6
1915	53,499	53,074	693.8	695.8
1910	27,855	27,606	361.2	336.5
1905	24,265	28,149	314.7	343.1
1900	21,395	26,577	277.4	324.0
1895	18,065	25,807	234.3	314.6
1890	10,310	12,807	133.7	156.1
1885	13,075	15,945	169.5	194.4
1880	7,710	8,202	100.0	100.0

TABLE 10—*Assessed value and the "estimated true value" of rural property in County "C" and the percentage index or increase over 1880 (Data for 1875 not available)*

Year	Ass'd val.	Est. true val.	Ass'd val. index	Est. true val. index
1925	20,927,832	22,526,298	1,176.0	553.3
1920	24,835,122	22,890,069	1,396.6	562.2
1915	21,871,420	42,796,522	1,229.0	1,051.2
1910	13,885,600	26,212,845	780.3	643.8
1905	13,976,800	24,983,643	784.4	613.6
1900	10,975,600	18,780,007	616.70	461.3
1895	2,527,392	15,698,085	142.0	385.3
1890	2,316,222	8,388,612	130.1	206.0
1885	2,523,144	7,172,504	141.7	176.1
1880	1,779,514	4,071,181	100.0	100.0

TABLE 11—*School taxes and the "estimated true value" of school taxes raised on rural property in County "C" and the "percentage index" or increase over 1880 (Data for 1875 not available)*

Year	School taxes	Est. true val. sch. taxes	Sch. tax. index	Est. true val. sch. tax. index
1925	106,485	67,395	934.6	556.0
1920	112,918	50,818	991.1	419.2
1915	54,176	53,746	475.5	443.4
1910	67,278	66,677	590.5	550.1
1905	26,230	30,533	231.0	251.9
1900	24,030	29,850	210.9	246.3
1895	24,734	35,334	217.0	291.5
1890	21,440	26,633	188.1	219.7
1885	24,762	30,197	217.3	249.1
1880	11,393	12,120	100.0	100.0

TABLE 12—*Population, average daily attendance, and school enrollment in County "C", and the percentage index or increase over 1875*

Year	Population	Index	Average daily attendance	Index	Enroll.	Index
1925	15,109	132.3	2,487	137.7	3,097	91.0
1920	15,431	135.3	2,442	135.2	3,364	98.8
1915	16,089	141.1	2,335	129.3	3,644	107.1
1910	15,375	134.8	2,241	124.1	3,476	102.1
1905	15,928	139.7	2,470	136.8	3,930	115.5
1900	17,037	149.4	2,779	153.9	4,442	130.5
1895	15,696	137.6	2,628	145.5	4,514	132.6
1890	15,019	131.7	2,384	132.0	4,307	126.6
1885	13,899	121.9	2,778	153.9	4,611	135.5
1880	14,534	127.4	2,389	132.3	4,345	127.7
1875	11,400	100.0	1,805	100.0	3,402	100.0

These tables of data show a fairly consistent tendency for both the property value and school costs to rise in the same ratio. The "estimated true values" give a more marked tendency. It would appear from the data in uncorrected form, that for the first 20 years covered by this investigation, the "school expenditures" had increased more rapidly than did either the "assessed valuation" or the "school taxes." Since that time the "assessed valuation" has assumed the more rapid increase, and "school expenditures" have taken second place. This tendency is more apparent than real, as will be shown by a study of the estimated or corrected data. These estimated data show a tendency to increase in similar ratio with the "school expenditures," increasing for the most part more rapidly than the property valuation.

It would seem that in both the rural and urban areas there has been a tendency for the "assessed valuation" to increase more rapidly than the "school taxes", if one studies the uncorrected data, whereas the corrected data give a different result. It appears that for the rural areas the property valuation has increased faster than the school taxes. This was not true of the urban areas, where there was a decided tendency for school taxes to increase at a more rapid rate than the property valuation. This was probably due to the more rapid rate of expansion of the city school systems. These data seem to indicate that those living in urban areas have been more alert to their educational needs, and have expanded the educational facilities more rapidly than those living in the rural areas.

These data indicated that there had been a tendency operating to cause a sudden rise in the rate of increase of school taxes during the last ten to 15 years. This

was shown by the curves for both the "estimated true data" and the "real data."

Attention has already been called to the fact that anything unusual that causes the base year to deviate widely would cause a distortion of the entire trend line. If, however, the logarithmic method is used, it will show the average periodic rate of increase or decrease, which would not permit the tendency operating to distort the first year to distort cumulatively each succeeding year.

TABLE 13—*"Average periodic rate" of increase or decrease from 1875 to 1925*

Logarithmic Index

Kind of data	Corrected data	Uncorrected data
County "C"		
Assessed valuation	118.72	123.43
School taxes	114.95	119.01
School expenditures	121.71	117.62
Average daily attendance	.....	103.13
Enrollment	.....	99.03
Population	.....	102.82
Urban		
Assessed valuation	119.56	136.42
School taxes	124.66	132.16
Rural		
Assessed valuation	120.88	131.46
School taxes	120.94	128.15

A study of this table shows the static condition relative to population, average daily attendance, and school enrollment. It also shows that the urban areas have spent more in proportion to their wealth than the rural areas. The uncorrected data seem to indicate that the school expenditures have outstripped the increase in wealth; however, the corrected data show that this probably was not the case.

USING THIS METHOD TO PREDICT FUTURE TRENDS

Any prediction of the future is dependent upon certain assumptions, among which are: (1) the data selected to show the past trends are representative; and (2) the factors affecting the past are similar to those that will be encountered in the future. These are not necessarily valid assumptions, and it must be kept in mind continually that predictions can never be better than approximations to what may occur.

Three methods may be used to predict the future trend: (1) The difference between the last year and the first in the period studied gives the amount of increase for the 50-year period. Since the sampling included 11 years, to divide this difference by 11 would give the average periodic increase in dollars. The assumption that the periods to be predicted will approximate the average of the past enables one to predict by simply adding to each successive period that increment. Such predictions give a straight line which amounts to a line drawn through the first and last year in the period studied and prolonged into the future. This will be called the "arithmetic increase." This method gives undue emphasis to the first and last years of the period. Any condition seriously causing these years to fluctuate from the normal trends will unduly affect the future estimates. (2) The Educational Finance Inquiry used the regression question as the means for predicting the future trends. This plan also gives a straight line and will be called the "regression straight line." For the formula, consult any well-known works on statistics. (3)

The third method is to find the logarithmic index, as explained earlier, which is used as one uses interest rate in compound interest. This gives the accelerating or curvilinear trend line. To test the reliability of the attempted estimates, the data were divided into two periods. The data from 1875 to 1905 inclusive formed the basis for prediction for the years 1910 to 1925 inclusive and were compared with the known data for 1910 to 1925 inclusive. The other period from which prediction was made was that of 1875 to 1925 inclusive and formed the basis for a prediction for the period from 1930 to 1950. The accuracy of the last prediction cannot now be measured.

The tables that are to follow show these predictions for both periods for assessed valuation, school taxes, school expenditures, population, average daily attendance, and enrollment. The fiscal data also are shown in terms of the "estimated true values."

TABLE 14—*Prediction of assessed valuation in County "C" in thousands of dollars*

Year	Actual data	Arithmetic str. line	Log. curve	Regression str. line
1875	$ 2,381			
1880	2,282			
1885	3,182			
1890	2,998			
1895	3,315			
1900	15,063			
1905	17,729			
Predicted periodic increment 1875-1905		$ 2,192	139.68%	$ 2,332
1910	18,421	19,921	$ 24,764	15,578
1915	28,494	22,114	34,590	17,930
1920	33,337	24,306	48,316	20,282
1925	29,184	26,499	67,487	22,634
Predicted periodic increment 1875-1925		2,436	128.43%	3,091
1930		31,620	37,811	33,430
1935		34,057	48,561	36,521
1940		36,494	62,396	39,590
1945		38,930	80,101	42,670
1950		41,367	102,873	45,750

TABLE 15—*Prediction of "estimated true valuation" of County "C" in thousands of dollars*

Year	Actual data	Arithmetic str. line	Log. curve	Regression str. line
1875	$ 6,234			
1880	6,858			
1885	10,054			
1890	12,253			
1895	21,624			
1900	26,356			
1905	35,769			
Predicted periodic increment 1875-1905		$ 4,219	133.73%	$ 4,822
1910	34,512	39,988	$ 47,834	36,035
1915	39,261	44,208	63,969	40,859
1920	33,344	48,427	85,546	45,681
1925	34,850	52,646	114,008	50,503
Predicted periodic increment 1875-1925		2,601	118.72%	3,682
1930		37,452	41,374	47,766
1935		40,053	49,120	51,499
1940		42,655	58,315	55,132
1945		45,256	69,232	58,815
1950		47,858	82,192	62,498

TABLE 16—*Prediction of school taxes in County "C"*

Year	Actual data	Arithmetic str. line	Log. curve	Regression str. line
1875	$ 33,149			
1880	19,103			
1885	37,837			
1890	31,750			
1895	42,799			
1900	45,425			
1905	50,585			
Predicted periodic increment 1875-1905		$ 2,205	106.22%	$ 3,781
1910	95,133	52,790	$ 53,731	52,135
1915	107,625	54,995	57,073	55,916
1920	211,552	57,200	60,622	59,697
1925	201,020	59,405	64,392	63,478
Predicted periodic increment 1875-1925		15,079	119.91%	15,679
1930		216,099	239,233	275,776
1935		231,178	284,711	191,455
1940		246,257	338,834	207,134
1945		261,336	403,246	222,813
1950		276,415	479,903	238,492

TABLE 17—*Prediction of "estimated true value" of school taxes in County "C"*

Year	Actual data	Arithmetic str. line	Log. curve	Regression str. line
1875	$ 31,378			
1880	20,322			
1885	46,142			
1890	39,440			
1895	61,141			
1900	56,428			
1905	58,683			
Predicted periodic increment 1875-1905		$ 3,900	110.92%	$ 6,069
1910	94,284	62,583	$ 65,091	68,726
1915	106,770	66,483	72,198	74,795
1920	93,524	70,383	80,082	80,864
1925	127,227	74,283	88,826	86,933
Predicted periodic increment 1875-1925		8,713	114.95%	8,388
1930		133,940	146,245	118,138
1935		144,653	168,108	126,526
1940		153,366	193,240	134,914
1945		162,079	222,129	143,302
1950		170,792	255,337	151,690

TABLE 18—*Prediction of school expenditures in County "C"*

Year	Actual data	Arithmetic str. line	Log. curve	Regression str. line
1875	$ 16,768			
1880	36,100			
1885	45,410			
1890	46,732			
1895	54,130			
1900	57,639			
1905	65,135			
Predicted periodic increment 1875-1905		$ 6,481	121.94%	$ 6,713
1910	67,634	61,153	$ 79,425	72,742
1915	172,183	67,634	96,850	79,455
1920	188,264	74,115	118,098	86,168
1925	141,402	80,596	144,008	92,881
Predicted periodic increment 1875-1925		10,148	121.71%	13,311
1930		151,550	172,100	159,766
1935		161,698	209,462	173,077
1940		171,846	254,936	186,388
1945		181,994	310,282	199,699
1950		192,142	377,644	213,010

TABLE 19—*Prediction of "estimated true value" of the school expenditures in County "C"*

Year	Actual data	Arithmetic str. line	Log. curve	Regression str. line
1875	$ 17,600			
1880	38,404			
1885	55,378			
1890	58,052			
1895	77,328			
1900	71,601			
1905	75,562			
Predicted periodic increment 1875-1905		$ 8,280	127.43%	$ 3,753
1910	67,030	83,842	$ 96,288	61,563
1915	170,816	92,122	122,699	65,316
1920	83,229	100,402	156,355	69,169
1925	89,494	108,682	199,243	73,022
Predicted periodic increment 1875-1925		6,535	117.62%	6,746
1930		96,029	105,262	114,975
1935		102,564	123,809	121,721
1940		109,099	145,624	128,467
1945		115,634	171,282	135,213
1950		122,169	201,461	141,959

TABLE 20—*Prediction of population in County "C"*

Year	Actual data	Arithmetic str. line	Log. curve	Regression str. line
1875	$11,400			
1880	14,534			
1885	13,899			
1890	15,019			
1895	15,696			
1900	17,037			
1905	15,928			
Predicted periodic increment 1875-1905		$ 646	105.68%	$ 712
1910	15,375	16,574	$16,832	17,579
1915	16,089	17,220	17,788	18,291
1920	15,431	17,866	18,798	19,003
1925	15,109	18,513	19,865	19,715
Predicted periodic increment 1875-1925		337	102.82%	274
1930		15,446	15,535	15,731
1935		15,783	15,973	16,005
1940		16,120	16,423	16,279
1945		16,457	16,886	16,553
1950		16,794	17,362	16,827

A study of these tables would be discouraging to any one who had hopes of predicting with any degree of accuracy. These data seem to indicate that, for this study at least, a straight line method of prediction was better. From a practical point of view it probably is a safer method to follow, because it gives a lower estimated amount and as such will be less likely to lead to unwarranted expansion.

For purposes of prediction it is doubtful if a person should attempt to correct for the purchasing power of the dollar. Such fluctuations in purchasing value of money do not affect the amount of money the administrator will have. For the purposes of studying the past trends, corrections probably serve a purpose, but for prediction he must content himself with the amount of money available and not what it will buy.

To be serviceable the estimates should be made for a short period of time, probably 25 years, and constantly revised in the light of changing conditions. A budget

based on future estimates of more than five years probably is unsound. In the case of building programs one must depend upon estimates longer than five years. In view of those conditions it seems that the only solution lies in a flexible program that will care for these extreme variations, and yet utilize the past trends. This will necessitate conservatism and judgment in the matter of predictions.

For data showing a tendency toward a straight line, either the "arithmetic" or "regression method" is preferred, with no decided preference. Since the "arithmetic method" gives undue weight to the first and to the last period, probably the "regression method" would be better in cases where such trends are noticeably away from the average trend. Ease of calculation favors the "arithmetic method."

For data showing a marked tendency to curve positively or negatively the "logarithmic" or "compound-interest method" probably is the best. The difficulty

TABLE 21—*Prediction of average daily attendance in County "C"*

Year	Actual data	Arithmetic str. line	Log. curve	Regression str. line
1875	$1,805			
1880	2,389			
1885	2,778			
1890	2,384			
1895	2,628			
1900	2,779			
1905	2,470			
Predicted periodic increment 1875-1905		$ 95	105.19%	$ 89
1910	2,241	2,565	$2,598	2,788
1915	2,335	2,660	2,732	2,877
1920	2,442	2,755	2,837	2,966
1925	2,487	2,850	2,984	3,055
Predicted periodic increment 1875-1925		62	103.10%	13
1930	2,549	2,549	2,564	2,518
1935	2,611	2,611	2,643	2,531
1940	2,673	2,673	2,724	2,545
1945	2,735	2,735	2,808	2,558
1950	2,797	2,797	2,895	2,572

TABLE 22—*Prediction of the school enrollment in County "C"*

Year	Actual data	Arithmetic str. line	Log. curve	Regression str. line
1875	$3,402			
1880	4,345			
1885	4,611			
1890	4,307			
1895	4,514			
1900	4,442			
1905	3,930			
Predicted periodic increment 1875-1905		$ 75	102.41%	$ 57
1910	3,476	4,005	4,024	4,477
1915	3,644	4,080	4,120	4,534
1920	3,364	4,155	4,219	4,591
1925	3,097	4,230	4,320	4,648
Predicted periodic increment 1875-1925		—27	99.03%	—94
1930		3,070	3,066	3,021
1935		3,043	3,036	2,927
1940		3,016	3,006	2,883
1945		2,989	2,976	2,739
1950		2,962	2,947	2,645

here lies in its rapid increase as the period is lengthened, and conservative estimates lead one to doubt that such ideal and satisfying results will continue.

In the face of what has been shown, it is doubtful if the results from either method described are worth the effort involved in securing them. Perhaps a fourth method, which may be called the "best-guess method" for want of a better name, will be better. For practical purposes one could project a line into the future with a ruler upon the same graph which shows the past trends. This line is to be projected as nearly like the past trend as the eye can determine. Ease of computation, coupled with the tendency to place undue faith in estimates involving complicated arithmetical procedure, favors the "best-guess method."

The purpose of this paper has been to set forth a method whereby similar studies might be carried on in other sections of the country. To illustrate its operation the writer has shown actual data collected and treated by this method. The conclusions drawn from these data are not applicable to all sections of the country, but are illustrative of the method and its use. A number of similar studies will give us a valuable body of data from which general and more far-reaching conclusions may be drawn.