Melvin P. Loy

West Virginia University Bulletin

Series 40, No. 5—I November 1939

THE WEST VIRGINIA ACADEMY OF SCIENCE

Proceedings of The Morgantown Meeting (1938)

Entered as second-class matter July 15, 1929, at the post-office at Morgantown, West Virginia, under the act of August 24, 1912

Issued Monthly

WEST VIRGINIA UNIVERSITY BULLETIN

PROCEEDINGS

of

THE WEST VIRGINIA ACADEMY OF SCIENCE

Volume 12

The Fifteenth Annual Session

WEST VIRGINIA UNIVERSITY

MORGANTOWN WEST VIRGINIA

May 6-7, 1938

PUBLISHED BY THE UNIVERSITY

MORGANTOWN

1939

Contents

PAPERS PRESENTED TO THE GEOLOGY AND MINING SECTION

PAPERS PRESENTED TO THE MATHEMATICS AND PHYSICS SECTION

PAPERS PRESENTED TO THE SOCIAL SCIENCES SECTION

OFFICERS OF THE WEST VIRGINIA ACADEMY OF SCIENCE

The Officers for 1937-38

President	T. L. Harris, Morgantown
Vice-President	Wallace Smith, Montgomery
Secretary	J. E. Judson, Buckhannon
Treasurer	C. G. Brouzas, Morgantown
Member of the Committee on Publications	H. A. Davis, Morgantown

The Chairmen of Sections

Biology	S. B. Talbot, Elkins
Chemistry	Charles Lazzell, Morgantown
Geology and Mining	J. H. C. Martens, Morgantown
Mathematics and Physics	J. K. Stewart, Morgantown
Social Science, Group I	A. J. Dadisman, Morgantown
Social Science, Group II	J. E. Winter, Morgantown

The Officers for 1938-39

President	Wallace Smith, Montgomery
Vice-President	A. M. Reese, Morgantown
Secretary	J. E. Judson, Buckhannon
Treasurer	C. G. Brouzas, Morgantown
Member of the Editorial Board	L. H. Taylor, Morgantown
Member of the Editorial Board	A. A. Schoolcraft, Buckhannon
Member of the Editorial Board	J. K. Stewart, Morgantown

The Chairmen of Sections

Biology	C. C. Fenton, Morgantown
Chemistry	W. H. Walker, Charleston
Geology and Mining	J. B. Lucke, Morgantown
Mathematics and Physics	J. S. V. Allen, Bethany
Social Science, Group I	F. R. Gay, Bethany
Social Science, Group II	A. A. Schoolcraft, Buckhannon

MEMBERS OF THE WEST VIRGINIA ACADEMY OF SCIENCE

*Abreu, Benedict E., Instructor in pharmacology, W. V. U., Morgantown.
Albert, C. E., acting president, Davis & Elkins College, Elkins.
Albert, Mabel M. (Mrs.), Ramsey Junior High School, Bluefield.
Allen, James E., president, Marshall College, Huntington.
Allen, J. S. V., instructor in physics, Bethany College, Bethany.
Allman, Floy, teacher of science, High School, Normantown.
Ambler, C. A., prof. of history, W. V. U., Morgantown.
Ammons, Nelle P., instructor in botany, W. V. U., Morgantown.
Anson, Charles P., prof. of social science, Potomac State School, Keyser.
Arnett, Jerome C., Aurora.
Atha, Lester, teacher, High School, Monongah.
Bailey, Sebie, science teacher, High School, Fairmont.
Bailey, Wayne, teacher of biology, High School, Rock.
Bell, Raymond, teacher, High School, Smithers.
Bennett, B. B., Assoc. prof. of English, Concord State College, Athens.
Bergy, Gordon A., prof. of pharmacy, W. V. U., Morgantown.
Bibbee, P. C., prof. of zoology, Concord State College, Athens.
Bird, Ralph, chemist, Athens.
Blackwell, A. C., prof. of chemistry, Morris Harvey College, Charleston.
Bloss, James R., physician, 418 11th Street, Huntington.
Boggess, Grace., teacher, High School, Farmington.
Bonar, Ross, principal, High School, Buckhannon.
Bowers, E. V., prof. of psychology, Marshall College, Huntington.
Brooks, Alonzo B., park naturalist, Oglebay Park, Wheeling.
Brouzas, C. G., librarian, and prof. of Classics, W. V. U., Morgantown.
Brown, A. Coleman.
Brown, Russell G., dept. of botany, New River State College, Montgomery.
*Brown, W. Carson, instructor, Dairy Husbandry, W. V. U., Morgantown.
Brown, W. S., Boyce Thompson Institute for Plant Research, Yonkers, N. Y.
Brownell, Phyllis, science teacher, High School, Ripley.
Burke, J. J., paleontologist, Carnegie Museum, Pittsburgh, Penna.
Burkhalter, Capt. L. I., C. C. C. chaplain, Elkins.
*Bush, Ivan H. Jr., head, biology dept., Alderson Broaddus College, Philippi.
Cameron, Hazel C., agricultural experiment station, W. V. U., Morgantown.
Campbell, Carl G., prof. of chemistry, Marshall College, Huntington.
Cardear, R. H., prof. of business, Wesleyan College, Buckhannon.
Chandler, Everett R., science teacher, 239 Virginia Ave., Chester.
Chapman, Daisy V., biology teacher, High School, Williamson.
*Chapman, Randolph, Marshall College, Huntington.
*Church, E. L., president, Potomac State School, Keyser.
Clark, Friend E., prof. of chemistry, W. V. U., Morgantown.
Collett, A. R., prof. of chemistry, W. V. U., Morgantown.
Collins, Berenice E., dean of girls, High School, Charleston.
Colwell, Robert C., prof. of physics, W. V. U., Morgantown.
Colwell, Rachel H., prof. of home economics, W. V. U., Morgantown.
Core, E. L., asst. prof. of botany, W. V. U., Morgantown.
Craig, F. Waldo, State Department of Agriculture, Charleston.
Cramblet, W. H., president, Bethany College, Bethany.
*Crane, Keith D., Alderson Broaddus College, Philippi.
*Cunningham, Allen B., 314 Bellview Ave., Fairmont.
Cushman, M. S., head, dept. of history, Concord State Teachers' College, Athens.
Cutright, Frank, prof. of biology, Concord State College, Athens.
Cutright, Samuel C., student, Concord State College, Athens.
Dadisman, A. J., prof. of economics, W. V. U., Morgantown.
Darlington, H. C., prof. Marshall College, Huntington.
Dater, Henry M., Kent State University, Kent, Ohio.
Davies, E. C. H., prof. of chemistry, W. V. U., Morgantown.
Davis, Hannibal H., assoc. prof. of mathematics, W. V. U., Morgantown.

* New Members.

Dawson, H. Donald., prof. of chemistry, Bethany College, Bethany.
Dawson, Hubert, chemist, Boomer.
*Dayton, Ervin L., Potomac State, Keyser.
Dodds, Gideon S., prof. of histology, W. V. U., Morgantown.
Downing, R. H., instructor in Mathematics, W. V. U., Morgantown.
Downs, Wm. R., graduate student, M. I. T., Boston, Massachusetts.
Drummond, Earl, West Liberty State Teachers' College, West Liberty.
*Duncan, Ira J., asst. chemist, W. V. U., Agric. Expt. Station, Morgantown.
Dustman, R. B., prof. of agricultural chemistry, W. V. U., Morgantown.
*Eckard, Edwin Woodrow, prof. of economics, Concord College, Athens.
Eiesland, John A., prof. of mathematics, W. V. U., Morgantown.
Emerson, G. H., asst. prof. of pharmacology, W. V. U., Morgantown.
Erskine, Wm. H., instructor in mathematics, Bethany College, Bethany.
Farnsworth, Bonnie, teacher of science, High School, Linn.
Fenton, C. C., prof. of pathology, W. V. U., Morgantown.
Ferry, James F., land-use planning specialist, Morgantown.
Fisher, Virginia, teacher, North View Jr. High School, Clarksburg.
*Folsom, L. W., 617 Spruce Street, Morgantown.
Forbes, Raymond, teacher of chemistry, High School, Oak Hill.
Ford, O. R., assoc. prof. of physics, W. V. U., Morgantown.
Forman, A. H., prof. of electrical engineering, W. V. U., Morgantown.
Fox, Robert K., asst. prof. of chemistry, Bethany College, Bethany.
Franzheim, Charles M., Wheeling.
*Frasure, Carl M., asst. dean, and prof. of Political science, W. V. U., Morgantown.
Fridley, Harry M., assoc. prof. of geology, W. V. U., Morgantown.
Fromme, Fred D., U. S. Department of Agriculture, Washington, D. C.
Frye, Wilbert M., teacher, High School, Hanging Rock.
Galbraith, F. D., prof. of chemistry, Potomac State School, Keyser.
Galpin, Sidney L., land-planning consultant, Morgantown.
Garber, Ralph J., State College, Pa.
Gatherum, R. S., head, dept. of mathematics, Concord State College, Athens.
Gay, F. R., prof. of English, Bethany College, Bethany.
*Gibson, John Jr., prof. of chemistry, Morgantown.
Gilbert, Frank H., prof. of botany, Marshall College, Huntington.
Gist, Russell H., agricultural extension service, W. V. U., Morgantown.
*Gould, Arthur B., prof. of chemistry, Salem.
Green, James W. Jr., Terrace Avenue, Elkins.
Green, N. Bayard, teacher of biology, High School, Elkins.
Greenlee, Leslie E., teacher of biology, High School, Nitro.
Grey, Mrs. H. P., teacher of biology, High School, Beckley.
Gribble, Lloyd R., asst. prof. of zoology, W. V. U., Morgantown.
Grimes, R. A., teacher of science, High School, Clay.
Grimm, R. J., assoc. prof. of chemistry, New River State College, Montgomery.
Grose, E. R., Glenville State Teachers' College, Glenville.
Hall, Arthur W., prof. of electrical engineering, W. V. U., Morgantown.
*Haller, Karl, Bethany.
Handlan, John W., curator of museum, Oglebay Park, Wheeling.
Hansford, R. C., dept. of chemistry, George Washington University, Washington, D. C.
*Harris, A. E., Huntington.
Harris, T. L., prof. of sociology, W. V. U., Morgantown.
Harshbarger, Jennie, teacher of biology, High School, Fairmont.
*Haught, C. D., Fairmont State Teachers' College, Fairmont.
Haught, D. L., dean, Concord State College, Athens.
Haught, O. L., in South America.
Hazlett, Mary R., teacher of science, 333 Wellwood Street, Pittsburgh, Pa.
Heck, E. T., asst. geologist, State Geological Survey, Morgantown.
*Henderson, H. O., prof. of dairy husbandry, W. V. U., Morgantown.
Herndon, L. K., 420 Beauregard Street, Charleston.
Hill, Caton N., principal, High School, Sutton.
Hill, George H., engineer, State Road Commission, Charleston.
Hill, Hubert, prof. of chemistry, W. V. U., Morgantown.

Hill, L. B., prof. of education, W. V. U., Morgantown.
Hill, Lawrence E., student, W. V. U., Morgantown.
Hodge, W. W., prof. of chemical engineering, Morgantown.
Hogue, Mahalia, teacher of chemistry, High School, Wadestown.
Holtzman, Howard E., technician, Hopemont Sanitarium, Hopemont.
Holy, John S., teacher of science, High School, Alum Bridge.
Hopkins, Charles, teacher of social science, High School, Montgomery.
Hoskins, Homer A., chemist, State Geological Survey, Morgantown.
Hron, Ralph F., prof. of physics, Marshall College, Huntington.
Hunt, Geo. R., prof. of zoology, Fairmont State College, Fairmont.
Hurst, Hugh, teacher of science, University High School, Morgantown.
Hutchinson, Kenneth D., asst. prof. of economics, W. V. U., Morgantown.
*Hutton, Eugene E., High School, Huttonsville.
Hyde, R. E., research director, State Dept. of Education, Charleston.
Hyma, Nicholas, prof. of chemistry, Wesleyan College, Buckhannon.
Jacobson, Carl A., prof. of chemistry, W. V. U., Morgantown.
James, G. Claire, dept. of science, Glenville State College, Glenville.
Jarrell, M. G., box 392, Oak Hill.
Jenni, Clyde B., chemical engineer, Philadelphia, Penna.
Johnson, G. S., chemist, 1523 Quarrier St., Charleston.
Jones, Clement R., College of engineering, W. V. U., Morgantown.
*Jones, Lloyd Meredith, assoc. prof. of physical education, W. V. U., Morgantown.
Judson, J. E., prof. of biology, Wesleyan College, Buckhannon.
King, Genevieve, Morgantown.
Kiplinger, C. C., assoc. prof. of chemistry, West Liberty.
Kirby, David, State Board of Education, Charleston.
Kirkpatrick, Forest H., dean of personnel, Bethany College, Bethany.
Klinger, Earl, chemist, State Road Commission, Morgantown.
*Knotts, Z. R., New River State College, Montgomery.
Koehler, Walter Allos, prof. of chemical engineering, Morgantown.
*Kozak, Andrew, dept. of mathematics, Concord State Teachers' College, Athens.
*Krause, A. E., supt. of schools for Deaf and Blind, Romney.
Laing, James T., prof. of sociology, Kent State University, Kent, Ohio.
Lambert, John M., 848 Clark Street, Shinnston.
Largent, Robert J., dean, Marshall College, Huntington.
Law, Lewis B., U. S. Weather Bureau Office, Elkins.
Lawall, Charles E., acting president, W. V. U., Morgantown.
Lazzell, Charles L., assoc. prof. of chemistry., W. V. U., Morgantown.
Leitch, Andrew, prof. of psychology, Bethany College, Bethany.
*Levy, Fritz, Memorial Hospital, Elkins.
Lilly, V. G., dept. of plant pathology, W. V. U., Morgantown.
Lively, E. L., prof. of sociology, Fairmont State College, Fairmont.
Lay, Melvin P., prof. of biology, Marshall College, Huntington.
Lucke, J. B., asst. prof. of geology, W. V. U., Morgantown.
*McCaskey, A. E., Marshall College, Montgomery.
Maclin, E. S., New River State College, Montgomery.
McCray, Charles M., teacher of science, High School, Princeton.
McCue, John B., chemist, State Geological Survey, Morgantown.
McNeill, E. Meade, prof. of biology, Concord State College, Athens.
Martens, J. H. C., assoc. prof. of geology, W. V. U., Morgantown.
Matheny, John W., asst. prof. of history, New River State College, Montgomery.
Mauzy, Frank, dean, Potomac State School, Keyser.
*Meadows, Charles, Louden Heights, Charleston.
Meakin, H. V., landscape architect, State Park, Watoga.
Merrill, Vernon L., student, Washington, D. C.
Miller, Myrtle, teacher of science, Jr. High School, Fairmont.
Miller, W. S., Bethany.
*Mittong, O. Kenneth, Clarksburg.
Molby, F. A., prof. of physics, W. V. U., Morgantown.
Montgomery, J. G., 308 Seneca Street, Oil City, Penna.
*Moore, Carl, Valley Bend.
Morris, Samuel, prof. of chemistry, W. V. U., Morgantown.

Musgrave, Sally Lou, teacher of chemistry and biology, Point Pleasant.
Myers, E. E., Philippi.
*Nason, Leigh M., New River State College, Montgomery.
Neely, Jack, Kingston.
*Neese, S. E., supt. Watoga State Park, Seebert.
Netting, M. Graham, herpetologist, Carnegie Museum, Pittsburgh, Penna.
O'Brien, Lawrence R., teacher, High School, Montgomery.
Ohlson, H. C., teacher of science, High School, Huntington.
Oliver, Joe, teacher of mathematics, High School, Smithers.
Orton, C. R., dean, college of agriculture, W. V. U., Morgantown.
Palmer, Carol, Washington Irving High School, Clarksburg.
Palmer, John C. Jr., attorney, Rock Ledge, Wheeling.
Parks, Otia C., teacher of chemistry, High School, Spencer.
Patterson, Robert C., prof. of biology, Potomac State School, Keyser.
Percival, W. Clement, assoc. prof. of forestry, W. V. U., Morgantown.
*Parry, Meredith, principal, Kingston High School, Kingston.
Pepovitch, Peter, High School, Kermit.
Potter, Charles, chemist, Coal Authority, Box 1188, Fairmont.
Price, Paul H., assoc. prof. of geology, W. V. U., Morgantown.
Purdum, R. B., prof. of chemistry, Davis and Elkins College, Elkins.
Pyle, F. J., prof. of education, 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, Box 816, Morgantown.
Regier, C. C., prof. of history, West Liberty State College, West Liberty.
Reynolds, Clarence N. Jr., prof. of mathematics, W. V. U., Morgantown.
Rice, Ralph L., teacher of social science, High School, Berkeley Springs.
Rogers, H. F., prof. of chemistry, Fairmont State College, Fairmont.
Ryan, Thomas, student, Montgomery, W. Va.
Saposnekow, Jacob, asst. prof. of sociology, W. V. U., Morgantown.
Schaefer, W. H., Salem.
Schoolcraft, A. A., prof. of education, Wesleyan College, Buckhannon.
Seyler, Zelma K., teacher of biology, High School, Wellsburg.
Shahan, J. Buhl, Elkins.
Shilliday, C. Lee, prof. of biology, Morris Harvey College, 115 Brooks Street, Charleston.
Shouse, James B., prof. of education, Marshall College, Huntington.
*Shreve, E. Carl, Potomac State College, Keyser.
Shreve, O. D., teacher of chemistry and physics, Huntington.
Shughron, Nelle, teacher, High School, War.
Shutts, H. A., prof. of mathematics, Fairmont State College, Fairmont.
Skuce, Thomas W., conservation commission, Charleston.
Smith, Reynolds, Morgantown.
Smith, Wallace, prof. of mathematics, New River State College, Montgomery.
Spangler, R. C., dept. of botany, W. V. U., Morgantown.
*Sparks, Margaret, instructor, Bethany College, Bethany.
*Stalnaker, Elizabeth, prof. of psychology, W. V. U., Morgantown.
Stevenson, C. A., prof. of education, Davis and Elkins College, Elkins.
Stewart, Joseph K., instructor in mathematics, W. V. U., Morgantown.
*Stike, Dana Lee, Matoaka.
Stout, Wilbur, State geologist, Columbus, Ohio.
Strader, L. D., teacher of biology, High School, Bolivar.
Straley, H. W. III., Stralehurst, Princeton.
Straley, Joseph, Davy.
Strausbaugh, Perry D., prof. of botany, W. V. U., Morgantown.
Strickland, Cecil, teacher, Clendenin.
Strosnider, Ruth, teacher of chemistry, Blacksville.
Sumpstine, Wilbur J., professor of biology, Bethany College, Bethany.
Sutton, J. B., Morgantown.
Talbot, S. Benton, prof. of biology, Davis and Elkins College, Elkins.
Taylor, Carlton F., asst. plant pathologist, W. V. U., Morgantown.
Taylor, Leland H., assoc. prof. of zoology, W. V. U., Morgantown.
Tissue, Rhema Smith, Morgantown.

Todd, Leslie J., prof. of chemistry, Marshall College, Huntington.
*Trawick, M. W., West Liberty.
Trent, W. W., State supt. of schools, Charleston.
Tucker, R. C., State geological survey, Box 265, Morgantown.
Turner, Bird M., prof. of mathematics, W. V. U., Morgantown.
Ulbrich, Albert, medical student, 1065 E. Broad street, Westfield, N. J.
Utterback, W. I., prof. of biology, Marshall College, Huntington.
*Van Landingham, A. H., W. V. U., Morgantown.
Van Tromp, H. O., physician, French Creek.
Vehse, Chas. H., dept. of mathematics, W. V. U., Morgantown.
Vest, G. Ellis, Bluefield.
Vest, M. L., W. V. U., Morgantown.
Wagner, John R., prof. of chemistry, Glenville State College, Glenville.
Walker, W. H., teacher of chemistry, Morris Harvey College, Charleston.
Warner, Kent, Charleston.
Weakley, Chas. E. Jr., Agricultural Expt. Station, W. V. U., Morgantown.
Weimer, B. R., prof. of biology, Bethany College, Bethany.
Wells, Dana, instructor in geology, W. V. U., Morgantown.
White, Frank S., prof. of psychology, Fairmont State College, Fairmont.
White, Raymond C., graduate student, W. V. U., Morgantown.
White, Ryland, Fairmont State College, Fairmont.
Wiles, I. A., physician, 1056 Gage St., Hubbard Woods, Ill.
*Williamson, Louis G., Marshall College, Huntington.
Wilmoth, Stark A., principal, Jr. High School. Elkins.
Wilson, Kester, teacher of chemistry, High School, Fairmont.
Wimer, Ralph P., teacher of science, High School, Parsons.
Winter, John E., prof. of psychology, W. V. U., Morgantown.
Wolfe, Russell, physician, Elkins.
Wooddell, W. S., dept. of chemistry, Concord State College, Athens.
Woods, Roy C., professor of education, Marshall College, Huntington.
Yost, A. W., teacher, High School, Farmington.
Young, A. F., asst. supt. of schools, Wellsburg.
Zucchero, Peter J., Montgomery.

THE MINUTES OF THE FIFTEENTH ANNUAL MEETING

THE FIFTEENTH Annual Meeting of the West Virginia Academy of Science was held at West Virginia University, Morgantown, on May 6 and 7, 1938. The first general session was called to order by the president, T. L. Harris, at 10:00 a. m. on May 6.

The president reported on the program of the Academy during the year just ended. He presented Mr. Gerald Jenny, the University Editor, who has edited the *Proceedings* during the recent years. He stated further that an editorial board was needed to aid Mr. Jenny in determining which papers were to be published in the *Proceedings*. Mr. Jenny stated that he was pleased to continue serving the Academy.

The treasurer reported the financial condition of the Academy and stated that his books were ready for the Auditing Committee.

The following report of the Executive Committee was read by the Secretary:

THE EXECUTIVE COMMITTEE REPORT

"The Executive Committee of the West Virginia Academy of Science wishes to report that:

(1) Invitations have been received from New River State, Potomac State, Salem College, Morris Harvey College, and West Virginia Wesleyan College for the Academy to hold its 1939 meeting on their respective campuses.

(2) Miss Bernice Collins appeared before the Executive Committee and made two requests for the Junior Academy.

(a) The sum of $20 be given to the Junior Academy by the Senior Academy for the publication of a news-letter for next year.

(b) Miss Daisy Chapman of South Charleston was appointed as Junior Sponsor, and Miss Virginia Fisher of Clarksburg as Senior Counselor for next year. In order to carry out the work of the Junior Academy, one person is necessary from the northern part of the state and one from the southern part.

(3) The Executive Committee recommends that Miss Collins's request be granted provided there is enough money in the treasury to take care of the first request.

(4) Maurice Brooks, Chairman of the West Virginia Biological Survey Committee, presented a summary of the collection work done by Neil D. Richmond during the summer of 1937. The Carnegie Museum has set aside a fund for aiding in this work and Mr. Brooks requests the Academy to add $100 through the Biological Survey.

(5) The Executive Committee recommends that $100 be granted for this work if the treasury permits. After necessary bills

are paid, whatever amount is left, up to $100, will be given for this work.

"The Executive Committee wishes to make the following further recommendations:

(1) That we adopt the plan of President Boucher of West Virginia University, that the University pay twice as much as the Academy for the publication of the *Proceedings*. The University's share is not to exceed $300.

(2) That the Academy approve the suggestion made by President Boucher that an Editorial Board of three members, empowered to call for assistance on members qualified in their fields, to cooperate with the University Editor in preparing and passing on papers to be accepted for publication in the *Proceedings*. The Board of three members is to be selected by the President of the Academy. The members are to serve as long as they will.

(3) That P. D. Strausbaugh be selected as permanent delegate to the A. A. A. S. meeting.

(4) That the Secretary mail out at least two letters to each member during the first semester and to include in these the bills from the treasurer.

(5) That the *Proceedings* be sent to no member who has not paid his dues for the year for which the *Proceedings* were issued.

(6) That the next meeting be held at Morris Harvey College in Charleston on May 5 and 6, 1939."

The report was accepted.

The Legislative Committee report was made and the following recommendations were read:

THE LEGISLATIVE COMMITTEE REPORT

(1) The Legislative Committee of the West Virginia Academy of Science requests the support of the Academy to secure passage of a bill by the State Legislature or to proceed with any other action which will permit high-school teachers to attend the Academy with pay for their regular service.

(2) Through action by the State Legislature to make a compulsory, workable sterilization law for the inmates of our state institutions for the insane and feeble-minded.

The report was accepted.

Mr. Wallace Smith reported for the Junior Academy:

"The Junior Academy of Science has been seriously hindered in its work this year by having no funds for the publishing of the Science News Letter. In spite of this drawback there are at present 26 chapters, a number of which are quite active. There are also several members who have affiliated with the Academy this year.

"I should like to make the following recommendations for next year:

First: That the Senior Academy allow on its budget, funds sufficient for the publication of the News Letter at least twice a year.

Second: That Miss Daisy Chapman, sponsor of the Mound Science Club of South Charleston High School, be appointed Junior Sponsor. Miss Chapman has the most active and ambitious club in the southern part of the state. Also, for best results it is most necessary that there be one sponsor in the north and one in the southern section."

Treasury:	Collections	$5.50	May 4
	Expenses	1.25	May 4
	Balance	4.25	May 4

"Two new club members were enrolled this year and two individual members. A program of all high-school students is to be presented which promises to be very good."

The report was accepted.

Treasurer C. G. Brouzas made a report for the membership committee, submitting 27 names of proposed new members. These had previously been approved by the Executive Committee. They were elected and are indicated by the stars before their names in the complete membership list on page 6.

Dr. P. D. Strausbaugh, the Academy's delegate to the Indianapolis meeting of the American Association for the advancement of Science, read the following report:

THE ACADEMY CONFERENCE REPORT

"The annual meeting of the Academy Conference was held in the Louis XIV Room of the Claypool Hotel, Indianapolis, Indiana, December 27, 1937. Dr. Ernest C. Faust of the Louisiana Academy and President of the Conference was in the chair. The program carried out was as follows:

1. The Place and Reasons for Existence of State Academies. Frank E. E. German, Colorado-Wyoming Academy of Science.
2. What Next? E. C. L. Miller, Virginia Academy of Science.
3. Presentation of a mimeographed report on the Academies' use of research grants. Otis W. Caldwell, General Secretary of A. A. A. S., Atlanta, Georgia.
4. Discussion of research grants by representatives of the various academies.

"As indicated in the program, the main interest and discussion centered around the subject of research grants. Such grants are to be made only to those who anticipate using them for the support of investigational work, and therefore careful and adequate provision should be made for the best possible use of available funds. The

plan of the Indiana Academy (See Proc. W. Va. Acad. of Sci., vol. 11, p. 14) was mentioned as an example of sufficient procedures in regulating applications for research grants. From the discussion, in which several of the delegates participated, it was evident that a number of the Academies have set up some thoroughly elaborated plans to control the assigning of research grants.

Dr. Bert Cunningham of Duke University and delegate from the North Carolina Academy was elected President of the Academy Conference for the ensuing year.

"After adjournment of the Conference, the delegates attended the complimentary dinner given by the A. A. A. S."

The report was accepted.

Chairman P. D. Strausbaugh made the following report for the F. E. Brooks Memorial Arboretum Committee.

THE FRED E. BROOKS MEMORIAL ARBORETUM

"Last year your Committee on the Fred E. Brooks Memorial Arboretum at Watoga State Park, Pocahontas County, reported certain objectives planned for the further development of the proposed arboretum. At this time we are prepared to report these objectives realized or in the process of realization. Trails have been established, a shelter house erected, and the marker at the entrance bearing a bronze plate has been placed according to plans described in our previous report.

These developments were made possible through the enthusiastic interest and continuous cooperation of the late Mr. T. M. Cheek, who did everything he could to assist your committee, not merely in planning, but in actually getting the work under way and completed. By arrangement with the proper authorities he was able to provide CCC labor to carry out the program and to procure funds for the purchase of necessary materials, including the bronze plate for the marker. Mr. Cheek, only a few days before his passing, informed us that all expenses had been cared for. The Academy, and especially the Fred E. Brooks arboretum, has lost an ardent supporter, and appropriate resolutions should be spread upon the minutes expressing our deep appreciation of the service rendered by Mr. Cheek in the development of this project.

In the further development of the arboretum, the introduction of additional species and the labeling of specimens must be considered as the next important steps. In our report of last year, certain suggestions were made, but to date nothing has been done because it seemed to us best to postpone this phase of the work until after the trails had been located. The committee named to pursue this program of development for the arboretum should receive some instructions concerning available funds for the work and the extent to which new introductions, labeling, etc. may be desired. Should the Academy attempt to develop this arboretum as possible from the standpoint of educational values, or should it be considered at this

time as a finished project? Your committee believes that the membership in the Academy should answer this question and give at least some general indication of the policy to be pursued in the future regarding the further development of this project.

Fred E. Brooks Memorial Arboretum Committee
E. Meade McNeill
R. B. Dustman
P. D. Strausbaugh, chairman

Comments were made after the reading of the report by Chairman Strausbaugh, in which he stated that funds were needed from the Academy in order to carry out the aims of the Committee. Thus far, funds have come only from the outside. After some discussion by a number of Academy members it was suggested by Dr. Dodds that a further report be made. This report, made by Chairman Strausbaugh, follows:

STATEMENT OF POLICY FOR THE FURTHER DEVELOPMENT OF THE FRED E. BROOKS MEMORIAL ARBORETUM

In the further development of the Fred E. Brooks Memorial Arboretum, it will be the intent of the Academy to adhere to the following policy:

1. The natural conditions throughout the extent of the arboretum are to be preserved in so far as this is possible. All plans formulated for the development of the arboretum should permit the growth of the vegetation in the "wild state".

2. New species introduced should be selected from the native flora of the state. Cultivated ornamental exotics are not to be introduced. The rare species of our state flora, not already growing in the arboretum, should be introduced first. Care should be taken to exclude any and all species that might ultimately spread widely and become undesirable weeds.

3. A list of the species growing in the arboretum is to be prepared, and 1500 to 2000 copies should be printed for the use of visitors.

4. Interesting plants along the trails should be marked with aluminum numbers corresponding to the numbers appearing in the printed list.

5. To cover cost of printing, to purchase aluminum numbers, and to start the introduction of new species, the committee should be authorized to spend at least $50.

6. A framed picture and brief biography of Fred E. Brooks is to be placed in the shelter house for the information of visitors. Also a map of the arboretum area is to be placed in the shelter house.

7. To enlist his interest and service in caring for the arboretum, an invitation is to be extended to the Superintendent of Watoga State Park to become a member of the West Virginia Academy of

Science, with the understanding that for such a period as may be determined by the Academy, all fees will be remitted.

8. One small area in the arboretum is to be planted with species obtained from the nature trails of the Brooks farm near French Creek.

R. B. Dustman
E. Meade McNeill
P. D. Strausbaugh, chairman

Chairman W. W. Hodge reported for the Committee to award the A. A. A. S. Grant.

THE AWARD OF THE A. A. A. S. GRANT

The A. A. A. S. grant of $25 for 1937 was awarded by the Committee to Assistant Professor Earl L. Core, of the Department of Zoology and Botany, West Virginia University, as an aid to his research work leading to the publication of a revision of Millspaugh's check-list of the West Virginia flora. Professor Core has submitted to the Committee a concise summary of his investigation, which is appended as a part of this committee's report. Evidently the 1937 grant was expended for a very useful purpose.

The Committee received two applications for the 1938 A. A. A. S. grant. The first one was from Professor Robert C. Patterson, Department of Biological Sciences, Potomac State College, Keyser, West Virginia. The money was to be expended in helping defray the expenses involved in a study of West Virginia mammals and in the collection and mounting of typical specimens. Mr. A. B. Brooks, park naturalist at Oglebay Park, Wheeling, West Virginia, was to be associated with Professor Patterson in this research project.

The second application for the 1938 A. A. A. S. Grant was received from Mr. H. W. Straley III. He proposed spending the money as part payment of the expenses to be incurred in making a geomagnetic reconnaissance survey of a part of the Appalachian Mountain System. Apparently this investigation would be carried on in quadrangles and along dikes in the vicinity of Chapel Hill and Wilmington, North Carolina.

Both proposed investigations had much merit and were carefully considered by your Committee. The final decision was to award at least a portion of the 1938 grant to aid in the study and collection of West Virginia mammals. Unforseen circumstances arose and Professor Patterson up to the present time has not been able to undertake his proposed investigations; hence the 1938 A. A. A. S. grant has not been expended.

To give this A. A. A. S. grant more publicity and to acquaint the members of the West Virginia Academy of Science more fully with the facts that this grant-in-aid is available each year for assisting in some fundamental scientific research of at least state-wide importance, your Committee thinks it would be advisable for the Sec-

retary of the Academy to inclose with one set of his notices to the members of the Academy a mimeographed sheet explaining the purposes for which this grant can be applied most advantageously. If this suggestion is approved by the Academy the Committee will be pleased to proceed along these lines before recommending further awards.

The Committee on the A. A. A. S. Grant
Dean B. R. Weimer, Bethany College
Prof. E. L. Lively, Fairmont State College
Prof. W. W. Hodge, W. Va. University,
Chairman

The report was accepted.

WORK DONE ON GRANT TO EARL L. CORE

The following report, submitted by Professor Earl L. Core, was read:

"In continuation of research leading toward publication of a revision of Millspaugh's check-list of the West Virginia flora, the sum of $25 granted by the American Association for the Advancement of Science through the West Virginia Academy of Science to Earl L. Core in 1937 was expended in partial payment of expenses incurred in travel connected with the botanical exploration of relatively little known portions of the State, as follows:

Marshall Co., along Fish Creek near Bellton
Marion Co., watersheds of Pawpaw and Buffalo Creeks
Barbour Co., along Route 92 between Evansville and Belington
Doddridge Co., along Route 55 between Salem and Shirley
Ritchie Co., along Route 74 between Joseph's Mills and Pennsboro
Clay Co., along Route 13 between Ivydale and Clendenin
Putman Co., along Route 35 between Nitro and Buffalo
Mason Co., along Route 35 between Robertsburg and Point Pleasant
Morgan Co., along Route 9 near Berkeley Springs
Berkeley Co., along Route 9 near Hedgesville
Pendleton Co., along North Fork River
Randolph Co., near Harman
Grant Co., near Mt. Storm
Lincoln Co., near Yawkey.

"In the course of this work approximately 1400 specimens of vascular plants were collected. These are being mounted for filing in the herbarium of West Virginia University, where they are available for inspection."

Respectfully submitted,
Earl L. Core

The report was accepted.

President Harris then appointed the following committees:

Nominations: B. R. Weimer, chairman, S. B. Talbot, P. D. Strausbaugh.

Resolutions: Frank Cutright, chairman, A. A. Schoolcraft, H. F. Rogers.

Auditing: A. R. Collett, chairman, Frank Gilbert, Raymond Bell.

After a short intermission vice-president Smith introduced President Harris, who delivered the presidential address, "The Place of Social Science in the Development of West Virginia Resources."

A meeting of college presidents and other educators along with the members of the Academy was called at noon by President Cramblet of Bethany College for the purpose of organizing a Department of Higher Education of the State Education Association.

Beginning at 1:30, the various sections held their meetings. The papers presented are listed in the program on page 23. A science exhibition was held in the Chemistry Building from 4:00 to 6:00 p. m. A meeting of the Biological Survey Committee was held after the Zoology section meeting.

At 6:15 p. m. Friday, the annual banquet was held at the University Cafeteria. The principal address of the meeting was delivered by Mr. Frank Bane, Executive Director of the National Social Security Board. His subject was "Social Security, A New American Reality." A portion of this address was broadcast over the University's new remote control facilities through Station WMMN, Fairmont.

After this address an informal reception for the members and guests of the Academy was held in Elizabeth Moore Hall.

Following the reception the members were guests of the Engineering Department and attended the West Virginia University Student Engineering show.

The second business meeting was held Saturday morning, May 7. Mr. Maurice Brooks read the following report on the State Biological Survey Committee:

REPORT OF THE WEST VIRGINIA BIOLOGICAL SURVEY COMMITTEE

"At the Huntington meeting the West Virginia Academy of Science approved a grant of $100 to defray the expense of a collector during the summer of 1938. Mr. Neil D. Richmond, of Fairmont, was selected for this work, and during the season he collected extensively in 22 counties, his collections of Bryophyta, reptiles and amphibians, and Mollusca being especially noteworthy. Plans approved at this meeting will aid in a continuance of this desirable work, and he will also be assisted by a grant from Carnegie Museum at Pittsburgh. It is hoped that a number of phases of collecting can be completed in the State during the coming season.

"Since little work of a zoological nature has been carried on in the southwestern portion of the State, it is recommended that special efforts be made to fill in gaps in our knowledge of the biota of this section. Mr. Richmond, Mr. Kutchka of the Carnegie Museum, and Mr. Leonard Lewellyn, also retained by the Carnegie Museum, will collect in this territory during 1938.

"Progress is being made in preparing and revising keys and check-lists of special plant and animal groups. Among the vertebrates, Mr. Richmond and Miss Grace Boggess have prepared an excellent key to the reptiles and amphibians, this key having been submitted to the Academy Editorial Board for possible publication as a part of the *Proceedings*. Mr. A. B. Brooks and Dr. Robert C. Patterson have done much work on a check-list of the mammals of the State, Mr. Karl Haller also making valuable contributions to this endeavor. The writer has prepared a check-list of the birds of the state, now awaiting publication. Dr. Stanley T. Brooks of the Carnegie Museum has published a series of papers on the molluscs of the State, and Dr. Earl Core is proceeding with the revision of Millspaugh's *"Flora of West Virginia."*

"During the past year Dr. Core announced that more than 4000 specimens have been added to the herbarium. Dr. Frank Gilbert has made extensive and valuable contributions from the southwestern portion of the State.

About 30 persons attended the annual meeting of the committee, held on the afternoon of Friday, May 6, at West Virginia University. The following officers were elected for the coming year:

Chairman, Maurice Brooks
Secretary, Robert C. Patterson
Curator of Collections, Earl L. Core

The report was accepted.

Professor A. J. Dadisman read the following report of the Committee on Preservation of Wild Life:

"First: We highly commend the steps taken by the State Conservation Commission, in cooperation with the Department of Free

Schools, to advance instruction in conservation. The beginning was made by the publication, by the department of publicity of the Conservation Commission, of a booklet on the conservation of natural resources. This was designed to assist teachers in presenting the subject in their schools. Later, committees consisting of teachers and authorities on conservation were appointed for each county. These committees met and outlined recommendations for the practical presentation of conservation in the elementary schools. In March they were called together for a meeting in Charleston to correlate their reports. Among the recommendations adopted at this meeting were the following:

1. To integrate the teaching, as it pertains to other subjects, rather than to adopt a series of texts and the subject of conservation and teach this as a separate subject.

2. To teach conservation through high schools. (The original plan was to teach it in the first eight grades.)

3. To teach conservation to teachers first.

Action taken following the state-wide meeting will be put into usable form by the two cooperating agencies.

"*Second*: Through the efforts of a member of this Committee a Junior Nature League has been formed, the purpose of which is to combat the indiscriminate killing of wild life such as is practiced by some of our sportsmen's organizations. The Committee wishes to recommend the organization of similar groups in other places. We believe that the practice is exceedingly dangerous that permits and encourages the killing of animal life which is not protected by law and which, *in the judgment of any individual,* is destructive to game and other useful wild life. We believe in the regulation of shortage and overabundance of species by capable authorities.

"Third: There has been a marked revival of interest in general nature study during recent years. Out of this have come the nature trail, nature schools, wide observance of arbor and conservation days, and addition of courses in schools of higher education. This trend is fundamental and will eventually result in preservation of wild life to a degree not to be obtained otherwise.

"*Fourth*: The knowledge of wild life as to species, distribution, life histories, economic importance, and ecological relationships has been advanced to a far greater extent than ever before through the recent publication of books, periodicals, reports, and special articles. The West Virginia Academy of Science, the State Biological Survey, and many other groups are to be encouraged in such endeavor. On the whole, however, the knowledge of wild life in the State is very incomplete. This fact is both challenging and accusing. Various important groups of wild life are being studied and results published by agencies outside the State. While knowledge gained in this way is most helpful and welcome, this Committee urges all influential state agencies to encourage young students of promising

ability to undertake the study of groups of wild life which have received sufficient attention."

A. B. Brooks, Chairman
Committee on the Preservation of Wild Life
A. J. Dadisman
P. C. Bibbee
N. B. Green
S. B. Talbot
Members

The report was accepted.

The report of the Auditing Committee follows:

"Your Auditing Committee wishes to report that it has examined the books of the Treasurer and has found everything in order."

A. R. Collett
Frank Gilbert
Raymond Bell

Some discussion took place concerning the number of times a member should appear on the program and the amount of time that should be allotted for any one paper. The following recommendation was made:

"Be it the sense of this group, that section chairmen use great care in the matter of time allotted to each paper and in the number of times a speaker may appear on any program, and further that the chairmen should strictly enforce the time limit of papers."

The section committee chairmen reported as follows:

Botany, 27 present, Earl L. Core, chairman; for 1939, W. J. Sumpstine.

Zoology, 38 present, S. Benton Talbot, chairman; for 1939, C. C. Fenton.

Chemistry, present, 45, C. L. Lazzell, chairman; for 1939, Dr. W. H. Walker.

Geology, 20 present, J. H. C. Martens, chairman; for 1939, J. B. Lucke.

Mathematics and Physics, 35 present, J. K. Stewart, chairman; for 1939, J. S. V. Allen.

Social Science, Group I, 50 present. A. J. Dadisman, chairman; for 1939, F. R. Gay.

Social Science, Group II, 40 present. John E. Winter, chairman; for 1939, A. A. Schoolcraft.

President Harris then appointed the following committees to serve for the coming year:

Legislative: A. J. Dadisman, J. E. Judson, J. Buhl Shahan, H. O. Van Tromp.

Junior Academy: Virginia Fisher, Senior Counselor, Daisy Chapman, Wallace Smith, and J. E. Judson.

Membership: A. C. Blackwell, chairman, Frank Gilbert, E. C. H. Davies, J. E. Judson, E. Meade McNeill, W. S. Schaefer.

Activities: Earl Core, chairman, John Wagner, and L. G. Raub.

F. E. Brooks Arboretum: P. D. Strausbaugh, chairman, E. Meade McNeill, and R. B. Dustman.

A. A. A. S. Grant: W. W. Hodge, chairman, J. E. Judson, and B. R. Weimer.

State Biological Survey: Maurice Brooks, chairman, A. M. Reese, Frank Gilbert, J. E. Judson, S. B. Talbot, H. D. Bond, B. R. Weimer, C. M. Roberts, E. R. Grose, E. Meade McNeil, L. M. Peairs, R. C. Patterson, C. L. Shilladay, A. P. Handlan, H. W. Shawhan, and A. B. Brooks.

Preservation of Wild Life: A. B. Brooks, P. C. Bibbee, A. J. Dadisman, N. B. Green, and S. B. Talbot.

Resolutions:

The West Virginia Academy of Science takes this opportunity to express its appreciation to President Boucher of West Virginia University for his cordial welcome to the organization and to Dr. T. L. Harris and his committees for their tireless efforts to make this meeting a success.

We regret the untimely passing of the late T. M. Cheek, who co-operated so willingly and efficiently with the Academy in its work at Watoga State Park, and we realize that a prize has departed from us.

Dr. B. R. Weimer reported for the Nominations Committee:

"Your committee recommends that the following men be elected to serve as officers of the Academy for the coming year: for President, Wallace Smith; for Vice-President, A. M. Reese; for secretary, J. E. Judson; for treasurer, C. G. Brouzas."

This report was accepted, and the secretary was instructed to cast the ballots of the Academy for these men.

Dr. Harris then introduced the new president, who spoke briefly.

The meeting adjourned and excursions were made to the following places:

Arthurdale, Federal Homestead Project in Preston County.

Friendship Hill, Old Home of Albert Gallatin.

THE GENERAL PROGRAM OF THE MORGANTOWN MEETING

FRIDAY, MAY 6, CHEMISTRY AUDITORIUM

The business meeting was followed by the Presidential Address, "The Social Sciences as a Potential Factor in the Development of West Virginia Resources," by T. L. Harris.

THE MEETINGS BY SECTIONS

Botany and Horticulture

Hazel C. Cameron: Some physiological effects in animals of a plant hormone "auxiphyle" from peas.

C. F. Taylor: Apple spray injury.

W. J. Sumpstine: An addition to the range of *Pinus strobus* in West Virginia.

Earl L. Core: The flora of Roaring Plains, West Virginia.

Dr. F. A. Gilbert: The genus *Dioscorea* in Southern West Virginia.

Dr. F. A. Gilbert: *Eupatorium purpureum* and its allies in Southern West Virginia.

Louis G. Williams: Additions to the *genus Chaetomium* of West Virginia.

Zoology, Physiology, and Medicine

G. S. Dodds and Hazel C. Cameron: The normal and the rachitic shape of the head of the tibia and other bones.

N. B. Green: A preliminary report of life history studies of some West Virginia amphibia.

J. E. Spargo, B. E. Abreu and G. A. Emerson: Treatment of prolonged blood-coagulation time after inhalation of H_2SO_4 fumes.

B. E. Abreu, C. C. Fenton, G. A. Emerson: Pharmacological and pathological effects of α — chlorisobutylene.

C. C. Fenton: Lesions of the breast.

N. D. Richmond and G. S. Boggess: Amphibians of Marion County.

Fritz Levy: Giant cells.

J. E. Andes and G. A. Emerson: Lack of guanidinemic or other toxic responses to ingestion of West Virginia *Eupatorium urticaefolium.*

B. E. Abreu and G. A. Emerson: Biochemorphology of triglycolamidic acid.

G. A. Emerson and B. E. Abreu: Adrenin content of adrenals of cats in West Virginia: Variation with age.

G. S. Dodds: A human fetus showing undescended stage of testis.

K. Haller: Three new mammals from the Northern Panhandle of West Virginia.

M. G. Netting: Snakes of West Virginia.

Chemistry

Friend E. Clark: Graduate work in chemistry at West Virginia University.

J. F. Bartlett: Experience in foreign laboratories.

V. G. Lilly: Growth substances for fungi: II. Critical survey of literature 1936-37.

F. Woltz and H. D. Dawson: A comparison of the conductivity of a few electrolytes in water and solutions of deuterium oxide.

H. D. Dawson: Certain aspects of the catalytic oxidation of carbon.

B. E. Abreu and G. A. Emerson: Comparison of the Moodey colorimetric method and bio-assay methods in estimating epinephrine in biological fluids.

W. Schuyler Miller: Some hydrate structures.

W. Carson Brown: Recent developments in oxidized flavor in milk.

G. A. Bergy: Some newer wetting agents.

J. A. Gibson: Recent developments in photography.

Mrs. E. P. Deatrick: Stereochemistry in 1938.

Joyce Scahill: The solubility of salicylic acid in alcohol-castor oil mixtures.

A. H. VanLandingham and T. B. Clark: Methods for determining the relative value of proteins for chickens.

E. C. H. Davies and Lyda M. Arnett, Jr.: Heats of reaction for the formation of silicic-acid gels.

H. R. McGraw, A. R. Collett and C. L. Lazzell: Some alkoxy-ethyl and alkoxy-ethoxy-ethyl esters of salicylic acid.

Geology and Mining

E. T. Heck: The Pottsville series in Pendleton County, West Virginia.

John B. Lucke: Local base levels in West Virginia.

L. W. Folsom: Drainage changes near Morgantown.

Paul D. Wilson: Joints in coal.

Mathematics and Physics

R. C. Colwell, A. W. Friend, and D. A. McGraw: The velocity of sound.

C. N. Reynolds, Jr.; Thoughts on the 4-color problem.

John R. Wagner: Tesla coil.

A. B. Cunningham: A particular transformation associated with the congruence of bisecants of a composite cubic.

J. K. Stewart, A. W. Friend, and R. C. Colwell: The sand patterns on circular segments.

R. H. Downing: On transformations in flat-sphere geometry.

M. L. Vest: Notes on some curves associated with a variable triangle.

C. H. Vehse: Mathematical approach to the problem of hob tools.

J. K. Stewart: Four thousand grades in mathematics.

Social Sciences, Group I

Charles Hopkins: Frontiersmen in 1938.

Carl M. Frasure: Along the Danube.

Margaret Sparks: The George-Deen act.

James T. Laing: The drain of talent out of the Virginias.

R. H. Gist: Five years of agricultural adjustment in West Virginia.

F. R. Gay: The modernity of Sophocles.

Harry M. Dater: Supplying Lyon (France) with coal in the eighteenth century: a study in government regulation.

K. D. Hutchinson: Trend of fashion.

E. W. Echard: Keynes's theory of unemployment.

C. G. Brouzas: The preference for the blonde type in ancient Greece and Rome.

A. J. Dadisman: Government aid for homes for low-income groups.

Social Sciences, Group II

E. V. Bowers: A study of the experimental factor in objective test scores.

Earl Hudelson: Evidence on the problem of class size.

Richard E. Hyde: Pupil survival rates in West Virginia.

F. H. Kirkpatrick: Vocational preferences and the liberal arts college.

Andrew Leitch: Delusions of a paranoiac.

E. S. Machin: What becomes of the West Virginia high-school graduate?

L. M. Nason: Shop teacher looks at psychology.

A. A. Schoolcraft: The incidence of cheating among teachers in training when scoring their own test papers.

J. B. Shouse: Reliability of the base of college grading.

Elizabeth M. Stalnaker: Results of a mental survey in the schools of Monongalia county.

Frank S. White: Intelligence and choice of teaching field.

John E. Winter: Uniform intelligence tests for the entire state.

Roy C. Woods: Mimeograph and dictation methods of giving an objective test.

Papers Read at the Morgantown Meeting

THE SOCIAL SCIENCES AS A POTENTIAL FACTOR IN THE DEVELOPMENT OF WEST VIRGINIA RESOURCES*

THOMAS L. HARRIS

Department of Sociology and Public Welfare, West Virginia University

WE ARE HEARING a great deal about the conservation and development of our natural physical resources. This trend of thought and activity is needed; indeed it is long overdue. As a nation and as a state, we have recklessly wasted rich resources in timber, coal, oil, and gas, and through soil erosion; and we have neglected the development of some potential resources. We are already beginning to pay the penalty, for many of our best economists believe that one important factor in the downward economic trends since 1929 is the actual decrease in our available natural physical resources. In 1938 we are actually a poorer nation in these natural physical resources than we were 40 years ago.

In attempting effectively to prevent further loss and possibly to recoup some losses already suffered, American society is calling upon her physicists, chemists, and biologists to give aid. Vital and promising new industries, especially in chemical engineering, already are salvaging for useful purposes products formerly cast aside as waste. Huge hydro-electric plants are harnessing for productive purposes water power and electric current, both of which meant little or nothing to our primitive ancestors. The biologists are doing genuinely creative work in helping to breed more productive plants and animals.

All these achievements and many more are adding to our material resources and are raising the standards of living of our people, thus rendering genuine human service. Those of us whose primary work is in the field of the *social sciences* willingly and gladly pay tribute to the faithful and effective work of our colleagues in the field of the physical and biological sciences. Their achievements are basic and indispensable; they must and will be continued and greatly enlarged.

In the last generation or so a new field of facts, conditions, and problems is being recognized by higher education, by business and industry, and by the professions. Socially-minded men and women are asking if it may not be possible to apply the rational, rigorous methods of science to the needy field of human relations. Taxpayers and society as a whole seem willing to take a chance. In colleges and universities throughout the land, departments of economics, political science, and sociology have been established and are growing. The more traditionally minded among our academic friends still shake their heads in some doubt as to whether the concept and technique of "science" is applicable to the study of human

* The address of the president.

relations. In one sense, at least, their doubts are well founded. A man can study physics or chemistry or biology with entire freedom from the handicaps of emotion or prejudice or tradition. The right hind leg of a cat does not arouse either hatred or love on the part of the biology student who dissects the cat. The student is in pursuit of anatomical facts. The chemical engineer does not have personal love for one chemical process more than for another. He seeks, objectively, the *facts* about the process that serve his scientific interest or his practical purpose.

When we enter upon the objective study of *human* relations the approach is, in most cases, inevitably affected by emotional attitudes, varying in their number and nature with the particular individual and with the social environment in which he has been brought up. A loyal Seventh Day Adventist finds it difficult to accept geological interpretations of the material world. A wage-earner's son and a well-to-do employer's son find it difficult to agree upon the merits and demerits of labor unions—as this writer has found to be true in his own sociology classes. It is all too true that in certain human relations fields such as race, religion, industrial conflict, and family problems, the application of a scientific technique and a non-emotional and rational approach is genuinely difficult.

This difficulty, however, is not conceived by our growing number of social scientists as entirely insurmountable. In the analysis and study of some of our present vital human problems, the application of an objective analytical method, partly statistical, already is yielding significant results. The unemployment studies of the United States Bureau of Statistics and of the Federal Reserve Board, the analysis of the depression of 1929-1934 by the Brookings Institution, the Hoover Commission Report on Recent Social Trends, the Research Bureaus of our State Departments of Public Assistance and of the Federal Social Security Board, have all yielded a considerable amount of data, much of which meets high standards of scientific technique. It is now being seriously proposed by our National Congress that the government set up, on an independent, non-political basis, a *permanent* commission to study constantly our economic, social, and governmental problems, trends, and conditions, and at appropriate times make recommendations and reports as to needed legislation to meet changing conditions. The personnel of this proposed commission would be made up of representative, socially-minded citizens of all walks of life, including a number of the most competent social scientists to be found.

Whatever we may think personally of the merits of the above proposal, evidence accumulates every day that a socio-economic policy of aimless drift will not much longer be tolerated by the American people. In the personal and social demoralization which follows in the wake of 18 million persons on relief and another 18 million on the border line of dependency; after 8½ years of these conditions, it seems reasonably certain that some more rational and fundamental, permanent approach toward at least a *partial* solution of these problems can and should be found.

My thesis in this paper is that, in our nation, and *especially* in our own state of West Virginia, it is highly probable that unbiased, objective studies of the *causes* of our present unfortunate and abnormal socio-economic conditions will yield fruit well worth the time and money these studies will cost. I propose now to state, specifically, a few of our unsolved socio-economic problems and to mention a few pieces of work in the fields of pure or applied social science which are already yielding some valuable results, looking toward the improvement of present conditions.

1. The public-school situation in West Virginia is one in which all our people are interested either as parents or tax-payers or both. The necessary shortening of the school term this present year has brought the problem to a focus, and the general efficiency and morale of our public schools are at stake. It does not contribute toward a solution of this vital problem for us to take extreme positions and say that the whole blame or cause lies here or lies there, with a particular legislative act or a particular person or policy. This whole problem is an excellent example of the need for an objective, factual, analytical approach. Personal abuse or criticism is likely to do more harm than good, for they tend to cloud the real issues. There are many *different* causal factors in this school situation and it is earnestly to be hoped that the regular legislative session of 1939 will have placed before it an array of pertinent facts that will enable it to enact soundly remedial legislation.

2. West Virginia has a large problem of low-income farmers. Until recently it has been assumed here in America that extreme poverty of the type that makes people dependent upon others for their support is confined to city populations. For the first time in our state and national history, our last seven years of experience have proved this assumption false. For reasons evidently connected in some way with our rapidly changing society, large numbers of formerly self-supporting and self-respecting farm people are dependent upon public relief. About 20,000 West Virginia farm families or about 20% of our total farm population are now, partly or entirely, dependent, for their subsistence, upon public charity. Almost as many more are on the borderline of dependency. What are the causes for this new and difficult problem? Are prices for farm products too low? Are farmers lacking in their old-time industry and thrift? Is a too liberal government unnecessarily pauperizing them? Has the once fertile soil been wasted by lack of adequate policies and practices, thus causing our soil no longer to be able to yield its owners a living? Have unwise tax policies discouraged scientific reforestation by farmers? Have the promising and capable young men and women yielded to the call of the bright lights and gayer life of the cities, leaving only the less energetic and intelligent to till the farms?

All these questions, and others, cry aloud for answers. If and when we have the answers, what can or will we do about it?

Adequate answers to these difficult but very important human-welfare problems can be found only by patient, constant, open-minded study of the actual conditions. A sympathetic attitude plus a scientific technique of analysis and action are greatly needed to deal with these situations. The conditions as we have them were, in one sense, unpreventable. That is, no one has desired them to come to pass; but the policies of socio-economic ignorance and aimless drift which allowed these problems to develop cannot be allowed to continue indefinitely in a civilized society.

We should mention at least three very worthy recent semi-scientific enterprises which promise to make some real contributions to an improvement of some of our West Virginia conditions.

1. Our State Planning Board, with the assistance of W. P. A. workers, has recently published a mimeograph entitled "A Study of the People of West Virginia". Some very significant and basic information is thus made available to our citizens, including population and occupation statistics, the illiteracy problem, and other facts. Our Planning Board is to be commended for conducting such a study in the early part of its work, for it thereby recognizes the validity of a scientific basis of fact as an essential prerequisite for effective state planning.

2. Our West Virginia Department of Public Assistance, created by the legislature in June, 1936, is another example of the recognition of the need for accurate and scientific bases for important and extensive state programs. Approximately 10 million dollars is being spent annually by West Virginia for care of the various groups of needy people. About 1,100 full-time employees are in the work of administration and distribution of these funds.

In order to handle this large problem that is so close to human life, and to handle it as efficiently and economically as possible, our legislature very wisely created a division of research and statistics, to keep accurate, complete, and analytical records of the various types of work done by the Department of Public Assistance. These records are of practical value in daily administration processes of the County Departments of Public Assistance and in forecasting future needs. They are also of value for scientific purposes as records of general trends and tendencies in the different categories of relief.

3. About four years ago the Upper Monongahela Valley Association was formed in Northern West Virginia with the purpose of promoting united, cooperative effort in the development of new or additional agricultural and other resources in ten counties. This organization has already demonstrated its soundness and value, by helping make possible more and better production in the agricultural fields of high-grade poultry products and improvement of live-stock breeds and also by developing attitudes and policies that will legitimately increase tourist business in this section of the state.

A valuable by-product of these cooperative undertakings has been the creation of a spirit of neighborliness and goodwill and the capacity to work together, which nearly all of us individualistic Americans need.

A few examples of social science research already done in West Virginia are:

1. A comprehensive study of the sources of tax revenues made by certain faculty members of West Virginia University. This study was the chief basis of the drastic changes in the West Virginia tax laws made in 1933, which have attracted national attention.

2. A study of methods of assessments of property for taxation made under the direction of a University of Minnesota man, assisted by a West Virginia University economics professor.

3. Extensive aid of a research character rendered by members of the political science and Law College staffs of West Virginia University, to legislative committees studying problems of probation and parole and of justice of the peace courts.

4. A sociological study of negro miners in West Virginia made by a citizen of West Virginia as his Ph. D. thesis at Ohio State University.

5. A sociological study of the values and problems of 4-H clubs in West Virginia, made by a member of the Agricultural Experiment Station staff at West Virginia University.

In those aspects of our West Virginia life, properly included in the fields of the social sciences, relatively only a bare beginning has been made both in research and in application of that research to the solution of concrete problems. The future *potential* values are large that may come to the people of our state by the *further* application of the scientific spirit and the scientific technique. They are large enough and significant enough to challenge the most united efforts of men of vision and of genuinely scientific caliber.

In closing my remarks may I call the attention of our members to two concrete problems of policy which we must take up and deal with in our business sessions. Our West Virginia Academy of Science is now 15 years old; old enough to get out of our swaddling clothes and stand up on our feet. As a relatively new type of group in our state we have had and will have particular problems to deal with. Others who know more of the Academy's history than this writer does, say that even now our organization is the most effective factor in the State for the bringing together and developing the *esprit de corps* of those men and women working in the field of higher education. But we are not satisfied just to hold our own. We must go forward.

1. As to finances. The publication of our Proceedings has been too expensive and the expense has fluctuated too greatly. A more businesslike way must be found to stabilize this part of our functions.

2. For several years there have been spasmodic attempts on the part of our Academy officers to give some editorial supervision to the papers presented for publication in our proceedings. For the sake of keeping the *size* of our annual volume of Proceedings within appropriate limits, and for the sake of improving the *quality* of material approved by the Academy for publication, the creation of a responsible and continuing board of editors is imperative.

Both these matters must be taken up in our business sessions.

The Botany and Horticulture Section

THE FLORA OF ROARING PLAINS, WEST VIRGINIA*

EARL L. CORE

Department of Botany, West Virginia University

IT IS GENERALLY UNDERSTOOD that the major portion of the Middle and Southern Appalachian Mountain Region was more or less densely forested at the time of its first occupation by White men. Nevertheless, scattered up and down along the tangled mountain masses there exist certain areas which apparently were not occupied by trees at the time of the first settlements. The *grassy balds* of North Carolina and Tennessee constitute a subject which has stirred wide popular speculation but which only recently has been adequately considered by an ecologist. [1], [2], [3] The *heath balds* of the same region have also provoked considerable discussion on the part of botanists.[4]

Farther north, in the Alleghenies of West Virginia, there are areas which superficially have some features in common with the balds. These likewise fall into two categories, "old fields" and "huckleberry plains." The subject of old fields, which is closely related to that of grassy balds, will be treated in a subsequent paper.

Numerous flat-topped mountain ranges in parts of Pendleton, Grant, and Randolph Counties and elsewhere, above 4,000 feet in elevation, are covered with a type of vegetation dominated by ericads, particularly species of *Gaylussacia* and *Vaccinium* which are locally of some economic value to mountain folk and which explain the name "huckleberry plains." The most extensive area of this type of situation is to be found in the region of "The Plains" or "The Roaring Plains"[5] and it occurred to me that a detailed study of this area would probably explain the origin of the vegetation, not only of this region, but also of all other similar areas in the State.

This uninhabited, plateau-like area lies on the higher Alleghenies at and around the juncture of the boundary lines of the counties named. It is capped and upheld by the massive Pottsville Conglomerate, and some points are over 4,700 feet high, the greatest elevation, 4,760 feet, being only 100 feet below Spruce Knob, the highest point in the State. Thousands of acres of rolling, treeless barrens

---

* Contribution No. 6 from the Herbarium of West Virginia University.

[1] Camp, W. H. The grassy balds of the Great Smoky Mountains of Tennessee and North Carolina. Ohio Jour. Sci. 31: 157-164. 1931.

[2] Wells, B. W. Andrews Bald: The Problem of its Origin. Castanea 1: 59-62. 1936.

[3] Wells, B. W. Southern Appalachian Grass Balds. Jour. Elisha Mitchell Sci. Soc. 53: 1-26. 12 fig. 1937.

[4] Cain, S. A. An ecological study of the heath balds of the Great Smoky Mountains. Butler Univ. Bot. Studies 1: 177-208. 1930.

[5] Other names are used locally for portions of the area, as Red Creek Plains, Flat Rock Plains, Baker Plains, and Rohrbaugh Plains.

are swept by winds often of terrific force, explaining the name *Roaring* Plains. Scarcely any evidence of a possible earlier forest cover is to be found and it is easy to form the conjecture that the vegetation for centuries has been similar to that existing at present.

The dry, sterile, rocky soil supports a scanty covering of such species as *Pteris aquilina, Lycopodium dendroideum, Picea rubra, Carex brunnescens, Clintonia borealis, Trillium undulatum, Polygonum cilinode, Dicentra eximia, Corydalis sempervirens, Ribes prostratum, Pyrus americana, Rubus strigosus, Prunus pennsylvanica, Aralia hispida, Cornus canadensis, Kalmia latifolia, Menziesia pilosa, Gaylussacia baccata, Vaccinium pennsylvanicum, V. vacillans,* and *V. erythrocarpon.* The innumerable bare rocks are coated with many species of lichens.

Depressions in the surface are swampy and, especially near the margins of the Plains, covered with a dense growth of underbrush. Species of the moister spots include *Carex stipata, C. gynandra, Veratrum viride, Stenanthium gramineum, Alnus incana, Ilex verticillata, I. monticola, Epilobium angustifolium, Vaccinium macrocarpon,* and *V. Oxycoccos.*

However, despite the unusually barren conditions at present, so inhospitable for plant growth, there is historical proof that the region was once covered with a fine forest. The following account, selected from the writings of Hu Maxwell[6] and dated more than half a century ago, well describes the area as it existed at that time:

"Before me far away toward the south and west extended the bare gloomy domain of the Red Creek Plain. To the east there was nothing but dark forests and a tangled wilderness of fallen trees and gnarled undergrowth and huge angular rocks.

"These plains are well worth a ride of fifty miles to see. They extend perhaps thirty miles along the summits of the Alleghenies, interrupted at times by belts of timber a mile or two wide[7], beyond which the open plains again commence. The top of the mountain is flat, except here and there rugged ridges and huge promontories of rocks rising above the level of the plains, and giving the scene an appearance of distance and mystery that must be witnessed before it can be understood. These mounds and pyramids of rocks often look to be miles away, when they are really not many rods.

"A few generations ago, as I have been told, what is now open plains, was then as densely wooded as part of the mountain top still is. But, tremendous forest fires swept over the summits and the timber and the jungles were burnt, and the dead trunks of trees were broken by the storms of winter, until nothing but a dreary wreck, splintered by storms and blackened by the conflagrations that roll over them, remained to show that forests had once been there. At this time, even trunks of the trees have disappeared, except here and there a log wedged in among the rocks, as though it

[6]Wheeling Intelligencer, April 22, 1886.
[7]These belts of timber no longer exist and have not for many years.

had been lodged there by the flood of some river. I saw in the distance also a few ancient trees yet standing, dead and silent, but unconquered. There was something approaching to the sublime in the picture. The great black trunks of trees, their branches burnt by fires and torn away by the tornadoes, still stood grand and defiant, looking over the surrounding desolation where years before had perished all verdure, and where now was nothing but death.

"The rocks are white, nearly like snow, unless covered with gray moss. Almost the whole formation of the ground is of rock piled on rock, heaped and flung together in tumultuous confusion. No soil at all was visible, except in rare places, and I was at a loss to account for the trees that formerly stood there, until I recollected that the soil that then furnished sustenance for the vegetation had been burnt up in the summer fires.

"There are other plains to right and left of this one, as large as it is. Notable among these are the Roaring Plains and the Baker Plains. Bands of wolves now roam over these plains, and the past winters have played havoc with sheep among the farms lower down.

"It was over this dangerous trail that Imboden led his cavalry the time he made his raid into Tucker county and captured Hall at St. George. He carried his cannon on mules and by some means which I cannot explain, led his little army through.

"From the eastern verge of the plain, where I sit on a rock writing this, the valley of the South Branch of the Potomac can be seen winding away toward the east and the less beautiful but more romantic North Fork is down beneath me, and finds its way through a tortuous ravine from the west. Towards the south and east and West the mountains are piled one above another and beyond another, until a blue haze hides from the view those which may be still more distant."

APPLE SPRAY INJURY
(A Literature Review)

CARLTON F. TAYLOR
Department of Plant Pathology, West Virginia University

SPRAY INJURY to apple trees dates back to the use of commercial spray materials. In 1890 Weed (*39*) reported injury caused by Bordeaux mixture, though no statement was made as to the conditions under which the Bordeaux was applied. Lime sulphur was first used as a summer spray by Cordley *(7)* in 1908, and by 1910 Wallace (*38*) had collected sufficient data for a bulletin on lime-sulphur injury. Likewise the development of arsenical and oil sprays has been accompanied by host injury.

This paper is presented as a partial review of the literature pertinent to injury by copper and sulphur spray materials; the inclusion of literature on oil and arsenical sprays has not been attempted.

Plant protection is the principle involved in the application of most orchard fungicidal sprays; rarely, as in the case of lime sulphur following infection periods, is eradication achieved (*15*). The ideal protectant is one which will provide sufficient toxic constituents in solution to kill the germinating fungus spore without proving toxic to the host. Some reserve material must be present on the host to maintain the soluble fungicide at a level sufficient for adequate protection. The safety of copper sprays is dependent upon weather conditions. The concentrations which may prove desirable for warm and bright days may easily become injurious in cool, damp weather. On the other hand reserve sulphur materials may oxidize rapidly during extremely warm weather and may cause burning. Likewise slow drying of the spray material may lead to injury before certain constituents become altered to form a less harmful material.

TYPES AND PRIMARY CAUSES OF SPRAY INJURY

Direct injuries. Direct spray injury of several types has been reported. Among these types are listed the following:

1. *Leaf yellowing and dropping.* This was observed by Stewart and Eustace (*36*) in Western New York in 1902 and attributed to spraying with Bordeaux mixture and Paris green during cold, wet weather, when the foliage was unusually tender. Hedrick (*17*) in 1907 ascribed this and other types of Bordeaux injury to the weather conditions following spraying and noted the wide variation in susceptibility between varieties. Young and Walton (*40*) in 1925 reported a similar injury following lime-sulphur application and observed that frosted leaves were frequently affected before uninjured ones. The foregoing workers have also reported that a wide variation exists in the susceptibility of different varieties.

2. *Leaf burn.* This was described by Wallace *(38)*, and Young and Walton (*40*) as a marginal burning which appeared within three or four days after application. This was more severe in the path of the spray gun and occurred more frequently with lime sulphur than with other less caustic sulphur sprays. This is primarily a sulphur injury.

3. *Leaf scald.* Larger areas of the leaf are involved and frequently the entire leaf is scorched. The affected areas are light brown and irregular in shape. This is a sulphur injury, more severe with lime sulphur, and follows spray application in very warm weather. Young and Walton *(40)* reported this as occurring only on that side of the tree in direct sunlight.

4. *Leaf sulphur shock.* Schneiderhan (*33*) reported a case resulting from application of lime sulphur and lead arsenate applied at 70° F. and 70° relative humidity. In this case the temperature rose to 90° F. later that day and was followed by continued high maximum temperatures. Marginal burning developed on the day following application and the leaves made no further growth.

5. *Fruit scald.* The affected areas become necrotic. The lesion may involve only a few cell layers or may extend for a considerable distance into the fruit. Young and Walton (*40*) and many others have studied this type of injury and find it to be caused by the same conditions which induce leaf scald.

6. *Fruit russet due to copper sprays.* A report from the Geneva, N. Y., Experiment Station in 1894 (*1*) attributes russeting to spraying in wet seasons and notes the wide range in varietal susceptibility among apple varieties. Hedrick (*17*) described the injury as being initiated in the form of small, round, black or brown spots about the stomates. Later the area becomes rough and russeted because of the ruptured epidermis and development of cork cells. He believed that little injury was caused after the fruit hairs had been shed and the stomates changed to lenticels. Sanders *(32)* in 1917 reported that russeting could be reduced by substituting a sulphur material for Bordeaux mixture at the petal-fall spray.

7. *Fruit russet due to sulphur sprays.* Wallace (*38*) found less russeting on the lime-sulphur-sprayed fruits than on the unsprayed. More recent workers have reported some injury from this source. Groves (*14*), 1936, reports that apples injured by early sprays of lime sulphur show many patches or flecks of russet distributed over a considerable part of the fruit. This russet is not as deep as that caused by copper sprays and is generally less extensive.

SECONDARY EFFECTS OR INDIRECT INJURIES

Under this heading one may consider injuries which do not constitute a burn or observable blemish on foliage, fruit, or spur.

1. *Reduction in photosynthetic ability.* In 1933 Heinicke and Hoffman (*18*) described an apparatus for measuring the carbon

dioxide assimilation of single leaves under conditions approaching normal. Other workers have adopted this apparatus, and all work reported under this heading was performed in essentially the same manner. Hoffman (*22*) reported a reduction in apparent photosynthesis of 44.7% as late as one week after lime-sulphur application, when a light-green apple leaf was used. However, when a dark green leaf was used the reduction was only 16.3% in comparison with the unsprayed check on the day following application. This depressing effect had entirely disappeared at the end of the week. Heinicke *(19)*, enclosing an entire mature tree in the photosynthetic chamber, obtained reductions in activity amounting to 50% for the first week following application of lime sulphur. Hoffman (*24*) found that the respiration rate for the sprayed leaves was slightly higher than for the unsprayed leaves but that this increase was too small to account for the depression in the rate of apparent photosynthesis. Hyre (*26*) observed that lime sulphur, 2½ gal. per 100 gal., with or without lead arsenate at three pounds per 100 gal., gave essentially the same reduction when applied either to the lower surface alone or to both surfaces. This reduction was much greater at 100° F. than at 85° and 70° F. Hoffman *(23)*, Christopher (*5*), and Hyre (*26*) have reported reductions from other sulphur sprays to be of less magnitude than those caused by liquid lime sulphur. Hoffman *(22)*, Clore *(6)*, and Christopher *(5)* found no reduction in apparent photosynthesis following application of Bordeaux mixture. Certainly sufficient evidence is at hand to prove that application of certain sprays, particularly to leaves of low vigor, will markedly reduce the rate of carbohydrate formation.

2. *Reduction in growth rate of leaves.* Dutton (*10*) in 1932 showed that excessive spraying reduced the size and number of apple leaves. Measuring leaf areas on terminal branches of sprayed trees, Mills (*29*) showed that leaves receiving a complete schedule of lime sulphur (1-40) had, in some cases, significantly smaller leaves than those sprayed with flotation sulphur. No significant reduction in area occurred in the absence of visible burning. Lime sulphur at higher dilution had, in some cases, an intermediate effect.

3. *Effect on fruit set.* Current season effects from lime-sulphur spraying have long been noted. In 1917 Sanders (*32*) reported excessive fruit drop in Nova Scotia following application of lime-sulphur spray. Howlett and May (*25*) claimed that in many cases this loss was more apparent than real, showing that the normal June drop usually occurred shortly after the first cover spray and that, unless severe injury had occurred, sufficient apples remained after this drop. They claimed that this drop is a seasonal phenomenon which occurs regardless of spraying and is not in itself an indication of injury. However, there is a considerable amount of evidence showing that the use of a too caustic spray material may reduce the set of fruit buds of the following season. Dutton *(11)* reported a case where a consecutive lime-sulphur schedule over a period of seven years resulted in an average annual yield of 341 pounds per

tree as compared with 645 pounds on trees receiving an elemental sulphur spray. Folsom *(13)* reported the cumulative effect on young McIntosh trees receiving the same spray schedule for eight consecutive seasons. Fruit production was significantly lower in the lime-sulphur and control series than in the wettable flotation sulphur and bentonite sulphur-dust series. The low yield in the control series was attributed to the lack of disease control.

4. *Effect on fruit quality.* DeLong and Pickett *(8)* and Hockey and Ward *(20)* have reported a slightly higher total sugar content in apples sprayed with Bordeaux mixture as compared with those sprayed with liquid lime sulphur in Nova Scotia.

5. *Effect on oil sprays.* Sulphur present on the foliage may lead to severe burning when summer oil sprays are applied. Similarly, burning may occur when sulphur sprays follow too shortly after delayed-dormant oil sprays in the spring. Burkholder *(4)* reports a case where an oil-lead spray applied 12 days after a sulphur first cover spray led to as high as 90% drop of fruit on Turley and Stayman with severe leaf burn on weaker trees.

PREDISPOSING FACTORS IN SPRAY INJURY

1. *Temperature and humidity.* Schneiderhan *(34)* presented data obtained from branches sprayed under widely different atmospheric conditions. He concluded that the time required for drying spray liquids on leaves and fruits is directly correlated with spray injury. These limited experimental data are supplemented by a great deal of observational data which emphasizes the importance of temperature and humidity in determining spray injury. It is generally agreed that liquid lime sulphur should not be applied when the temperature rises above 85° F., though injury may not occur at higher temperatures and has occurred at considerably lower ones. High humidity tends to delay drying of the spray film and may permit appreciable burning by the polysulphides of lime sulphur before they become dispersed as elemental sulphur on drying. On the other hand Peterson *(31)* states that under extremely rapid drying conditions chemical breakdown may be prevented and a dry polysulphide residue may be established. This may later go into solution on the foliage and produce a delayed polysulphide type of injury.

Peterson also reported that under temperatures approaching 100° F. the rate of vaporization from elemental sulphur increases rapidly and the relatively resistant leaf tissues may be penetrated and killed by the active vapors. Thus, in extremely hot weather, even the elemental sulphurs may be unsafe to use.

In the case of copper sprays the material is deposited as a relatively insoluble film on the host surface. During cool periods of continuous moisture, dangerous quantities of copper may be dissolved, causing injury to the host. Generally speaking the use of copper sprays in cool, poor drying weather is to be avoided.

2. *Injured host surfaces.* Frequently the leaf or fruit surface becomes broken. This may occur as a result of disease or insect attack, mechanical bruising or rubbing due to high winds, extreme force of the spray stream at high pressure when the nozzle is held too close to the branch, or rolling or cracking of the leaves due to early frost injury. Spray material entering through such openings may kill the underlying cells.

3. *Host vigor.* In 1910 Wallace *(38)* reported that circumstantial evidence indicated that more injury occurred on weakened trees. Blake *(3)* reports that apple leaves early in the season are more susceptible to spray injury when nitrogen is deficient. Moore *(30)* reports that Bordeaux russeting on Bramley's Seedling in England was more severe on those plots receiving only nitrogen than on those receiving nitrogen and potash, potash alone, or no fertilizer. Rootstock affected this russeting, more developing on trees on certain clonal stocks than on others. Groves *(14)* states that fruit on trees suffering from root trouble, mouse injury, growing on rock breaks, and otherwise weakened trees tend to injure more easily than fruit on normal trees. Mills *(28)* observed that considerable leaf scorch occurred on winter injured trees, especially on Baldwins, regardless of spray material used. Many observations have indicated that leaves are more susceptible following protracted periods of cool weather [Adams *(2)* and Schneiderhan *(35)*].

4. *Age of leaves and fruit.* Dutton *(9)* found young leaves more susceptible than those hardened by age or by temperature, low humidity, and much sunlight. Hedrick *(17)* believed that fruit was much more susceptible to copper injury when young. Sanders *(32)* found the greatest copper injury to fruit at the petal-fall stage with a rapid decrease in susceptibility within two weeks. He makes the following statement concerning lime sulphur and Bordeaux: "Two weeks after the blossoms seems to be the time when lime sulphur does its greatest damage, while at this period Bordeaux is comparatively harmless in so far as russeting of the fruit and causing 'drop' is concerned."

CHOICE OF SPRAYS

In selecting the orchard spray one must balance fungicidal efficiency against toxicity to the host plant. There is no advantage to be gained from spraying the tree with a material so innocuous that protection is not obtained. On the other hand, a material causing too severe host injury nullifies the advantages offered by its fungicidal efficiency. Generally speaking, such efficiency is obtained at the expense of safety to the host.

In the past few years a wide variety of proprietary spray materials has been placed on the market. These are mostly compounds of copper or sulphur but show wide differences in method of preparation. Of those which have been sufficiently tested the wettable

sulphurs give reasonable fungicidal action and do not injure the host under ordinary spraying conditions.

Many investigations have been conducted on the use of materials which tend to render lime sulphur non-toxic to the host. It has been found that many of the salts of heavy metals precipitate the polysulphides of lime sulphur and also combine with the water-soluble arsenic of the insecticide. The use of iron sulphate in lime sulphur-calcium arsenate sprays has been favorably reported from Nova Scotia and British Columbia *(27)*, *(21)*, (*12*). The iron salt precipitates the caustic polysulphides and prevents any burning action on scab infections already initiated and thus may give somewhat poorer scab control. Hamilton *(16)* and Thurston *(37)* have found lower concentrations of lime sulphur effective in scab control and less likely to cause severe injury to the host.

DISCUSSION

This paper, based on reported cases of injury to apples, may convey the notion that lime sulphur and, to some extent, Bordeaux mixture, are materials too dangerous to use in the modern spray program. That this danger may be exaggerated is indicated by the fact that the use of these two materials is still worldwide. Orchards have been sprayed with liquid lime sulphur for at least 25 years and still produce crops that tax the physical ability of the trees to support them. Undoubtedly lime sulphur and Bordeaux mixture may cause serious injury if used without discretion. If properly used they are without rivals in fungicidal efficiency and in cheapness of materials. In the light of present knowledge it appears that the orchardist should continue their use in periods favoring fungus dissemination, substituting other materials when milder fungicides are permissible and when atmospheric or host conditions are such that serious burning or russeting may occur.

SUMMARY

This paper is based on a review of the literature.

Several types of direct spray injury are recognized. These include leaf yellowing and dropping, leaf burn, leaf scald, leaf sulphur shock, fruit scald, and fruit russet.

Secondary effects of spray injury include reduction in photosynthetic ability, reduction in growth rate of leaves, and reduction in fruit yield as a cumulative effect of caustic sprays over a period of years.

Limited experimental data and many observations show that temperature and humidity play an important role in governing the amount of spray injury induced.

Factors leading to breaks in the leaf epidermis or to lowered tree vigor predispose to spray injury.

Despite admitted failings of lime sulphur and Bordeaux mixture, these two fungicides still have no completely satisfactory substitute for apple spraying.

LITERATURE CITED

(1) Anonymous. 1894. Spraying pear and apple orchards in 1894. New York (Geneva) Agr. Exp. Sta. Bul. (n. s.) *84*, 36 p., illus.

(2) Adams, J. F. 1923. Spray injury. Trans. 36 Ann. Meet. Peninsula Hort. Soc. *1922*: 24-31.

(3) Blake, M. A. 1934. Growth status of fruit trees and spray burning. New Jersey State Hort. Soc. News *15* (3): 581.

(4) Burkholder, C. L. 1937. Spray injury and fruit russet. Hoosier Hort. *19*: 134-139.

(5) Christopher, E. P. 1936. The effect of flotation sulphur spray on the CO_2 assimilation of apple leaves. Proc. Amer. Soc. Hort Sci. *33*: 149-151, illus.

(6) Clore, W. J. 1936. The effect of Bordeaux, copper, and calcium sprays upon carbon dioxide intake of Delicious apple leaves. Jour. Amer. Soc. Hort. Sci. *33*: 177-179, illus.

(7) Cordley, A. B. 1908. The lime-sulphur spray as a preventive of apple scab. Rural New Yorker *67*: 202, illus.

(8) DeLong, W. A., and Pickett, A. D. 1931. On a possible effect of fungicides upon the composition of apples. Science (n. s.) *73*: 649-650, illus.

(9) Dutton, W. C. 1932. Spray injury studies. I. Injuries from summer applications on apples. Michigan Agr. Exp. Sta. Special Bul. 218, 68 p., illus.

(10) Dutton, W. C. 1932. Spray injury studies. II. Secondary effects of spray injury to apple foliage. Michigan Agr. Exp. Sta. Special Bul. 219, 38 p., illus.

(11) Dutton, W. C. 1938. The seriousness of spray injury. Proc. 42 Ann. Meet. Virginia State Hort. Soc. Virginia Fruit *26* (1): 150-156, illus.

(12) Eastham, J. W. 1935. Report of the Provincial Plant Pathologist. Rept. British Columbia Dept. Agr. 1934: R30-R37. (Original not seen. Reviewed in Review Appl. Mycology *14*: 495, 1935).

(13) Folsom, Donald. 1935. Apple scab control. *In* Summary report of progress, 1935. Maine Agr. Exp. Sta. Bul. 380, 3 p. illus.

(14) Groves, A. B. 1936. Spray injuries on the apple fruit. Virginia Fruit *24* (9): 16-22, illus.

(15) Hamilton, J. M. 1931. Studies of the fungicidal action of certain dusts and sprays in the control of apple scab. Phytopathology *21*: 445-523, illus.

(16) Hamilton, J. M. 1937. Summer fungicides on apples in western New York. Proc. 82 Ann. Meet. New York State Hort. Soc. *1937*: 34-48, illus.

(17) Hedrick, U. P. 1907. Bordeaux injury. New York (Geneva) Agr. Exp. Sta. Bul. 287, 85 p., illus.

(18) Heinicke, A. J., and Hoffman, M. B. 1933. An apparatus for determining the absorption of carbon dioxide by leaves under natural conditions. Science, n. s. *77*: 55-58, illus.

(19) Heinicke, A. J. 1938. The manufacture of food materials by the foliage of apples as influenced by spraying and some other conditions. Proc. 79 Ann. Meet. Pennsylvania State Hort. Soc. News *15*: 16-24, illus.

(20) Hockey, J. F., and Ward, R. W. 1932. Studies in apple storage. I. The influence of fungicides on flavour and sugar content. Sci. Agr. *12*:709-715, illus.

(21) Hockey, J. F. 1934. Copper and sulphur sprays on apples, 1933. 70th Ann. Rept. Nova Scotia Fruit Growers Assoc. *1933*: 62-66, illus.

(22) Hoffman, M. B. 1933. The effect of certain spray materials on the carbon dioxide assimilation by McIntosh apple leaves. Proc. Amer. Soc. Hort. Sci. *29*: 389-393, illus.

(23) Hoffman, M. B. 1934. Carbon dioxide assimilation by apple leaves as affected by lime-sulphur sprays. II: Field experiments. Proc. Amer. Soc. Hort. Sci. *30*: 169-175, illus.

(24) Hoffman, M. B. 1936. The effect of lime-sulphur spray on the respiration rate of apple leaves. Proc. Amer. Soc. Hort. Sci. *33*: 173-176, illus.

(25) Howlett, F. S., and May, Curtis. 1930. Spray injury and fruit set. Ohio Agr. Exp. Sta. Bimonthly Bul. 144, 4 p., illus.

(26) Hyre, Russell A. 1938. The effect of several sulphur sprays on the photosynthesis of apple leaves in a controlled environment. (Abstract) Phytopathology *28*: 10.

(27) Kelsall, A. 1935. The iron sulphate and lime-sulphur mixture as a spray. Canadian Chem. Metallurgy *19*: 239.

(28) Mills, W. D. 1936. Fruit diseases in 1935. Proc. 81 Ann. Meet. New York State Hort. Soc. *1936*: 13-17.

(29) Mills, W. D. 1937. Leaf growth as affected by spray materials. Proc. 82 Ann. Meet. New York State Hort. Soc. *1937*: 211-214.

(30) Moore, M. H. 1936. Some observations on the influence of manurial dressings and of certain other factors on the incidence of scab (*Venturia inaequalis* (Cooke) Wint.) and of spray-injury in apples. Jour Pomol. Hort. Sci. *14*: 77-96, illus.

(31) Peterson, P. D. 1935. The safe use of sulphur as a fungicide. Proc. 37 Ann. Meet. Maryland State Hort. Soc. Rept. Maryland Agr. Soc. *19*: 191-198.

(32) Sanders, G. E. 1917. The effect of certain combinations of spraying materials on the set of apples. Proc. Entomological Soc. Nova Scotia *2* (1916) : 17-21, illus.

(33) Schneiderhan, F. J. 1936. The spray injury problem. Mountaineer Grower *7* (74) : 1, 5-7, illus.

(34) Schneiderhan, F. J. 1937. The spray injury problem. Trans. Peninsula Hort. Soc. 1936. Bul. Delaware State Board Agr. *26* (5) : 47-54.

(35) Schneiderhan, F. J. 1937. Weather as a factor in causing spray injury. Proc. 39 Ann. Meet. Maryland State Hort. Soc. *21* (1936) : 151-159.

(36) Stewart, F. C., and Eustace, H. J. 1902. Two unusual troubles of apple foliage. I. Frost blisters on apple and quince leaves. II. Spotting and dropping of apple leaves caused by spraying. New York (Geneva) Agr. Exp. Sta. Bul. 220, 17 p., illus.

(37) Thurston, H. W. Jr., and Worthley, H. N. 1936. Some problems in apple spraying in Pennsylvania. Pennsylvania Agr. Exp. Sta. Bul. 324, 19 p., illus.

(38) Wallace, Errett. 1910. Spray injury induced by lime-sulphur preparations. Cornell Univ. Agr. Exp. Sta. Bul. 288, 33 p., illus.

(39) Weed, Clarence M. 1890. Ohio Agr. Exp. Sta. Bul., vol. 3, no. 1, 2d series, p. 139-144.

(40) Young, H. C., and Walton, R. C. 1925. Spray injury to apple. Phytopathology *15*: 405-415, illus.

AN ADDITION TO THE RANGE OF *Pinus strobus* (WHITE PINE) IN WEST VIRGINIA

W. J. SUMPSTINE, Department of Biology, Bethany College

THE WHITE PINE, Pinus strobus, is one of the conifers with a wide distribution in the Appalachian highlands but is almost completely absent in the eastern Midwest. The state of Ohio has a small stand in its northwest section in Trumbull, Ashtabula, and Geauga Counties. There is another small station on Cedar Point in Lucas County, and a few trees have been reported by Emma E. Laughlin in the Ohio Journal of Science of January, 1916, as occurring at Raven Rocks, Belmont County, near the Monroe County line.

All of these stations are apparently on the outer eastern edge of that great midwestern ecological peninsula which crowds our northern Appalachian district. The border between the two districts is marked by the mixing of prairie and montane forms of plant life and because of this position forms an interesting and fascinating area for ecological studies, for it is here that the West meets the East.

On this border life-zone, the white pine has a rather spotty distribution. It is not abundant in Western Pennsylvania but tends to occur in isolated stations in the various counties. It has never been reported from Lawrence, Wenago, Warren, or Elk Counties and thins out in its distribution as one travels to the east in that state.

It has been reported in twelve of the counties of West Virginia, and according to Mr. A. B. Brooks (West Virginia Trees, 1920) it occurs or did occur in Pocahontas, Greenbrier, Raleigh, Tucker, Gilmer, Jackson, Monongalia, Preston, Ritchie, Tyler, Wetzel, and Wirt Counties. No mention is made, in any of the literature reviewed, of its occurrence in the counties of the Northern Panhandle.

During the summer of 1937, while doing research ecology in Hancock county, the writer found two small stations of Pinus strobus situated in that area of the county known as Tomlinson Run State Park. This region, comprising approximately 1300 acres, has been set aside by the State of West Virginia and by the Federal Government as a part of that now-popular recreational and conservational movement, and is a section worthy of concentrated study, located as it is on this border line of the West and East. A large part of the area is of the ravine association type and supports a wide variety of plants characteristic of such habitat. A summary of this region with its flora will appear in a later publication. The first station found had but one specimen, a beautiful symmetrical tree with a height of about 60 ft. It was located close to what apparently had been the ruins of an old homestead. The position of the tree immediately raised the question as to whether "the tree was there because of the house or the house because of the presence of the tree." A few days later the question was answered with the discovery of

four more specimens in one group, located in such position as to preclude the possibility of their having been planted by settlers of that region. The last-mentioned trees, badly mutilated by Christmas tree hunters, were stunted.

The finding of these two stations of Pinus strobus in Tomlinson Run Park of Hancock County shows that the white pine does and did exist in the Northern Panhandle of the State. Future work may bring more stations into view.

Inquiry among some of the older residents of this section brought forth the interesting information that the white pine was once quite common in this park region but was practically exterminated by lumbering operations. None of those questioned could give any information as to other stands in that county.

The writer wishes to acknowledge the assistance given to him by Dr. O. E. Jennings of the University of Pittsburgh and Carnegie Museum in identification and studies of the distribution of Pinus strobus in Pennsylvania and Ohio.

Addenda—In the discussion following the presentation of this paper in the Botany section of the West Virginia Academy of Science, several of the botanists of the State gave added information as to the distribution of the White Pine in West Virginia. STRAUSBAUGH reported its occurring in Marion, Harrison, Mineral, Hardy, Nicholas, and Webster Counties. CUTRIGHT reports its occurrence in Braxton County. F. E. BROOKS reports it from Wyoming County, while McNEILL tells of its occurrence in Monroe County near Indian Mills.

ADDITIONS TO THE GENUS *CHAETOMIUM* OF WEST VIRGINIA

LOUIS G. WILLIAMS

Department of Botany, Marshall College, Huntington

OLD, MOIST chamber cultures of various materials used in obtaining moulds for class use, almost without exception, produced perithecia on the filter paper or on the bottom of the dish after a few weeks.

The perithecia were in most cases of the genus *Chaetomium* in the *Ascomycetes*. In order to find the source of these fungi and to study their habits of growth, bits of decaying paper, rabbit's hair, dung of various animals, and similar detritus were placed on filter paper in a series of sterilized moist chambers. In a few weeks, in most cases, mycelium with developing perithecia appeared on the filter paper in the culture. Apparently the Chaetomiums make use of cellulose to a great extent but appreciate the addition of nutrient material from the original source, since they do not do so well when transferred to filter paper alone.

The transfer of perithecia, asci, or ascospores to potato dextrose agar usually produced a good growth of mycelium, but not in all instances were perithecia obtained on this material alone. The addition of rat dung to the media was necessary to obtain desired results in these cases.

Mucors contaminated many of the agar cultures and it was only in the closing days of the experiment that a method of overcoming this difficulty was obtained.

Lack of time prevented the possible solution to the correct physiological conditions for the fructifications of several *Chaetimium* species which did not develop perithecia.

Of the Chaetomiums obtained, three proved to be new to the flora of West Virginia, and specimens of each have been placed in the Marshall College Herbarium.

Chaetomium cochlioides Palliser
Chaetomium bostrychoides Zopf.
Chaetomium elatum Kze.

The species of the ascomycetous *Chaetomium* are present on practically all dung and forms of detritus containing considerable cellulose materials and need only the correct moisture conditions to produce perithecia and ascospores. Of the species of *Chaetomium* obtained from the culture of such detritus, three proved to be new to the flora of West Virginia.

A Human Fetus Showing Undescended Stage of Testis

(An Abstract)

G. S. DODDS

School of Medicine, West Virginia University

It is one of the well-known facts of human development that the testes have their origin well up within the body cavity, whence, shortly before birth, they migrate to their permanent position in the scrotum. It is also well known that while the testis is yet well within the body cavity, it becomes connected with the bottom of the scrotal sac by a cord, the gubernaculum testis, which passes through the inguinal canal. During the descent of the testis the gubernaculum does not share in the general growth of the fetus, but actually becomes shorter as the testis passes through the inguinal canal into the scrotum. In the adult the gubernaculum is represented by a very short structure attaching the testis to the bottom of the scrotum.

Despite the general familiarity of embryologists with the facts as stated, there are exceedingly few illustrations in the literature showing the undescended testis and the gubernaculum. The paper as presented at the section meeting showed a lantern slide and dissection of a fetus of about six months, showing the testes while not yet far below the kidneys, and each testis connected with the pelvic floor by a gubernacular cord nearly as thick as the testis itself. The dissection is a part of the embryological collection of the School of Medicine of West Virginia University.

The Normal and the Rachitic Shape of the Head of the Tibia and Other Bones*

G. S. DODDS and HAZEL C. CAMERON

The School of Medicine and the Agricultural Experiment Station,
West Virginia University

* Published under the title: Studies on experimental rickets in rats: II. The healing process in the head of the tibia and other bones. Amer. Jour. Pathol. 14:273-296. 6 pls. 1938.

PHARMACOLOGICAL AND PATHOLOGICAL EFFECTS OF ∝-CHLORISOBUTYLENE

B. E. ABREU, CLEMENT C. FENTON, and G. A. EMERSON

Departments of Pharmacology and Pathology, West Virginia University

OF THE halogenated hydrocarbons only chloroform, ethyl chloride, and ethyl bromide have ever come into wide use as anesthetic agents, and these three agents are now recognized as having too slight a margin of safety and too much danger of toxic sequelae for general use. The series of halogenated simple hydrocarbons offers a very large number of potentially useful anesthetic agents, and it is surprising that, until recently, so little systematic work has been done upon these agents. Studies are in progress at the Universities of California and Louisville Medical Schools on certain of these agents, and the series of saturated and unsaturated halogenated hydrocarbons have been intensively studied[1]. In the unsaturated series, ∝-chlorisobutylene has been specially selected as showing a wide margin of safety and a high anesthetic potency. Study of this agent was recommended as long ago as 1932 by Professor P. K. Knoefel.

∝-Chlorisobutylene is a colorless liquid with a pleasant, mildly camphoraceous odor. Its b. p. is 68° C., and the specific gravity at 20° C., 0.92. The substance used in the present experiments was prepared by a modification of the method of Mouneyrat[2], which involves the reaction between 1,2 dichloro isobutane and alcoholic potash. Yield was sacrificed to sharpness of fractionation, although good yields of slightly contaminated ∝-chlorisobutylene are readily obtained. All of our preparations were washed with water, dried with anhydrous sodium sulfate, and used as soon after preparation as was feasible. In the infrequent experiments in which it was necessary to store the agent, it was kept in contact with reduced iron, in the dark.

A modification of Fuehner's method[3] employing a 20-liter flask was utilized in the study of the agent. White mice were used as the test animals, 5 or 10 being exposed, for 10-minute periods, to varying concentrations of the compound. During the time of exposure insufficient carbon dioxide was produced or oxygen consumed to have any influence on the result. Anesthetic and lethal ranges were determined for the compound and are as follows:

Anesthetic Range

Concentration mM/liter	Ratio of animals anesthetized to animals used
0.5	0/10
0.65	0/10
0.70	2/10
0.75	6/10
0.90	10/10
1.0	10/10

Lethal Range	
Concentration mM/liter	Ratio of animals killed to animals used
2.25	0/10
2.5	1/10
3.0	6/10
3.5	9/10

The *Certain Safety Factor*[4], which is the ratio between the highest tolerated concentration and the minimal certain anesthetic concentration, is found to be 2.7.

In the study of the chronic toxicity, animals were anesthetized for 1 hour daily until death resulted. Tissues have been examined from animals dying after 30 minute, 1 hour, two 1-hour, and three 1-hour exposures.

The pathological findings in 6 animals indicated that lung irritation was produced resulting in damage to the alveoli. Examination of the liver gave variable results. Some damage was noted but could not be entirely ascribed to the compound, since examination of an untreated animal of the colony demonstrated a liver which was abscessed. No conclusions may be drawn with regard to liver damage until a larger series has been treated, and suitable controls observed.

The theory of mediation of pathological effects of halogenated hydrocarbons, proposed by Professors Knoefel and Peoples, is based on the ready hydrolysis of the agents resulting in liberation of halogen acid. The release of this halogen acid into the tissues may then account for the pathological findings with such compounds as chloroform, carbon tetrachloride, ethyl bromide, and ethyl chloride. Knoefel and Peoples believe that the unsaturated halogenated hydrocarbons, in which the halogen is attached to the unsaturated carbon atom, should be less capable of releasing halogen acid, *in vivo,* because of their greater inertness *in vitro.* This conclusion has been supported to some degree[1]. Professor Knoefel, in recommending α-chlorisobutylene for study, believed on this basis that it should be the least capable of producing any pathology.

From this study it cannot be concluded that the pathological effects are due to this release of halogen acid. It may be that there are some impurities present which would result in the effect, or the mouse colony may have had a low grade infection and would succumb to any agent which influenced their general physiological condition. Professor F. C. Whitmore has suggested that the compound may not release halogen acid but might undergo intramolecular rearrangement to form isobutyraldehyde, the presence of which in minute amounts could very well explain the pathological findings. Professor Peoples in a personal communication states that there are no pathological findings in rats exposed to anesthetic concentrations of the agent.

Summary:—The *Certain Safety Factor* for ∝-chlorisobutylene has been determined as 2.7. For short exposures, the agent has a wide margin of safety and might offer possibilities as a potent general anesthetic.

Pathological findings on chronic exposure indicate that the agent produces severe damage to the alveoli, but various factors, such as special susceptibility of the strain of mice used, possible contaminants not removed in our preparation, or intramolecular rearrangement of the compound, may explain these findings. Further work on other strains of mice and other species of animals is strongly indicated.

---

[1] Abreu, B. E. 1937. M. S. Thesis in Pharmacology, University of California Library, Berkeley, Calif.

[2] Mouneyrat, A. Annales de Chimie et de Physique (7) 20: 533.

[3] Fuehner, H. 1921. Biochem. Zeit. 115: 235.

[4] Peoples, S. A., B. Abreu, and C. D. Leake. 1936. J. Pharm. Exper. Therap. (Proc.) 57: 138.

SOME PHYSIOLOGICAL EFFECTS IN ANIMALS OF A PLANT HORMONE "AUXIPHYLE" FROM PEAS

HAZEL C. CAMERON

Agricultural Experiment Station, West Virginia University

A SUBSTANCE isolated from peas by Leonian and Lilly and found to cause reproduction in fungi has been found to produce estrus in spayed rats and mice when injected in oil by the usual technique. The distilled liquid, of deep yellow amber color and penetrating odor, is soluble in oils and gives the deep red color of the Kober test for estrogenic substances as modified by Cohen & Marrian. It produces no apparent hastening of sexual maturity in young immature rats, does not substitute for vitamin E, and contains only small amounts of vitamin A. It gives a negative response for androgenic substances when tested upon capons.

When injected into rats 2 x daily for 10 days, it causes a decrease in the weight of the testes of from 25 to 75%, and an increase in the weight of the spleen averaging 38% in males and 220% in females. The change in the weight of the ovaries was slight and variable as was that of the liver. The substance represents less than 0.1% of the weight of the original peas and is potent in mice in doses of 0.1 gm.; hence it is unlikely that the effects produced are the result of impurities.

LESIONS OF THE BREAST

CLEMENT C. FENTON

Department of Pathology, West Virginia University

IN THE FOLLOWING series of 133 lesions of the breast, which were examined at the pathology laboratory of West Virginia University during the last 12 years, the following examples were encountered:

Inflammatory	11	8.3%
Cystic hyperplasia and cysts	28	21.0
Tumors	94	70.7
Total	133	100.0%

All of the specimens were removed by surgical means for diagnosis. They consisted of either the removal of the entire localized mass or a portion of it, or of the entire breast, or the entire breast with the axillary lymph nodes. The diagnoses were based upon the gross and histological characteristics of the lesions. The cases were not followed from the clinical aspect.

The inflammatory conditions were classified as follows:

Abscesses	6
Chronic inflammation	3
Tuberculosis	1
Non-specific granuloma	1
Total	11

Abscesses of the breast occur in the course of acute mastitis. They are seen most frequently in the lactating breast, but may be observed during pregnancy and, also, occasionally in the mammary gland of non-pregnant women and in the male breast. The infection *(9)* reaches the gland usually through fissures of the nipple. The organisms responsible, in most instances, are the staphylococci, aureus or albus, or occasionally *(6)* the streptococcus. In one of our cases, the micrococcus tetragenous was the causative agent, a very infrequent invading organism.

Chronic inflammation of the gland may follow upon an acute inflammation, or it may be chronic from the onset. There may be considerable induration and the condition is often mistaken for cancer. Microscopically, besides a *(8)* proliferation of connective tissue, there is an abundant infiltration of lymphocytes, plasma cells, and often mast cells in the interstitial fibrous tissue. There may be either atrophy or proliferation of the glandular epithelium.

Tuberculosis of the breast is uncommon *(4)* and is usually not associated with lactation. It is about eight times more common in the female breast and is usually secondary to tuberculosis elsewhere in the body *(1)* such as the lungs or lymph nodes. In the early stages it forms a hard mass which is usually mistaken for cancer.

It must be differentiated from chronic mastitis with pseudo-tubercles. Our case was one of definite tuberculosis with areas of conglomerate tubercles showing caseous necrosis and the presence of numerous Langhans giant cells. The sections were not stained for the acid-fast organisms.

The last inflammatory lesion is listed as a non-specific granuloma. Bell *(1)* calls similar lesions pyogenic granulomata. Certain diseases such as tuberculosis, syphilis, leprosy, etc. are known as infectious granulomata. The lesion resembled none of the specific granulomata but was probably infectious in origin.

The cystic conditions of the mamma include the following:

Cystic hyperplasia	26
Galactocele	1
Sebaceous cyst	1
Total	28

Cystic hyperplasia of the breast has many synonyms such as chronic cystic mastitis, chronic mastitis, cystic disease, Schimmelbusch's disease, etc. It is considered *(3)* the most frequent of all benign lesions of the mammary gland and occurs almost exclusively in women. It is a disease of mature life and its greatest frequency is between the ages of 30 and 50. The condition is rare before the age of 20. Both breasts are usually affected but sometimes only one breast is involved. As a rule the breast is not enlarged. Palpation discloses several firm nodules or a diffuse induration. On section, the cut-surface may show either a single large cyst which may be blue in color, the blue dome cyst of Bloodgood, or *(2)* the cut-surface most frequently shows many cysts which vary in size, or there may be a solid mass of tissue in which cysts are few in number or absent.

The microscopic appearance is variable. There is an abundance of dense connective tissue which is usually infiltrated with lymphocytes. The cysts, as a rule, are dilated ducts but the glands also are likely to show cystic changes. In the non-cystic type, there is a hypertrophy of the lobules resembling a fibro-adenoma and sometimes described as an adenomatous type of cystic mastitis.

Authorities differ in opinion as to the nature of cystic hyperplasia. Some consider it inflammatory. Others consider it neoplastic. The majority agree with McFarland *(9)* that it is the result of abnormal or excessive stimulation from hormones of the ovary. There is also a considerable variance of opinion as to the relationship of cystic disease of the breast to cancer. Some consider the lesion precancerous *(4)* while others *(7)* claim that carcinoma develops just as frequently in breasts which are free of cystic hyperplasia as those in which the disease had previously existed. Four of our cases of cancer developed in breasts which were the seat of chronic cystic disease.

A galactocele is a retention cyst. It is due to obstruction of a milk duct. Most frequently one large cyst is found in the gland although several may occur. The cyst, as in our single case, is usually excised. *(1)*

Sebaceous or dermoid cysts are quite common in other regions of the skin such as the forehead and scalp, but are rare *(5)* in the breast. One example was found in the series.

New growths were the most frequent lesions encountered. There were 94 tumors of various types. They comprise 70% of the total lesions of the series. Of these 53 or 56.3% were benign and 41 or 43.7% were malignant.

The benign tumors consisted of the following varieties:

Lipomata	2
Osteoma	1
Myxoma	1
Fibro-adenoma	44
Pure adenoma	1
Duct papilloma	1
Squamous cell papilloma	1
Total	53

Lipomata are composed of adipose tissue. They are considered rare in the breast. They may be single, *(6)* multiple, or bilateral and may reach a considerable size.

Osteoma is a rare tumor of the mammary gland. I have found five examples of osteoma or osteo-chondroma, tumors composed of bone or a mixture of bone and cartilage in the breasts of dogs. According to Ewing *(7)* they are quite frequent in these animals.

One example of myxoma was seen. It is uncommon in the mammary gland. The growth consists of a connective-tissue stroma which contains mucin. Myxomatous change is more frequently seen as a degenerative transformation of other tumors such as a chondroma, fibroma, sarcoma, etc. rather than a pure type as in this case.

Fibro-epithelial tumors of the breast are very common. In this series, they include the fibro-adenomata, a pure adenoma, and the duct papillomata, 48 examples in all.

The fibro-adenomata are tumors which are most frequently observed in girls and young women. It is more common in women who have not borne children. According to McFarland *(9)* they comprise about one-fourth of the tumors of the breast. They are quite numerous in our series because quite a number of them were removed from the breasts of college students. They are rare in the male breast, but six of them are included in this group. Five of them occured in college students and one in a young physician who had recently graduated from medical college. Oliver and Major *(10)* do not consider them true neoplasms, but rather localized masses of hypertrophied and hyperplastic breast tissue. The tumors are

usually small in size, firm in consistence and well encapsulated. Occasionally they may reach a very large size. They cut with considerable resistance and present firm, densely fibrous cut-surfaces. Microscopically the glandular tissue has either a lobular arrangement about which a very dense connective tissue forms, or irregular ducts are seen surrounded by a dense connective tissue. The former is *(8)* known as the peri-canalicular type and the latter as the intra-canalicular type. In some tumors there is an intermingling of both types. They do not recur on removal but similar tumors may later *(1)* appear in the same or in both breasts.

Pure adenoma of the mammary gland is *(7)* rare. Only one tumor of this type was observed in the series. Grossly it is well encapsulated like the fibro-adenoma but is softer in consistence. Microscopically the tumor is composed of almost solid glandular acini with little intervening connective-tissue stroma.

The duct papilloma is included with the fibro-epithelial tumors. It is also known as papillary intra-cystic fibro-adenoma, cystadenoma, and papillary cystoma. It is a fairly common tumor and usually occurs after the menopause but occasionally it is observed in young subjects. Its location is usually beneath the nipple. A cyst wall generally encloses it. Microscopically the tumor is composed of papillary folds of connective tissue which are covered by a hyperplastic epithelium. It is surrounded by a cyst wall made up of dense connective tissue. This type of growth on account of its very cellular character is considered precancerous and is likely to develop into a duct carcinoma.

One case of squamous cell or hard papilloma of the breast was examined. It shows the same characteristics as tumors of this type which may arise on the surface of the skin in any region of the body. Papillomata are usually a few centimeters in size *(3)* and show an excessive thickening of the epithelial surface which is rough, horny, and brushlike in appearance. Microscopically there is an extensive hyperplasia of the squamous epithelium covering the surface with an extension of these thickened masses of epithelium into the corium.

Malignant tumors are not as frequent as the benign ones in this series. Two main types were observed. The sarcomata which arise from the supporting structures and the carcinomata which arise from the ducts and glandular elements of the gland. There were only 3 examples of the former and 38 of the latter.

Sarcoma of the mammary gland is uncommon. According to McFarland *(9)* they comprise about 3% of all breast tumors. Sarcoma of the breast may manifest itself at any age but is most often seen between 30 and 50. Three cases were examined in this series. Two arose in very large breasts which were the seat of fibro-adenomata. Microscopically the connective-tissue stroma had undergone a sarcomatous change and was very cellular. It consisted of spindle cells of an embryonic type combining the ducts. The third case was that of a pure small spindle-cell sarcoma. It recurred

locally six times before the patient died. Microscopic examination always showed essentially the same picture, namely, solid proliferation of small spindle cells with fewer small round cells. Hemorrhage and necrosis was always extensive.

Carcinoma is the most frequent malignant tumor of the mammary gland. It is about 100 times as common in the female as in the male. McFarland *(9)* claims that it constitutes about three-fourths of breast tumors, and *(2)* Bloodgood, about one-half. However, in this series it makes up only 28.6%. The reason for the small percentage is that a large number of tumors of the series occurred in young individuals. Carcinoma *(6)* is seen most frequently between the ages of 35 and 55. The tumor shows a varying degree of malignancy and, if untreated, invariably results in death. The average duration of life *(3)* in untreated cases is about three years.

There are numerous types of carcinoma of the breast. A classification of the types which were studied is as follows:

Scirrhous carcinoma	19
Medullary carcinoma	5
Duct carcinoma	12
Gelatinous carcinoma	2
Total	38

Scirrhous caricnoma is the most frequent form of malignancy of the mammary gland. It its early stage it forms a hard nodule in the substance of the gland which soon becomes adherent to the skin or deeper fascia. Its growth is slow. Later in the course of its growth it causes puckering of the skin and retraction of the nipple. Microscopically the tumor consists of small nests of atypical epithelial cells surrounded by a very abundant dense connective-tissue stroma. Although the tumor grows slowly, metastases occur early so that its *(1)* prognosis is about the same as the softer forms of cancer of the breast.

Medullary carcinoma is less common than the preceeding form. The tumor is usually large, soft, and bulky, and tends *(7)* to cause ulceration of the overlying skin. Its growth is quite rapid, and therefore it is very malignant. Microscopically it consists of masses or sheets of atypical epithelial cell with little intervening connective-tissue stroma. Occasionally the cells have an alveolar-like arrangement.

It is very difficult to decide what malignant tumors of the mammary gland belong to the group of duct carcinomata. Forms of both medullary and scirrhous carcinoma evidently arise from the epithelium of the ducts. The comedo carcinoma belongs to this group. There were three distinct cases of comedo carcinoma in the group. This type of cancer is characterized by the fact that material resembling that of comedones can be expressed from the cut-surface. The gross appearance of the duct carcinomata is variable and it is

very difficult to classify them from their microscopic appearance. Microscopically the tumors show ducts lined with atypical proliferating cells with a varying amount of necrotic material in *(3)* their centers. These growths are of low-grade malignancy and offer good prognosis.

Gelatinous carcinoma is rare. It comprises about 1% of the cancers *(6)* of the breast. We encountered two in our series. It is considered the least malignant *(7)* of the cancers of the gland. The tumor is large and bulky. On section, the cut-surface is soft and gelatinous. Microscopically it is composed of degenerating epithelial cells in small masses surrounded by a stroma *(1)* containing mucin.

Metastatic carcinoma was found in the axillary nodes of four cases of this series when the nodes were removed with the breast. One case of carcinoma was found in a dog's breast which was sent to the laboratory for diagnosis. Also in a mass which was removed from the axilla, aberrant breast tissue was found.

In the series of breast lesions which has been presented, inflammatory, cystic, and neoplastic conditions were found. The latter constituted the largest group. Of the 94 tumors, 88, or 93.6%, occurred in the female breast, and 6, or 6.4%, occurred in the male breast. Of all of the lesions combined, 92, or 70%, were innocent, and 41, or 30%, were malignant.

(The author wishes to express his indebtedness to Mr. F. L. Hawk for the microscopic preparations and the bacteriological examinations.)

BIBLIOGRAPHY

1. Bell, E. T. 1938. Text-book of Pathology, Lea and Febiger, Phila., 405-415.

2. Bloodgood, J. C. 1917. Lesions of Female Breast. Binnie's Regional Surgery, Blakiston, Phila., 1, 23, 557-630.

3. Boyd, W. Text-book of Pathology. Lea and Febiger, Phila., 749-771.

4. Cahill, J. A., and Caulfield, P. A. 1938. The possible Relationship of Chronic Cystic Mastitis to Malignancy. South. Med. Jour. 31, 3, 245-249.

5. Cheatle, G. L., and Cutler, M. 1931. Tumours of the Breast. Arnold, London, p. 306.

6. Delafield and Pruden. 1936. Text-book of Pathology. Wood, Balt., 1009-1029.

7. Ewing, J. 1928. Neoplastic Diseases. Saunders, Phila., 522-583.

8. Karsner, H. T. 1935. Human Pathology. Lippincott, Phila., 836-845.

9. McFarland, J. 1924. Surgical Pathology. Blakiston, Phila., 407-483.

10. Oliver, R. L., and Major, R. C. 1934. Cyclomastopathy: A physiological conception of some benign tumors with an analysis of 400 cases. Am. J. Cancer 21, 1, 1-85.

AMPHIBIANS OF MARION COUNTY

N. D. RICHMOND, Department of Biology, Marshall College, and
G. S. BOGGESS, Farmington High School

THIS PAPER is based on the collections and notes of the authors over a period of eight years. Many of the records are based on specimens brought in by the students of biology at Farmington High School. The authors wish to express their appreciation for the advice and assistance given them by Mr. M. Graham Netting, curator of herpetology at the Carnegie Museum, Pittsburgh.

Marion county is situated in northcentral West Virginia. Its total area is 313.6 square miles and its ranges in elevation from 847.3 ft. to 2003.0 ft. above sea level. The county is drained by the lower parts of the Tygart and West Fork Rivers, which join in the county to form the Monongahela River, and by the tributaries of these streams. Most of the county is hilly farm land cut up by wooded ravines.

Marion county is in the known range of three species of salamanders *(Ambystoma jeffersonianum, A. opacum, and Hemidactylium scutatum)*, which have not yet been taken there. As these are all secretive forms and difficult to find except during their breeding seasons a more intensive search of suitable areas at the proper time should reveal them. It is also within the known range of *Acris crepitans*, but as this is a noisy little frog with an easily recognized call and a long breeding season the authors feel safe in stating that it probably does not occur in Marion county.

After the discussion of each species a list is given of the localities where it has been collected and from which one or more specimens have been deposited in the collection of the Carnegie Museum at Pittsburgh or in the collection of the West Virginia Biological Survey at Morgantown.

Necturus maculosus maculosus (Rafinesque). Mud Puppy

Known to occur in Buffalo Creek, where it is fairly common and is often taken with hook and line.

(Buffalo Creek near Farmington)

Cryptobranchus alleganiensis (Daudin). Water Dog, Hellbender

Known from one specimen in the teaching collection of the biology department at Fairmont State Teachers College, from the Tygart River at Benton's Ferry. This specimen has a total length of 17 inches.

Ambystoma maculatum (Shaw). Spotted Salamander

The distribution of this form in Marion county is known largely from the occurrence of the egg masses which are common in ponds throughout the county. Only two specimens have been collected.

(Metz, Rachel)

Triturus viridescens viridescens Rafinesque. Common Newt

Common in ponds throughout the county. The land form is common although not abundant. The breeding season is apparently all of the warmer months as eggs, larvae, and adults may be found in the ponds all summer and early spring.

(Plum Run, Rachel reservoir)

Gyrinophilus porphyriticus porphyriticus (Green). Purple Salamander

Common in cold springs and small streams. The adults are more easily found in early spring but the larvae are common all summer.

(Mode Run, Katy, Farmington)

Pseudotriton ruber ruber (Sonnini). Red Salamander

Not abundant, usually found under logs and trash in wet places.

(Glady Creek, and "Marion county")

Eurycea bislineata bislineata (Green). Two-lined Salamander

Common throughout the county, under rocks near streams and in wet ravines. One mass of eggs collected May 12, 1936, have embryos with limb buds. Another mass taken May 1, 1938, was hatching when collected.

(Farmington, Buffalo Creek, Glady Creek, Burnt Cabin Run, Winfield, Ices Run, Dunkard Mill Run)

Eurycea longicauda (Green). Long-tailed Salamander

Generally distributed throughout the county although not as common as *E. b. bislineata.*

(Mode Run, Winfield)

Plethodon cinereus (Green). Red-backed Salamander

Common in wooded areas, especially so in cut-over areas where fallen logs, bark, and other debris abound on the ground. While both the red and the lead-colored phase are found, the red phase is the more common. It has been observed that in certain localities the dark phase is more abundant than in others although at present no explanation of this can be offered.

(Fairmont, Farmington, Ida May, Glady Creek, Hammond, Curtisville)

Plethodon glutinosus (Green). Slimy Salamander

Common throughout the county under logs and stones. This form has a great variety of habitats ranging from damp ravines to dry open hillsides. Some of the specimens are peculiar in having a distinct band of large dirty-white spots on the side extending from the side of the head to the base of the tail.

(Mode Run, Sapp Run, Glady Creek, Hammond, Winfield, Fairmont, Curtisville)

Plethodon wehrlei Fowler and Dunn. Wehrle's Salamander

Known to occur in this county from one specimen in the collection of the Carnegie Museum, Pittsburgh, this specimen, CM 6081, is labeled, "W. Va., Marion Co., Oct. 1932, collected by N. D. Richmond" (Netting, 1937). The exact locality where this specimen was taken is not known and all efforts to relocate the species in Marion county have been unsuccessful.

Aneides aeneus (Cope and Packard). Green Salamander

Apparently this form is limited in Marion county to the region around Valley Falls as it has not been found except in the rocks at the falls and in the lower ends of Glady Creek and Burnt Cabin Run, which enters the Tygart River just below the falls. It is always taken in crevices of large rocks and cliffs although on cloudy, rainy days it may be found out on the face of the rocks. The rock of that region is largely a conglomerate of the Pottsville series.

(Glady Creek, Burnt Cabin Run)

Desmognathus fuscus fuscus (Rafinesque). Dusky Salamander

This is the most abundant and most generally distributed salamander in the county. It may be found in almost every wet ravine and small stream, usually in abundance. It is one of the few salamanders that may be collected throughout the winter in this area.

(Fairmont, Chesapeake, Farmington, Buffalo Creek, Mill Fall Run, Winfield, Curtisville)

Desmognathus fuscus ochrophaeus Cope. Mountain Salamander

Generally distributed and abundant throughout the county in damp woods and ravines.

(Sapp Run, Chesapeake, Hammond, Winfield, Fairmont, Glady Creek)

Desmognathus phoca (Matthes). Seal Salamander

Common in small streams and wet ravines although not as abundant as the other two species of *Desmognathus*.

(Farmington, Buffalo Creek, Hammond, Winfield, Curtisville)

Bufo americanus americanus, Holbrook. American Toad

Common all over the county. Usually starts calling about the last week in March, and breeds in swamps, ponds, ditches, and margins of streams.

("Marion County," Farmington)

Bufo woodhousii fowleri Hinkley. Fowler's Toad

Generally distributed over the county and during its breeding season appears to be abundant. It has been observed breeding in the Tygart River at Valley Falls and in a small, spring-fed pond at Farmington.

(Valley Falls, Glady Creek)

Pseudacris brachyphona (Cope). Mountain Swamp Tree Frog

Common all over the county. They have been observed breeding in small swamps but are even more common in roadside ditches; none has been seen or heard in large ponds or streams. In 1938 they were first heard calling on March 19 in a small marsh near Farmington. At this time only males were seen. A week later males, females, and eggs were found there. The eggs were newly laid and attached to floating and submerged stems of grass. On April 20 they were heard calling in a ditch near Glady Creek. In this ditch, about ten ft. long and one to two ft. wide, eight males were counted. No females were seen, although four newly-laid masses of eggs were found. The eggs were all attached to submerged leaves. Considerable variation was noticed in the size of calling males. Of the eleven calling males taken, the largest has a total length of 32 mm. and the smallest, 24 mm. It was also noticed that where these frogs were calling in company with *Bufo a. americanus* and *Hyla crucifer*, their calls were easily overlooked.

(Farmington, Katy, Hammond, Guyses Run, Glady Creek, Curtisville)

Hyla crucifer Wied. Spring Peeper

Abundant all over the county. In the spring they may be heard in almost every suitable breeding place, even in swampy spots in towns. In 1938 they were first heard calling on February 12, although the height of the chorus was not reached until late March and April. In May they have been observed calling from bushes in the vicinity of the breeding areas, sometimes three or four ft. from the ground.

(Fairmont, Guyses Run, Glady Creek)

Hyla versicolor versicolor LeConte. Tree Frog

Generally distributed over the county although not often collected. In the summer of 1933 they were observed to be abundant around the artificial pool at Mannington.

(Farmington).

Rana catesbeiana Shaw. Bull Frog

Common along streams throughout the county although it is not abundant.

Rana clamitans Latreille. Green Frog

Common along streams throughout the county. This species and *R. palustris* are the most abundant of the large frogs.

(Colfax, Winfield, Farmington, Glady Creek)

Rana palustris LeConte. Pickerel Frog

Common along streams and in wet meadows throughout the county. On April 30, 1938, they were first heard calling along Buffalo Creek, where the males were sitting on trash in shallow water.

(Farmington)

Rana pipiens Schreber. Leopard Frog

Not common, the only records of it being seven specimens from three localities. While these have been classified as *R. pipiens* they are not typical, the most conspicuous difference being the greater number and smaller size of the spots on the back and sides. They have 25-30 small round spots arranged

in three to four rows on the back and three to four rows of small spots on the sides below the dorso-lateral folds. A small irregular white spot in the center of the tympanum is present in most of the specimens. The dorsal spots range in size from 1-4 mm. in diameter, with most of them being 3 mm. In some of the specimens the bars on the legs are small, there being instead numerous small spots and reticulations. The largest specimen, a male, has a head-body length of 70 mm., the largest female examined has a head-body length of 58 mm. In body shape and proportions they agreee with *R. pipiens*. Four of these are now in the collection of the Carnegie Museum at Pittsburgh.

(Colfax, CM12, 754-12, 758; Glady Creek; Rachel; the three specimens from the last two localities have not been catalogued at this time.)

Rana sylvatica LeConte. Wood Frog

Generally distributed over the county. It has been observed breeding in ponds along Koon's Run, Prickett's Creek, and Ices Run. Outside of its breeding season it is seldom met.

(Koon's Run, Rachel)

BIBLIOGRAPHY

Netting, M. Graham. 1937. Wehrle's Salamander, *Plethodon wehrlei* Fowler & Dunn, in West Virginia. Proc. W. Va. Acad. Sci. 10:91.

GIANT CELLS

FRITZ LEVY

The Golden Clinic, Davis Memorial Hospital, Elkins

THE AUTHOR'S experimental work in traumatic parthenogenesis of frogs and his findings of different chromosome numbers in the developing tadpoles led him to a comparative study of the pathology of cell-division in many tissues of 112 animals and man.

Besides pure hypertrophies the outcome of two processes are called "giant cells." Since it has been shown that they arise by abnormal development, it is out of the way to attribute to them special functions not performed by other cells. On the contrary if they have any function, it is only the same function or the rest of this function of the original cell.

Multinuclear symplasmes are found when the cytoplasma is liquified so that cells with unchanged nuclei are fused. There are rather similar multinuclear areas characteristic for certain abnormal tissues, as tuberculosis, syphilitic gumma, foreign body-giant cells, and some tumors as epulis, giant cell-tumors of bones, sarcomas, etc. These multinuclear formations may be a help toward diagnosis but not toward prognosis, since the malignancy of the growth depends upon the aggressiveness of the active cells and not upon the inactivated areas of confused cells. When these "giant-cells" have any particular function they do not have this function as "giant-cells" but as areas of confused cells with this peculiar function.

The pathology of cell-division reveals how heteroploid cells arise. Since the processes dividing nucleus and cytoplasma are more or less independent, and running more or less concurrently, in some cells the synchronization fails. This failure may be the premature or postponed split of a chromosome, the so-called heterokinesis (changed movement). When such a chromosome comes too late into the telophasis it may not be included in its regular nucleus. Consequently this nuclear division results in two different nuclei, the first of which with N (normal) -1 chromosomes, the other one with N + 1 chromosomes. Bridges found the non-disjunction of x-chromosomes in *Drosophila melanogaster* explaining the origin of exceptional males and females. If a group of chromosomes goes its own way, it may be found as a separate nucleus, the term being "caryomerie." Following Boveri we speak of a monaster if the centrosomes are not separated, so that the spindle is very defective. The sequel is that instead of two nuclei with N chromosomes, one nucleus with 2 N chromosomes originates. Such a bivalent nucleus also results from the fusion of two univalent nuclei. The author described such fusion in the explantate of the frog's testicle in cell-culture, explaining that the feature often called "amitosis" is a misconception, not a

division of nuclei but a fusion. (Other investigators placed the transitional pictures of this process in the proper order, but turned, so to speak, the movie film in the wrong direction). That the so-called segmentation of the nucleus in the leucocytes is neither a nucleus division nor a kind of amitosis, but only an augmentation of nuclear surface, was reported by the late Susanna Levy.

Finally all nuclei in these bivalent or plurivalent cells are exactly of the same age and undergo the next process of division at exactly the same time. In bivalent cells, we can find an apparently normal, bipolar giant-mitosis, or a giant-monaster, or tripolar or four-polar mitotic figures. The more plurivalent the cells are, the more complicated are the pluripolar figures.

The author demonstrated findings of the same process he found in heteromorphic cells in testicles of frogs and recently in man, in the bone-marrow resulting in the basket- or crown-shaped nuclei of the cells Howell called "megakaryocytes", in the "giant-cells" characteristic for "Hodgkins disease", known under the name of "Sternberg's or Dorothy Reed cell", and in some rapidly-growing carcinomas.

From the routine work of the pathologist it may be concluded: that the finding of plurivalent cells with one giant nucleus, or two or more nuclei or pluripolar mitosis, indicates that there were disturbed mitoses. The more mitoses going on, the more abnormal ones will be found among them, or, vice versa, the more results of abnormal mitoses we find, the more mitoses were going on.

Therefore we can say the examined tissues show a high rate of cell-division. This means a rapid growth which is *only one* factor of malignancy. The other one is the destroying power which is estimated by the vigor of infiltration into other tissues and destroying them.

In 1921, on the basis of his experiments and tissue examination, the author formulated for further study the hypothesis of *"tissue mutation"* for tissues developing from cells with abnormal contents of hereditary mass. The mutation arising in a differentiated tissue belongs to the larger group described by Morgan and his collaborators under the term "somatic mutation", meaning changes in the hereditary mass outside the germ cells, which cause "somatic mosaics".

The author emphasizes again that we are rather far from a solution of the cancer problem but is of the opinion that study of physiology and pathology of cell-division will elucidate a great many of the factors in this important complex of questions.

(The photomicrographs demonstrated at the meeting of the Academy were a selection of a larger series which will be published in several detailed papers.)

LITERATURE CITED

(1) Breitenbecher, J. K. 1922. Somatic mutations and elytral mosaics of *Bruchus*. Biol. Bull. V. *XLIII*: 10-22.

(2) Bridges, C. B. 1919. The developmental stages at which mutations occur in the germ tract. Proc. Exp. Biol. and Med. *XVII*: 1-2.

(3) ——— 1921. Triploid intersexes in *Drosophila melanogaster*. Science n. s., vol. LIV, no. *1394:* 252-254.

(4) Levy, Fritz. 1920. Die Kernverhaeltnisse bei parthenogenetischen Froeschen. Ein Beitrag zur Physiologie und Pathologie der Zelle. Sitzungsber. d. Preuss. Akademie d. Wissenschaften *XXIV:* 417-424.

(5) ——— 1921. Zur Frage der Entstehung maligner Tumoren und anderer Gewebsmissbildungen. Berliner Klin. Wochenschrift *34:* 989.

(6) ——— 1923. Untersuchungen ueber abweichende Kern- und Zellteilungsvorgaenge. I. Ueber heteromorphe Zellen im Hoden von Amphibien. Zeitschr. f. Anat. und Entwicklungsgesch *LXVIII:* 110-176.

(7) Levy, Susanna. 1921. Die Lochkerne in der lymphatischen Randschicht der Tritonleber. Arch. f. mikroskop. Anatomie, Bd. 54.

(8) Morgan, T. H., and Bridges, C. B. 1919. The origin of gynandromorphs. Carnegie Inst. Wash. pub. no. *278:* 1-122.

LACK OF GUANIDINEMIC OR OTHER TOXIC RESPONSES TO INGESTION OF WEST VIRGINIA *Eupatorium urticaefolium**

JEROME E. ANDES and G. A. EMERSON

Departments of Pathology and Pharmacology, West Virginia University

"MILK-SICKNESS" was once a common disease in some of the Middle Atlantic States and occurred in frequent epidemics among the early settlers. Garrison *(1)* notes early descriptions of the condition by Thomas Barbee (1809), Alexander Telford and Arthur Stewart (1812), and Daniel Drake (1841). Cutler *(2)* quotes the description of a typical epidemic in the biography of Lincoln by Nicolay and Hay; Lincoln's mother died of milk-sickness. The disease, rare today, is reported occasionally from certain localities.

A similar disease sometimes occurs in calves fed milk of cows which are not confined to pastures. Both the human and bovine types are more frequent in the fall months. These facts led to the suggestion that the disease was caused by drinking milk of affected cows. Jordan and Harris *(3)* isolated an organism, *Bacillus lacti morbi*, from the excreta of milk-sick animals, which they held responsible for causing milk-sickness. Unfortunately, it was not found possible to fulfill Koch's postulates with this organism. Recent investigators *(2, 4-7)* hold that the cause of milk-sickness is simple transmission, through the milk, of the toxic principle of white snake-root (richweed, *Eupatorium urticaefolium*) after leaves of this herb have been eaten by the cow.

Symptoms of milk-sickness include lassitude, vomiting, dyspnea, delirium, convulsions, and coma. In animals, the convulsions predominate, so that the disease is commonly known as the "trembles". Blood chemical changes which are described in the literature are acidosis, ketosis, hypoglycemia, retention of nitrogen, and hyperguanidinemia.

Special interest in the disease lies in the amazingly high guanidine content of the blood reported *(2)* after snake-root poisoning. Unusually high amounts of guanidine-like substances in the blood have been reported after intoxication with agents which damage the liver or kidneys, or cause convulsions; but none of these intoxications increases the guanidine content to the extent reported by Cutler *(2)* for snake-root poisoning. This condition therefore offered a crucial test for theories discussed in previous papers *(8)*, and a complete chemical and pathological examination was proposed.

Blood chemical studies were made on 4 female rabbits. Since approximately 15 ml. of blood must be drawn to permit all analyses, the rabbits were allowed to recover for several days before proceeding with experimental treatment. Small amounts of ferric chloride were added to their drinking water during this time.

---

* Sixth communication of a study of the pharmacological actions of crude drugs of the David Crude Drug Collection, West Virginia University.

Two rabbits were then fed the leaves and stems of snake root as their sole food, for 2 weeks. The other 2 were fed snake-root and alfalfa in equal quantities for a week. In both cases the snake-root was well tolerated; the rabbits ate well and there were no marked losses of weight. Blood chemical studies again were made directly after the period of feeding snake root.

No significant effects were noted on blood content of guanidine or other nitrogenous constituents, nor on the non-nitrogenous substances. Average values for 4 control determinations and for the 4 determinations after treatment were, respectively: guanidine, 0.59 and 0.62 mgm. per 100 ml. of blood; urea nitrogen, 13.8 and 16.3 mgm. per 100 ml.; glucose, 114 and 112 mgm. per 100 ml.; bilirubin, 0.21 and 0.15 mgm. per 100 ml.; icteric index, 3 and 2; carbon dioxide capacity, 55 and 47 volumes percent; and hemoglobin, 10.5 and 11.4 Gm. per 100 ml. of blood. Since there was no chemical evidence of liver or kidney damage and the rabbits appeared to be in good condition, no histological study of the organs was made.

The snake-root used consisted of 2 lots of the aerial portions of the herb furnished by the Department of Botany, West Virginia University, through the courtesy of Professors P. D. Strausbaugh and E. L. Core. The first lot was fed to the first 2 rabbits, and the second lot, collected about a month later, to the remaining 2 rabbits. Since drastic dessication is reported to decrease the toxicity, both samples were simply air-dried, without heating, before use. Both lots were collected in the fall, at the time of supposed highest toxicity; but petroleum ether extracts of neither lot gave positive chemical tests *(4)* for tremetol, the active principle.

Cutler *(2)* notes that snake-root collected around Nashville, Tenn., is also inactive, and a personal communication from Professor B. H. Robbins of the Department of Pharmacology, Vanderbilt University, confirms this. Apparently there is much variation in the toxicity of the herb. We have not yet been able to obtain samples of snake-root from localities where milk-sickness is known to occur.

SUMMARY

Continued feeding of leaves and stems of white snake-root, *Eupatorium urticaefolium*, did not cause "trembles" or milk-sickness in any of 4 rabbits, nor did it give rise to any significant changes in the blood content of guanidine, urea, glucose, vilirubin, or hemoglobin, or in the carbon dioxide capacity or icteric index. The white snake-root used was collected near Morgantown and was identified by the Department of Botany, West Virginia University. The present work confirms the reported marked variation in toxicity of the herb and suggests that the absence of endemic milk-sickness in West Virginia is due not to lack of widespread occurrence of the herb, but to the low toxicity of white snake-root growing in this State.

LITERATURE CITED

(1) Garrison, Fielding H.: *An introduction to the history of medicine.* Pp. 996. Philadelphia, 1929.

(2) Cutler, Jessie T. 1934. *J. Tenn. Acad. Sci. 9:* 1.

(3) Jordan, E. O. and N. M. Harris. 1909. *J. Infect Dis. 6:* 401.

(4) Couch, J. F. 1927. *J. Agr. Research 35:* 547.

(5) Bulger, H. A., F. M. Smith, and A. Steinmeyer. 1928. *J. Am. Med. Assoc. 91:* 1965.

(6) Walsch, W. E. 1930. *Ill. Med. J. 58:* 454.

(7) Mosely, E. L. 1917. *Med. Rec. 92:* 428.

(8) Andes, Jerome E., *et alii:* 1937, *J. Lab. Clin. Med., 22:* 1147, 1209; *23:* 9, 123; 1938, *Arch. Internat. de Pharmacodyn. et Therapie, 58:* 165.

THREE NEW MAMMAL RECORDS FROM THE NORTHERN PANHANDLE OF WEST VIRGINIA

KARL HALLER

Student, Bethany College, Bethany

Nycteris borealis borealis (Müller)
Red Bat

THUS FAR, specimens of the red bat taken in West Virginia are all from the eastern and southern counties. Apparently there are no records up to the present time from the Eastern Panhandle. A female of this species was taken at my home in Ohio county, about five miles north of Oglebay Park, on August 5, 1937. About a dozen bats were seen to fly from the barn and eight of them were collected. One of these was a red bat, the others were big brown bats, *Eptesicus fuscus fuscus*. Four of the brown bats, together with the red bat, were preserved as skins. Additional collecting of bats will probably lead to new forms for the Northern Panhandle area.

Synaptomys cooperi stonei Rhoads
Stone Mouse Lemming

Collecting of small mammals at Bethany, Brooke county, was begun during the second week of February and continued until the end of the second week of April 1938. Located on college property, north-northeast of Pendleton Heights, is a hill known as Reservoir Hill, which has been planted for a period of six years with larch, white pine, red pine, and Norway spruce. The ground is covered with matted grass and broom sedge, and here and there are a few scattered fruit trees. Haw apples and bramble thickets cover the southwestern slope of this hill. Under the mats of grass and beneath some of the pines were found many runways of small mice. Traps baited with singed bacon, peanut butter, apple, raisins, or rolled oats were set in these runways and resulted in the collecting of five Stone mouse lemmings, *Synaptomys cooperi stonei;* one meadow mouse, *Microtus pennsylvanicus pennsylvanicus;* one long-tailed shrew, *Sorex* ssp.; and many short-tailed shrews, *Blarina* ssp. Of the five mouse lemmings taken four were males, the first of which was taken on March 31, 1938.

Pitymys pinetorum scalopsoides (Audubon and Bachman)
Mole Pine Mouse

Three specimens of the mole pine mouse have been taken at Bethany. One, a male, was trapped on March 18, 1938, in the Parkinson woods behind the college. The trap was baited with bacon and set in a runway under a small, rotten log. It was interesting to note that for seven consecutive days short-tailed shrews, *Blarina* ssp., were caught in this particular trap, then one day elapsed and

the pine mouse was taken. The set trap remained in the runway for three more days but nothing else was trapped. It was necessary in many cases to trap out completely first the short-tailed shrews so that good specimens could be trapped. As the short-tailed shrews are carnivorous and very numerous, they completely or partially ate desirable specimens or were trapped first. Two other specimens of this species, a male and female, were collected on May 2, 1938, about a mile northeast of Bethany under a thick mat of leaves.

It is planned to continue the program for the study of mammals in the Northern Panhandle during the coming summer and year. It is hoped to extend the study into new regions other than the one around Bethany.

Some Alkoxy-Ethyl and Alkoxy-Ethoxy-Ethyl Esters of Salicylic Acid

HUGO R. McGRAW*, A. R. COLLETT, and C. L. LAZZELL

Department of Chemistry, West Virginia University

SINCE THE APPEARANCE of the mono- and di-ethylene glycol monoalkyl ethers on the market, various esters have been prepared from them. The glycol ethers possess the structure of an alcohol as well as that of an ether, and they are valuable as solvents and plasticizers[1]. The low vapor pressures that are a characteristic property of the glycol ethers are exhibited to a greater extent in their esters; thus the esters are much slower to evaporate than the slow-drying glycol ethers.

A search through the literature revealed no mention of the salicylic acid esters of the glycol ethers. The therapeutical value of the liquid esters of salicylic acid as analgesics and antipyretics has long been recognized. Of these the methyl ester, oil of wintergreen, is probably the best known, while those of more recent origin include glycol monosalicylate, methoxy-methyl salicylate, and the alkoxy-ethylidene salicylates. In view of these facts it was thought that the alkoxy-ethyl and alkoxy-ethoxy-ethyl esters of salicylic acid might be of value by virtue of their low vapor pressures as well as of the effect of ether-linkages.

METHOD OF PREPARATION

Since salicylic acid is plentiful and several of the mono- and diethylene glycol monoalkyl ethers are commercially available, direct esterfication appeared to be the most convenient method of preparation. The preparation was carried out according to the method of Fieser[2] for the preparation of esters of aromatic acids.

The commercial glycol ether was first distilled and that part distilling within two degrees of the boiling point was used for the reaction. In the ratio of 0.2 mols salicylic acid to 1.75 mols glycol ether, these materials were refluxed together, in the presence of sulfuric acid as a catalyst, for about five hours. The results obtained when the reaction was continued for a greater length of time showed that a longer period of reflux was unnecessary. The reaction mixture was washed with water and the ester extracted in ether. The ethereal solution was then treated with a dilute solution (10%) of sodium carbonate to remove any sulfuric acid that might remain after the first washing. After all traces of salts so formed were washed from the ethereal solution, it was dried over anhydrous sodium sulfate for about twelve hours.

* Condensed from a thesis submitted in partial fulfillment of the requirements for the degree of Master of Science to the Faculty of the Graduate School of West Virginia University, by Hugo R. McGraw, 1936.

The dried ethereal solution was then filtered through glass wool into a Claissen flask and, after removal of the ether by distillation on a steam bath, a rough separation of fractions was obtained by distillation at a pressure of two or three millimeters. The low boiling fraction that first came over, consisting mainly of unreacted glycol ether, was discarded, and the remaining fractions containing the ester were fractionated through columns of various lengths, depending upon the boiling point and viscosity of the ester, until the refractive indices of the different fractions showed that a pure product had been obtained. It was impossible to determine this by a constant boiling point since at such very low pressures a very slight change in pressure causes a considerable change in temperature.

The compounds prepared were analyzed for their carbon and hydrogen content by the combustion method. The results of the analyses are given in Table 1. Several physical properties of these new compounds were determined and these are presented in Table 2.

TABLE 1

	% Carbon			% Hydrogen		
	calc.	found		calc.	found	
Methoxy-ethyl salicylate	61.19	61.11	61.35	6.168	6.190	6.307
Ethoxy-ethyl salicylate	62.85	62.73	62.77	6.679	6.640	6.830
Butoxy-ethyl salicylate	65.51	65.61	65.88	7.619	7.450	
Ethoxy-ethoxy-ethyl salicylate	61.38	60.93	61.84	7.139	7.148	7.381
Butoxy-ethoxy-ethyl salicylate	63.79	63.88	63.99	7.860	7.905	

TABLE 2

	Molecular Weight (grams)	Boiling Point °C	Press. (mm. Hg)	D^{25} abs.	$n^{25}D$	Molecular Refraction (calc.)	Molecular Refraction (found)
Methoxy-ethyl salicylate	196.1	147.5± .3	6.0	1.1602	1.5198	49.755	51.365
Ethoxy-ethyl salicylate	210.03	157.2± .3	7.3	1.1236	1.5116	54.358	56.053
Butoxy-ethyl salicylate	238.14	176—177	6.6	1.0768	1.5015	63.564	65.210
Ethoxy-ethoxy-ethyl salicylate	254.14	173—174	4.5	1.1978	1.5304	65.247	65.580
Butoxy-ethoxy-ethyl salicylate	282.18	187.0± .5	3.0	1.0543	1.4861	74.453	76.857

DISCUSSION

The alkoxy-ethyl and alkoxy-ethoxy-ethyl salicylates were prepared with the thought that they might be of therapeutical value. In order to be of value in this respect, Fourneau[3] states that the

ester "should pass readily through the skin, be non-irritant, and have an odor neither disagreeable nor too persistent." Since the boiling points of these esters are very high, evaporation from the surface of application would be very slow, thus allowing the ester ample time to penetrate the skin. In the work of preparation, no irritating effects were noticed even when the parts of the hands on which some of the material had been spilled were massaged briskly. Methoxy-ethyl salicylate has an odor very similar to that of oil of wintergreen and, while the ethoxy-ethyl ester has the same odor, it is much less pronounced. The butoxy-ethyl and the two alkoxy-ethoxy-ethyl esters have distinct odors yet none has as pronounced an odor as that of oil of wintergreen, nor are they as disagreeable.

Tests are now being conducted at the West Virginia Medical School to determine the therapeutical value of the esters reported in this paper.

SUMMARY

1. The alkoxy-ethyl and alkoxy-ethoxy-ethyl salicylates, which have not been reported previously in the literature, have been prepared by the direct esterification of salicylic acid and the mono- and di-ethylene glycol monoalkyl ethers. The following esters have been prepared:

(1) Methoxy-ethyl salicylate
(2) Ethoxy-ethyl salicylate
(3) Butoxy-ethyl salicylate
(4) Ethoxy-ethoxy-ethyl salicylate
(5) Butoxy-ethyl salicylate

2. A few of the physical properties of these compounds have been observed.

3. It has been proposed that these esters may be of value as therapeutical products. An investigation concerning this value is now being conducted.

---

[1] Reid and Hoffman. 1928. J. Ind. Eng. Chem. 20, 497.
[2] Fieser. 1935. Experiments in Org. Chemistry, D. C. Heath and Company, p. 63.
[3] Fourneau. 1925. Organic Medicaments, P. Blakiston's Son & Co., Philadelphia, pp. 31-32.

GROWTH SUBSTANCES FOR FUNGI: II. CRITICAL SURVEY OF LITERATURE 1936-37*

VIRGIL GREENE LILLY

Department of Plant Pathology, West Virginia University

MANY IMPORTANT investigations of the effects of "growth substances" during the past two years have increased our knowledge of the nutritional requirements of fungi. Leonian and Lilly *(8)* have proposed the general term "auxithals" to replace the phrase "growth-promoting substances." Many fungi produce all the auxithals they require for growth on synthetic media, while others cannot. Still others grow readily on synthetic media but are greatly stimulated by the addition of certain auxithals.

The investigation of auxithals is but a phase of the larger study of the nutrition of fungi. It cannot be emphasized too strongly that auxithals will not promote growth of fungi unless all the necessary food-stuffs and minerals are present in the medium in proper concentration. Caution is necessary in comparing the results of different investigators unless *all* the conditions are the same. The composition of the media in some cases is as important as the auxithals added. Leonian and Lilly *(9)* showed that thiamin was effective in promoting growth of certain fungi only when nitrogen was supplied in the form of amino acids, rather than as ammonium nitrate. The amino acids *per se* did not permit growth. That the effect of the amino acids was due to some auxithal (impurity) is rendered less likely, because some synthetic amino acids were effective when used with thiamin, and not with ammonium nitrate. It was the *combination* (amino acids plus thiamin) that induced growth.

Auxithals may be classified as (a) isolated and of known structure, (b) isolated and of partially known constitution, and (c) not yet isolated and of unknown constitution. In the opinion of the writer the third class is the largest. Certainly it is the most difficult to discuss and the most important to investigate. A better understanding of this class of auxithals depends on the isolation, identification, and synthese of these factors. However, progress in this field will be slow.

VITAMIN B_1 AND ITS CONSTITUENTS AS AUXITHALS

The action of Vitamin B_1 (thiamin, aneurine) on the growth of fungi has been studied extensively. Some fungi, so far as is now known, require thiamin; others can use the pyrimidine or the thiazole moiety; others require thiamin or both of its constituents. The growth of still other fungi is inhibited by thiamin (Rhizopus). Some fungi synthesize thiamin when grown on a synthetic medium. At least, such a medium supports growth of thiamin requiring

* Published with the approval of the Director of the West Virginia Agricultural Experiment Station as Scientific Paper No. 215.

organisms. The possibility is by no means excluded that other compounds may replace thiamin. Until crystalline thiamin is isolated from such fungi, the question must remain open. The fungi that grow upon the addition of either the pyrimidine or thiazole moiety are apparently able to synthesize the other half of the thiamin molecule, and finally the thiamin itself for such a mycelium when ground, extracted with water, and added to the medium permits the growth of Vitamin B_1 requiring fungi *(9)*.

Comparatively few fungi must secure their thiamin *per se* from extraneous sources, as many of them will grow equally well when supplied with either the pyrimidine or thiazole moiety, or both. Robbins *(15)* found *Phytophthora cinnamomi* and *Phytophthora capsici* required thiamin in order to grow on a synthetic medium. Leonian and Lilly *(9)* found that *Phytophthora erythroseptica, Pythium polymastum,* and *Pythiomorpha oryzae* required thiamin; no growth resulted from the use of the pyrimidine or thiazole moiety, or both together.

As soon as the constitution of Vitamin B_1 was established and methods of synthesis perfected, attention was directed to testing the effect of the intermediates on the growth of fungi. This development makes possible the study of the relation between chemical constitution and activity.

Schopfer *(19)* tested 4-methyl-5-B-hydroxyethyl thiazole on *Rhodotorula rubra* and *R. flava;* this compound was only slightly active for the first yeast. Both yeasts made excellent growth with aneurine or a suitable pyrimidine. 2-methyl-4(6)-amino-5-aminomethyl pyrimidine or 2-methyl-4(6)-thioformylaminomethyl pyrimidine were as effective as aneurine in equivalent amounts. 2, 5-dimethyl-4(6)-amino pyrimidine was only slightly effective, thiochrome was inactive. Schopfer *(20)* found 4-methyl-5-B-hydroxyethyl thiazole to be without effect on *Absidia ramosa* and *Parasitella simplex*, while 2-methyl-4(6)-amino-5-aminomethyl pyrimidine was as effective as aneurine. Muller and Schopfer *(11)* found *Mucor ramannianus* Moll to respond to 4-methyl-5-B-hydroxyethyl thiazole, but not to the pyrimidine tested. They found 4-methyl thiazole, 4, 5-dimethyl thiazole, or 2-mercapto-4-methyl thiazole to be inactive for *Mucor ramannianus*. They used a medium containing a large amount of dextrose and asparagine.

Phycomyces blakesleeanus was proposed by Schopfer some years ago as a test organism for the assay of Vitamin B_1. Schopfer and Jung *(21)* found recently (1937) that aneurine could be replaced by its pyrimidine and thiazole moieties for this fungus. This has been confirmed by Robbins *(15)* and by work in this laboratory. The most extensive studies of the effect of various thiazoles and pyrimidines upon this fungus are those of Robbins and Kavanagh *(16, 17)*. They tested 36 pyrimidines and 15 thiazoles on *P. blakesleeanus;* they drew the following conclusions: To be active for *P. blakesleeanus* a pyrimidine must have an amino group in position 6,

and a mono-substituted methyl group in position 5. The substituent in position 5 may be: $-CH_2Br$, $-CH_2OEt$, or CH_2NH_2. Leonian and Lilly *(9)* showed that the $-CH_2OH$ group was also active. For a thiazole to be active, position 2 must be unsubstituted, position 5 must be substituted with a B-hydroxyethyl group. For greatest activity the hydroxyl group must be free. Replacement of the hydroxyl by the ethoxyl group or by chlorine decreased the activity. It must be remembered that not all possible substituted thiazoles have been tested. Further work with *other* organisms will no doubt show that specificity varies with the fungus.

Robbins and Kavanagh *(18)* tested the response of a number of fungi to synthetic Vitamin B_1, to 2-methyl-5-bromomethyl-6-amino pyrimidine and 4-methyl-5-B-hydroxyethyl thiazole. They are of the opinion that organisms that grow well on the addition of pyrimidine are able to synthesize the thiazole moiety and complete the synthesis of thiamin. *Pythium butleri* makes little or no growth on the thiazole moiety alone, but grows as well on pyrimidine alone as on the two together. The medium in which *Pythium butleri* had grown (addition of pyrimidine alone) was sterilized. *Phycomyces blakesleeanus* then grew very well in the above medium. Schopfer *(21)* has made a very extensive study of the nutrition of *Phycomyces blakesleeanus* as affected by thiamin. He found that the yield of dry mycelium depended upon the amount of nitrogen (asparagine) in the medium and the amount of thiamin added. The greater the quantity of nitrogen the greater was the amount of Vitamin B_1 necessary to produce the maximum crop. The amount of nitrogen remaining constant, no increase of mycelium was noted when thiamin was added in concentrations higher than the optimum. The production of 1 milligram of dry mycelium requires about 0.0005 gamma of thamin. In the above experiments dextrose was present in excess.

The mycelium of *Phycomyces blakesleeanus* grown upon a medium containing Vitamin B_1 proved inactive as a supplement when fed to rats. Schopfer and Jung *(22)* found that rats lost weight rapidly and died when a Vitamin B_1-free diet was supplemented by mycelium. The effect was not due to toxicity, for when mycelium and Peters concentrate were fed, gain in weight was normal. They conclude that Vitamin B_1 as such is destroyed by the fungus in the process of growth.

Leonian and Lilly *(9)* grew *Blakeslea trispora* and *Pythiomorphia gonapodioides* in media containing 2-methyl-5-ethoxymethyl-6-amino pyrimidine. After ten days the mycelium was filtered and well washed with distilled water. The mycelium was then ground in a mortar, and the filtered infusion was added to a synthetic medium. Inoculations of *Phytophthora erythroseptica, Pythium polymastum,* and *Pythiomorpha oryzae* (none of which grows on the intermediates of thiamin) grew very well. It appears that *Blakeslea trispora* and *Pythiomorphia gonapodioides* synthesize thiamin, or some other compound or compounds which replace it

for these test fungi. *Cunninghamella blakesleeana* grown in a medium with ammonium nitrate was able to synthesize thiamin as shown by the test fungi.

Schultz, Atkin, and Frey *(25, 26)* devised a quantitative test for thiamin based on increased fermentation (CO_2 production) by bakers yeast (Fleischmann's) in the presence of thiamin. For this yeast 4-methyl-5-B-hydroxyethyl thiazole is without effect; 2-methyl-5-ethoxymethyl-6-amino pyrimidine is about as effective as thiamin. Later Schultz, Atkin, and Frey *(27)* tested thiamin and its constituents on various other strains of yeast in the presence of various bioses. Their data are insufficient for much generalization. Schopfer and Jung *(23)* found that the Vitamn B_1 content of wheat-germ extracts could be assayed as accurately by *Phycomyces blakesleeanus* as by the rat test. In view of the fact that this fungus responds to the constituents of thiamin, it would be well to choose a fungus that responds only to Vitamin B_1 *per se*.

THE BIOS QUESTION

Growth substances for yeast have been studied since the time of Pasteur; Wildiers called this substance bios. It is known now that bios is complex; various "factors" are needed by various strains of yeast. Kogl *(4)* announced in 1935 the discovery of a new bios which Kogl and Tonnis *(5)* a year later isolated in crystaline form. This auxithal was named biotin. Isolation from yeast extract was abandoned because of difficulties in purification. From 250 kg. of dried duck egg yolk Kogl and Tonnis isolated 1.1 mg. of crystaline biotin. More than 98 percent of the material was lost during the long process of purification. To obtain 100 mg. would require 25 metric tons of dried egg yolk.

Biotin is active for "Rasse M" yeast in dilutions of $1:4 \times 10^{11}$. Kogl and Tonnis define the activity of their preparation in terms of yeast units (SE). One SE is the quantity of biotin which produces 100% increase in yield of Rasse M yeast in 5 hours under standard conditions. Crystaline biotin contains 25×10^9 SE/gm.

Kogl and Haagen-Smit *(6)* found many seeds to contain biotin. In rice the biotin is concentrated in the bran; rice bran contains 7,000 SE/gm., while the polished grain contained only 470 SE/gm. It will be recalled that Vitamin B_1 is also concentrated in rice polishings. Kogl and Haagen-Smit from tests on excised pea embryos concluded that the function of biotin is concerned with the growth of the embryo. They found that growth of the excised embryo was stimulated to a greater degree by a combination of thiamin and biotin than by biotin alone; still greater growth resulted when oestron was added to the two.

Kogl and Fries *(7)* investigated the content of biotin in dry mycelium of *Phycomyces blakesleeanus* and found 30,000 SE/gm. The fungus was grown upon a medium containing thiamin. Five-sixths of the biotin produced by the fungus in 12 days was found

in the medium. The dry mycelium of *Polyporus adustus* likewise contained 30,000 SE/gm., or 1.2 gamma of biotin.

Kogl and Fries *(7)* tested the effect of thiamin, biotin, and inactive inositol on the growth of a number of fungi. They confirmed the work of Schopfer that the only auxithal needed for the growth of *Phycomyces blakesleeanus* is aneurine. *Phytophthora cactorum* likewise requires Vitamin B_1. *Ashbya gossypii (Nematospora gossypii)* requires *three* auxithals for maximum growth on synthetic medium: thiamin, inositol, and biotin; it makes good growth however upon the addition of biotin and inositol. With optimum concentrations of aneurine and inositol, one part of biotin in 2,500,000,000 parts of medium induced maximum growth. *Lophodermium pinastri* likewise requires these three auxithals for maximum growth; good growth results with aneurine and biotin. No appreciable growth results when the three auxithals are used separately. The only auxithal required by *Hellvella infulva* and *Polyporus adustus* is Vitamin B_1. Aneurine is active in concentrations down to 1:250,000,000,000 for *Polyporus adustus*. At the time this work was done, the intermediates of thiamin were not available. So far as the writer knows these fungi have not been tested with the intermediates.

One fungus may synthesize an auxithal needed by another; Kogl and Fries *(7)* demonstrated this by growing together *Ashbya gossypii* and *Polyporus adustus*. Neither fungus is able to grow alone on synthetic media. *Ashbya gossypii* forms thiamin, which is needed by *Polyporus adustus;* the latter synthesizes biotin, which is needed by the first. Some time elapsed before the fungi started to grow, then both grew very well. Kogl and Fries term this type of mutual aid *"kunstliche Symbiose;"* in nature it is probably of great importance. Unfortunately it is not known whether *Polyporus adustus* requires thiamin *per se,* or whether the intermediates will suffice. Hence it is impossible to say at present if *Ashbya gossypii* produces thiamin or one or both of its intermediates.

Fardon, Norris, Loofbourow, and Sister M. V. Ruddy *(1)* of the Institutum Divi Thomae (Cincinnati) discovered when yeast cells are slowly killed by ultra-violet radiation, a substance is produced which exerts a proliferation effect on yeast. This growth substance seems to be elaborated during the slow injury and final death of the yeast cells during irradiation. This substance may be removed from the cells by dialysis or filtration through a Seitz bacterial filter. Not only yeast cells, but many animal cells as well, are induced to proliferate by this substance. For the details the reader is referred to the literature *(2, 3, 10, 12, 13, 14, 28)* for a full discussion.

AUXITHALS OF UNKNOWN CONSTITUTION

The list of natural products used in mycological media is long and ranges from malt extract to pea infusion. This use of a large number of natural products is not the result of caprice, but because these natural products contain the foodstuffs and auxithals required by certain fungi. They are satisfactory for their purpose, which is

to permit growing fungi *in vitro;* but little information is available as to the specific compounds responsible for growth.

Certain fungi require foodstuffs and auxithals drawn from a living host. And further to complicate the situation, various hosts are required by some parasites at different stages of development. Little or nothing is known about their requirements for food or auxithals.

BIBLIOGRAPHY

(1) Fardon, J. C., Norris, R. J., Loofbourow, J. R., and Ruddy, Sister M. V. 1937. Stimulating materials obtained from injured and killed cells. Nature *139:* 589.

(2) ———— Carroll, Sister M. J., and Ruddy, Sister M. V. 1937. The stimulation of yeast respiration by radiations. Studies Inst. Divi Thomae *1:* 17-40.

(3) ———— and Ruddy, Sister M. V. 1937. A respiratory stimulating factor. Ibid *1:* 41-52.

(4) Kogl, F. 1935. Ueber Wuchsstoffe der Auxin-und der Bios-Gruppe. Ber. *68,* A, 16-28.

(5) ———— and Tonnis, B. 1936. Ueber das Bios-Problem. Darstellung von krystallisierten Biotin aus Eigelb. Zeit. Physiol. Chem. *242:* 43-73.

(6) ———— and Haagen-Smit, A. J. 1936. Biotin und Aneurin als Phytohormone. Ibid *243:* 209-226.

(7) ———— and Fries, N. 1937. Ueber den Einfluss von Biotin, Aneurin und Meso-Inosit auf das Wachstum verschiedener Pilzarten. Ibid. *249:* 93-110.

(8) Leonian, L. H., and Lilly, V. G. 1937. Partial purification of a vitamin-like substance which stimulates sexual reproduction in certain fungi. Amer. Jour. Bot. *24:* 700-702.

(9) ————————. 1938. Studies on the nutrition of fungi. I. Thiamin, its constituents, and the source of nitrogen. Phytopathology 28, 531-548.

(10) Loofbourow, J. R., Norris, R. J., and Morgan, Sister M. N. 1937. Specificity of bios preparations for bacteria. Studies Inst. Divi Thomae *1:* 193-196.

(11) Muller, W., and Schopfer, Wm. M. 1937. L'action de l'aneurine et ses constituents sur *Mucor ramannianus* Moll. Comp. rend. *205:* 687-689.

(12) Norris, R. J., and Ruddy, Sister M. V. 1937. A study of growth, respiration and fermentation by bios-like substances. Studies Inst. Divi Thomae *1:* 53-64.

(13) ———— and Hart, Sister M. J. 1937. Biological assay of dialyzed fractions of bios. Ibid *1:* 65-78.

(14) ———— and Kreke, C. W. 1937. Three metabolic stimulating factors. Ibid *1:* 137-162.

(15) Robbins, Wm. J. 1938. Organisms requiring vitamin B_1. Proc. Natl. Acad. Sci. *24:* 53-56.

(16) ———— and Kavanagh, F. 1938. The specificity of pyrimidine for *Phycomyces blakesleeanus.* Ibid *24:* 141-144.

(17) ———— and ————. 1938. The specificity of thiazole for *Phycomyces blakesleeanus.* Ibid *24:* 145-147.

(18) ————————. 1938. Vitamin B_1 or its intermediates and growth of certain fungi. Amer. Jour. Bot. *25:* 229-236.

(19) Schopfer, Wm. H. 1937. L'action des constituents de l'aneurine sur des levures, *Rhodotorula rubra* et *flava.* Comp. rend. *205:* 445-447.

(20) ————. 1937. L'aneurine et ses constituents, facteurs de croissance de Mucorinees *(Parasitella, Absidia* et de quelque expeces de *Rhodotorula).* Comp. rend. soc. biol. *126:* 842-844.

(21) ————. 1937. Recherches sur le metabolisme de l'azote d'un micro-organisme acellulaire *(Phycomyces blakesleeanus,* Bgf.*)*. Le role des facteurs de croissance. Protoplasma *28:* 381-449.

(22) ———— and Jung, A. 1935. Recherches sur la synthese de la vitamin B_1 par *Phycomyces*. Arch. Mikrobiol. 4: 345-349.

(23) ————————. 1936. Determination de la teneur en vitamines B_1 d'un extrait de germe de isle. Comp. rend. soc. biol. *122:* 249-251.

(24) ————————. 1937. L'action de produits de disintegration de l'aneurine sur *Phycomyces*. Comp. rend. *204:* 1500-1501.

(25) Schultz, A., Atkin, L, and Frey, C. N. 1937. A fermentation test for Vitamin B_1. Jour. Amer. Chem. Soc. *59:* 948-949.

(26) ————————————. 1937. A fermentation test for Vitamin B. II. Ibid. *59:* 2457-2460.

(27) ————————————. 1938. Thiamine, pyrimidine and thiazole as bios factors. Ibid *60:* 490.

(28) Sperti, G. S., Loofbourow, J. R., and Dwyer, Sister C. M. 1937. Proliferation-promoting factors from ultra-violet injured cells. Studies Inst. Divi Thomae *1:* 163-192.

A COMPARISON OF THE CONDUCTIVITY OF A FEW ELECTROLYTES IN WATER AND SOLUTIONS OF DEUTERIUM OXIDE

H. D. DAWSON and FRANK WOLTZ

Department of Chemistry, Bethany College, Bethany

SOMETIME AGO Dr. Herrick Johnston of the Ohio State University, in discussing the matter of research in the small college suggested to one of the writers among other subjects the idea around which this report has been constructed.

Since the discovery of deuterium oxide by Dr. Urey, a vast amount of research has developed not only on the oxide but about deuterium, heavy oxygen, and other isotopes.

A rather careful survey of the literature does not show very much work treating the topic of electrical conductivity of electrolytes in heavy water, and for our paper we have chosen to compare the conductivity of three salts, NaF, NaCl, and NaBr, dissolved in water and in a 20% solution of D_2O in water. The concentrations of the salts were never very large.

While we do not feel that the highest degree of accuracy has been attained, nevertheless we think the results are fairly comparable with each other and in keeping with facilities now at our disposal.

Lewis and co-workers,[1] using a fraction of a milliliter of 90-97% D_2O, were able to show the mobilities of ions in D_2O to be less than in H_2O. LaMer and Baker[2] give an interesting treatment on the conductance of KCl and of deuterochloric acid in H_2O—D_2O mixture. LeMer and Chiturn[3] show the equivalent conductance of CH_3COOK, approximately .015 N., in mixtures of D_2O and H_2O. Longsworth and MacInnis of the Rockefeller Institute for Medical Research published[4] an article having to do in part with mobilities of potassium and chloride ions. They first used a .05 N. solution and varied the D_2O—H_2O ratio and in another series used several concentrations of NaC1 and KC1 in nearly 100% D_2O. Where possible to do so, comparisons of our data will be made with data of articles cited.

EXPERIMENTAL

The salts employed were of "analyzed, analytical quality" but not further purified. The water used for all conductivities was drawn from one large pyrex supply bottle and was protected from contamination. The water would have a very low conductivity but not as low as so-called "conductivity water". We do not take its conductivity into account, for it would be less than the other measuremental errors. The deuterium oxide was obtained from the Ohio Chemical Company and distilled before use and twice, very slowly, between each series of determinations. The apparatus illustrated by Fig. A consisted of B, a Leeds-Northrup No. 7651

[1] Journal American Chemical Society 55: 3504 (1933); ibid. 55: 4730.
[2] Journal Chem. Phys. 3: 406 (1935).
[3] Journal American Chemical Society 58: 1642 (1936).
[4] Journal American Chemical Society 59: 1666 (1937).

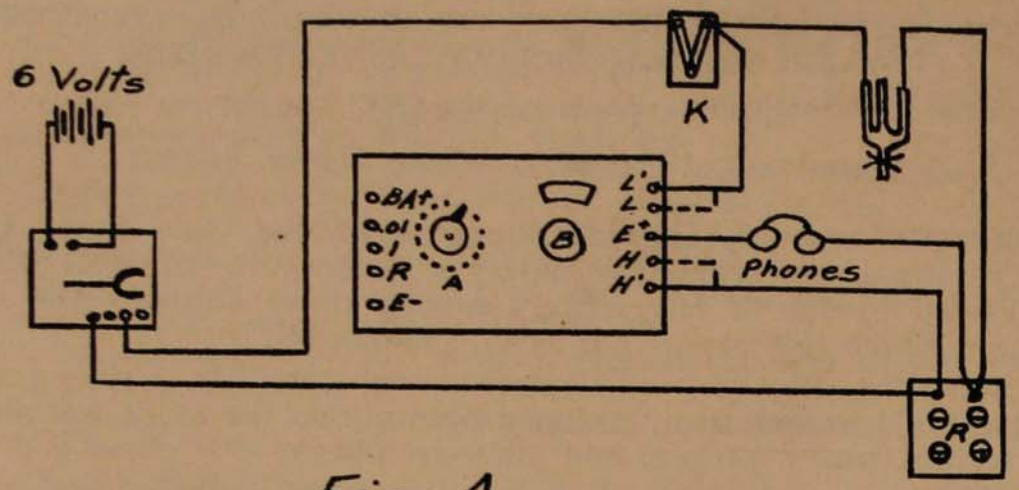


Fig. A

Potentiometer; R is a dial-type, variable, resistance box. The conductivity cell is of the adjustable U variety. The high-frequency alternating current was produced by a Type 213-B audio oscillator manufactured by the General Radio Company. The conductivity cell was maintained at 25° C. ± 0.04° for all determinations, by means of a thermostated water bath. Conductivity determinations made on aqueous solutions of KCl were merely for developing technique and checking results against some standard data.

For this purpose molar concentrations were considered. In other instances it seemed advisable to use molal concentrations. Salts, H_2O, D_2O, and solutions were all weighed rather than measured with one exception, to be noted later. The tables report "equivalent conductances" based on molal concentrations rather than molar. The differences are extremely small for these dilute solutions, and to compute molarities would have required accurate specific gravity data for each concentration which are not now available.

The method of making various concentrations consisted in: (a) weighing out accurately approximately 20 g. of H_2O or D_2O and placing in the cell; (b) an accurate weight of solute was dissolved in a weighed quantity of solvent, either H_2O or D_2O; (c) additions of one, two, three, etc., cc. portions were taken from the solution, (b), and added to the cell contents, (a), by means of a pipette; (d) the weight of one cc. of the solution delivered by a one cc. pipette was determined for each solution made up in (b). Resistances were determined potentiometrically by methods too well known to require comment.

Concentrations were computed in this manner:

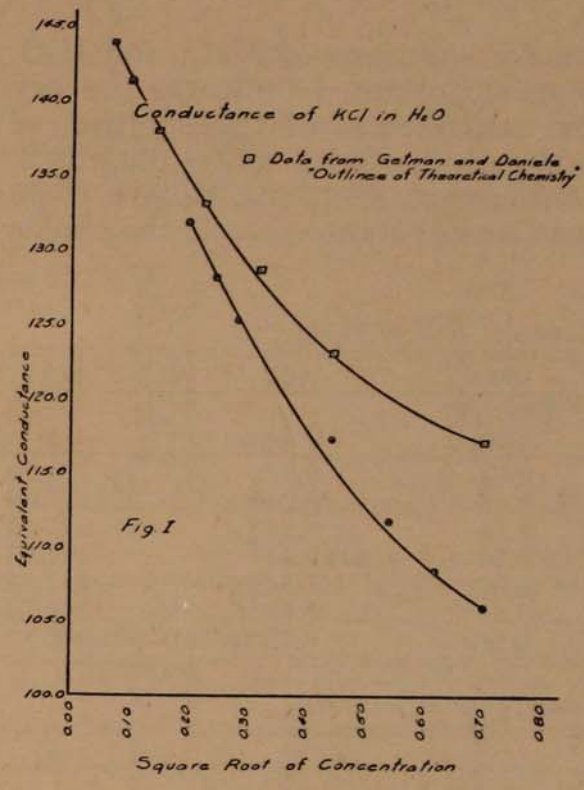
$$\text{Molal concentration, } c = \frac{\text{wt. per cc. of salt added} \times \text{no. cc.} \times 10^3}{[\text{wt. of liquid in cell} + (\text{no. cc.} \times \text{wt. of solvent per cc.})] \times \text{mol. wt. salt}}$$

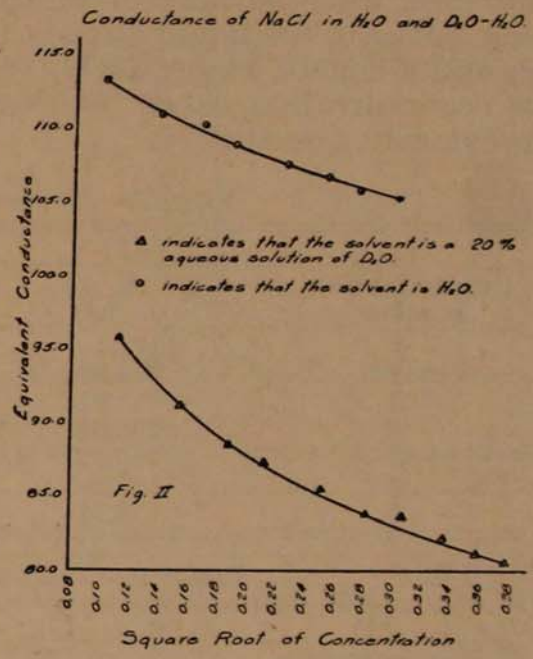
Equivalent conductances were computed in the usual manner:

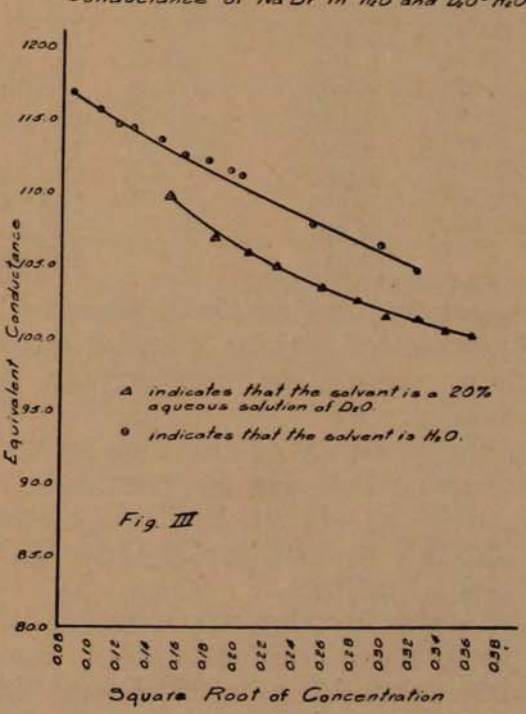
$$\text{Equivalent conductance, } \Delta, = \frac{10^3 \times \text{cell constant, K}}{\text{molal concentration} \times \text{resistance of solution}}$$

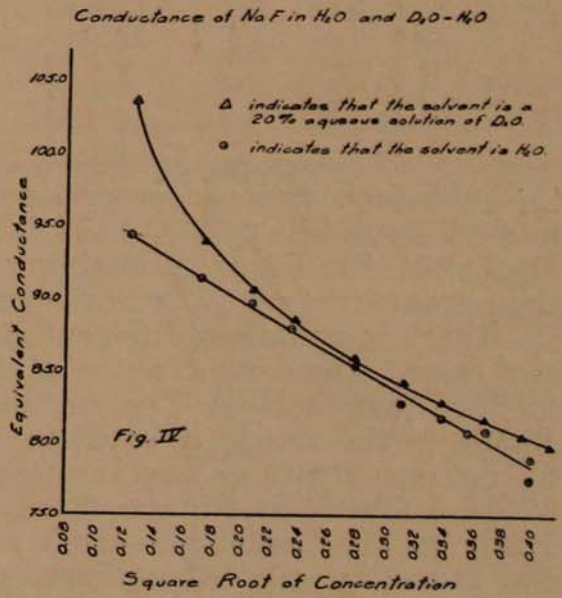
EXPERIMENTAL RESULTS

The data obtained on the conductivity of KCl in H_2O solutions are presented in Table 1. Columns 3, 4, and 5 denote molar concentrations, the square root of the concentrations, and equivalent conductances, respectively. The lower curve of Fig. 1 shows the square root of concentrations of Table 1 plotted against equivalent









conductances. The upper curve is for similar data taken from "Outlines of Theoretical Chemistry" by Getman and Daniels. While our conductances are not as high, particularly at greater concentrations, yet our data are consistent and satisfactory for desired comparisons. It may be mentioned also that practically all of the later data are on solutions where square roots of concentrations are less than 0.4. Below this point, agreement of the two curves is much closer than above.

Table 2 gives conductivity data for solutions of NaCl and H_2O. In this table and in all following ones, Column I indicates the key number, also the number of cubic centimeters of the solution of salt added to the liquid already in the conductivity cell. Columns 2, 3, and 4 denote, respectively, resistances of solutions, square roots of concentration, and "equivalent conductances" on the basis previously discussed.

TABLE 1—*Conductance of KCl in H_2O*

(1) Determination number	(2) R (ohms)	(3) Mols. per liter	(4) $\sqrt{}$ conc.	(5) Δ
1	1171.1	0.04	0.2	131.95
2	802.93	0.06	0.245	128.33
3	613.61	0.08	0.283	125.44
6	263.62	0.20	0.447	117.25
7	184.32	0.30	0.548	111.81
8	146.99	0.39+	0.625	108.52
9	116.71	0.50	0.707	105.89

TABLE 2—*Conductance of NaCl in H_2O*

(1) Determination number	(2) R (ohms)	(3) $\sqrt{}$ conce	(4) Δ
G-1	5434.4	0.100	113.11
G-2	2875.85	0.139	110.92
G-3	2001.93	0.168	110.06
G-4	1569.80	0.190	108.93
G-6	1130.65	0.225	107.62
G-8	908.97	0.252	106.73
G-10	776.07	0.274	105.94
G-13	651.57	0.300	105.22
G-15	590.69	0.315	105.78

Table 3 shows data for various concentrations of NaCl dissolved in a 20% solution of D_2O in H_2O. The data of Tables 2 and 3 have been plotted in Figure 2, enabling one to make direct comparison of the conductance of NaCl in the two media.

There is a marked differential in the mobility of the ions in the two cases. The conductances of the ions in D_2O are approximately 80% of that in H_2O. The viscosity ratio, as shown by Baker and LaMer in the article referred to, is about 1 to 1.04 for H_2O to D_2O at the concentrations used in these determinations.

In Tables 4 and 5 are shown the data for the conductance of NaBr in H_2O and D_2O—H_2O respectively. The equivalent conductances are plotted against square roots of concentrations in

Fig 3. The mobility of the bromide ions is almost identical with that already shown for chloride ions, as it should be, in H_2O. The sodium ions are common to both sets of data. It is well known that C^{s+}, Rb^+, K^+, Cl^-, Br^-, and I^- all have about the same velocities in water. The ordinary mobility of ions of the same charge is primarily a function of ionic volume and not of mass. From our data it would appear that the bromide ion is able to move more rapidly in a D_2O—H_2O solvent

TABLE 3—*Conductance of NaCl in D_2O—H_2O*

(1) Determination number	(2) R (ohms)	(3) $\sqrt{}$ molal conc.	(4) Δ
B- 1	5149.1	0.112	95.69
B- 2	2805.9	0.155	91.07
B- 3	1995.0	0.188	88.45
B- 4	1569.7	0.212	87.23
B- 6	1140.1	0.252	85.42
B- 8	924.27	0.282	83.99
B-10	785.60	0.307	83.71
B-13	667.23	0.336	82.16
B-16	590.98	0.359	81.19
B-19	537.75	0.378	80.51
number	(ohms)	$\sqrt{}$ molal conc.	Δ

TABLE 4—*Conductance of NaBr in H_2O*

(1) Determination number	(2) R (ohms)	(3) $\sqrt{}$ molal conc.	(4) Δ
E- 2	7115.	0.086	116.79
E- 3	4970.8	0.104	115.49
E- 4	3891.2	0.118	114.69
E- 5	3229.0	0.129	114.38
E- 7	2477.9	0.148	113.57
E- 9	2067.0	0.163	112.51
E-12	1694.3	0.180	112.04
E-15	1475.0	0.194	111.31
E-17	1369.6	0.202	111.06
E'- 3	1798.9	0.176	110.89
E'- 7	903.25	0.252	107.78
E'-11	654.09	0.298	106.24
E'-14	564.25	0.323	104.64

TABLE 5—*Conductance of NaBr in D_2O-H_2O*

(1) Determination number	(2) R (ohms)	(3) $\sqrt{}$ c molal	(4) Δ
F- 2	2383.0	0.154	109.63
F- 3	1706.1	0.184	106.96
F- 4	1353.8	0.208	105.71
F- 5	1139.8	0.227	104.94
F- 7	895.47	0.259	103.29
F- 9	756.11	0.282	102.49
F-11	669.29	0.302	101.53
F-14	579.75	0.324	101.33
F-17	525.43	0.342	100.47
F-21	474.62	0.361	100.07

than the chloride ion. For the concentrations treated, the velocity in D_2O—H_2O is about 96% of that in H_2O alone, as contrasted with approximately 80% for chloride.

In Tables 6 and 7 have been grouped, respectively, the conductivity results for NaF in the two solvents, H_2O and D_2O—H_2O, and, as before, the equivalent conductances have been plotted against square roots of concentration in Fig 4. The fluoride ion appears to be approximately 80% as conductive in H_2O as chloride and bromide ions.

In the D_2O—H_2O solution the fluoride seems to conduct about as well as the chloride although not nearly as well as the bromide. It will be noted that the NaF conducts somewhat better in the D_2O—H_2O solution than it does in H_2O. We would not expect this reversal. Conductivities of NaF both in H_2O and the D_2O—H_2O were carefully rechecked on other occasions, the second results agreeing as well as could be expected with the first.

Conduction of hydrogen ions in H_2O is abnormally rapid—so rapid in fact that on the basis of Stoke's Law the volume of H_3O^+ ion would be absurdly small. A grotthus chain-type of conduction wherein the proton is passed from molecule to molecule is generally regarded as responsible for a part of the rapid conduction. Ions are normally hydrated, and when a potential is applied, the ion carries along the hydrating molecules. The "ionic volume" is not that of a simple ion, but the ion plus its sheath of hydrating water molecules. Conductivity is not proportional to atomic mass but rather to ionic volume, as already noted.

Conductivity in all phases is a complex phenomenon and it is conceivable that the fluoride ion, in particular, is less hydrated in a solution of D_2O—H_2O than in H_2O. If this is the situation, then its ionic-volume would be less and its mobility and corresponding conductance greater than in H_2O. The fluoride ion would need to

TABLE 6—*Conductance of NaF in H_2O*

(1)	(2)	(3)	(4)
Determination number	R (ohms)	$\sqrt{c}$ molal	Δ
C- 1	4316.9	0.123	94.18
C- 2	2312.7	0.171	91.22
C- 3	1627.7	0.206	89.56
C- 4	1288.7	0.234	87.82
C- 6	946.40	0.277	85.14
C- 8	776.89	0.310	82.73
C-10	666.83	0.337	81.72
C-13	562.71	0.369	80.80
C-16	502.09	0.399	77.52
C'-10	603.91	0.356	80.68
C'-14	489.26	0.400	78.95

TABLE 7—*Conductance of NaF in D_2O—H_2O*

(1) Determination number	(2) R (ohms)	(3) $\sqrt{c}$ molal	(4) Δ
D- 1	3947.9	0.125	103.39
D- 2	2199.3	0.173	93.81
D- 3	1581.3	0.208	90.42
D- 4	1260.2	0.236	88.33
D- 6	927.92	0.279	85.84
D- 8	759.50	0.311	84.03
D-10	656.44	0.337	82.75
D-13	559.56	0.368	81.40
D-16	498.60	0.393	80.36
D-19	455.52	0.413	79.73
D'- 5	802.26	0.303	84.18
D'- 7	637.87	0.344	81.92
D'- 9	543.72	0.376	80.51
D'-11	481.26	0.401	79.77
D'-13	439.66	0.422	78.82
D'-14	421.74	0.432	78.70

behave differently than the bromide and chloride, but the fluorides are unlike the other halides in many respects.

SUMMARY

The conductivities of NaCl, NaBr, and NaF have been measured and compared for a number of low concentrations, using as solvents H_2O and a 20% solution of D_2O in H_2O. The equivalent conductances of NaCl and NaBr were found to be lower in the D_2O—H_2O solutions than in H_2O. In the determination we made, the NaF appeared to conduct slightly better in the D_2O—H_2O solvent.

SOME HYDRATE STRUCTURES

W. SCHUYLER MILLER

Department of Chemistry, Bethany College, Bethany

WATER MAY occur in crystals in holes, sheets, or tubes in an otherwise rigid structure and may be driven out of such crystals by heat without necessarily disrupting the structure. For example, in the zeolites we have such continuously variable quantities of water. Or, it may occur as coordinated water, in which case the water molecules are grouped around particular ions. It is with this type that this paper is concerned.

We are all familiar with Werner's theory of complex compounds; for example, the hexammine type. Several of the earlier writings pointed out that the number $6H_2O$ in hydrates was especially common, and this was taken to indicate a close relationship to the hexamine salts. Thus nickel sulfate hexahydrate $NiSO_4.6H_2O$, could be written

$Ni(H_2O)_6SO_4$, or in more detail, $\left[\begin{array}{ccc} & H_2O & \\ H_2O & | & H_2O \\ > & Ni & < \\ H_2O & | & H_2O \\ & H_2O & \end{array}\right] SO_4$

It is the writer's purpose to review a little of the X-ray work done on hydrates, describing their structures, and pointing out the agreement with Werner's formulas.

First let us consider the relation between the coordination number and the radius ratio of the building units in a crystal. From Linus Pauling's figures (J. A. C. S. *51:* 1016. 1929.) we see that for a ratio of metal radius to water radius of 0.225 the coordination may be 4; at a ratio of 0.414 the coordination may be 6; and at a ratio 0.732 the coordination may be 8. The polyhedrons are a tetrahedron, octahedron, and cube, respectively.

From X-ray studies we are able to determine the effective radii of the various units, and from these we may readily obtain the radius ratio and compare the corresponding coordination number with the known hydration. For example, the beryllium ion to water radius ratio is $0.30/1.36=0.221$. X-ray studies of $BeSO_4.4H_2O$ show the four waters to be tetrahedrally arranged about the beryllium ion, the whole acting as a composite positive ion in building up the crystal. Similarly in $NiSO_4.6H_2O$, the radius ratio is $0.74/1.36=0.54$, and X-ray studies show a sixfold group about each nickel. Many hydrates have been studied, especially by Wyckoff and by Hassel. Werner's hypothesis of a symmetrical group is substantiated, the coordination group not exceeding the possible maximum, though of course it may be smaller.

A question next arose concerning those hydrates which crystallized with seven molecules of water, such as $NiSO_4.7H_2O$. From the dissociation tension of such salts it seemed evident that the seventh

water is held in a different linkage. Thus in the original theory it was suggested that six waters make up the complex and the seventh is in an outer sphere, probably attached to the sulfate group. This too has been substantiated by X-ray investigation. My friend and former colleague, Dr. C. M. Schwartz, of Syracuse, working with Dr. Beevers in Professor Bragg's laboratory in Manchester, England, has shown that six of the waters in $NiSO_4.7H_2O$ are coordinated around the nickel and the seventh water is linked between one of the sulfate oxygens and three coordinated waters. (Notice that here we have the tetrahedrally bonded water corresponding to two positive and two negative regions on the water molecule.) *

The ion sizes we mentioned above are often assisting factors in determining the structures of these compounds. I may cite a case as example: some little time ago we were interested in the structure of peroxides and polysulfides, and in searching the literature we came upon the structure of $SrO_2.8H_2O$ reported by one Natta in the Gazz. Chim. Ital. Now eight waters are permitted, since the ion radius ratio is well above 0.732, but we did not believe his structure to be the correct one; his coordinated cubes were oriented so that the water molecules fell on the cell diagonals. Our reasons for disagreeing were two; first, there was not the best of agreement between his calculated and observed intensities of the diffracted X-ray beams; and second, a consideration of ion sizes made it seem hardly possible that the water molecules could occupy these positions. We therefore took some diffraction photographs of this octahydrate and analyzed the structure. By suggesting that the coordinated groups are in a position twisted on the c-axis, so that the individual molecules did not lie on the diagonals, we were able to get considerably better agreement between the observed and calculated intensities; furthermore, by means of a little descriptive geometry and the use of clay models made to scale, we found that we now had contact all around, whereas Natta's proposed structure impossibly crowded the molecules in some places and left unusually large open spaces in other parts of the cell.

We continued the work with $CaO_2.8H_2O$ and $BaO_2.8H_2O$ and found that these have similar structures with cubically coordinated waters. They are all tetragonal, and from our powder diffraction data we believe that the space group is P_4/m (C_4^1h), one molecule per unit cell.

The metals are divalent, and since there are eight waters surrounding each metal ion, the bond strength to each is ¼. One can readily construct a Pauling diagram symbolically representing the carrying over of the charge from the metal to the peroxide oxygen, the tetrahedrally bonded waters having one negative bond satisfied by the metal ion, and the other negative and both positive bonds satisfied by other waters and the peroxide oxygen.

In conclusion I wish to acknowledge the valuable aid of Dr. Aden J. King, of Syracuse University, in whose laboratories the octahydrate studies were made.

* See Bernal and Fowler, J. Chem. Phys. 1: 515. 1933.

RECENT DEVELOPMENTS IN OXIDIZED FLAVOR IN MILK

(An Abstract)

W. CARSON BROWN

Department of Dairy Husbandry, West Virginia University

AT THE WEST VIRGINIA AGRICULTURAL EXPERIMENT STATION a study of the acidity of 221 individual samples of freshly-drawn cows' milk has shown no apparent correlation between the natural acidity of the milk and its tendency to develop oxidized flavor when contaminated with copper. All experiments in which acidity was studied were carried out on pasteurized winter milk, and the tendency to develop oxidized flavor was determined by the addition of 1.3 p. p. m. of copper added after pasteurization, followed by a three-day storage period at 35° to 40° F. The presence of oxidized flavor was determined by taste.

Anderson, Dowd, and Stuewer (1937) found that the titratable acidity of winter milk is higher than that of summer milk. Since this seasonal change occurs in coincidence with the change of susceptibility of milk to oxidized flavor, it seemed possible that this condition may have been partially responsible for oxidized flavor. Anderson and his co-workers found an association between acidity and the tendency to develop oxidized flavor and that "milk of high acidity invariably developed an oxidized flavor upon pasteurization." However, at West Virginia the analysis of the data obtained from 220 individual cows' samples did not show any difference in the apparent acidity of the milk from cows whose milks were susceptible to oxidized flavor and those whose milks were free from this defect.

Anderson and co-workers were able to eliminate oxidized flavor from a commercial milk supply by reducing the titratable acidity to 0.145%. However, in the present study, neutralization to 0.13% titratable acidity, or in a small number of cases to 0.10%, did not effect the development of the flavor.

No explanation is offered for the discrepancy in results which have occurred except that possibly the milk used by Anderson and his co-workers was subject to the development of oxidized flavor without copper contamination, while the milk used in these trials would not develop oxidized flavor unless contaminated with copper. It is also possible that in their work, because of neutralization, the milk did not dissolve sufficient copper from the equipment to cause the flavor to develop. In all trials herein reported the copper was added after pasteurization in the form of a copper-sulphate solution. In view of these facts it would have been desirable to have made several trials upon naturally susceptible milk, but during the past two years milk of this type has not been available, except in rare cases, in the University herd.

The results of these experiments indicate that metal-developed oxidized flavor is not related to the acidity of freshly-drawn milk and that the standardization of the titratable acidity to 0.13% does not decrease the tendency for oxidized flavor to develop.

METHODS FOR DETERMINING THE RELATIVE VALUE OF PROTEINS FOR CHICKENS

(An Abstract)

A. H. VANLANDINGHAM and T. B. CLARK

Department of Agricultural Chemistry and Animal Husbandry,
West Virginia University

THE DETERMINATION of the nutritive value of an isolated protein, or the protein value of any food or mixture of foods in the nutrition of animals, generally involves a study of the response of experimental animals to specific dietary regimes, so planned that the response may be definitely (preferably quantitatively) related to the amount and character of the protein consumed. For such studies three different types of experiments may be used: (1) the growth method, (2) the slaughter method, and (3) the balance trial.

In a study of the relative value of proteins for growth with chickens both the growth method and the metabolism or balance trial were used. With the growth method, groups of 10 one-day-old chicks were placed on the test ration and continued for a period of six weeks. Records were kept as to the rate of growth and the amount of food consumed in seven-day periods for the six weeks test period. With the balance trials chicks from six to 12 weeks of age were used. The chicks were placed in individual cages provided with screen bottoms and porcelain pans underneath to catch the excrement. Collections were made for seven days and analyzed for nitrogen. The percentage of nitrogen retention was calculated.

Diets containing approximately 16 percent of crude protein in which 88 percent of the protein in the diet was supplied by single protein supplements were used with both types of experiments. Comparable results were obtained with both methods, one serving as a check on the other. In the balance trials the basal diet containing dried whole egg gave approximately the same percentage of nitrogen retention as a normal mixed ration. Fish meal and casein were about equal, with nitrogen retention values 10 to 15% less than that obtained from the normal mixed ration, while meat scraps permitted less than half as much nitrogen to be retained as with the normal mixed ration. A mixture of equal parts of fish meal and meat scrap gave nitrogen retention values approximately midway between the value obtained where meat scrap and fish meal were fed alone in the basal diet.

HEATS OF REACTION FOR THE FORMATION OF SILICIC-ACID GELS

EARL C. H. DAVIES and LYDA M. ARNETT, JR.
Department of Chemistry, West Virginia University

EARLIER INVESTIGATIONS carried on in this laboratory have been reported to the Academy.* They indicated that the cracks, developing in silicic-acid gels during syneresis, are similar to those in glass and in other similar solids without fibrillar structure. Controlled unidirectional crushing experiments seemed to confirm this parallelism between the physical structure of glass and silicic-acid gels.

Generally, silicic-acid gels are prepared by mixing water glass with suitable concentrations of acid. The commercial water glass contains different amounts of silica (SiO_2) held up by sodium hydroxide (NaOH, from $Na_2O + H_2O$). The general formula for ordinary water glass may be written $(Na_2O)\ (SiO_2)y \cdot xH_2O$. For many purposes the more definite sodium metasilicate may be used. Its formula may be written as $Na_2O \cdot SiO_2 \cdot xH_2O$ or as $Na_2SiO_3 \cdot xH_2O$, where x usually varies between 5 and 9. A typical reaction for the formation of a silicic-acid gel is,

$$Na_2SiO_3 \cdot 5H_2O + 2HCl + \text{water} = 2NaCl + SiO_2 \cdot xH_2O.$$

The extra acid and the salt formed in the reaction may be washed away leaving $SiO_2 \cdot xH_2O$ in a nearly pure condition. If the silica concentration is sufficient, this silica hydrate will set to a gel. The time of gelation will be less for the higher temperatures. After the gel has set, it will undergo syneresis, a phenomenon common among gels. During syneresis the gel contracts, water collects on the surface, cracking may occur, and finally the gel assumes a condition of dryness characteristic of its peculiar nature. Syneresis may be observed with custard pies and is an underlying cause of deterioration of films of house paint. With silicic-acid gels, the final product of syneresis is silica (SiO_2), which chemically is identical with sand or quartz. Before complete loss of water has occurred, the product is the commercially important "silica gel" used for many purposes including the recovery of gasoline from casing head gas and the manufacture of gas refrigerators.

TEMPERATURE CHANGES DURING THE FORMATION OF SILICIC-ACID GELS

Since the original aim of this investigation was to determine the heat accompanying the process of gelation, the first approach was to observe whether or not a temperature effect could be detected during the actual process of gelation. To accomplish this, solutions of a silicate and an acid were prepared. The silicate was prepared by diluting a commercial water glass to a density of 1.16. The acid used was a hydrochloric-acid solution of approximately 6 normal strength, obtained by mixing c. p. acid with an equal volume of water. When these two solutions were mixed in equal amounts, a

* Earl C. H. Davies, Proc. W. Va. Acad. of Science, 9:64-66 (1935); ibid. 11:55-58 (1937); J. Phys. Chem. 35:3618 (1931).

mixture was obtained which was acid and which set in 15-20 minutes. The rise in temperature observed upon the initial mixing was in the neighborhood of 7.5° C. In this case, the observations were made by first pipetting the acid into an open Dewar flask and then slowly stirring in the silicate. The procedure is carried out in this manner to prevent the formation of clots of colloidal silica which are formed at any point in the solution where the mixture happens to become alkaline. By using the described method, the result is a solution with a homogeneous appearance resembling that of water. Observations of temperature were made by using a mercury thermometer graduated in tenths of degrees and covering the range 0 to 100° C. As mentioned above, the temperature rapidly rises to a maximum of about 7.5° above the starting temperature, requiring about 90 seconds when the two solutions were mixed in approximately 40 seconds. After this first effect, the time-temperature curve is typical of the cooling curve which would be obtained by observing the temperature fall in a solution in which no reaction was taking place. At the time of setting of the gel, there is no noticeable change in the slope of the curve, except possibly a slight slowing down of the cooling. This may be accounted for by the fact that the gel is not as good a conductor of heat as the liquid mixture.

The calorimeter consisted of a Dewar flask serving as a container, fitted with a stopper through which passed a thermometer of the type described above, a motor-driven stirrer, and a separatory funnel through which to add the silicate. To make observations with this apparatus, the acid was pipetted into the calorimeter, the stopper placed in position, and the silicate pipetted into the separatory funnel. The beginning temperature was noted and the silicate allowed to flow into the calorimeter. This required 30-40 seconds for the introduction of 100 cc. Time-temperature readings were taken for a period of 15 minutes from the beginning of the mixing. When a rigid gel was formed, it was impossible to stir after the mixing was complete, so that it was necessary to turn the motor off after that time. In order to make the results comparable, stirring was discontinued in all instances after mixing was complete.

The solutions used in these experiments were hydrochloric-acid solutions of concentrations 3 normal and 2.640 normal used in conjunction with a 2.638 normal silicate solution. With the first-mentioned acid, when no gel was formed during the period of observation, the average temperature rise of three representative determinations was 12.91° C. However, with the second acid, which gave a very slightly acid mixture and thus set in less than 5 seconds, the average temperature rise of four representative determinations was only 12.70° C. Although in the latter case the temperature rise was not as great as in the former case, the temperature remained constant for a period of 3-3.5 minutes before the cooling effect was detectable. When the stronger acid was used, the temperature rose to its maximum and then began to cool immediately. This is graphically illustrated in Fig. 1, in which representative

cooling curves for the two types of mixtures are plotted. The large initial temperature rise is omitted in order to have the characteristic portions of the curves on a large enough scale to bring out the

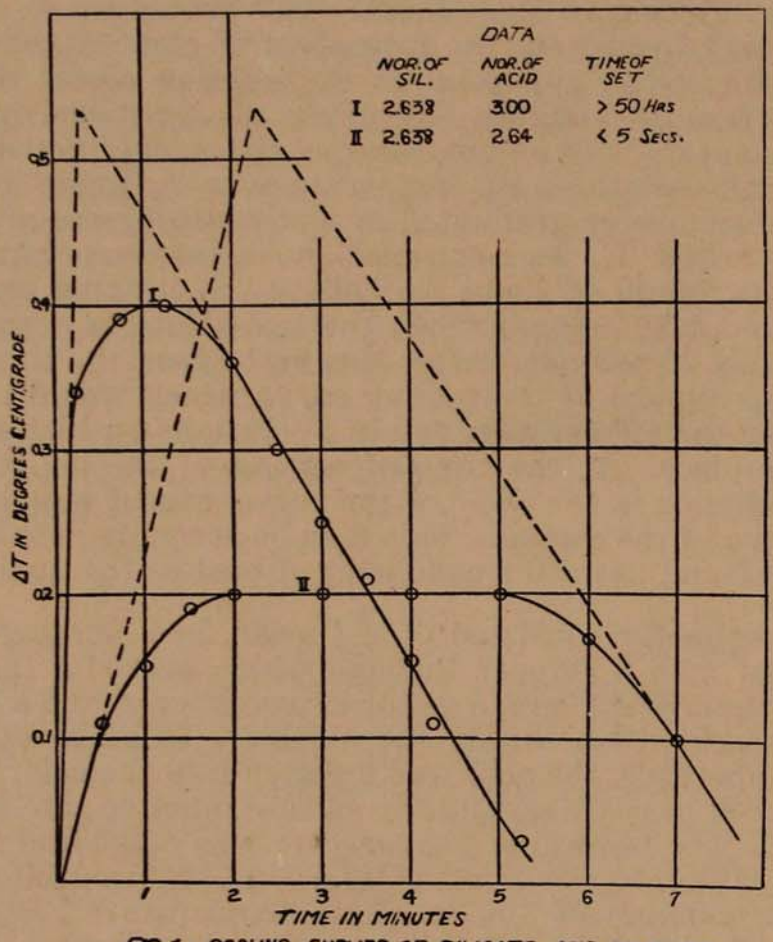


FIG. 1 - COOLING CURVES OF SILICATE-ACID MIXTURES

differences in the two types. If tangents are drawn to the heating and the cooling curves in both instances, the intersections occur at approximately the same temperature height. This indicates that although the heating in the case of gel formation may be considerably slowed down in its last stages, in both cases the total temperature rise would have been approximately equal if cooling could have been eliminated.

HEATS OF REACTION BETWEEN SODIUM METASILICATE AND CERTAIN ACIDS

The silicate solutions were prepared from solid sodium metasilicate pentahydrate. It was labeled as "$Na_2SiO_3 \cdot 5H_2O$ Pure". A titration of a sample with standard acid showed that the sample corresponded very closely to the formula given. This was also confirmed by the determination of the melting point.

The master silicate solution was prepared by dissolving the solid sodium metasilicate in distilled water until the density of 1.16

was reached. This solution was then 24.6% sodium metasilicate pentahydrate and when titrated with standard acid, using phenolphthalein as the indicator, showed an equivalent basicity of 2.638 normal. Three dilutions of the silicate solution were made. These were made by diluting with water according to the following ratios, 1:1, 1:3, 1:7. The original acid solutions were approximately 3 normal and dilutions were made of these in the same ratios as with the silicate. All of these solutions were standardized using as the original standard hydrochloric acid whose normality was determined by precipitation of the chloride with silver nitrate.

To determine the heats of reaction of these solutions, it was necessary to have a different calorimeter. A Dewar flask was again used as a container in the calorimeter. This one was of about 450 cc. capacity and a diameter of about 6.25 cm., silvered on all exposed surfaces. The flask was placed in the center of a metal can of 13 cm. diameter. The space between the can and the flask was packed with cotton batting. A cardboard form was placed around the flask so as to hold the insulation in place, thus allowing the flask to be removed from the assembly. To measure the temperatures, standardized Beckmann thermometers permitting readings to 0.001° C. were used. A separatory funnel was fitted into the stopper to provide a means for introducing the silicate into the calorimeter which contained the acid. Heat capacities were determined by passing into the calorimeter a measured amount of electricity and noting the temperature rise. A length of glass tubing was inserted through the stopper and led to the bottom of the flask. Here it was bent in a circle whose plane is horizontal. At five points on the outer edge of this circle, holes were made to allow the air to enter the liquid at several points and thus make for more efficient stirring. Before passing into the flask, the air passed through a flowmeter, a wash bottle containing potassium hydroxide solution, and a wash bottle containing concentrated sulfuric acid. These two wash bottles removed the carbon dioxide and the water vapor. The passage of air through the solutions produced a cooling effect for which it was necessary to make a correction.

Observations were made with the starting temperature at 26 ± 1.0° C. Before beginning a determination, the two solutions to be used were placed in 400 cc. beakers side by side, along with the Dewar flask and the stopper with its fittings of thermometers, etc. Two sets of pipettes, one 100 cc. and one 50 cc. pipette, were rinsed with the silicate and acid, respectively, and also placed near the rest of the apparatus and materials. After about 30 minutes, when it was assumed that thermal equilibrium had been attained, the Dewar flask was placed in position in the can and 150 cc. of the acid pipetted into the flask. The stopper was next placed in the flask and 150 cc. of the silicate solution pipetted into the separatory funnel. Connection was made with the air current and the flow adjusted to that value judged necessary for adequate stirring. This value was constant throughout the determinations. The tempera-

ture was recorded and the silicate allowed to flow in. The introduction of the silicate required 30-40 seconds. With hydrochloric, sulfuric, and nitric acids the maximum temperature was reached in about 90 seconds. With the acetic acids, the original solution, the 1:1 and the 1:3 dilutions required about 150 seconds to reach the maximum temperature. However, the 1:7 dilution of acetic acid corresponded closely with the previously mentioned acids on this point. The correction for the heat capacity of the calorimeter was 29.4 calories. From a knowledge of the heat capacity, the temperature rise, and the concentrations of the solutions, it was possible then to calculate the heats of reaction.

To make a test of the apparatus and procedure, a determination of the heat of neutralization of hydrochloric acid and a very pure (Baker's Analyzed) sodium hydroxide was made in the manner described above. In this case, the solutions were approximately 0.50 normal. The value obtained for this reaction was 13,885 cal. as compared with the value 13,888 calories as determined by Richards and Rowe. This agreement was considered sufficient to justify the use of this method for the determinations.

The calculation of the heat of reaction of the sodium metasilicate per equivalent was made by employing the following formula:

$$\text{Heat of Reaction} = \frac{\text{Temperature Rise x Heat Capacity}}{\text{Volume of Silicate x Normality of Silicate}}$$

These calculations give the values found in the last column of Table 1 and are shown graphically in Fig. 2.

TABLE 1.—*Heats of reaction of sodium metasilicate with acids per equivalent of silicate*
(150 cc. of each solution used for a determination)
Temperature = 26.0° ± 1.0° C.

	Normality of silicate	Normality of acid	Temperature rise	Heat Capacity calories/degree	Heat of reaction
			1. HYDROCHLORIC ACID		
A	2.638	2.926	12.566	317.9	10,100 cal.
B	1.325	1.510	6.080	322.4	9,880
C	0.6622	0.7480	3.032	324.4	9,910
D	0.3294	0.3808	1.543	326.0	10,200
E	0.1000	0.1269	0.599	328.6	13,100
			2. SULFURIC ACID		
A	2.638	2.991	14.318	323.4	11,720
B	1.325	1.521	7.143	325.4	11,700
C	0.6622	0.7544	3.569	326.5	11,750
D	0.3294	0.3798	1.782	327.4	11,810
E	0.1000	0.1266	0.717	328.0	15,680
			3. NITRIC ACID		
A	2.638	3.357	12.158	321.6	9,880
B	1.325	1.510	6.062	325.1	9,930
C	0.6622	0.7540	3.055	326.4	10,030
D	0.3294	0.3770	1.572	327.4	10,420
E	0.1000	0.1256	0.593	328.6	13,000
			4. ACETIC ACID		
A	2.638	3.030	11.488	322.4	9,350
B	1.325	1.516	5.924	323.8	9,650
C	0.6622	0.7550	3.014	325.9	9,890
D	0.3294	0.3786	1.574	327.2	10,420
E	0.1000	0.1262	0.682	328.4	14,920

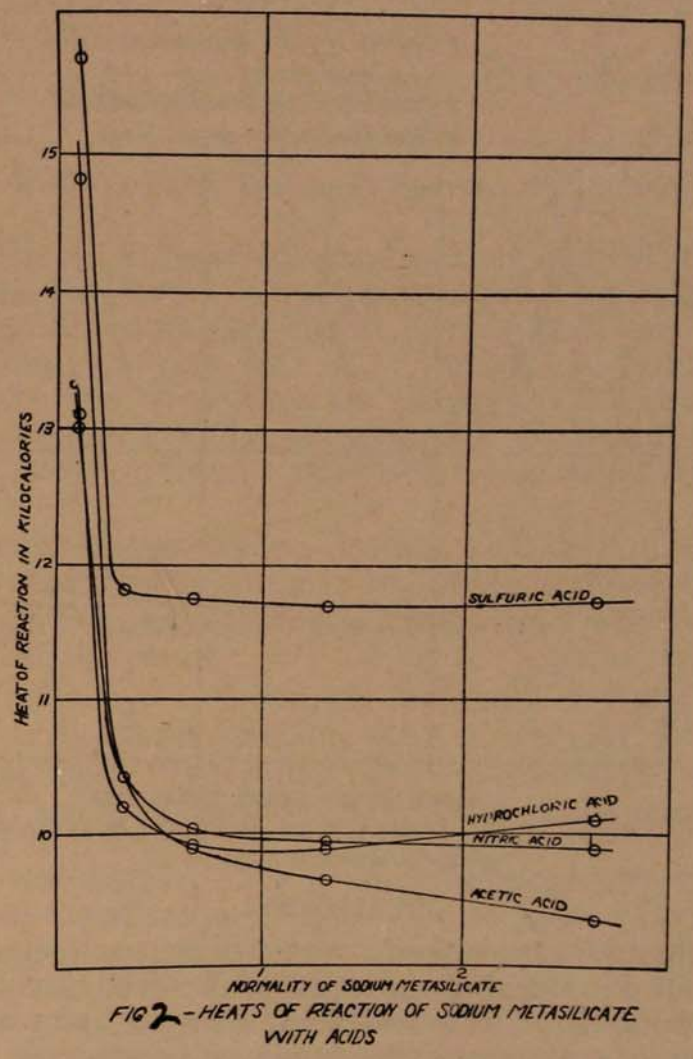


FIG 2.—HEATS OF REACTION OF SODIUM METASILICATE WITH ACIDS

In all of the determinations so far discussed, the concentration of the acid and the concentration of the silicate have been in the approximate ratio of 1.14. Another set of determinations was made using hydrochloric acid of constant concentration with a varying concentration of silicate. The data obtained are shown in Table 2 and Fig. 3.

TABLE 2.—*Heats of reaction of sodium metasilicate and hydrochloric acid per equivalent of silicate*

	Normality of silicate	Normality of acid	Temperature rise	Heat Capacity calories/degree	Heat of reaction
F	1.325	2.958	6.838	317.4	10,900 cal. 10,730
G	0.6622	2.958	3.715	315.0	11,790 11,550
H	0.3294	2.958	2.173	312.0	13,720 13,440

In the last column where two values occur for the heat of reaction, the smaller value directly below the original figure has been corrected for the heat of dilution of the excess acid present in the determination.

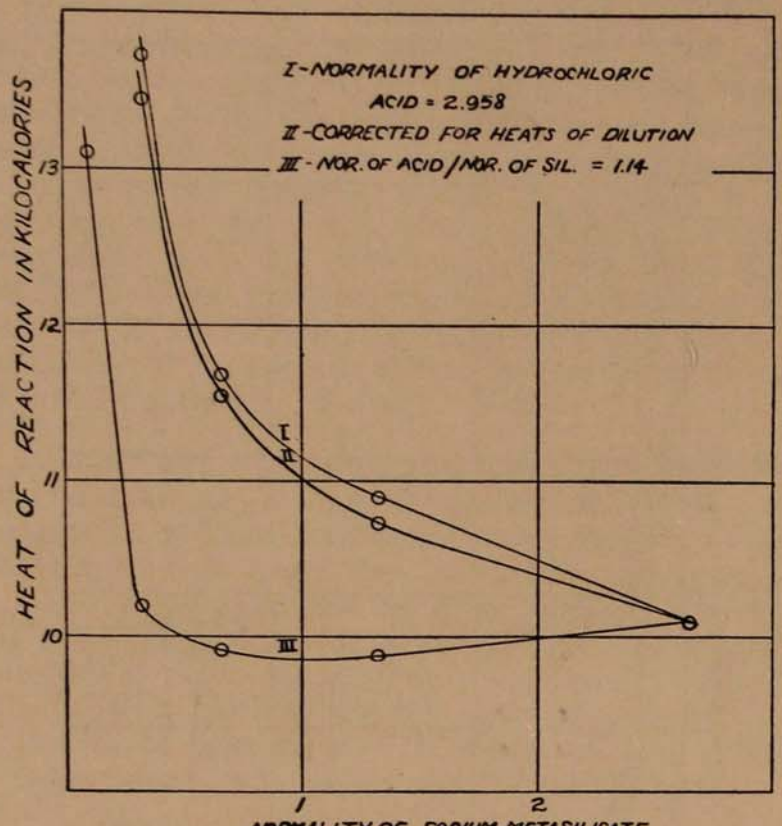


FIG 3 - HEATS OF REACTION OF SODIUM METASILICATE WITH HYDROCHLORIC ACID

SUMMARY

1. Preliminary experiments have been conducted to observe whether or not a thermal effect could be detected during the process of gel formation from the action of an acid upon a water glass solution. Using a mercury thermometer to observe temperatures of gel mixtures in Dewar flasks, time-temperature curves show no discontinuity.

2. Solutions of sodium metasilicate of 2.638 normality mixed with hydrochloric acid solutions of 3.0 and 2.64 normal strength, respectively, give the following results. With the former mixture a temperature rise of 12.90° C. is obtained with a cooling effect entering immediately. In the latter instance, a temperature rise of 12.70° C. is obtained with a constant temperature for a period of 3-4 minutes.

3. The heats of reaction of sodium metasilicate with hydrochloric, sulfuric, nitric, and acetic acids have been measured at 2.638, 1.325, 0.6622, 0.3294, and 0.100 normal concentrations of the silicate. For each individual acid, these values are fairly constant down to 0.25—0.40 normal below which values the heats of reaction rise rapidly.

4. The effect of excess acid concentration upon the heats of reaction has been studied briefly in the case of hydrochloric acid and it has been found that this excess has a positive effect upon the heat of reaction; that is, a higher value is obtained than when merely enough acid is used to neutralize the silicate.

THE POTTSVILLE SERIES IN PENDLETON COUNTY, WEST VIRGINIA

E. T. HECK

West Virginia Geological Survey, Morgantown

IN 1896 the United States Geological Survey published the Franklin Folio, by N. H. Darton, covering most of Pendleton County. In 1927 the West Virginia Geological Survey published a report on Pendleton County, written by J. L. Tilton, W. F. Prouty, and P. H. Price. In 1931 the West Virginia Geological Survey published a report on Randolph County, in which D. B. Reger reinterpreted some of the Pendleton County data previously reported by Tilton in the 1927 report.

The portion of these reports dealing with the Pottsville rocks in Pendleton County may be summarized briefly as follows:

1. Rocks of Pennsylvanian age (Pottsville) are confined to the western part of the county.

2. North of Onego a maximum thickness of 683 feet of Pottsville rocks was measured on Long Run of Roaring Creek.

3. South of Onego, Pottsville rocks are confined to small patches on the highest knobs of Spruce Mountain and the maximum thickness reported is 150 feet.

Recent investigations have proved the maximum thickness and hence the areal distribution of Pottsville rocks on Spruce Mountain to be considerably larger than previously reported. In the spring of 1938 the writer visited several coal openings on the east side of Spruce Mountain, four miles southwest of Onego. At the points observed the coals were too thin to be of commercial value, but the area containing coal-bearing rocks was by no means completely prospected.

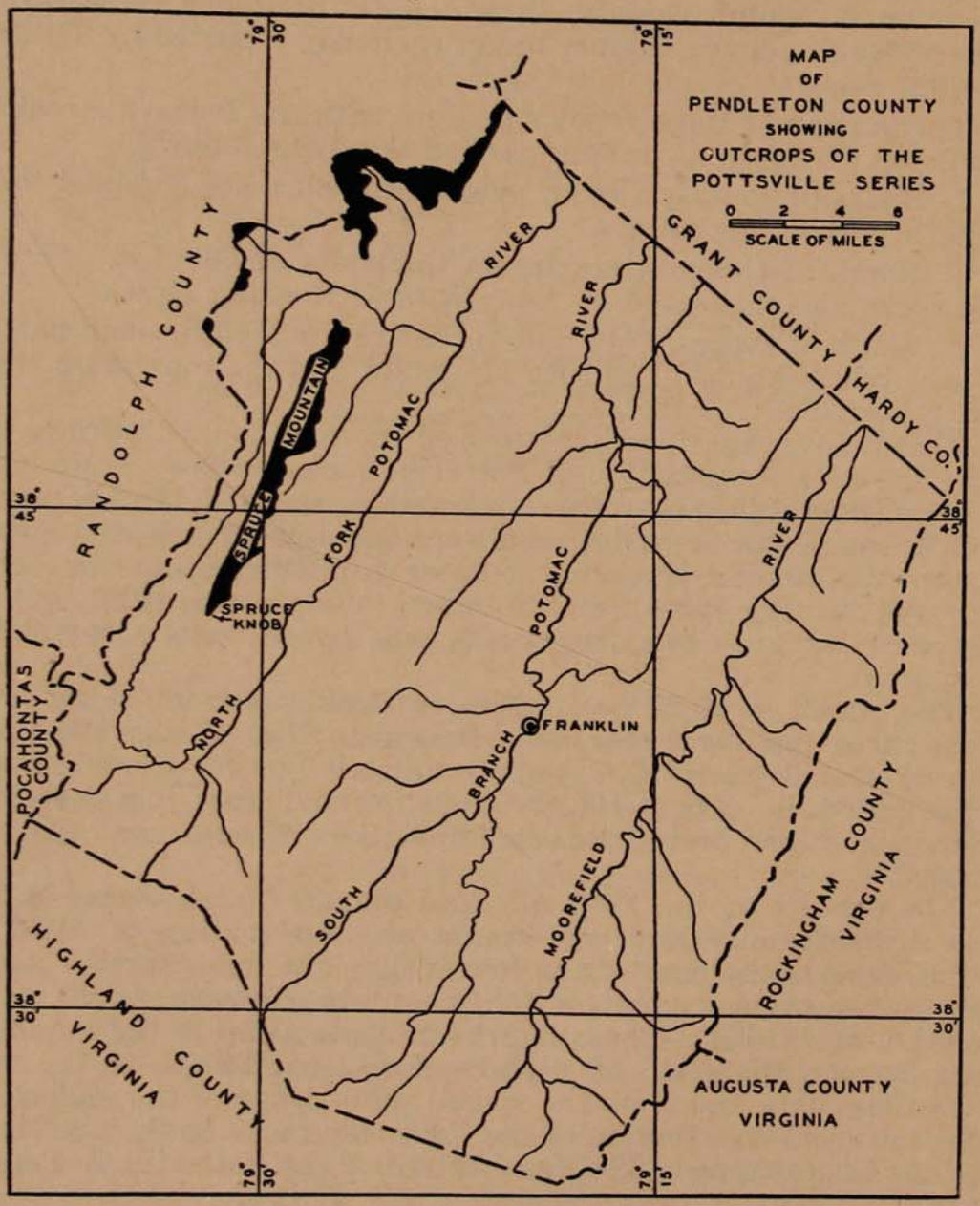
The lowest seam of coal varies in thickness from 16 to 26 in. at the three exposures observed. It is about 100 ft. above the base of the Pottsville series and is approximately 800 ft. below the crest of the mountain. About 100 ft. above the coal seam just described, another seam had been prospected and 18 in. of weathered coal was exposed.

The contact of the Pottsville and Mauch Chunk series is that of a disconformity and was found at an elevation of 3675′ B. Reger[1] reports the base of the Pottsville eight miles farther southwest on the highest point of the mountain (Spruce Knob) at an elevation of 4815′ B. These figures indicate a dip to the northeast along Spruce Mountain of slightly more than 140 ft. to the mile. From these data and from the structural attitude of the underlying rocks the areal distribution of the Pottsville rocks on Spruce Mountain has been mapped. The areal extent of the Pottsville in Pendle-

[1] Reger, D. B. 1931. Randolph County, W. Va. Geol. Sur., p. 213.

ton County, as revised by the writer, is shown in solid black on the accompanying map.

As none of the coals older than Pennsylvanian has been found to be of commercial thickness and purity in West Virginia, the areal extent of Pottsville and younger rocks is of economic importance. It is with this thought in mind that the writer feels justified in reporting the present known areal extent of rocks of the Pottsville series in Pendleton County, even though the data are not complete as desirable.



LOCAL BASE LEVELS IN WEST VIRGINIA

JOHN B. LUCKE

Department of Geology, West Virginia University

ADVANCE SUMMARY

WEST VIRGINIA has a few strikingly flat areas, near river headwaters, which appear to be old-age in stream habit and degree of reduction of slopes. Structural observations nearly always show them to be surrounded by very resistant sandstones and floored with limestone or shale, or both. The extremely "old" character is thus due to natural damming downstream from the flat area, i. e., to a local base level.

A present-day practice which is all too prevalent is to consider any local erosion level, no matter how small, to be at least a partial peneplane and therefore subject to correlation with similar levels in other areas. The writer attempts to demonstrate the inherent weaknesses in this practice, utilizing the West Virginia local base levels as field evidence.

INTRODUCTION

In traversing the Valley and Ridge physiographic province from east to west a profound change in general aspect is apparent. In the vicinity of Harrisburg or Martinsburg the general aspect is one of wide valleys, or lowlands, which are either surrounded by, or adjacent to, high narrow ridges of more resistant rocks. Further west the topography becomes characterized by multiple ridges, comparatively close together, with narrow intervening valleys. The same resistant sandstone formations (namely the Pottsville, Pocono, Oriskany, and Medina) give rise to ridges in both areas, but the spacing of ridges due to more tightly folded structures is much closer in the western segment of the province.

West of the Allegheny Front there are but few continuous valleys caused by breaching of more or less gentle anticlines and domes in the dominantly plateau structure. Many of these have such flat bottoms, steep rims, and symmetrical patterns that they are called "coves". Such is the Burke Garden cove in the Pocahontas quadrangle (Va.-W. Va.) described by Fenneman[1] as a partial peneplane. A much larger, but similar cove in West Virginia, known as the Canaan Valley, is but one of a group of features which appear to have had parallel geomorphic histories.

LOCAL BASE LEVELS IN WEST VIRGINIA

The shaded portions of Figure 1 all denote areas near the headwaters of westward-flowing streams which are extremely flat and well-graded and which in every case lie upstream from comparatively youthful gorges.

The most perfect example is Canaan Valley in Tucker County, a true cove. Although the rocks are geologically younger than those

[1] Fenneman, Nevin. 1938. **Physiography of the Eastern United States.** McGraw-Hill, p. 254 and Fig. 71.

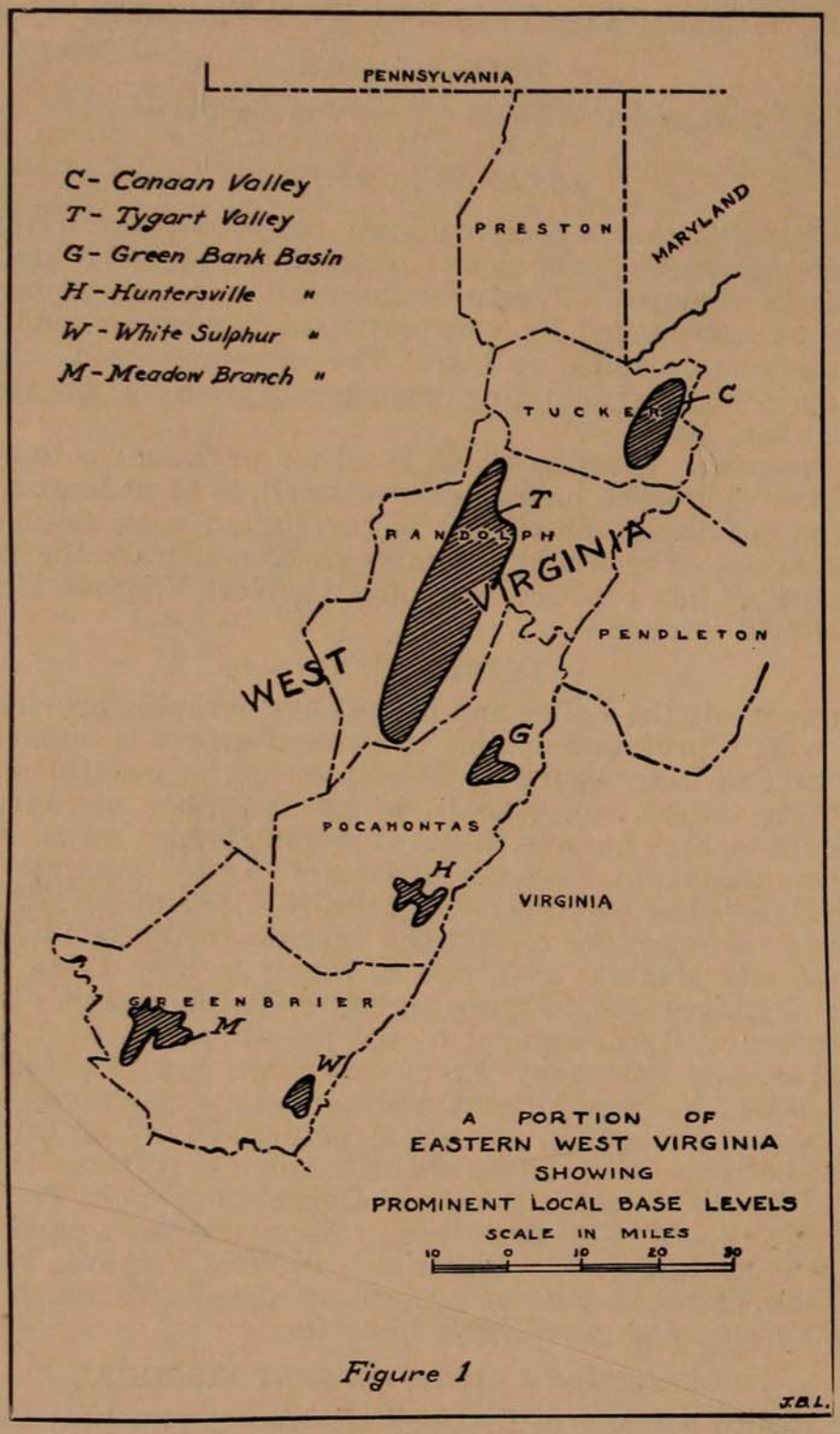


Figure 1

at Burke Garden, it appears to have undergone a parallel development in other respects. It is floored with weak Mauch Chunk shale and highly soluble Greenbrier limestone. The only outlet is the precipitous gorge of the Blackwater River, on the western edge of the valley, carved in the exceedingly tough Pottsville sandstones and conglomerates. The attitude of the Pottsville formation is shown

in Fig. 2. The Pottsville here plays the same role of a natural dam that the strong Clinch sandstone plays at Burke Garden. Such a dam, temporarily resisting erosion while weak rocks upstream are effectively base-leveled, produces what is known as a local base level of erosion. The term is obviously limited to local areas, or to a single stream, to distinguish it from a regional or ultimate base level, such as sea level, which limits the degree of downcutting by *many* streams flowing through widely separated drainage basins. The five other local base levels shown on Figure 1 differ from Canaan Valley only in size and shape and are characterized by slightly different structural variations of natural dams. As shown in Fig. 2, each basin is rimmed by one or more of the strong, ridge-making sandstones.

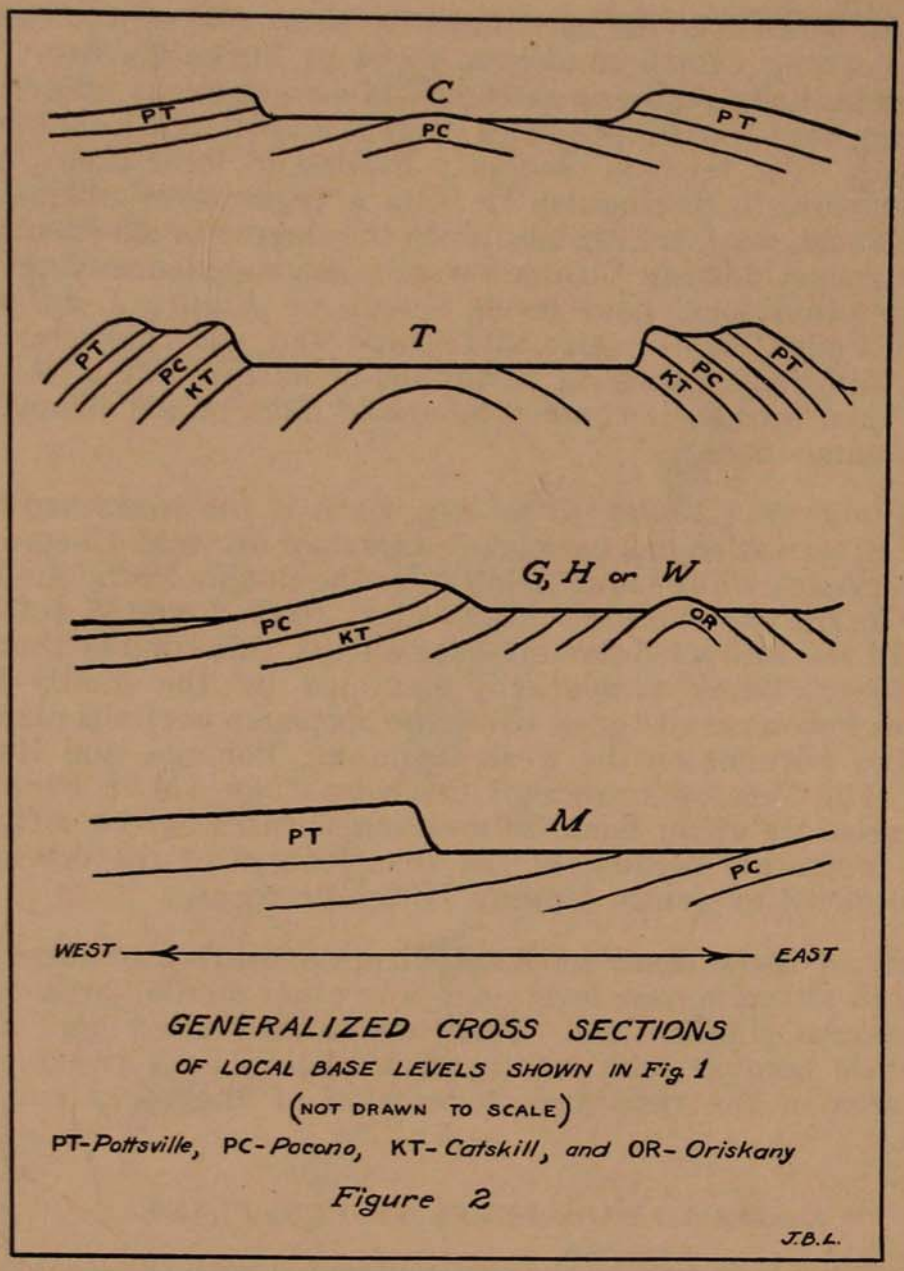
In the Tygart Valley (T in Fig. 2) it is the westward-flowing Tygart River which has base-leveled its floor on weak Chemung and Portage shales while being held up by the double Pottsville-Pocono barrier on the western edge of the valley. In G, H, and W (of Fig. 2) we again see westward-flowing headwaters, this time of the Greenbrier River, being temporarily dammed by the gently-dipping resistant Pocono sandstones, while the upstream portions plane their flat valley bottoms on the weak Chemung, Portage, and Hamilton shales. The Meadow branch of the New River (M in Fig. 2) has base-leveled its upper basin to amazing flatness on the soft Mauch Chunk formation because of the effectiveness of the downstream dam produced by gently dipping Pottsville rocks.

None of these areas in West Virginia bears any generic connection to ultimate base level or to any other similar area (outside of structural similarities). They are characterized here as local base levels because each was produced *solely* as a result of local differences in the resistance to erosion of the rocks cut by its stream.

LOCAL BASE LEVEL VS. PENEPLANE

The peneplane may be sharply contrasted with the local features defined above. As originally proposed by Davis (spelled peneplain) and as commonly used in the literature, a peneplane represents the penultimate stage of the cycle of *regional* erosion by rivers. Ideally, the peneplane is an almost-plane surface produced by prolonged erosion of a large area by multiple streams or stream systems. Its level (altitude) is controlled by *ultimate* base level (i. e., sea level, or sea level projected) entirely without regard for local rock differences.

Thus in the Appalachian region the Schooley peneplane has attained widespread recognition largely because it is a surface which bevels hard and soft formations alike. Any surface which does not do this may not be designated a peneplane without reservations.



GENERALIZED CROSS SECTIONS
OF LOCAL BASE LEVELS SHOWN IN Fig. 1
(NOT DRAWN TO SCALE)
PT-Pottsville, PC-Pocono, KT-Catskill, and OR-Oriskany

Figure 2

J.B.L.

THE HARRISBURG PENEPLANE

The Appalachian region was base-leveled again after the Schooley peneplanation, but for so short a period of time that only the comparatively weak rock belts were beveled. In the vicinity of Harrisburg and extending far south through the Shenandoah Valley an extremely flat graded surface, truncating folded beds, was produced. According to Fenneman[2],

"The floor of the Great Valley is a plain, eroded to various degrees, generally not beyond maturity. At most places where it has been dissected its nearly plane surface may be hypothetically restored by sighting over the hilltops. The

[2] Ibid. p. 247.

old surface at the horizon of the hilltops, generally called the 'Tertiary Peneplane', is here called the Harrisburg or (following Stose) the valley floor peneplane."

The writer follows Fenneman in the use of Harrisburg, but cannot justify "valley floor" as a specific, scientific term, especially in a region by no means characterized by any single valley.

Although the Harrisburg peneplane is only a partial peneplane in the sense that it was developed only in lowland areas of weak rocks, its use is fully justified where it dominates the topography of a great region like that around Harrisburg. It has obvious cyclic significance, is due to the work of multiple streams, and can often be correlated with the higher Schooley level by projected profiles.

Between such a widespread, regional erosional surface and the local type of surface described from West Virginia are many gradations. To use the term "partial peneplane" seems to beg the question, since it is clear that none but the highest erosional level beveling everything but scattered monadnocks can be considered a "complete" peneplane. Both "strath" and "berm" have been proposed for varying degrees of secondary erosion levels, but these too have not been unanimously adopted in the literature. The writer knows no single way to clarify the confusion of usage at the present time, but he draws attention to the unsoundness of considering any surface a peneplane which can be demonstrated to be without cyclic significance.

Fenneman[3] himself has decried a too-liberal application of peneplanes to regions where other processes may frequently be invoked. As a result of such practices attempts are made to correlate many surfaces which may or may not have cyclic significance. Yet in his recent volume he[4] states,

"Throughout the mountainous area the so-called Harrisburg or Tertiary peneplane is a system of graded valleys, largely under independent control and having little or no relation to ultimate base level. If all the altitudes in all these valleys were plotted on a single map, it would be impossible to deduce therefrom the amount of uplift at any one place since the close of the Harrisburg cycle."

To this the corollary might be added that it would therefore also be impossible to assign any correlative significance to erosional surfaces in the dominantly mountainous part of the Valley and Ridge province, or in the strongly folded portions of the adjacent Appalachian plateaus. In other words, in the characteristically mountainous areas the use of Harrisburg, or even of peneplane, is essentially meaningless unless the surface can be shown to bear definite connections with a fairly widespread surface of obviously cylic character. The floor of Burke Garden, therefore, is no more

[3] Fenneman, Nevin. 1937. Cyclic and non-cyclic aspects of erosion. Bulletin, Geol. Soc. Amer., vol. 47, no. 2, pp. 173-185.
[4] op. cit. p. 253.

correctly a "partial peneplane" than the floor of Canaan or any other valley beveled as a result of local rock differences rather than because of any relation to ultimate base level.

CONCLUSION

Local areas in West Virginia serve admirably to demonstrate that base leveling is not *per se* a product of peneplanation, but may well be due to extreme differences in rock resistance, especially well-developed in breached anticlines.

Wherever base leveling can logically be attributed to local conditions of this type, the resulting flat area should be called a local base level to emphasize its origin. Peneplane is a term which has little significance if not cyclic. If we would remain on sound scientific footing, we must restrict the use of peneplane to surfaces which, by reason of some connected relation to ultimate base level, or to each other over wide areas, can be assigned a correlative significance. Its use should be discouraged for all surfaces which are isolated in dominantly mountainous terrain and which may therefore be attributed solely to local conditions.

THE SAND PATTERNS ON CIRCULAR SEGMENTS

J. K. STEWART, A. W. FRIEND, and R. C. COLWELL

Department of Mathematics and Physics, West Virginia University

WHEN A CIRCULAR PLATE is vibrating as a whole the differential equation of motion is

$$(\Delta^4 - k^4)w = 0 \quad - \quad - \quad - \quad - \quad - \quad (1)$$

$$\Delta^2 = \frac{d^2}{dr^2} + \frac{1}{r}\frac{d}{dr} + \frac{1}{r^2}\frac{d^2}{d\theta^2} \quad - \quad - \quad - \quad (2)$$

The solution of this with the proper boundary conditions gives a series of circles satisfying certain Bessel Functions and a series of diameters. It is possible however to make the plate vibrate in segments and then many figures appear which are not given by the mathematical theory above. If the segments go from the center to the circumference, then each one is bounded by two radii and a segment of the circumference of the plate. As will appear in the following discussion, these segments are very much like triangles and as the angle at the apex is made smaller, there is little difference between a triangle and a circular segment.

Now Ella Goldmann[1] has shown that a triangular segment has patterns given by the formula

$$w = A\cos\frac{m\pi x}{a}\cos\frac{n\pi y}{a} + B\cos\frac{n\pi x}{a}\cos\frac{m\pi y}{a} = 0 \quad - \quad (3)$$

One of these in Fig. 1 is taken from Miss Goldmann's article. The triangle in Fig. 1a first has an angle of 60°, and when six of these are joined together, a hexagonal plate is formed (Fig. 1b). If, however, the angle is narrowed to 10 degrees (Fig. 1c), there are 36 segments and the resultant plate is practically a circle (Fig. 1d). In this way it is possible to work out thousands of new forms for the sand patterns on a circular plate.

When a plate breaks up into segments as in equation (1), each segment may also break into parts. Hence each segment is bounded by the parts of two radii and the parts of the circumference of two circles. These segments may be fitted together to form a

[1] E. Goldmann, Anwendung der Ritzschen Methode. 1918.

washer-like plate with a definite sand pattern. The equation for a square plate is

$$w = A\cos\frac{m\pi x}{a}\cos\frac{n\pi y}{a} + B\cos\frac{n\pi x}{a}\cos\frac{m\pi y}{a} = 0 \quad - \quad (4)$$

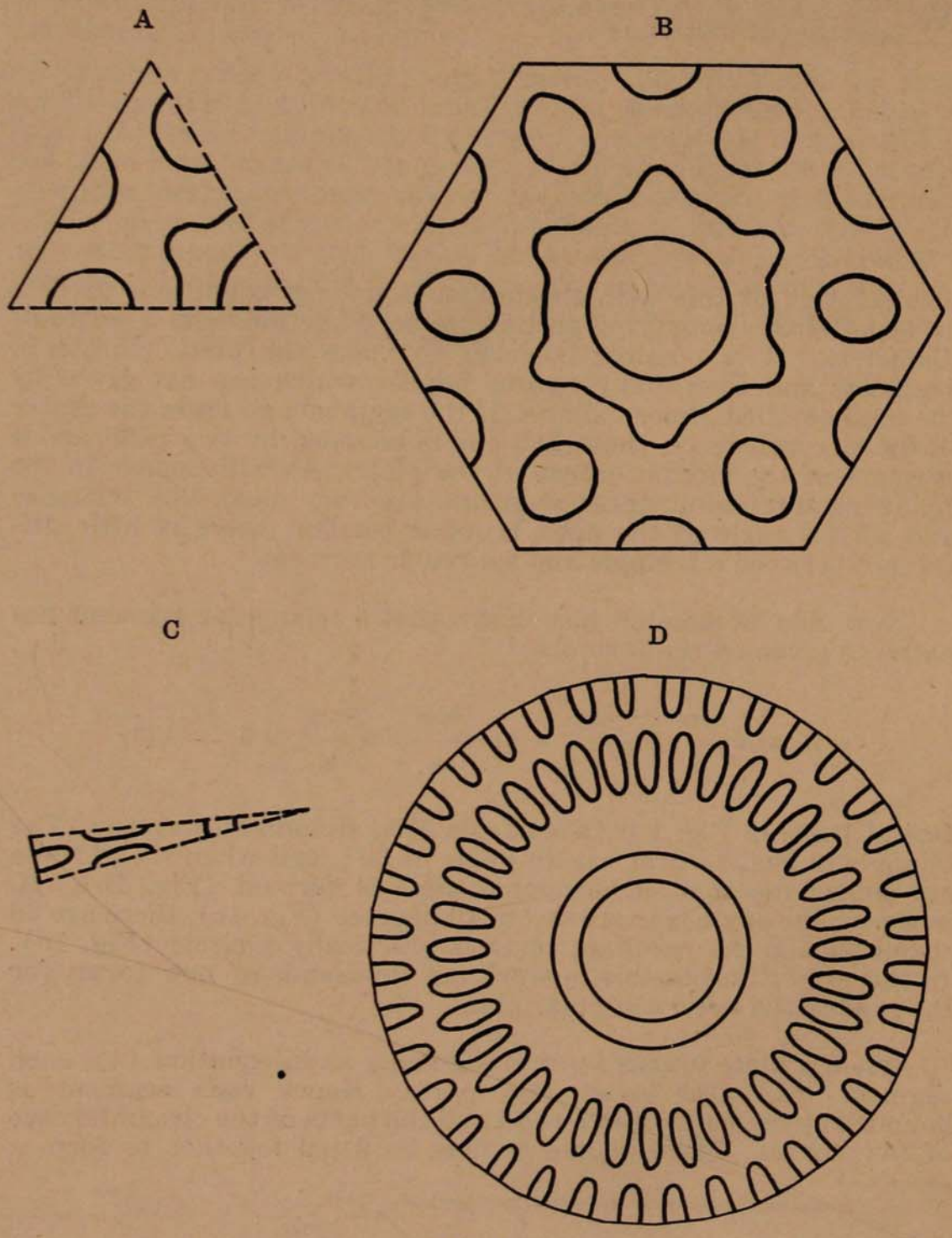


FIG. 1

When this is written

$$w = A\cos\frac{m\pi\varrho}{a}\cos\frac{n\pi\varrho\theta}{a} + B\cos\frac{n\pi\varrho}{a}\cos\frac{m\pi\varrho\theta}{a} = 0 \quad - \quad (5)$$

the equation will give the sand pattern on a curved segment since ϱ and $\varrho\theta$ are the polar coordinates of the required patterns.

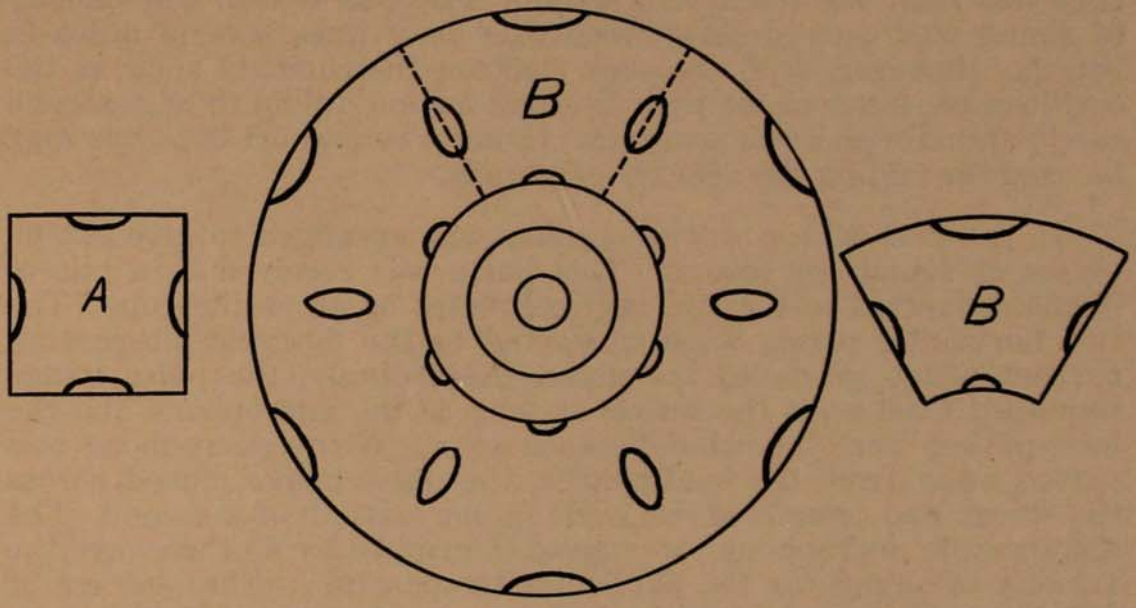


FIG. 2

These segments and the resulting circles are shown in Fig. 2.

THE VELOCITY OF SOUND

R. C. COLWELL, A. W. FRIEND, and D. A. McGRAW
Department of Physics, West Virginia University

AS LONG AS time intervals were measured with clocks and chronometers it was rather difficult to get accurate measurements, since chronometers never gave satisfactory results for divisions of time less than one tenth of a second. For this reason the velocity of sound was usually determined over base lines several miles in length. However, with the new electron instruments such as the oscilloscope, intervals of time as small as one millionth of a second can be found with great accuracy. Hence a very short base line may be used for finding the velocity of sounds.

In the first device, a loud speaker was arranged to give out 60 pulses of sound per second. This pulse was received in a microphone connected to the two vertical plates of an oscilloscope. The two horizontal plates were connected to the 60-cycle alternating current which produced the pulse. Accordingly, the pulse image remained fixed upon the screen as long as the microphone and the loudspeaker were the same distance apart. If the microphone was moved away from the loudspeaker, the pulse image moved across the screen and completed one cycle in one sixtieth of a second. The distance the microphone was moved multiplied by 60 then gave the velocity of sound for the particular temperature. The average of 300 measurements reduced to O°C gave a velocity of 331.54 meters per second. This compares very favorably with the widely accepted value 331.36 meters per second.

The main disadvantage of the first method was that the microphone had to be moved a considerable distance (5 to 6 meters) for each measurement. In a later device two microphones were used approximately 5.75 meters apart and a double throw switch connected first one and then the other to the vertical plates of the oscilloscope. This was equivalent to moving one microphone through the distance 5.75 meters. The microphones were moved a little each time with respect to the loudspeaker and adjusted until the two images (one from the first microphone, the other from the second microphone) fell exactly in the middle of the screen. The velocity found in this way agreed with the result given above.

In all measurements in which sensitive microphones are being used, the echoes from the walls and surrounding objects give rise to spurious pulsations. In order to avoid these a box ten feet long and two feet high and two feet in cross-section was lined with absorbent cotton. The loudspeaker formed one end of the box and the microphone moved back and forth along a rod in the central axis of the box. In this third case, the loudspeaker amplified the thousand-cycle note of a vibrating tuning fork. With the proper linear sweep upon the oscilloscope, these vibrations appeared as a

series of stationary sine waves upon the screen of the oscilloscope. When the microphone was moved along the axis, the sine waves moved across the screen. By measuring the distance the microphone moved to cause one sine wave to take the place of the adjacent wave, the wave length of the note could be determined accurately. From this the familiar formula $v=nl$ permits the calculation of the velocity of the sound wave.

A PARTICULAR TRANSFORMATION ASSOCIATED WITH THE CONGRUENCE OF BISECANTS OF A COMPOSITE CUBIC

A. B. CUNNINGHAM

Department of Mathematics, West Virginia University

1. Given a conic r, a line s meeting r once, and two projective pencils of surfaces

(1) $|F_{n+m+1}| : r^n s^m$; $|F'_{n'+m'+1}| : r^{n'} s^{m'}$, where $n \leqq m+1$, $n' \leqq m'+1$.

Through a generic point P passes a single surface F of |F|. The unique bisecant t through P, r, s meets the associated F′ in one residual point P′, image (T) of P. On each t of the congruence $Q_{1,2}$ lie ∞^1 pairs of points P, P′. De Paolis[1] discussed the involutorial transformation associated with the congruence of lines meeting a curve of order m and an (m—1)—fold secant, while Vogt[2] studied the transformations for a linear congruence. In the present paper a transformation is discussed in which the congruence is a $Q_{1,2}$, bisecants of a conic and a line meeting it once. The transformations associated with this congruence fall into three cases,

I, $n = m+1$, $n' = m'+1$
II, $n < m+1$, $n' < m'+1$
III, $n = m+1$, $n' < m'+1$

where the transformation studied in this paper belongs to the first case.

2. Consider the two projective pencils of surfaces

(2) $|F_4| : r^2 s \mu_7$; $|F'_2| : r \mu'_2$,

where μ_7, μ'_2 are the residual intersections of the two pencils. The curve μ_7 meets r, s in 7, 3 points[3] and μ'_2 meets r, s in 2, 0 points.

From a point O_r on r there is a pencil of transversals on s. Each direction of this pencil determines an F′ which meets the associated F in one residual point. Thus the image (T^{-1}) of O_r is a plane curve, one point on each line of the pencil. At O_r, the tangent plane of an F′ meets the pencil in one line, while the tangent cone of the associated F meets the pencil in 2 lines; hence O_r is 3-fold on the image curve of order 4 which meets s in 3 points besides A. A being the point of intersection of r and s. Therefore,

(3) $O_r \infty (T^{-1})\ r_4 : O^3_r$ A 30_s, similarly
$O_r \infty (T)\ r'_4 : O_r$ A 30_s.

From a point O_s on s there is a cone, K_2, of transversals on r. The point O_s determines an F′ and K_2 intersects the associated F in r, s and a residual s_3 which meets r in 3 points O_r and s in O_s, O_{s_1}

---

[1] De Paolis, "Alcuni particolari trasformazioni involutori dello spazio", Roma Accademia die Lincei Rendiconti, ser. 4, vol. 1 (1885), pp. 735-742, 754-758.

[2] Vogt, "Zentrale und windschiefe Raum-Verwandtschaften", Schles. Ges. Vaterl. Kult. Jahresber. 84 Abt. v. M. Sket., pp. 8-16 (1906).

[3] Snyder, V., and Sharpe, F. R., "Certain types of involutorial space transformations", Am. M. S. Trans., vol. 2 (1920), pp. 52-78. Noether, M., "Sulle curve multiple di superficie algebriche", Annali di Matematica, ser. 2, vol. 5 (1871), pp. 163-177.

where the latter is distinct from O_s. Each generator of K_2, as a direction through O_s, determines an F and meets the associated F′ in one residual point; thus the image (T) of O_s is a curve on K_2, one point on each generator. At O_s the tangent plane of an F intersects K_2 in s and one other generator, hence the curve contains O_s and meets s in another point O_{s1}. Therefore,

(4) $O_s \wr (T^{-1}) s_3 : O_s\, 3O_r\, A\, O_{s1}$.
$O_s \wr (T) s'_3 : O_s\, 3O_r\, A\, O_{s1}$.

Let w be the plane of the conic r. The only lines of the congruence in w is the pencil through A and the two pencils of surfaces meets w in r only. Any point P, on a line PO_rA, does not determine an F, consequently the image (T^{-1}) of A is the lines PO_rA. Any point P determines (T^{-1}) the same direction through A, namely that of the corresponding r_4. Therefore,

(5) $A \wr (T^{-1}) w$; similarly, $A \wr (T) w'$.

Let v be a plane determined by the tangent to r at A and the line s; the pencil through A is the total part of the congruence in v. As any point $P' \wr (T^{-1})$ P on the line P′A, therefore $v \wr (T^{-1})$ v′ line by line. For each direction through A there is determined an F′ and the line meets the associated F in one residual point, then for all directions the image locus is a curve one point on each line of the pencil. At A the tangent plane of an F′ and the tangent cone of the associated F meets v in one and two lines respectively, hence A is 2-fold on the curve of order 3 since the tangent to r drops off. This line is also one of the two tangents at A. Therefore,

(6) $A^h \wr (T^{-1}) C_3 : A^2\, O_s$; $A^h \wr (T) C'_3 : A^2\, O_s$.

The locus of all r_4 is a surface R, i. e., $r \wr (T^{-1}) R$. As every $r_4 : O^3_r\, A$, $s'_3 : 3O_3$; $R : A^{3+k}\, r^3\, s^3$. The image of A (T^{-1}) as a point on r is a composite curve consisting of C_3 and the tangent to r at A, consequently R has an additional branch through A and is of order 7. The line $s \wr (T^{-1})$ a surface S which is the locus of the curves s_3. As every $s_3 : O_s\, O_{s1}$, $r'_4 : 3O_s$; $S : A^3\, r^3\, s^2$. For A as a point on s the associated K_2 is composite, becomes the planes w, v and since the latter contains C_3, C_3 is the image (T^{-1}) of contact of r and s at A, also S is of order 6.

From any point Q′ on μ'_2 there is a unique transversal t meeting r, s in O_r, O_s. Any point P on t determines an F and t meets the associated F′ in Q′, thus $Q' \wr (T^{-1}) t$. Every point P′ on t determines the same F′ and t meets the associated F in one residual point P, hence $P \wr (T) t$. Considering all points Q′ the result is

$$\mu'_2 \wr (T^{-1}) L \quad ; \quad \mu_x \wr (T) L$$

where μ_x is the locus of points P. From O_r the pencil on s and the cone on μ'_2 intersect in 2 lines, and the surface $L : r^2$. From O_s the cones on r, μ'_2 intersect in 2 lines besides the 2 lines O_r $[r, \mu'_2]$; $L : s^2$. As a plane through s meets L in s and 2 generators, L is of order 4 and $[\mu_x, s] = (x—2)$ points.

(7) $\mu'_2 \varpi (T^{-1}) L_4 : A^2 r^2 s^2 \mu'_2 \mu_x$
$\mu_x \varpi (T) L_4 : A^2 r^2 s^2 \mu'_2 \mu_x$. Similarly,
$\mu_7 \varpi (T) L'_8 : A^4 r^4 s^4 \mu'_y \mu_7$
$\mu'_y \varpi (T^{-1}) L'_8 : A^4 r^4 s^4 \mu'_y \mu_7$, and μ'_y meets s in (y-4) points.

Since μ_7, μ'_2 meets w in only points of r, μ_x, μ'_y intersects r in x, y points respectively.

3. The eliminant of the parameter from the two projective pencils $|F_4|$, $|F'_2|$ is a point-wise invariant surface K_6. A generic plane, π', contains 2 transversals therefore a homolodial surface, likewise the transformation, is of order 8. π' meets every r_4, s'_3 and every line of the pencil in w, and $\varphi_8 : A^{4+k} r^4 s^3$. Therefore

$\pi' \varpi (T^{-1}) \varphi_8 : A^{4+k} r^4 s^3 \mu_7 \mu_x$
$\pi \varpi (T) \varphi'_8 : A^{4+k} r^4 s^3 \mu'_2 \mu'_y$

The intersection of two φ_8's gives the order of μ_x as x=8. From 2 φ_8's the order of μ'_y is y=13.

Every point on r, s is invariant for 3, 1 directions consequently $K_6 : r^3 s$ and is tangent to R_7, S_6 along r, s. The Jacobian (J) consists of $w^3 S_6 R_7 L_4 L'_8$.

Summarizing, we have the following correspondences (T^{-1}) :

$\pi' \varpi \varphi_8 : A^{4+k} r^4 s^3 \mu_7 \mu_8$
$K_6 \varpi K_6 : A^3 r^3 s \mu_7 \mu_8 \mu'_2 \mu'_{13}$
$r \varpi R_7 : A^{4+k} r^3 s^3 \mu_7 \mu_8$
(8) $s \varpi S_6 : A^3 r^3 s^2 \mu_7 \mu_8$
$\mu'_2 \varpi L_4 : A^2 r^2 s^2 \mu_8 \mu'_2$
$\mu'_{13} \varpi L'_8 : A^4 r^4 s^4 \mu_7 \mu'_{13}$
$A \varpi w : A r$

4. Cut by a plane, ζ, through s which meets r in a point O besides A. The two pencils of surfaces become

(9) $|f_2| : A O^2 4P$ $\quad$ $|f'_2| : A O 2P'$

where 4P, 2P' are the points of intersection of ζ with μ_7, μ'_2. ζ meets L_4, L'_8 in 2 lines σ, 4 lines σ', which are not rationally separable; also μ_8, μ'_{13} in 2P, 4P' points. Therefore we have the following correspondences (T^{-1}) for the monoidal plane transformation.

$\pi' \varpi \varphi_5 : A^{1+k} O^4 4P 2P$
$k_5 \varpi k_5 : A O^3 4P 2P 4P' 2P'$
$O \varpi r_4 : A^{1+k} O^3 4P 2P$
(10) $2P' \varpi 2\sigma : O^2 2P' 2P$
$4P' \varpi 4\sigma' : O^4 4P 4P'$
$A \varpi w : A r$
$j = w^2 r_4 2\sigma 4\sigma'$.

Where every φ has the same direction through A and is tangent to r_4 there, also the curves k_5, r_4 are mutually tangent at O.

5. If we let the planes w, v be the coordinate planes $x_4=0$, $x_3=0$, then we may write

r [$x_1 x_3 - x_2^2 = x_4 = 0$, $\quad$ s [$x_2 = x_3 = 0$
[r, s] = A(1, 0, 0, 0,), $\quad$ H [$x_1 x_3 - x_2^2 = 0$.

The transversal through P(y) meets r, s in N(y^2_2, y_2, y_3, y^2_3, O), M(H, O, O, y_3, y_4). The two pencils of surfaces may be taken the form

$$|F_4| \equiv F_1 - \varrho\, F_2 = 0 \qquad |F'_2| \equiv F'_1 - \varrho\, F'_2 = 0, \text{ where}$$

$$F_1 \equiv (a_1\, x_1\, x_2 + a_2\, x_1\, x_3 + a_3\, x^2_2 + a_4\, x_2\, x_3 + a_5\, x_2\, x_4 + a_6\, x^2_3 + a_7\, x_3\, x_4)x^2_4 + a_8\, H^2 + x_4\, H(a_9\, x_7 + a_{10}\, x_2 + a_{11}\, x_3) = O.$$

$$F_2 \equiv (\alpha_1\, x_1\, x_2 + \alpha_2\, x_1\, x_3 + \alpha_3\, x^2_2 + \alpha_4\, x_2\, x_3 + \alpha_5\, x_2\, x_4 + \alpha_6\, x^2_3 + \alpha_7\, x_3\, x_4)x^2_4 + \alpha_8\, H^2 + x_4\, H(\alpha_9\, x_1 + \alpha_{10}\, x_2 + a_{11}\, x_3) = O.$$

$$F'_1 \equiv a'_1\, x_1\, x_2 + a'_2\, x_1\, x_3 + a'_3\, x^2_2 + a'_4\, x_2\, x_3 + a'_5\, x_2\, x_4 + a'_6\, x^2_3 + a'_7\, x_3\, x_4 = O.$$

$$F'_2 \equiv \alpha'_1\, x_1\, x_2 + \alpha'_2\, x_1\, x_3 + \alpha'_3\, x^2_2 + \alpha'_4\, x_2\, x_3 + \alpha'_5\, x_2\, x_4 + \alpha'_6\, x^2_3 + \alpha'_7\, x_3\, x_4 = O.$$

The equations of the transformation (T^{-1}) are

$$(11)\quad \left[\begin{array}{l} \tau\ x_1 = y_1\, R_7 - K_6\, y^2_2 = y_1\, y_4\, S_6 + K_6\, H \\ \tau\ x_2 = y_2\, R_7 - K_6\, y_2\, y_3 = y_2\, y_4\, S_6 \\ \tau\ x_3 = y_3\, R_7 - K_6\, y^2_3 = y_3\, y_4\, S_6 \\ \tau\ x_4 = y_4\, R_7 = y^2_4\, S_6 + K_6\, y_3\, y_4, \text{ where} \end{array}\right.$$

$$K_6 \equiv F_2\, F'_1 - F'_2\, F_1,\ x_4\, S_6 \equiv F_1[\partial\, F'_2] - F_2[\partial\, F'_1] + x_3\, K_6$$
$$R_7 \equiv F_2(\partial\, F'_1) - F_2(\partial\, F'_2) \equiv y_4\, S_6 + K_6\, y_3, \text{ if}$$

$$(12)\quad \left[\begin{array}{l} (\partial\, U) \equiv y^2_2\, \partial\, U/\partial\, y_2 + y_2\, y_3\, \partial\, U/\partial\, y_2 + y^2_3\, \partial\, U/\partial\, y_3, \\ [\partial\, U] \equiv H\, \partial\, U/\partial\, y_1 + y_3\, y_4\, \partial\, U/\partial\, y_4, \text{ then} \end{array}\right.$$

$$x_4\, L_1 \equiv F'_1[\partial\, F'_2] - F'_2[\partial\, F'_1]$$
$$x_4\, L'_8 \equiv F_1[\partial\, F_2] - F_2[\partial\, F].$$

The transformation (T) takes the form

$$(13)\quad \left[\begin{array}{l} \tau\ y_1 = x_1\, R'_7 + K_6\, x^2_2 = x_1\, x_4\, S'_6 - K_6\, H \\ \tau\ y_2 = x_2\, R'_7 + K_6\, x_2\, x_3 = x_2\, x_4\, S'_6 \\ \tau\ y_3 = x_3\, R'_7 + K_6\, x^2_3 = x_3\, x_4\, S'_6 \\ \tau\ y_4 = x_4\, R'_7 = x^2_4\, S'_6 - K_6\, x_3\, x_4, \text{ where} \end{array}\right.$$

$$x_4\, S'_6 \equiv F'_1[\partial\, F_2] - F'_2[\partial\, F_1] - 2x_3\, K_6$$
$$R'_7 \equiv F'_2(\partial\, F_1) - F'_1(\partial\, F_2) + x_3\, K_6 \equiv x_4\, S'_6 - K_6\, x_3.$$

The plane ξ may be taken as, $x_2 = ux_3$, Then the equations of the monoidal plane transformation (T^{-1}) become

$$(14)\quad \left[\begin{array}{l} \tau\ x_1 = y_1\, r_4 - u^2\, k_5 \\ \tau\ x_3 = y_3\, r_4 - k_5 \\ \tau\ x_4 = y_4\, r_4 \end{array}\right.$$

ON TRANSFORMATIONS IN FLAT-SPHERE GEOMETRY

R. H. DOWNING

Department of Mathematics, West Virginia University

IN THIS PAPER we give a discussion of the transformations involved in the development of flat spread-sphere geometry in a non-Euclidean odd dimensional space, $\overline{S}_{n-1}$.

A non-reducible quadric may be carried by projection into the form

$$(1) \qquad \Sigma\, x_i\, y_i = 0, \quad i = 1, 2, \ldots, n/2$$

This quadric spread, which we will consider as fixed, will be called the absolute surface, or simply the absolute.[1] There exists a group of $\infty^{n(n-1)/2}$ transformations, the automorphic group of the quadric (1). This group is generated by the following $\frac{n(n-1)}{2}$ infinitesimal transformations, using the Lie symbols.[2]

$$(2) \qquad \begin{aligned}
&\text{a)} \begin{cases} x_k \dfrac{\partial f}{\partial x_i} - y_i \dfrac{\partial f}{\partial y_k} \\ x_i \dfrac{\partial f}{\partial x_k} - y_k \dfrac{\partial f}{\partial y_i} \end{cases} \qquad
\text{c)}\ x_{n/2} \frac{\partial f}{\partial x_{n/2}} - y_{n/2} \frac{\partial f}{\partial y_{n/2}} \\
&\text{b)} \begin{cases} y_i \dfrac{\partial f}{\partial x_k} - y_k \dfrac{\partial f}{\partial x_i} \\ x_k \dfrac{\partial f}{\partial y_i} - x_i \dfrac{\partial f}{\partial y_k} \end{cases} \qquad
\text{d)} \begin{cases} y_i \dfrac{\partial f}{\partial y_{n/2}} - x_{n/2} \dfrac{\partial f}{\partial x_i} \\ x_i \dfrac{\partial f}{\partial x_{n/2}} - y_{n/2} \dfrac{\partial f}{\partial y_i} \end{cases} \\
&\text{c)}\ x_i \frac{\partial f}{\partial x_i} - y_i \frac{\partial f}{\partial y_i} \qquad
\text{e)} \begin{cases} x_i \dfrac{\partial f}{\partial y_{n/2}} - x_{n/2} \dfrac{\partial f}{\partial y_i} \\ y_i \dfrac{\partial f}{\partial x_{n/2}} - y_{n/2} \dfrac{\partial f}{\partial x_i} \end{cases}
\end{aligned}$$

$$i = 1, 2, \ldots, \frac{n-2}{2}$$

to which must be added $\Sigma\, x_i \dfrac{\partial f}{\partial x_i} + \Sigma\, y_i \dfrac{\partial f}{\partial y_i}$ since we are using homogeneous coordinates.

The quadric (1) may be represented parametrically by the equations

$$(3) \quad \varrho x_i = -p_i\, q_{n/2},\ \varrho y_i = q_i\, p_{n/2},\ \varrho x_{n/2} = p_{n/2}\, q_{n/2},\ \varrho y_{n/2} = \Sigma\, p_i\, q_i$$

There exists on the quadric (1) two special sets of flat generators of $\frac{n-2}{2}$ dimensions, namely

$$(4)\quad \text{a)}\ x_i = -\frac{p_i}{p_{n/2}}\,x_{n/2},\quad y_{n/2} = \frac{\Sigma\, p_i\, y_i}{p_{n/2}}$$

$$\text{b)}\ y_i = \frac{q_i}{q_{n/2}}\,x_{n/2},\quad y_{n/2} = -\frac{\Sigma\, q_i\, x_i}{q_{n/2}}\quad i=1, 2, \ldots, \frac{n-2}{2}$$

and the absolute may be considered as generated by either one of these rulings. Any two generators a) and b) intersect in a point

$$\frac{x_i}{x_{n/2}} = -\frac{p_i}{p_{n/2}},\ \frac{y_i}{x_{n/2}} = \frac{q_i}{q_{n/2}},\ \frac{y_{n/2}}{x_{n/2}} = \frac{\Sigma\, p_i\, q_i}{p_{n/2}\, q_{n/2}}\quad i=1, 2, \ldots, \frac{n-2}{2}$$

Any two generators of the same kind intersect in general in an $\frac{n-6}{2}$—flat which, in the case of a generator a), is immersed in the coordinate space $x_i = x_{n/2} = 0$; and in that of a generator b), in an $\frac{n-6}{2}$ flat immersed in the coordinate space $y_i = x_{n/2} = 0$. The generators a) and b) are special self-dual flats in S_{n-1} and may be considered the analogues of the rectilinear generators of the quadric in ordinary space.

If we put

$$r_1 : \ldots : r_{n/2} : s_1 : \ldots s_{n/2} = p_1 : \ldots : p_{n/2} : q_1 : \ldots : q_{n/2}$$

r_i, s_i being the homogeneous coordinates of a space S_{n-1}, it appears that to a point r_i, s_i in this space which lies on the coordinate flat $(r_1 : \ldots : r_{n/2} : 0 : \ldots\ldots : 0)$ corresponds a flat generator a) and to a point on the coordinate flat $(0 : \ldots : 0 : s_1 : \ldots\ldots : s_{n/2})$ corresponds a flat generator b); that is to say: *the flat generators of the absolute are represented in S_{n-1} by two n/2-ary fields.*

The automorphic group (2) induces a mixed group of transformations in the p- and q- fields which we shall now study.[3] [4]

The transformations (2, a) form a subgroup of $G_{\frac{n(n-1)}{2}}$, the finite equations of which are:

$$(5)\quad x'_i = \Sigma\, a_{ik}\, x_k,\ y_i = \Sigma\, A_{ik}\, y_k,\ x'_{n/2} = x_{n/2},\ y'_{n/2} = y_{n/2}$$

where the parameters A_{ik} are the cofactors of the elements in the determinant $|a_{ik}|$, divided by this determinant itself. The p's and q's are transformed as follows:

(5) $p'_i = \Sigma\, a_{ik}\, p_k,\ q'_i = \Sigma\, A_{ik}\, q_k,\ p'_{n/2} = p_{n/2},\ q'_{n/2} = q_{n/2}$

Thus the p- and q- fields are transformed separately and linearly.

The transformations (2, c) form a subgroup with finite equations:

(6) $x'_i = w_i\, x_i,\ y'_i = \dfrac{1}{w_i}\, y_i,\ x'_{n/2} = w_{n/2}\, x_{n/2},\ y'_{n/2} = \dfrac{1}{w_{n/2}}\, y_{n/2}$

The p- and q- fields are transformed separately and linearly as follows:

(6′) $p'_i = w_i\, p_i,\ q'_i = \dfrac{1}{w_i}\, q_i,\ p'_{n/2} = w_{n/2}\, p_{n/2},\ q'_{n/2} = \dfrac{1}{w_{n/2}}\, q_{n/2}$

From (2, d), which form a subgroup, we have

(7) $\begin{cases} x'_i = t_i\, x_{n/2} + x_i,\ y'_i = u_i\, x_{n/2} + y_i,\ x'_{n/2} = x_{n/2}, \\ y'_{n/2} = y_{n/2} - \Sigma\, u_i\, x_i - \Sigma\, t_i\, y_i - \Sigma\, u_i\, t_i\, x_{n/2} \end{cases}$

(7′) $p'_i = p_i - t_i\, p_{n/2},\ q'_i = q_i + u_i\, q_{n/2},\ p'_{n/2} = p_{n/2},\ q'_{n/2} = q_{n/2}$

Thus the p- and q- fields are transformed separately and linearly.

The transformations (2, b), which do not form a subgroup, have the finite equations:

(8) $x'_i = \Sigma\, \alpha_{ik}\, y_k + x_i,\ y'_i = \Sigma\, \beta_{ik}\, x_k + y_i,\ x'_{n/2} = x_{n/2},\ y'_{n/2} = y_{n/2}$
where $\alpha_{ik} = -\alpha_{ki},\ \beta_{ik} = -\beta_{ki},\ \alpha_{ii} = \beta_{ii} = 0$

The p- and q- fields are transformed jointly as follows:

(8′) $\begin{cases} \varrho\, p'_i = -\Sigma\, \alpha_{ik}\, q_k\, p_{n/2} + p_i\, q_{n/2} \\ \varrho\, q'_i = -\Sigma\, \beta_{ik}\, p_k\, q_{n/2} + q_i\, p_{n/2} \\ \varrho\, p'_{n/2} = p_{n/2}\, q_{n/2} \\ \varrho\, q'_{n/2} = p_{n/2}\, q_{n/2} \end{cases}$

This is a quadric involution for $n > 4$. If $n = 4$ the p- and q- fields are not transformed.

From (2, e), which form a subgroup, we have:

(9) $\begin{cases} x'_i = w_i\, y_{n/2} + x_i \\ y'_i = v_i\, y_{n/2} + y_i \\ y'_{n/2} = y_{n/2} \\ x'_{n/2} = x_{n/2} - \Sigma\, v_i\, x_i - \Sigma\, w_i\, y_i - \Sigma\, v_i\, w_i\, y_{n/2} \end{cases}$

(9′) $\begin{cases} \varrho\, p'_i = p_i\, q_{n/2} - w_i\, \Sigma\, p_i\, q_i \\ \varrho\, q'_i = q_i\, p_{n/2} + v_i\, \Sigma\, p_i\, q_i \\ \varrho\, p'_{n/2} = p_{n/2}\, q_{n/2} + \Sigma\, v_i\, p_i\, q_{n/2} - \Sigma\, w_i\, q_i\, p_{n/2} - \Sigma\, v_i\, w_i\, p_i\, q_i \\ \varrho\, q'_{n/2} = p_{n/2}\, q_{n/2} + \Sigma\, v_i\, p_i\, q_{n/2} - \Sigma\, w_i\, q_i\, p_{n/2} - \Sigma\, v_i\, w_i\, p_i\, q_i \end{cases}$

The p- and q- fields are transformed jointly by this quadric transformation.

The corresponding group on the r_i, s_i coordinates in S_{n-1} follows:

I. $r'_i = \Sigma\, a_{ik}\, r_k,\ s'_i = \Sigma\, A_{ik}\, s_k,\ r'_{n/2} = r_{n/2},\ s'_{n/2} = s_{n/2}$

II. $r'_i = w_i\, r_i,\ s'_i = \dfrac{1}{w_i}\, s_i,\ r'_{n/2} = w_{n/2}\, r_{n/2},\ s'_{n/2} = \dfrac{1}{w_{n/2}}\, s_{n/2}$

III. $r'_i = r_i - t_i\, r_{n/2},\ s'_i = s_i + u_i\, s_{n/2},\ r'_{n/2} = r_{n/2},\ s'_{n/2} = s_{n/2}$

IV. $\begin{cases} r'_i = -\Sigma\, \alpha_{ik}\, s_k\, r_{n/2} + r_i\, s_{n/2},\ r'_{n/2} = r_{n/2}\, s_{n/2} \\ s'_i = -\Sigma\, \beta_{ik}\, r_k\, s_{n/2} + s_i\, r_{n/2},\ s'_{n/2} = r_{n/2}\, s_{n/2} \end{cases}$

V. $\begin{cases} r'_i = r_i\, s_{n/2} - w_i \Sigma\, r_i\, s_i \\ s'_i = s_i\, r_{n/2} + v_i \Sigma\, r_i\, s_i \\ r'_{n/2} = r_{n/2}\, s_{n/2} + \Sigma\, v_i\, r_i\, s_{n/2} - \Sigma\, w_i\, s_i\, r_{n/2} - \Sigma\, v_i\, w_i\, r_i\, s_i \\ s'_{n/2} = r_{n/2}\, s_{n/2} + \Sigma\, v_i\, r_i\, s_{n/2} - \Sigma\, w_i\, s_i\, r_{n/2} - \Sigma\, v_i\, w_i\, r_i\, s_i \end{cases}$

We may now state the following: *There exists a group of* $\infty^{n(n-1)/2}$ *transformations, the automorphic group of the quadric (1), that is, the absolute. These transformations induce a mixed group of linear and quadric transformations on the p- and q- fields. They induce a corresponding group of the* r_i, s_i *coordinates of the image space.*

In a former paper[5] the correspondences of certain elements in the spaces $\overline{S_{n-1}}$, S_n, and S_{n-1} were shown. Added to these we may easily prove that to an oriented point[6] of intersection of tangent flats X and Y[1] in $\overline{S_{n-1}}$ corresponds an oriented point of intersection of generators P and Q of the quadric $M_{n-1}^{(2)}: \Sigma\, x_i\, y_i + z^2 = 0$ in S_n, and an $\dfrac{n-2}{2}$ — flat of the principal complex in the image space S_{n-1}.

Also, to oriented $(n-2)$—flats U, which unite the generators P and Q and which are tangent to the quadric $M_{n-1}^{(2)}$, correspond the surface elements of S_{n-1}[7].

We will now state the following: *In the continuum of the oriented tangent flats U there exists a group* $G_{n+1\,.\,n+2/2}$, *and its dual* $H_{n+1\,.\,n+2/2}$, *of one-valued analytic contact transformations*[8] *which carry unions of oriented flats U into unions of flats. In the image space we have the corresponding transformations* $\Gamma_{n+1\,.\,n+2/2}$, $H_{n+1\,.\,n+2/2}$ *which carry* $\dfrac{n-2}{2}$ *-flats into flats.*[9]

A transformation of the group $G_{n+1\,.\,n+2/2}$, $H_{n+1\,.\,n+2/2}$ which carries singular oriented flats U into singular oriented flats belongs to a subgroup $G^x_{n(n+1)/2}$, $H^x_{n(n+1)/2}$, the automorphic group of the quadric $M_{n-1}^{(2)}$. These two series of transformations have for image in S_{n-1} the group $\Gamma^x_{n(n+1)/2}$, which leaves the principal complex invariant, and the transformations $H^x_{n(n+1)/2}$ of this complex

Consider a flat in the image space S_{n-1}:

$$(10)\quad \begin{cases} \sigma_0 r_1 + \varrho_1 r_{n/2} - \sigma_{n/2} s_1 = 0 \\ \sigma_0 s_{n/2} + \Sigma \sigma_1 s_1 + \varrho_{n/2} r_{n/2} = 0 \\ \sigma_{n/2} s_{n/2} + \Sigma \sigma_1 r_1 - \varrho_0 r_{n/2} = 0 \end{cases} \qquad i = 1, 2, \ldots, \frac{n-2}{2}$$

The group $\Gamma_{n+1\,.\,n+2/2}$ which carries flats into flats has a corresponding group $A_{n+1\,.\,n+2/2}{}^{(10)}$, of the ϱ_i, σ_i coordinates, which when applied to the transformations $\Gamma_{n+1\,.\,n+2/2}$, with respect to (10) give the corresponding transformations of $A_{n+1\,.\,n+2/2}$. Thus to the group $\Gamma_{n+1\,.\,n+2/2}$ corresponds the projective group of the quadric $\Sigma\, \varrho_i\, \sigma_i = 0$. To points of this quadric will then correspond flats (10) in the image space S_{n-1}.

The Lie symbols of the group $A_{n+1\,.\,n+2/2}$ of the quadric $\Sigma\, \varrho_i\, \sigma_i = 0$ follow:

$$\sigma_{n/2}\frac{\partial f}{\partial \varrho_0} - \sigma_0 \frac{\partial f}{\partial \varrho_{n/2}},\ \sigma_1 \frac{\partial f}{\partial \varrho_0} - \sigma_0 \frac{\partial f}{\partial \varrho_1},\ \sigma_{n/2}\frac{\partial f}{\partial \varrho_1} - \sigma_1 \frac{\partial f}{\partial \varrho_{n/2}},$$

$$\varrho_1 \frac{\partial f}{\partial \varrho_{n/2}} - \sigma_{n/2}\frac{\partial f}{\partial \sigma_1},\ \varrho_1 \frac{\partial f}{\partial \varrho_0} - \sigma_0 \frac{\partial f}{\partial \sigma_1},\ \Sigma \sigma_1 \frac{\partial f}{\partial \sigma_1} + \varrho_{n/2}\frac{\partial f}{\partial \varrho_{n/2}} + \varrho_0 \frac{\partial f}{\partial \varrho_0},$$

$$\varrho_1 \frac{\partial f}{\partial \varrho_1} - \sigma_1 \frac{\partial f}{\partial \sigma_1},\ \varrho_k \frac{\partial f}{\partial \varrho_1} - \sigma_1 \frac{\partial f}{\partial \sigma_k},\ \sigma_0 \frac{\partial f}{\partial \sigma_{n/2}} - \varrho_{n/2}\frac{\partial f}{\partial \varrho_0},$$

$$\sigma_{n/2}\frac{\partial f}{\partial \sigma_{n/2}} + \varrho_0 \frac{\partial f}{\partial \varrho_0} - \sigma_0 \frac{\partial f}{\partial \sigma_0} - \varrho_{n/2}\frac{\partial f}{\partial \varrho_{n/2}},\ \sigma_{n/2}\frac{\partial f}{\partial \sigma_0} - \varrho_0 \frac{\partial f}{\partial \varrho_{n/2}},$$

$$\varrho_1 \frac{\partial f}{\partial \sigma_k} - \varrho_k \frac{\partial f}{\partial \sigma_1},\ \varrho_k \frac{\partial f}{\partial \sigma_{n/2}} - \varrho_{n/2}\frac{\partial f}{\partial \sigma_k},\ \varrho_k \frac{\partial f}{\partial \sigma_0} - \varrho_0 \frac{\partial f}{\partial \sigma_k},$$

$$\sigma_1 \frac{\partial f}{\partial \varrho_k} - \sigma_k \frac{\partial f}{\partial \varrho_1},\ \varrho_{n/2}\frac{\partial f}{\partial \varrho_k} - \sigma_k \frac{\partial f}{\partial \sigma_{n/2}},\ \sigma_k \frac{\partial f}{\partial \sigma_0} - \varrho_0 \frac{\partial f}{\partial \varrho_k},$$

$$\varrho_{n/2}\frac{\partial f}{\partial \sigma_0} - \varrho_0 \frac{\partial f}{\partial \sigma_{n/2}},\ \sum_1^{n/2} \varrho_1 \frac{\partial f}{\partial \varrho_1} + \sum_1^{n/2} \sigma_1 \frac{\partial f}{\partial \sigma_1}.$$

The Lie symbols of the group $\Gamma_{n+1\,.\,n+2/2}$ in S_{n-1} are:

$$r_{n/2}\frac{\partial f}{\partial s_{n/2}},\ r_{n/2}\frac{\partial f}{\partial r_1},\ r_{n/2}\frac{\partial f}{\partial s_1},\ r_1 \frac{\partial f}{\partial s_{n/2}},\ -\left(r_1 \frac{\partial f}{\partial r_1} + s_1 \frac{\partial f}{\partial s_1} + r_{n/2}\frac{\partial f}{\partial r_{n/2}}\right),$$

$$r_1 \frac{\partial f}{\partial r_1} + s_1 \frac{\partial f}{\partial s_1},\ r_k \frac{\partial f}{\partial r_1} + s_k \frac{\partial f}{\partial s_1},\ \Sigma s_1 \frac{\partial f}{\partial r_1},\ r_1 \frac{\partial f}{\partial r_1} - s_1 \frac{\partial f}{\partial s_1},$$

$$\Sigma r_i \frac{\partial f}{\partial s_i}, \frac{r_i s_k - r_k s_i}{r_{n/2}} \frac{\partial f}{\partial s_{n/2}}, \frac{1}{r_{n/2}} \left[s_k \Sigma s_i \frac{\partial f}{\partial s_i} + r_k \Sigma s_i \frac{\partial f}{\partial r_i} + s_k s_{n/2} \frac{\partial f}{\partial s_{n/2}} \right],$$

$$\frac{1}{r_{n/2}} \left[r_k \Sigma r_i \frac{\partial f}{\partial r_i} + s_k \Sigma r_i \frac{\partial f}{\partial s_i} + s_{n/2} r_k \frac{\partial f}{\partial s_{n/2}} \right], s_{n/2} \frac{\partial f}{\partial r_k},$$

$$\frac{r_{n/2} s_{n/2}}{r_i s_i} \left[r_i \frac{\partial f}{\partial r_i} + s_i \frac{\partial f}{\partial s_i} + r_{n/2} \frac{\partial f}{\partial r_{n/2}} \right], s_{n/2} \frac{\partial f}{\partial s_k},$$

$$\frac{s_{n/2}}{r_{n/2}} \left[\Sigma r_i \frac{\partial f}{\partial r_i} + \Sigma s_i \frac{\partial f}{\partial s_i} + s_{n/2} \frac{\partial f}{\partial s_{n/2}} \right], \sum_1^{n/2} r_i \frac{\partial f}{\partial r_i} + \sum_1^{n/2} s_i \frac{\partial f}{\partial s_i}$$

these being arranged in the same order as the transformations of the group $A_{n+1\ .\ n+2/2}$.

The subgroup $\Gamma^x_{n(n+1)/2}$ of the above group and the subgroup $G^x_{n(n+1)/2}$ of the group $G_{n+1\ .\ n+2/2}$ are given below by their Lie symbols. The dual transformations $H^x_{n(n+1)/2}$ and $H^x_{n(n+1)/2}$ are found very easily from these transformations and will be omitted here.

$$G^x_{n(n+1)/2}$$

$$z \frac{\partial f}{\partial y_{n/2}} - x_{n/2} \frac{\partial f}{\partial z}, y_i \frac{\partial f}{\partial y_{n/2}} - x_{n/2} \frac{\partial f}{\partial x_i}, z \frac{\partial f}{\partial x_i} - y_i \frac{\partial f}{\partial z},$$

$$x_i \frac{\partial f}{\partial z} - z \frac{\partial f}{\partial y_i}, \Sigma y_i \frac{\partial f}{\partial y_i} + z \frac{\partial f}{\partial z} + y_{n/2} \frac{\partial f}{\partial y_{n/2}},$$

$$x_i \frac{\partial f}{\partial x_i} - y_i \frac{\partial f}{\partial y_i}, x_k \frac{\partial f}{\partial x_i} - y_i \frac{\partial f}{\partial y_k}, x_i \frac{\partial f}{\partial y_{n/2}} - x_{n/2} \frac{\partial f}{\partial y_i},$$

$$z \frac{\partial f}{\partial x_{n/2}} - y_{n/2} \frac{\partial f}{\partial z}, x_i \frac{\partial f}{\partial y_k} - x_k \frac{\partial f}{\partial y_i}, x_k \frac{\partial f}{\partial z} - z \frac{\partial f}{\partial y_k},$$

$$x_k \frac{\partial f}{\partial x_{n/2}} - y_{n/2} \frac{\partial f}{\partial y_k}, y_i \frac{\partial f}{\partial x_k} - y_k \frac{\partial f}{\partial x_i}, z \frac{\partial f}{\partial x_k} - y_k \frac{\partial f}{\partial z},$$

$$y_k \frac{\partial f}{\partial x_{n/2}} - y_{n/2} \frac{\partial f}{\partial x_k}, \sum_1^{n/2} x_i \frac{\partial f}{\partial x_i} + \sum_1^{n/2} y_i \frac{\partial f}{\partial y_i}$$

$$\Gamma^x_{n(n+1)/2}$$

$$r_{n/2} \frac{\partial f}{\partial s_{n/2}}, r_{n/2} \frac{\partial f}{\partial r_i}, r_{n/2} \frac{\partial f}{\partial s_i}, r_i \frac{\partial f}{\partial s_{n/2}},$$

$$-\left(r_i\frac{\partial f}{\partial r_i}+s_i\frac{\partial f}{\partial s_i}+r_{n/2}\frac{\partial f}{\partial r_{n/2}}\right),\ r_i\frac{\partial f}{\partial r_i}+s_i\frac{\partial f}{\partial s_i},$$

$$r_k\frac{\partial f}{\partial r_i}+s_k\frac{\partial f}{\partial s_i},\ s_i\frac{\partial f}{\partial s_{n/2}},\ \frac{s_{n/2}}{r_{n/2}}\left[r_i\frac{\partial f}{\partial r_i}+s_i\frac{\partial f}{\partial s_i}+s_{n/2}\frac{\partial f}{\partial s_{n/2}}\right],$$

$$\frac{r_i s_k - r_k s_i}{r_{n/2}}\frac{\partial f}{\partial s_{n/2}},\ \frac{1}{r_{n/2}}\left[s_k\sum s_i\frac{\partial f}{\partial s_i}+r_k\sum s_i\frac{\partial f}{\partial r_i}+s_k s_{n/2}\frac{\partial f}{\partial s_{n/2}}\right],$$

$$s_{n/2}\frac{\partial f}{\partial r_k},\ \frac{1}{r_{n/2}}\left[r_k\sum r_i\frac{\partial f}{\partial r_i}+s_k\sum r_i\frac{\partial f}{\partial s_i}+r_k s_{n/2}\frac{\partial f}{\partial s_{n/2}}\right],$$

$$s_{n/2}\frac{\partial f}{\partial s_k},\ \frac{r_{n/2}s_{n/2}}{r_i s_i}\left[r_i\frac{\partial f}{\partial r_i}+s_i\frac{\partial f}{\partial s_i}+r_{n/2}\frac{\partial f}{\partial r_{n/2}}\right],$$

$$\sum_1^{n/2} r_i\frac{\partial f}{\partial r_i}+\sum_1^{n/2} s_i\frac{\partial f}{\partial s_i}$$

---

(1) Downing, R. H. Proceedings W. Va. Acad. of Sc. **10**, 149.

(2) Bianchi, I. Lezioni sulla teoria die gruppi continui finiti di trasformazioni: 150-151. Enrico Spoerri, Pisa (1918).

(3) Campbell, J. E. Theory of continuous groups: 46-48, Oxford, Clarendon Press (1903).

(4) Lie, S.-Sheffers, G. Vorlesungen über differential Gleichungen mit bekannten infinitesimalen Transformationen: 287-308. B. G. Teubner, Leipzig (1912).

(5) Downing, R. H. Proceedings W. Va. Acad. of Sc. **10**, 150.

(6) Study, E. Math. Ann. **91**:87 (1924).

(7) Downing, R. H. Read at a meeting of the Math. Asso. of Amer., March 1934, at Pittsburgh, Pa.

(8) Lie, S.Scheffers, G. Vorlesungen über Continuirliche Gruppen: 366-400, Teubner, Leipzig (1893).

(9) Lie, S.-Scheffers, G. Geometrie der Berührungstransformationen, I: 452, Teubner, Leipzig (1896).

(10) Eiesland, J. A. Tôhuku Math. Jour. **17**: 318 (1920).

(11) Lie, S.-Scheffers, G. **vide (9) supra**, p. 245.

Government Aid for Homes for Low-Income Groups

A. J. DADISMAN

Department of Economics, West Virginia University

CAREFUL SURVEYS indicate that more than one-third of the people living in our towns and cities throughout the United States live in substandard houses which menace public health, morals, and happiness. Indirectly we are all affected by this group by its influence on crime, disease, fire hazards, and epidemics. There is no part of the country or any type of city that does not have its problems of poor housing. The federal director of housing recently said, "The most pressing problem facing the people of the United States, for which no final solution has as yet been demonstrated, is that of housing low-income groups."

Poor housing conditions have existed for untold generations. The need for action to improve such conditions has been recognized by occasional persons for a century, but a challenge strong enough to bring action is very new. Since the country has been aroused, several bright new theories as to how to solve the housing problem have found their way to front pages of newspapers repeatedly. Nathan Strouss, Administrator of the United States Housing Authority, says, "We have just taken the greatest single step forward in national housing policy ever taken by any country." But this is a federal undertaking, and one often hears, "Why not let private industry take care of its own housing problem?" The answer is that it is simply impossible.

Families living in what might be called city slums pay rentals from $4 to $7 per room per month, or from $15 to $25 per house or apartment per month. The bare cost of upkeep and maintenance in the cities is equal to the rent paid by slum dwellers. Actual costs of operating large-scale housing projects properly cared for including heating, varies from $5 to $6 per room per month, which is all the rent a slum family can afford to pay. This allows nothing for taxes, interest, or payments on purchase obligations. The conclusion reached is that private industry under present conditions cannot rehouse dwellers in slum districts in any kind of suitable new houses. If private industry could have solved the housing problem for slum dwellers, it is probable that it would have done so long ago. Then, if rehousing the slum dwellers is done at all, it must be done with government aid.

There have been several recent attempts at government aid for housing low-income groups. The main purpose of the subsistence homestead projects, which started on October 1, 1933, was to relocate and rehabilitate families left stranded by the decline of industry in the areas in which they lived. There were 149 projects

initiated which when completed would provide decent houses along with some income for approximately 18,690 families. To date 28 of these projects have been completed.

Arthurdale is typical of these projects. It was completed on August 25, 1937, and is now owned and operated by the Arthurdale Association, a non-profit cooperative organization of homesteaders, chartered under the laws of West Virginia. The project consists of 165 unit houses, 26 have 4 rooms, 23 have 5 rooms, and 116 have 6 rooms. Houses are heated with hot air, hot water, or steam. All have running water, modern plumbing, and electricity.

More than half of the accepted homesteaders were destitute miners. All but a few of the families were on relief when they were accepted for the project, and the average income from all sources for the 12-month period previous to applying for a place on this project was $467 per family. The average education was eighth grade. The average family income now is about $1,020 per year.

At Red House, 28 miles northwest of Charleston, is another subsistence homestead project consisting of 150 two-story, concrete cinder-block homes. The project has been completed and the houses are occupied by families from relief rolls from West Virginia. Red House was initiated by the Federal Emergency Relief Administration and deeded to the West Virginia Rural Rehabilitation Corporation. On July 1, 1935, it was transferred to the Resettlement Administration and is now under the Farm Security Administration.

The land use program of the Resettlement Administration calls for the addition of some 9,000,000 acres of misused and unproductive farm land, on which are located more than 16,800 families, to the holdings of the Federal Government. The average net income of these families, including relief, is less than $100 a year. Through the working out of this plan 350 families are being helped to relocate on land where they can hope for at least fairly good living conditions and an income sufficient to support themselves.

An entirely new approach to the problem of low-rent housing for low-income groups is presented by three suburban Resettlement Administration towns now being built. Instead of constructing new houses in congested areas, the plan is to build new suburban towns near growing cities. The families living in these homes are to be employed in the nearby cities. The first of three Resettlement towns to get under way was Greenbelt, located in Maryland five miles east of the corporate limits of Washington, D. C. When the project is completed, most of the 3,000 homes at Greenbelt, will consist of group houses, built of brick or cinder blocks, and 288 apartment units. The work is well along on the first 1,000 homes and 439 of them are already occupied. This is a venture in building an entirely new town of 3,000 housing units. "Living in Greenbelt will be as healthful, safe, and pleasant as modern knowledge can make it."

Five miles north of Cincinnati is Greenhills, a Resettlement Administration project of a 1,000-family suburban town. There are

now 110 houses completed and work is going ahead steadily. Greendale, near Milwaukee, is expected to have 750 homes ready for families to occupy within a year. Eventually it is planned that the three towns will provide low-rental homes for some 5,000 families. When these "suburban towns" are completed they will be owned permanently by local non-profit corporations. The Federal Government will turn the enterprises over to the corporations as soon as construction is finished. They will be rented indefinitely and cannot be purchased by tenants under any conditions. Families which occupy the houses in these new towns must have annual incomes between $1,000 and $2,200. Rents will vary from $18 to $42 with an average of $27.62 per month.

But the most far-reaching federal housing venture yet attempted is that provided for in the United States Housing Act, which was approved by President Roosevelt, September 1, 1937. The housing program was launched but a short time ago.

On March 17, 1938, President Roosevelt said, "Today marks the beginning of a new era in the economic and social life of America. Today we are launching an attack on the slums of this country which must go forward until every American family has a decent home."

E. B. Kyle, president of the West Virginia Real Estate Board, said in a recent address in Morgantown that the Federal Housing Act was "one of the finest things ever to affect the real estate business."

Nathan Strouss proclaimed this act as "the greatest single step forward in national housing policy ever taken by any country." Most people have given little attention to the Housing Act and have hardly noticed that Congress passed the Wagner-Steagall Act. Yet this new venture may be said to be revolutionary in its departure from former American ideals. Some observers say that this change in housing is as important in our historical development as the change from horse and buggy travel to that of railways, or dirt roads to hard-surface roads. Public housing for the first time in America has become a permanent program.

The new housing law provides for a public corporation known as "The United States Housing Authority" in the Department of the Interior, which will administer the act. The United States Housing Authority is permitted to lend $500,000,000 to local housing authorities during the next three years at 3% interest. This amount will provide for slum clearance and the construction of some 175,000 dwelling units for families of very low incomes. The funds for this purpose will be raised by United States Housing Authority Bonds sold to the general public and guaranteed by the Government. A local housing authority must be set up in order to share in the federal funds. The act contemplates a program consisting entirely of projects locally constructed, locally owned, and locally operated. The United States Housing Authority will have no authority to construct houses but will furnish financial and technical assistance

to local public housing agencies. The Federal Authority may provide 90% and the local authority at least 10% of the necessary funds for purchasing land and building houses. The local funds can be raised in various ways but issuing bonds is the popular way at present. Only "public housing agencies" are eligible to borrow and receive a subsidy from the Federal Authority. No aid of this type can be given to individuals or to corporations.

At the present time 30 states have laws which provide for the creation of housing authorities. The houses for low-income groups must cost no more than $1,000 a room or more than $4,000 per dwelling. In cities with more than a half million population the costs may be $1,250 per room. If the income from such houses is to pay interest on investment, taxes, and maintenance, the rents must be from $8 to $10 per room per month. But experience indicates that slum dwellers generally cannot afford to pay more than from $4 to $6 per room per month rent. To provide for this difference in amount of rent the United States Authority will provide an annual subsidy, which must be supplemented by the local community to the extent of one-fifth of the amount of the federal subsidy. The local authority's share may be in the form of cash or tax exemptions.

The annual subsidies will bring rents in the new projects down to a figure that the low-income families can afford to pay. Only those who are both ill-housed and under-privileged will be served by this act. No family may be accepted as a tenant in a public housing project whose aggregate income exceeds five times the rental of the quarters to be furnished or, in the case of large families, six times the rental.

On November 1, 1937, 51 projects with homes for 21,000 families, which were initiated by the Resettlement division of the Public Works Administration, were transferred to the United States Housing Authority and 50 additional projects in 19 states have been announced. Among these are three in West Virginia cities, Charleston, $1,200,000, Wheeling, $1,350,000, and Morgantown, $270,000. The largest project is in Brooklyn, New York, where 1,622 families in low-income groups soon will be transformed from slum-dwelling conditions to comfortable, healthful, and decent homes.

Tenants for the houses are generally selected by means of a score card. The income alone narrows the selection materially; however, ten times as many families as can be accommodated often apply for a place in a new project. If the points on the elaborate score card add up just right, the tenant is selected. The score card is one of human destiny; it sorts out of the population a class that has never been sorted out before. These homes are not for families on charity or on relief rolls. They are for the underprivileged but undefeated.

The United States Housing Authority Act also provides a Property Improvement Credit Plan whereby any individual, corporation,

farmer, tenant, or home owner may borrow from private lending institutions for improving and repairing properties, in some cases for new buildings. While the Federal Government does not lend for these repairs and improvements it insures the lending agency against loss. J. E. Cruise, state valuator for the United States Housing Authority, said, "approximately 3 to 5 million dollars would be needed to repair all houses in bad condition" in Morgantown alone.

The idea of government aid in housing is not new. Practically every major country in Europe has provided government aid for housing the low-income groups. Government aid in housing has been in progress in the United States but a short time. The Home Owners Loan Corporation has received the most attention until the very recent developments.

There are problems yet to be solved in connection with housing low-income groups. Many citizens who dislike slums disapprove of housing people by public subsidy. When a tenant's income exceeds the maximum for these tenants what will happen?

Unfortunately the housing activities of the Government have been scattered and unsettled. The Housing Division of the Public Works Administration initiated the 51 low-rent housing projects which were transferred to the United States Housing Authority November 1, 1937. The three suburban towns were started by the Resettlement Administration and transferred to the Farm Security Administration. There is no connection between the Farm Security Administration of the Department of Agriculture and the United States Housing Authority of the Department of the Interior. The subsistence homesteads which are not completed are now under the Farm Security Administration after some of them have been shifted as many as four times. There is plenty of room for honest differences of opinion about the housing program. It is so new, so vast, so far-reaching that no one can accurately determine its possibilities nor its limitations.

ALONG THE DANUBE

CARL M. FRASURE

Department of Political Science, West Virginia University

THE RECENT GERMAN annexation of Austria once more emphasizes the Danubian area as potentially one of the sorest spots in Europe. The present Danubian countries were born of the World War and the treaties that followed and their problems of national minorities, boundaries, tariffs, and the conflicting interests of large states have defied internal and external efforts to make for a firm peace and prosperity.

Before the World War Austria-Hungary contained fifty-odd million people representing several national groups among which there were jealousy and suspicion, even hostility. Economically the state was practically a unit, combining rich agricultural areas with booming industrial centres, which were fed by raw materials obtained mostly within the borders of the state. The economic unity of the area combined with the lack of political democracy to hold the state together in spite of the conglomeration of peoples with whom the government had to contend.

But all this was changed with the close of the Great War. National groups brought their influence to bear upon the Allies, and the political map of the Danubian area was redrawn with a confusion of factors entering into the reconstruction. Theoretically at least the principle of self-determination of people was the dominant influence in the "revolution" along the Danube. No one denies, however, that France's continued fear of Germany and of the possible rejuvenation of the monstrous Austro-Hungarian Empire played an overwhelming part in drawing the boundaries of the new states in such a way as to deprive Germany, Austria, and Hungary of millions of their nationals as well as strategic bits of territory and important economic interests. The inevitable result was an economic dislocation along the Danube that left most of the states there in bankruptcy or on the verge of bankruptcy. While the economic unity of the Danubian area was sacrificed on the altar of nationality in determining the boundaries of the new states, the national minority problem was not only not solved but has remained one of the most troublesome in international politics since the war.

Unredeemed nationals continue to make up a sizeable percentage of the population in the new states—in Czechoslovakia one-third, in Poland three-tenths, and in Jugo-Slavia almost one-sixth. In Rumania, an old state with greatly enlarged boundaries, nearly three-tenths of the population is of alien ancestry. Hungary as a new old state is more than 90% pure Magyar, while Austria was almost entirely German. The attempt, therefore, to solve the minority problem by breaking up the economic unity of the Austro-Hungarian Empire failed badly; and further, this unsuccessful attempt is one factor in the failure of democracy in most of the Danubian countries.

With their new boundaries determined by a variety of factors that gave little consideration to economic consequences, the Danubian states exercised their sovereign rights to legislate to the economic disadvantage of each other. Czechoslovakia and the former Austrian state are predominantly industrial, but they had no foreign market for their manufactured products. Their industrial capacity was far greater than their ability to consume and to sell abroad. Their natural market was to be found in the agricultural states of Hungary, Rumania, and Jugoslavia, which immediately built tariff barriers against foreign goods. The rolling plains of these three states, however, produced much more grain than the people could consume, but their natural market in Czechoslovakia and Austria was destroyed by high tariffs. Economic nationalism was rampant in the Danubian area.

As another step in this policy of economic self-sufficiency, manufacturing countries attempted to increase the growth of grain, while agricultural states started industries with the protection of high tariffs. Unnatural agricultural and industrial development led to higher prices, which the people generally could ill afford to pay, with the result that industry and agriculture suffered in all the countries. Yet economic self-sufficiency seemed to offer an ultimate security which must be achieved regardless of cost. While Austria in 1922 and Hungary in 1923 went into bankruptcy and were rescued by the League of Nations, other of the Danubian states were saved from a similar fate only by the financial assistance of outside powers, principally France. And, in spite of their efforts, none of these states has even approached the status of economic self-sufficiency. Czechoslovakia, it is true, has finally achieved a fair degree of harmony between industry and agriculture, but the state is not self-sufficient.

Growing economic distress in the Danube area was further emphasized by world economic conditions in the early nineteen-thirties, and it gradually dawned upon the Danubian states that only by some means of economic cooperation could they meet the common problems of surplus production, low prices, and disrupted currencies. National efforts to solve what were obviously international matters had proved of no permanent worth and in the end had probably made things worse. Yet, in spite of these facts, all proposed plans to date for the solution of the economic problems along the Danube have been half-hearted and in the last analysis disheartening. There is still the fear that a united programme against economic nationalism may jeopardize the political independence of these states. And the fact that the Great Powers purposely frame their own economic policies along lines that embarrass attempts at international action by the Danubian states may be a bigger obstacle to successful cooperation. This is particularly true of Germany and Italy, each of which fears the economic penetration and influence of the other in the Danubian area. France and England are perhaps as vitally interested but more for political than economic reasons.

Let us turn now to a brief statement of the more important plans proposed during the last few years to solve the economic problems of the Danube area, and note the obstacles in the way of their success.

In March 1931 Berlin and Vienna announced simultaneously a proposed treaty between their countries which "while completely maintaining the independence of the two states and fully respecting the obligation undertaken by them towards other states" was designed to "initiate a reorganization of European economic conditions by regional agreements." The protocol declared that any state was welcome to join Germany and Austria in enlarging the customs union which these two states proposed to create.

Even though the proposal might have aided in solving the economic difficulties of Germany and Austria, it was loaded with political dynamite which created havoc in the foreign offices of all the surrounding countries. Here, it was said, under another name is the Austro-German *Anschluss* which the Allies had forbidden in the treaties closing the World War. The French and Czechoslovakians were especially alarmed because of the possible effect such a union would have upon Czechoslovakia, a French ally. France also saw the economic arrangement as a prelude to a political union of the two countries to create a great German Power of more than seventy million people in Central Europe.

Italy opposed the plan on the basis that it would bring German influence down to her northern border along which live several hundred thousand Germans (Austrians) who might start a movement to return the Tyrol to the new German union. Italy also had a deadly fear that the success of the proposed customs union would be the beginning of increased German economic penetration into the Danube, which Mussolini felt was rightly an Italian sphere of influence. The World Court finally restored comparative calm in the foreign chancellories by rejecting the scheme as incompatible with the First Geneva Protocol of 1922, in which Austria had agreed not to alienate her economic independence in return for financial assistance through the League of Nations.

Nevertheless the Austro-German proposal focused the attention of Europe on the bad economic conditions which existed along the Danube. France and Italy were both alarmed at the possible consequences and various plans were submitted calling for the gradual development of a European economic structure in which each state could lower tariff barriers.

In March 1932 the French Government, headed by Andre Tardieu, presented a scheme which came to be called the Tardieu Plan. Most French proposals for solving the economic difficulties of the Danubian area from the start were suspected of being directed primarily at furthering French influence with the Little Entente states, and the Tardieu plan was no exception. Tardieu, wanting to save French investments and willing to lend more money if necessary, proposed that the Danubian states cut all tariffs between

them by ten percent and abolish import, export, and exchange obstacles to trade and commerce. To make this scheme effective he suggested that outside states waive most-favored-nation treatment with the Danubian countries.

At once a general protest was voiced against the Tardieu Plan not only by some of the Danubian states themselves but by numerous other countries. Germany and Italy with important trade connections along the Danube, larger than either France or England, refused to cooperate without some compensation, which seemingly could not be granted. For various reasons England and Poland were unenthusiastic, while in Paris Tardieu's proposal was attacked by Leon Blum, who declared that by leaving out Germany Tardieu had further strained the relations between that country and France. The Plan was finally lost for the political reason that it appeared to emphasize too much the influence of the Little Entente states, particularly Czechoslovakia.

September 1932 saw another attempt to meet the situation in all the Central and Eastern European countries through a conference held at Stresa and attended by 17 interested states. Two voluminous reports were prepared, but the recommendations contained little that was new, and inter-national disagreement prevented their application.

Two years later Mussolini took the initiative in Danubian economic affairs and produced the so-called "Rome Agreements," signed by Italy, Austria, and Hungary, which granted certain preferences for the goods of each country. To counteract this Italian threat of increased influence along the Danube the Czechoslovakian Foreign Minister (now President), Dr. Benes, brought into existence the economic Little Entente, comprising his own state, Jugoslavia, and Rumania. Since the political Little Entente was already in existence Italy and Germany both feared that this was one more step toward a union which would play directly into the hands of France as the sponsor of the Little Entente states. Possible competition of the economic Little Entente with the Rome Agreements, it was also believed, would result in worse economic chaos along the Danube than ever before.

While the Rome Agreements were aiding the commercial relations of Italy, Austria, and Hungary, Mussolini was casting about for means to strengthen the relationship and thereby minimize the economic Little Entente. As a basis for action he laid down a series of economic principles including bilateral treaties, preferential treatment, improvement of communications, and a better balance of payments. In March 1936 three protocols were signed by these states as supplementary to the 1934 treaties. In the new protocols the states reaffirmed their faith in the principles of the original treaties and agreed that no state would consider action in any political question without consulting the remaining two. These treaties were a warning to France to watch her step with the Little Entente. One month later Mussolini gave further evidence of his

policy along the Danube by negotiating a trade pact with Jugoslavia which necessitiated the cancellation of some of the commercial advantages he had already given to Austria and Hungary. Additional efforts at commercial peace among the Danubian states have been the negotiations of Austria and Hungary to find some common ground for trade relations with Czechoslovakia and the growing friendliness of Austria and Hungary.

All these moves looked toward greater economic stability along the Danube, where a natural economic unit once existed and might have been effectively recreated before the recent German invasion of Austria if the states concerned had not been so afraid of a revival of the old Austro-Hungarian Empire, and were not so convinced that a policy of economic self-sufficiency is both possible and profitable. Another factor, however, enters into the Danubian situation which, regardless of what the Danubian states themselves might do to bring about economic recovery, may prove to be an insurmountable obstacle to peace and prosperity along the Danube. This factor, which Germany has so strongly emphasized, is the conflicting interests of Germany, Italy, France and to some extent England in this important part of Europe. In other words the Danubian states are largely pawns in the international game of intrigue as played by the Great Powers.

France's dominant position in the Danubian area was threatened at once with the advent of Hitler in Germany in 1933 and has been increasingly weakened in succeeding years by Mussolini's successful campaign in Africa, the Italo-German "entente", and Hitler's move into Austria. France is neither a source of raw materials nor a market for surplus manufactured products for the Danubian states, and hence she does not materially figure in their national economy. Her early relations with them came about through their mutual fear of Germany and to a lesser extent of Austria and Hungary, and the willingness of France to lend the Little Entente states money, so badly needed to strengthen them against all possible enemies. France's interest in the Danubian area has been and is essentially political, and this has been of great importance to these states, but it has not helped them materially in solving their chaotic economic situation.

A stronger Germany and, at least, a more belligerent Italy have been quick to take advantage of this situation. Germany must import considerable foodstuffs of which some of the Danubian states have a surplus. Germany in turn has a surplus of manufactured goods which the agricultural countries of Hungary, Rumania, and Jugoslavia must import. Hence an aggressive Germany under Hitler has made great economic strides in the Danubian area. The world rearmament movement of the past few years has helped Germany along the Danube, where her trade has grown rapidly since 1932. Much of this trade has involved the exchange of guns and ammunition for wheat. The fact, however, that commerce alone has not been Germany's only consideration in the Danube countries is seen when we realize that Germany could have purchased wheat

upon the world market at a lower price than in southeastern Europe. Germany has hoped and not without result that close trade contacts in that part of Europe might tend to weaken the relations of these countries with France.

And yet a Germany with increasing influence in the Danubian area must inevitably come into contact if not conflict with an aggressive Italy. Germany's efforts to create an economic union with Austria in 1931 were strenuously opposed by Italy. German economic penetration in other of the Danubian states is certainly a threat to Mussolini's claim of an Italian sphere of influence in southeastern Europe, and we have already noted Italy's attempts to gain a trade advantage in this area through various commercial treaties. The inescapable conclusion of course is that the interests of Germany and Italy in the Danubian area are irreconcilable. A dominant position by either is a threat to the other, and especially is German domination a threat to Italy.

On the other hand a close relationship between Germany and Italy has certainly proved advantageous to both outside the Danubian area. It has been used to aid Italy in gaining a new colonial empire in Africa and Germany in destroying the Treaty of Versailles. And it is increasingly apparent that the attitude of these two states is helping to make possible Japanese invasion in China, which may be profitable to Germany, at least, in the future in that it may gain Japan's assistance against Russia. England and France have been unwilling to take definite action against either Germany, Italy, or Japan in their numerous treaty violations, in part, because of the tolerant if not openly helpful attitude which these three states have taken toward the policies of each other.

England is increasingly disturbed by the recent political and economic advantages which Germany and Italy have gained in the Danubian area. Her trade and financial relations there are of little comparative importance but the general policies of Hitler and Mussolini have forced England into a new and absolute military alliance with France. Italian prestige in the Mediterranean and Red Sea areas has certainly been enhanced by Mussolini's successful venture in Abyssinia and if this is followed by an Italo-German victory in Spain, England's potential difficulties in keeping open her trade routes to the Far East will be multiplied.

Nowhere in Europe, therefore, do the policies of the Great Powers conflict more than in the countries through which flows the historic Danube river. Small and weak themselves, these states are tempting morsels for larger powers with an insatiable ambition to expand their political and economic influence in Europe. Such a program, if carried far enough, can spell but one word and that is *war*. The Blue Danube, in this event, may well become the Red Danube.

THE DRAIN OF TALENT OUT OF THE VIRGINIAS

JAMES T. LAING

Department of Sociology, Kent State University, Kent, Ohio

ABOUT A YEAR AGO Professor Wilson Gee of the University of Virginia published a study which substantiated the somewhat current impression that the South is a region which loses a considerable proportion of its talented sons and daughters to other regions.[1] In order to test somewhat objectively the validity of this impression Gee and his assistants made a study of persons born in the South listed in the 1932-33 edition of *Who's Who In America* and found that of the 6,015 persons mentioned 2,229 were located outside of the south. This was a loss of 37.1% to the South of this group of Southerners of distinction—more than a third.

Since West Virginia was one of the 14 states which Gee gave as comprising the South,[2] my curiosity was at once aroused as to whether West Virginia is losing her talent to the same extent as the South in general, and a study of this problem was at first contemplated. Upon reflection, however, it was seen that the two areas (West Virginia and "the South") are hardly comparable because of the great difference in their size. According to Gee's study a person may move from Key West or El Paso to Wheeling and still be in the South whereas a person in West Virginia may move but a short distance and be outside that state. It was decided therefore to compare West Virginia with another southern state of somewhat comparable area. Virginia was selected not only because of this feature but also because of its geographical and historical contiguity.[3] With the aid of two NYA student helpers[4] the study was made with use of the 1932-33 edition of *Who's Who In America.* While a later edition was available the earlier one was used for purposes of comparison with Gee's study. The plan is to present this paper merely as a "note" with full knowledge of its tentative character[5] and to bring the study more nearly up to date for presentation at a future meeting of the Academy.

A comparison of the number of persons in *Who's Who* giving West Virginia and Virginia as a place of birth and as a place of residence reveals a larger number in the case of Virginia than West Virginia. A total of 777 persons gave Virginia and 245 gave West

---

[1] **The "Drag" of Talent Out of the South,** SOCIAL FORCES, v. 15, no. 3, March 1937, pp. 343-346.

[2] Gee named the following states as constituting the South: West Virginia, Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Tennessee, Kentucky, Louisiana, Arkansas, Texas, and Oklahoma.

[3] The area of West Virginia is 24,022 sq. mi.; that of Virginia, 40,262.

[4] Mr. Woodard Dunlap and Miss Dorothy Kilby spent some 150 or 200 hours on the study.

[5] It should be mentioned that there was considerable disparity between our figures for W. Va. and Va. and the summary appearing on p. 27 of this edition of Who's Who. This disparity also appeared in the case of Gee's figures and this summary. He found 6,015 persons in Who's Who born in the South, and Who's Who lists only 4,811 in these states. We found a total of 1,022 born in W. Va. and Va. while only 996 appear in the Who's Who summary. Since our study and that of Gee show this disparity in the same direction (our figures are larger than the summary) it would seem quite possible that the summary may be incorrect.

Virginia as their birthplace. Five hundred and thirty-three persons were found to be living in Virginia and 234 in West Virginia. Reducing these figures to a comparable basis one finds that 14.2 persons born in West Virginia per 100,000 of population in that state are listed in *Who's Who* as compared with 32.1 persons born in Virginia per 100,000 of population in that state.[6] Likewise there were 13.5 persons per 100,000 population living in West Virginia listed and 21.8 per 100,000 population in Virginia. In other words, Virginia has 2.26 times as many native sons in *Who's Who* as West Virginia and 1.61 times as many persons residing within its borders in proportion to population.

The disparity between the two states may be partially explained in a number of ways. In the first place, the older-settled states generally predominate as birthplaces of people whose names appear in *Who's Who*.[7] The explanation for this fact becomes apparent when one considers that most of these persons are in the older age-groups and, hence, population of a state whose development is characteristic of more recent times, as compared with an older-settled state, was relatively much smaller at the time when those included in *Who's Who* were born. Thus in 1870 West Virginia was only 36.1 percent as populous as Virginia while in 1930 this proportion had grown to 71.4%.[8] Another factor which became apparent as the study progressed was the proximity of Virginia to the District of Columbia, which is a concentration point for talented persons from many states connected with the various Government departments located in Washington. Quite a number of these were found to be living in suburban places across the border in Virginia and were thus counted as living in Virginia.

Of the 245 persons in *Who's Who* born in West Virginia 115 were found to be living outside the state. The loss of these persons of talent to other states constitutes a "drain" of 46.9% or almost half. Reference to Table 1 will indicate in which particular occupation these drains have occurred.[9] Numerically the losses were greatest, in the order named, among educators, religious workers, editors and authors, lawyers and judges, natural scientists, architects and engineers, politicians and diplomats, Army and Navy officers,[10] social scientists, and, finally, doctors, actors and artists, and the agricultural group. On a proportional basis the order is

---

[6] The population of West Virginia in 1930 was 1,729,205; that of Virginia was 2,421,851.

[7] See **Who's Who In America**, vol. 17, p. 18.

[8] If, for instance, we should assume an average age of 50 years and base our rates upon the population in 1880 we find that Virginia's rate is only 1.30 times as great as that of West Virginia. If we assume an average age of 60 years and base our rates upon the population of 1870 the disparity in favor of Virginia is practically wiped out, the rate being only 1.14 times that of West Virginia.

[9] The classifications in Table 1 and all succeeding tables are identical with those used by Professor Gee. They are used here for comparative purposes.

[10] While this category is used for comparative purposes its presence may be misleading because of the fact that Army and Navy officers rarely choose their locations. It is logically and statistically ridiculous to assume that West Virginia will ever offer a wide field for naval officers. This kind of "drain" in certain areas is inevitable and permanent.

TABLE 1—*West Virginia-born in Who's Who, 1932-33*

Classification	Total number	Number located in W. Va.	Number located outside W. Va.	Percentage of drain out of W. Va.
Religious workers	28	6	22	78.6
Lawyers and judges	47	39	8	17.0
Doctors	8	7	1	12.5
Educators	49	23	26	53.1
Editors, authors	23	10	13	56.5
Architects and engineers	8	2	6	75.0
Business men and bankers	28	15	13	46.4
Actors, artists	1	0	1	100.0
Politicians, diplomats	22	17	5	22.7
Social workers	1	1	0	0.0
Army and Navy officers	6	3	3	50.0
Natural scientists	8	1	7	87.5
Social scientists	4	2	2	50.0
Agricultural group	2	1	1	50.0
All others	10	3	7	70.0
Totals	245	130	115	46.9

somewhat shifted as follows: actors and artists (100.0%), natural scientists (87.5%), religious workers (78.6%), architects and engineers (75.0%), editors and authors (56.5%), educators (53.1%), and Army and Navy officers, social scientists, and the agricultural group (50% each). Among business men and bankers (46.4%), politicians and diplomats (22.7%), lawyers and judges (17.0%), and doctors (12.5%) the drain is less than half.

Table 2 gives some idea of the decrements of talented persons in various fields to other states which West Virginia has suffered

TABLE 2—*Persons born in West Virginia, now living elsewhere, compared with those born elsewhere, now living in West Virginia, in Who's Who In America, 1932-33*

Classification	Born in W. Va. now living out of W. Va.	Born out of W. Va., now living in W. Va.	Gain or loss to W. Va.
Religious workers	22	17	−5
Lawyers and judges	8	15	7
Doctors	1	7	6
Educators	26	18	−8
Editors, authors	13	8	−5
Architects and engineers	6	7	1
Business men and bankers	13	9	−4
Actors, artists	1	0	−1
Politicians, diplomats	5	10	5
Social workers	0	0	0
Army and Navy officers	3	0	−3
Natural scientists	7	3	−4
Social scientists	2	2	0
Agricultural Group	1	3	2
All others	7	5	2
Total	115	104	−11

as compared with the increments of persons in these same fields she has gained from the outside. The groups which lost in numbers through this exchange of talent were the educators (8), editors and authors (5), business men (4), natural scientists (4), Army and Navy officers (3), actors and artists (1), and the unclassified group (2). Those groups receiving gains were lawyers and judges (7), doctors (6), politicians and diplomats (5), the agricultural group (2), and architects and engineers (1). The aggregate net loss to West Virginia of only 11 persons indicates that she is, numerically at least, receiving almost as many persons of Who's Who calibre as she sends out. Whether or not she receives persons of equivalent quality is a question beyond the scope of the present paper.

Tables 3 and 4 furnish comparable data concerning Virginia. Of the 777 persons born in Virginia, 513 were living outside the state, indicating a drain of 66.0% or approximately two-thirds.

TABLE 3—*Virginia-born in Who's Who, 1932-33*

Classification	Total number	Number located in Va.	Number located outside Va.	Percentage of drain out of Va.
Religious workers	105	27	78	74.3
Lawyers and judges	103	38	65	63.1
Doctors	64	14	50	78.1
Educators	164	63	101	61.6
Editors, authors	62	22	40	64.5
Architects and engineers	33	7	26	78.8
Business men and bankers	67	22	45	67.2
Actors, artists	11	0	11	100.0
Politicians, diplomats	46	32	14	30.4
Social workers	3	1	2	66.7
Army and Navy officers	28	4	24	85.7
Natural scientists	30	12	18	60.0
Social scientists	16	10	6	37.5
Agricultural group	7	2	5	71.4
All others	38	10	28	73.7
Totals	777	264	513	66.0

The loss of its talented sons by Virginia is both numerically and proportionally greater than that of West Virginia. In every group but three, religious workers, natural scientists, and social scientists, Virginia loses a larger proportion of its natives to other states than does West Virginia. Furthermore, while West Virginia showed net gains in five occupational fields, Virginia showed such gains in only two—natural scientists and social scientists. In the exchanges of talented persons between the two states only six West Virginians have cast their lot with Virginia, whereas 20 Virginians were found in West Virginia. Numerically West Virginia has the advantage in exchange even though, on the qualitative side, it has given to Virginia two such native West Virginians as Senator Harry Byrd and William Jett Lauck, eminient economist, whose names can hardly be matched in the group of Virginians living in West Virginia.

TABLE 4—*Persons born in Virginia, now living elsewhere, compared with those born elsewhere, now living in Virginia, in Who's Who In America, 1932-33*

Classification	Born in Va. now living out of Va.	Born out of Va. now living in Va.	Gain or loss to Va.
Religious workers	78	36	–42
Lawyers and judges	65	11	–54
Doctors	50	10	–40
Educators	101	56	–45
Editors, authors	40	32	–8
Architects and engineers	26	11	–15
Business men and bankers	45	23	–22
Actors, artists	11	7	–4
Politicians, diplomats	14	7	–7
Social workers	2	1	–1
Army and Navy officers	24	13	–11
Natural scientists	18	29	11
Social scientists	6	12	6
Agricultural group	5	0	–5
All others	27	15	–12
Totals	513	263	–250

Upon the basis of the foregoing numerical data some general hypothesis concerning the comparative loss of talented persons by Virginia and West Virginia would seem to be justified. The present study shows that in proportion to the population of the two states, talented persons are found among the native sons of Virginia to a greater extent than among the native sons of West Virginia so far as this may be judged by *Who's Who* inclusion in 1932-33. West Virginia, however, is apparently better able to hold its talent within its borders than Virginia, the percentage of "drain" from Virginia being 1.41 times as great as that of West Virginia. Furthermore, West Virginia seems better able to attract a more nearly comparable number of talented persons from other states to match the "drain" of its own talent outward. Whether this condition, however, be temporary or more or less permanent only further research will reveal.

FIVE YEARS OF AGRICULTURAL ADJUSTMENT IN WEST VIRGINIA

R. H. GIST, State Agent
Agricultural Extension Division, West Virginia University

WHEN GEORGE WASHINGTON was searching for a farm manager, one of his requirements for the new man was that he be "one who can bring worn-out and gullied lands into good tilth in the shortest time." In 1798 Thomas Jefferson wrote Washington a long letter[1] about legumes and rotations with particular reference to winter vetch and cowpeas as possible soil-building crops on Virginia farms. In 1862 Abraham Lincoln signed the Land Grant College Act appropriating large areas of public land for the endowment of agricultural colleges. Thus we see that some of the earlier presidents gave consideration to the problems of agriculture. Soil erosion and agricultural conservation are not new problems for the nation, including our own Mountain State.

In the prosperous days of 1929, agriculture's part of the national income was slightly more than 10%. Three years later[2] this had dropped to 7½%. In these same three years the total national income had dropped from 79 billions to 47 billions of dollars. This was, indeed, severe deflation. Not only was the total national income greatly reduced, but the percentage going to agriculture dropped radically. A serious agricultural crisis was apparent. Many corrective legislative plans were suggested, and a few of them became national laws. The Smoot-Hawley tariff bill and the Agricultural Marketing Act, creating the Farm Board, were both aimed at the solution of agriculture's existing problems.

The reaction to some of these measures is recalled by many persons. The European reaction to our higher tariffs was the increasing of foreign tariffs of wheat, pork, tobacco, apples, and lard and the imposition of quotas and embargoes which literally closed many foreign markets to our products.

With the passage of the Agricultural Adjustment Act, which became a law on May 12, 1933, wheat, cotton, hogs, corn, rice, tobacco, and milk were recognized as basic commodities in the national production scheme. Four of these—wheat, corn, hogs, and tobacco—were of interest to West Virginia farmers. While West Virginia is not a great wheat-producing state, it was found that the farmers in the Eastern Panhandle, South Branch Valley, Greenbrier Valley, and lower Ohio Valley were interested in taking advantage of the wheat acreage reduction plan and the payments offered by Government contracts pertaining to this commodity. As a result of this interest, wheat associations of local farmers who had signed contracts were formed at Charles Town, Martinsburg, Moorefield, Lewisburg, and Point Pleasant. Under these contracts the farmers received certain payments, varying each year, for taking acreages out of wheat and renting these acreages to the

[1] Washington, Jefferson, Lincoln and Agriculture. U. S. D. A. 1937.
[2] G-48-U. S. D. A. 1935. Agriculture's Share in the National Income.

Secretary of Agriculture. A percentage of the average wheat acreage could thus be set aside and certain varying payments received annually by the producer.

Funds for the payment of the sums due on these wheat contracts were derived from a processing tax of 30 cents per bushel—the difference between the average farm price and the parity price on June 15, 1933. This tax became effective July 9, 1933, and was more than sufficient to meet the adjustment payments and administrative expenses during the first two years.

During the 32 months of operation of the wheat program in West Virginia, 972 farmers took advantage of these contracts. These wheat producers received, up to July 1, 1936, a total of $235,600.91[3] in rental and benefit payments or an average of $242.38. It must be remembered, however, that this was for a period covering three seasons, so that the average annual payment was only $80.79. Since the contracts were optional, it was natural that some producers dropped out of the program each year, and others came in.

THE CORN-HOG PROGRAM

Since corn production and hog production are so closely related, particularly in what is known as the cornbelt of the United States, the Agricultural Adjustment Administration offered producers a corn-hog contract. This provided for both the reduction of corn acreages and hogs for market.

Rental or benefit payments under the Corn-Hog Program in West Virginia had a wider application than either wheat or tobacco. The records indicate that payments have been made in each of the 55 counties, varying from $193.01 in Hancock to $116,007.93 in Jefferson. A total of $455,770.13[4] came to West Virginia farmers from this program in the two years 1934 and 1935. Processing taxes on hogs and corn furnished a large part of the funds for these payments.

Many payments pertaining to the 1935 corn-hog contracts had not been made before the Supreme Court decision of January 6, 1936, invalidating the Agricultural Adjustment Act. Provision was later made by congressional action for completion of payments under corn-hog and other similar contracts.

Under these voluntary corn-hog contracts offered to farmers, a percentage of the average corn acreage for the farm was set aside as acres rented to the Secretary of Agriculture. The average production of these contracted acres was computed, and farmers were paid a specified amount per bushel for taking this land out of corn and renting it to the Secretary. The hog part of the contract was computed on the average number of hogs produced for market on the farm during the previous two years. For hog reduction, farmers were paid fifteen dollars per head in 1934 on 25%, and in 1935 on 10% of their hogs produced for market.

[3] Agricultural Adjustment Administration mimeographed letter.
[4] Agricultural Adjustment Administration.

In 1935 the corn acreage contracted for retirement in West Virginia on 1,425 contracts was 7,605. This had an average yield of 30.9 bushels per acre. The rental payments on these acres amounted to $82,237.07 or an average of $10.81 per acre. The estimated corn acreage in the United States retired under 1935 corn-hog contracts was 11,969,274, so it may readily be seen that West Virginia's part in this particular program was small when compared with the entire participation of the 48 states.

THE TOBACCO PROGRAM

Tobacco statistics in West Virginia indicate that since 1910, the acreage and production trends have been downward. Tobacco reduction contracts were available to the tobacco farmers of West Virginia in 1934 and 1935. Producers in fifteen counties took advantage of these contracts and received in rental and benefit payments up to June 30, 1936, $178,732.17 for the two-year period. In 1934, 1881 farmers signed these voluntary contracts, and in 1935, 2,376 producers participated in the acreage reductions and benefit payments. The average payment per farm per year for compliance with the contract was $42.00 for West Virginia producers.

THE EFFECT ON PRODUCTION

State production figures for wheat, corn, and hogs, when viewed without explanation, appear very interesting. In 1934 the total wheat acreage of our state was 145,000.[5] The following year, while voluntary reduction contracts were still available, the acreage increased to 149,000. The production also increased from 1,856,000 bushels to 2,384,000 bushels. Part of this increase in the number of bushels no doubt was due to better weather conditions in certain areas of the state. Another factor in the acreage increase was the wheat processing tax of 30 cents per bushel. Farmers who fed their own wheat to poultry and livestock or ground their own flour did not pay this tax. Many of them who had not participated in the wheat reduction program increased their acreage to offset the necessity for purchasing this grain.

In comparing the 1934 and 1935 corn acreages of West Virginia, we find an increase of 42,000 acres which produced 1,887,000 bushels. Hogs on farms also increased 9,000 head when the figures are compared for January 1, 1935, and January 1, 1936.

Tobacco production, which had been declining for many years, continued its trend. In 1934[6] there were 2,800 acres and in 1935, 2,400 acres. Production in total pounds was 1,792,000 for 1934 and 1,596,000 for the following season, or a decrease of 196,000 pounds.

Thus it may be seen that wheat, hogs, and corn increased slightly in West Virginia during the time of these commodity contracts, while tobacco continued to decline in acreage and total production.

---

[5] W. Va. Agricultural Statistics. Bulletin (n. s.).
[6] Oct. 1936. W. Va. Dept. of Agriculture, Charleston.

NUMBER OF FARMS INCREASE

In 1930, the census reported 82,641 farms in West Virginia. Five years later the same authority reported 104,748 farms, or an increase of 22,107. If each of these 22,107 new farms raised two acres of corn, one-fifth of an acre of wheat, and one-half hog, the entire increase noted above would be assimilated.

THE AGRICULTURAL CONSERVATION PROGRAM

On January 6, 1936, the United States Supreme Court declared the Agricultural Adjustment Act unconstitutional. Congress passed an amendment to the Soil Conservation Act on February 11 of that year, providing certain payments for carrying out soil-conserving practices. Acreage control of the soil-depleting crops was also provided. This new act proved of much wider interest to our West Virginia farmers. In 1936, 22,500 farmers filled out worksheets. In 1937 this number was increased to 42,500, and in 1938 there will be more than 84,000 worksheets. This indicates that the program fits our farmers' needs to a greater extent than any previous program. There are no contracts. Participation, as in previous programs, is entirely voluntary. Acreage reductions of certain crops, such as wheat and tobacco, are contemplated since there is indication of large surpluses this year if worldwide weather conditions are favorable.

As a result of this greater interest in the agricultural conservation program, 15,365 West Virginia farmers completed practices in 1936 and had received a total amount of $655,175.52 up to September 30, 1937. A summary of the soil-conserving practices completed in the 1936 program shows 7,852 acres of alfalfa seeded; 62,535 acres of clovers; 22,954 acres of grass and grass mixtures; 13,925 acres of green manure crops, and the application of 64,508 tons of lime. Although the final tabulations for the 1937 program are not yet available, the indications are that more than 27,600 farmers completed soil-conserving practices last year for which they will receive approximately 925,000 dollars in payments.

With the much wider participation in the program in 1938, it is conservative to estimate that more than 40,000 West Virginia farmers will complete certain practices of a soil-conserving nature. These practices consist, among other things, of growing alfalfa and clover, liming, fertilization of forage crops, turning under green manure crops, and planting forest trees.

If soil conservation is accepted as a fundamental work to be done for the general welfare of all the people, then it is logical for the entire population to share in the cost. Certainly the problems of soil erosion are serious in many states, including our own. Forests were cleared and the land was cropped and allowed to erode while more forest land was being cleared. We have become conscious of this problem. An attempt at the solution has been made through the Agricultural Conservation Program now under way. It is recognized that the work now being done is only a beginning. The lack of soil-conservation policies during the past hundred years

cannot be corrected in a few months. The farm people of West Virginia are becoming conservation conscious, and they will undoubtedly do their part in the solution of the larger national problems.

Hundreds of thousands of acres of our poorer pastures must ultimately be planted to forest trees; our good pasture lands must be limed and fertilized for better production; thousands of acres of our poorer cultivated lands must be seeded to pasture to stop erosion, and a more intensive use made of our good land suited for cultivation. Certainly the task ahead challenges our best efforts toward a proper land-utilization plan for our West Virginia hills.

AAA Payments in West Virginia to Sept. 30, 1937

	1933-35 Wheat	1934-35 Corn-hog	1934-35 Tobacco	1936 ACP	Total
Barbour	$	$ 8,123.46	$	$21,599.43	$29,722.89
Berkeley	51,494.21	33,045.79		14,384.90	98,924.90
Boone		337.10	7,764.72	2,896.31	10,998.13
Braxton		4,173.99		10,479.47	14,653.46
Brooke		4,230.45		7,900.92	12,131.37
Cabell	1,064.87	4,873.10	33,558.80	23,459.27	62,956.04
Calhoun		10,885.54	424.29	9,287.67	20,597.50
Clay		3,339.05		6,639.56	9,978.61
Doddridge		2,030.35		5,442.68	7,473.03
Fayette		2,224.67		10,711.05	12,935.72
Gilmer		2,425.64		8,219.51	10,645.15
Grant	5,908.18	15,706.41		7,722.50	29,337.09
Greenbrier	8,131.75	12,466.90		19,283.37	39,882.02
Hampshire	6,661.85	22,611.60		16,003.35	45,276.80
Hancock		193.01		4,463.81	4,656.82
Hardy	11,991.12	34,571.90		10,917.41	57,480.43
Harrison		10,735.77		15,999.64	26,735.41
Jackson		6,604.74	4,132.75	10,898.75	21,636.24
Jefferson	116,512.54	116,007.93		24,174.57	256,695.04
Kanawha		14,123.77	3,272.97	6,892.88	24,289.62
Lewis		3,813.49		12,258.85	16,072.34
Lincoln		2,603.04	50,500.88	26,702.36	79,706.28
Logan		337.09	2,893.60	1,495.57	4,726.26
McDowell		337.09			337.09
Marion		2,394.56		7,260.48	9,655.04
Marshall		10,704.77		25,920.38	36,625.15
Mason	13,157.76	25,639.84	17,583.25	24,878.62	81,259.47
Mercer		2,177.28		15,418.32	17,595.60
Mineral	3,317.45	3,639.80		6,691.58	13,648.83
Mingo		337.09	569.62	122.13	1,028.84
Monongalia		2,013.69		7,089.56	9,103.25
Monroe	6,130.64	11,803.29	1,750.89	19,275.57	38,960.39
Morgan	3,843.76	3,388.51		14,914.40	22,146.67
Nicholas		5,155.43		11,017.38	16,172.81
Ohio		1,270.21		8,096.83	9,367.04
Pendleton	6,311.66	21,933.67		12,044.44	40,289.77
Pleasants		1,561.79		4,607.86	6,169.65
Pocahontas		3,975.73		15,809.41	19,785.14
Preston		5,132.58		34,540.13	39,672.71
Putnam	382.95	3,057.95	46,380.75	19,482.95	69,304.60
Raleigh		828.53		5,753.23	6,581.76
Randolph		2,750.60		21,631.63	24,382.23
Ritchie		522.75		5,883.59	6,406.34
Roane		933.43	295.66	12,457.69	13,686.78
Summers	692.17	4,137.69		8,716.14	13,546.00
Taylor		335.64		7,454.26	7,789.90
Tucker		958.17		6,998.49	7,956.66
Tyler		2,236.05		8,940.62	11,176.67
Upshur		6,665.32		12,869.36	19,534.68
Wayne		7,506.01	7,619.03	22,285.13	37,410.17
Webster		624.49		4,113.68	4,738.17
Wetzel		2,414.69		12,398.52	14,813.21
Wirt		2,301.77	1,044.72	10,341.33	13,687.82
Wood		3,003.32	1,040.24	8,069.30	12,112.86
Wyoming		563.60		2,258.68	2,822.28
Total	$235,600.91	$455,770.13	$178,732.17	$655,175.52	$1,525,278.73

THE MODERNITY OF SOPHOCLES

F. R. GAY

Department of English, Bethany College, Bethany

IT IS THE PURPOSE of this paper to show that the most typically Athenian of the three great Greek tragedians was essentially in accord with the best modern thought.

One of the most important religious developments of the past 15 years has been the movement toward a new orthodoxy represented on the Continent by Barth and in America by Niebuhr. This movement while no return to "Fundamentalism" is a denial of the efficacy of the "social gospel" to save the world, and it is rather skeptical of the possibility of world salvation. It affirms the validity of the "Christian oracles" without subscribing to the creed of verbal inspiration, and it admits the possibility of a continuous revelation of God through all the avenues of modern science, art, and spiritual inspiration.

Sophocles' position in religious thought is very similar to that of this school of the new orthodoxy. He does not break with traditional Greek religion in an age when it was being vigorously attacked. He criticizes current skeptical opinion, but he so purifies and moralizes the old religious views, he so emends them, suppressing their inadequacies and superstitions and emphasizing their universal element, that without impeding the progress of religious thought, he keeps it vitally attached to dateless tradition. Because he could "see life steadily and see it whole" he was able to separate the wheat from the chaff, the permanent from the temporal, and thus to take the middle position of refiner, interpreter, and sustainer of those ideas through which man has communicated with the Higher Powers.[1]

In his attitude toward morality he again shows his modern temper. Just as the saner element in the modern world has become distrustful of sheer intellectual cleverness, so also does Sophocles reveal his bias against it. Man may be exceedingly cunning, but there is no assurance but that all his cunning will bring him to evil instead of good.[2] He says this in an age and especially in a city where, as in our American democracy, mere shrewdness was at a premium. In Sophocles' time unscrupulous eloquence was becoming a menance to good government, just as today the demagogue flourishes in print and on the radio, disseminating his insidious propaganda with nothing to hinder except a few alert, courageous, and farsighted prophets and poets, novelists and dramatists, who relentlessly expose chicanery and ignorance.

If Professor Earle is correct in his interpretation of Oedipus Tyrannus 863-910, Sophocles in this chorus is covertly criticizing

---

[1] cf. Goodell, T. D., **Greek Tragedy**, 224 (Yale Univ. Press). Plumptre, E. H., **The Tragedies of Sophocles.** Introductory Essay, p. lxxvii (London, 1865).

[2] **Antigone**, 365, 6. Texnas refers strictly to inventive skill in art.

the HUBRIS of the tyrant Pericles. (Incidentally this interpretation removes some formidable difficulties which scholars have had to face.) In this case the parallel between Sophocles' attitude and that of such modern writers as Thomas Mann is obvious enough. Encouraging for defenders of democracy would be Sophocles' statement that dictatorial insolence, when it has surfeited itself on wealth that is not good for it, is hurled to dire doom.

Sophocles apparently has no direct connections with science as did Goethe but only the general interest of a Tennyson or a Browning. Professor Paul Shorey says that the chorus in the Antigone on the inventiveness of man is a striking illustration of the fact that while there have been great mechanical advances in modern times, the thought of mankind concerning these advances has not progressed.[3]

Our extremely realistic age has produced some doubtful benefits but has at least forced us to curb somewhat our romantic and neurotic sentimentalism. Euripides if alive today would doubtless exemplify it, but Sophocles would take the attitude of an interested and critical observer. Poised and calm in the higher atmosphere of pure thought and controlled feeling he would survey the welter of the modern world with philosophic detachment. He would incorporate his diagnosis of our political and social ills in a chorus of one of his tragedies as Eugene O'Neill on a different level has done in his "Mourning Becomes Electra", or as Maxwell Anderson in various passages of "The Wingless Victory". Sophocles was enough of a realist to feel an instinctive dislike for mawkish sentimentalism. Just as he could not understand why Electra should feel the binding force of the mother-daughter relationship after years of insolent treatment at the hands of Clytemnestra and her paramour, so would he be too realistic today to look with any favor upon those relaxing influences which Hollywood sentimentalism exerts on today's life.

Sophocles was able to adjust himself to his age without losing his sympathy with all that constitutes really progressive culture, whereas Euripides impresses one as a radical who has broken with the best ethical and artistic traditions of his own day without being able to formulate anything to satisfy the normal human craving for moral and aesthetic law and order. Sophocles' " religion of the imaginative reason", however, not only satisfied the greatest intellects of the Periclean age, but has a universal appeal to the religious and philosophic temperament in all ages.

Modern, too, is Sophocles' psychological subtlety. One of the finest psychological touches is Clytemnestra's utterance of her natural feelings on hearing the report of Orestes' death:

"There is a strange power[4] in motherhood; a mother may be wronged, but she never learns to hate her child."[5]

---

[3] cf. Paul Shorey, **Plato, Epicurus, and Lucretius.** Shorey cites John Morley, **Politics and History,** p. 67, and George Herbert's poem **Man.**

[4] deinon, mysterious (power), strangely potent (tie).

[5] Electra, v. 770.

Sophocles' depth of psychological insight often is best exhibited in the struggle which is going on in the mind of the actor. Through contrast of character he secures also some of his best modern touches.

Especially appreciated in modern literature is what we may call a cosmic sense. Like some of the greatest modern geniuses, Sophocles had a spiritual sensitiveness, a sort of subconscious rapport with what Emerson calls the 'Over-soul'. As Gilbert Murray puts it, "He feels, as Wordsworth does, the majesty of order and well-being; sees the greatness of God, as it were, in the untroubled things of life."[6]

Especially modern is Sophocles' flair for dramaturgy. His plays have been unusually successful on the modern stage, particularly in Germany, France, England, and the United States. That which may fail to impress the reader because of his inability to call the historic imagination to his assistance, will often move him profoundly as a spectator in the theatre. Sophocles had the genius to make character and action blend into an integrated whole in swiftly-moving scenes interspersed with choruses that in one aspect of their function supplied the place of our theatre programs and orchestral numbers between acts, and above all, he was able to do this without that "theatricality" which vitiates so much of our present dramaturgy.[7]

Oedipus Tyrannus as acted in Paris with M. Mounet-Sully in the title role never failed to draw full houses, and this demonstration before the cultured people of England and America, as well as France, had a great influence in these countries to place the revival of Sophoclean drama on a higher artistic level, and to silence those objectors who prefer to keep the Greek poet in a closet, thinking that he cannot be understood or enjoyed by a modern audience.

If Sophocles is as much of a modern as all this would indicate, why has he not exerted more influence over modern dramatic art? Sixty years ago an English critic answered this question for his countrymen by saying that most Englishmen are satisfied with a textual or critical knowledge of Sophocles and never really submit their minds to the influence of his art and philosophy.[8] The reason which Gildersleeve gave for the relatively greater popularity of Sophocles in Germany than in England is that Sophocles did not have a personality salient enough to attract the English mind, whereas the Germans care more for the art and less for the artist.[9] Mackail's statement that even among trained critics admiration for Sophocles is reluctant and qualified[10] is denied by Warren, who asserts that Sophocles has been persistently the favorite of the best

---

[6] **A History of Ancient Greek Literature**, 241, New York, 1897. Murray illustrates this by **Antigone** 332 ff, Ajax 669 ff, and the second **Oedipus** 1211 ff.

[7] For accounts of successful stage productions cf. J. T. Sheppard, **The Oedipus Tyrannus of Sophocles**, Chapter IV.

[8] An anonymous writer in the Westminister and Foreign Quarterly Review, Vol. 99, p. 1.

[9] **Essays and Studies**, p. 163.

[10] **Lectures on Greek Poetry**, London, 1912, p. 145.

critics.[11] Sheppard says that it is a fallacy to assume that Sophocles' art is and must be unpopular.[12] If by the word "popular" in dramatic criticism is meant "possessing such qualities as make a dramatist a delight to those literary critics who are temperamentally sympathetic with the highest type of dramatic poetry", then it may be asserted confidently that Sophocles is popular today, much more so than Euripides, and runs no risk of losing that popularity. Unobtrusive art with these critics is always the most popular, and in this particular Sophocles is supreme.[13] Nor do the greatest critics enjoy an obtrusive realism or an obtrusive morality, and Sophocles is too much of an artist to be a photographer or a preacher.[14] It is manifestly impossible to weigh an author's influence mathematically, and yet an effort was once made to compare the influence of Sophocles and Euripides by counting the number of references to them in literature, measuring the space which these references occupy, and counting and weighing the adjectives applied to each poet. A debate between C. A. Browne and F. A. Woods as to the relative popularity of Sophocles and Euripides was printed in an American scientific journal in 1910.[15] Browne "proves" by his statistics that Euripides is more than twice as eminent as Sophocles,[16] but Woods does not approve of Browne's method of measuring fame by the number of references or by their space, but thinks that the "adjective" method is the only one that can be trusted.[17] So by establishing a ratio of the adjectives of praise with the adjectives of dispraise he draws the conclusion that the position of Sophocles is "more majestic and more sublime". Browne thought that the adjective method, whatever validity it might possess for certain types of investigation, did not fit this particular instance, because Woods had failed to take account of one quality in Euripides which "more than outweighs the sum of his deficiencies," i. e., his "humanity, which has appealed to mankind far more than the majesty and ideal art of Sophocles."[18] So by the ambiguity of the word "popular" Browne escaped from the conclusion which Woods legitimately drew, assuming that one can really settle such a point by counting and weighing "adjectives of praise and dispraise."

Often those who prefer Euripides to Sophocles do so because of the stronger emotional appeal which the younger dramatist makes. Those who feel that this is the most essential element in tragedy would be inclined to rank Euripides higher. Others prefer Euripides because his style is better adapted both for ordinary conversation and for popular oratory, exhibiting a more versatile blending of humor with seriousness than the more strict and chaste manner of Sophocles. For this very reason, however, the majority of the

---

[11] **Essays of Poets and Poetry**, 18 (London, 1903), where he cites Aristotle, Dionysius of Halicarnassus, Dio Chrysostomus, Cicero, Virgil, Lessing, Goethe, Matthew Arnold, and Edward Fitzgerald.

[12] **Greek Tragedy**, Cambridge, 1911, p. 95.

[13] Cf. the article 'Sophocles' by Professor Shorey in the International Encyclopedia.

[14] Cf. W. L. Courtney, **Old Saws and Modern Instances**, London, 1918, p. 163.

[15] In 'Science', vols. 32, 33.

[16] **Ibid.**, vol. 32, pp. 464 ff.

[17] **Ibid.**, vol. 33, pp. 572 ff.

[18] **Ibid.**, p. 770.

world's greatest poets have preferred Sophocles. His uniting of sheer beauty and wholesome morality in a style which is characterized everywhere, in dialogue and chorus alike, by the purest taste and most delicate refinement is an achievement which in their opinion far outweighs any effects to be secured by mere cleverness and rhetorical fluency.

The American literary critic, Hamilton Wright Mabie, speaking of the Oedipus Tyrannus, says that "the dramatist, even when he throws no light on the ultimate solution of the problem with which he is dealing, feels so deeply and freshly, and discloses such sustained strength, that the vitality with which the facts are exhibited and the questions stated affirms its superiority over all the adversities and catastrophies of fortune."[19] This quality Sophocles shares with Shakespeare and the few other poets of the greatest genius, and this is what makes his dramas so effective on the stage in the Twentieth Century. Although, in the reaches of his poetic imagination, Sophocles is not as bold and sublime as Aeschylus,[20] in his artistry[21] and his dramaturgy he easily ranks first of all the Greeks and second only to Shakespeare among the poets of the world.[22]

---

[19] **Books and Culture, 182. (New York, 1909).**

[20] As Edward Fitzgerald wrote to C. E. Norton (Dec. 15th, 1878), "Then you know, Sophocles does not strike fire out of the flint, as old Aeschylus does." Victor Hugo ranked Aeschylus higher than Sophocles because the latter, "although he was free from darkness or obscurity or monstrousness, lacked the unknown, the infinite." (William Shakespeare, Book II, chapter 5).

[21] Sainte-Beuve said that many mediaevalists "fall into aberrations of taste that would be impossible to any one who has read Sophocles in the original text." (N. Lundis III, p. 396).

[22] Theodore Watts-Dunton names as the true dramatists who possess "absolute vision" Shakespeare, Aeschylus, Sophocles, and Homer. Chaucer is added with the qualification "hardly". (Article "Poetry" in the Ency. Brit., Eleventh ed.)

SUPPLYING LYON (FRANCE) WITH COAL IN THE EIGHTEENTH CENTURY: A STUDY IN GOVERNMENT REGULATION

HENRY M. DATER

Department of History, Kent State University, Kent, Ohio

IN THE PRE-INDUSTRIAL EUROPE of the eighteenth century, a city of 120,000 presented problems unique in their quality and severity. The existing methods of transportation aggravated, in a way unknown since the coming of the railroad, the problems of obtaining food, fuel, and other necessary supplies. Lyon, historically one of the first manufacturing centers of Europe, whose prosperity was based upon a thriving trade in silk goods, found itself faced after 1750 with a growing fuel shortage, as wood, the traditional reliance of both industrial and domestic consumers, became scarcer and dearer. Inevitably, the inhabitants turned increasingly to coal[1], supplies of which existed within 20 miles of the city.

The Loire coal field, the eastern end of which extended across the divide between the Loire and the Rhone Rivers into the valley of the Gier, contained, as indeed it does today, a quantity of high-grade coal suitable not only for domestic but also for metallurgical and other industrial uses.[2] From the mines in the vicinity of Rive-de-Gier, a practicable route existed by way of the valley of the Gier to Givors on the Rhone, where the fuel was transferred from wagons to barges for shipment to Lyon.[3] Although the transportation of bulky commodities by land cost a great deal, this particular route, so long as the quantity did not over-tax the existing facilities, proved satisfactory because the wagon road was not long and passed through a terrain easy to negotiate.

Despite its favorable location, however, Lyon experienced difficulties in obtaining adequate supplies. For one thing, the exploitation of the mines by private individuals had proceeded so unscientifically that the coal fields were threatened with permanent ruin. Alarmed by the gravity of the situation, the royal government, in an *arret de conseil* of January 14, 1744, reasserted the king's ownership of all sub-soil deposits, and consequently introduced a system of licensing to insure that only persons with adequate capital and knowledge might open new mines. At the same time it laid down certain rules for the construction of pits and galleries designed both to save the deposits and to protect the workers. Finally because it feared that the local courts would favor the

---

[1] Lyon, Arch. Mun., BB330, 92, April 29, 1762. BB366, Dec. 16, 1784. Rhône, Arch. Dep., C120. Mémoire pour les concessionnaires, Sept. 1, 1770. De Flesselles, Intendant of Lyon, to Calonne, controlor general, March 1, 1784, Ardascheff, P., **Les Intendants de Province sous Louis XVI,** Paris, 1909, 245.

[2] Ormsby, H., **France: A Regional and Economic Geography,** New York n. d., 39, 41, 42, 290. The coal mined in the western portions of the field either was consumed in Saint-Etienne, already a metallurgical center, or was shipped down the Loire in the direction of Paris. Rhône, Arch. Dep., C119, Sub-delegate at Saint Etienne to de Flesselles, Intendant of Lyon, July 7, 1784.

[3] **Ibid.,** C120, Mémoire pour les concessionnaires, Sept. 1, 1770.

resident proprietors of the surface, not only the enforcement of the *arret* but also cases resulting from its application were placed under the jurisdiction of the Intendant.[4] This document remained until the Revolution, the basis for all policing of the coal mines and around it grew up a rather elaborate system of royal regulation.

The wisdom of the government's action became, for the coal field upon which Lyon depended, apparent when in 1753 flooding caused the closure of all but three or four of the mines. Taking advantage of the licensing provisions of the *arret du conseil* of 1744, the authorities after prolonged investigation turned the mines over to a company which had the capital and skill necessary to construct suitable drainage works.[5] After a long period of conflict with the inhabitants of Rive-de-Gier, who came to the aid of the local proprietors, and during which the government had to make specific application of the general provision in the *arret* of 1744, that had reserved the jurisdiction over all law suits to the Intendant, the company, beginning in 1769, gradually obtained control of the mines.[6] Although for a time, because of the conflict between concessionnaires and natives, production actually declined, the more scientific exploitation ultimately brought results both in the number of pits, which by 1779 had risen to 30, and in the output of coal.[7] All this development was carried out under the direction of the Intendant, who functioned through a sub-delegate stationed at Rive-de-Gier. Despite the opposition of the inhabitants, the royal government pushed through the measures regarded necessary for supplying Lyon with coal.

No sooner had the mining question been settled, than the transportation problem arose to plague the authorities. As early as 1770, the concessionnaires had pointed out that, despite relative stability at the mine, prices had continued to rise sharply. In some cases after a comparatively short haul prices were double what the producer had charged.[8] Six years later the carters and the mine

---

[4] **Ibid.**, C120, Arrêt du conseil, Jan. 14, 1744. An **Arrêt du conseil** was an administrative order issued by one of the royal councils and, because of its simplicity, was the favorite method of legislation in the eighteenth century, there being no clear distinction between a simple order and formal legislation. The Intendant, a royal official dispatched from Paris to oversee the King's business in a district known as a **généralité**, exercised financial, executive, judicial, and even legislative functions.

For full discussion of the background of this document see Rouff, M., **Les Mines de Charbon en France au XVIII Siècle**, 1922, 164.

[5] Rhône, Arch. Dep., C120 Arrêt du conseil, Aug. 21, 1753. Mémoire pour les concessionnaires, Sept. 1, 1770. **Ibid.**, C121 Report of the Sub-delegate at Rive-de-Gier, Aug. 24, 1779.

[6] **Ibid.**, C120, Sub-delegate at Rive-de-Gier to Baillon, Intendant of Lyon, June 21, 1764, and to de Flesselles, Intendant of Lyon Sept. 12, 1767. Mémoire pour les concessionnaires, Sept. 21, 1770. **Ibid.**, C121, Arrêt du conseil, April 29, 1773. Rouff, M., **op. cit.**, 135. Gras, L. J., **Histoire Economique Générale des Mines de la Loire**, 2 vol. Saint Etienne, 1922, I, 77.

[7] Rhône, Arch. Dep., C121, Report of Sub-delegate at Rive-de-Gier, Aug. 24, 1779. The best available figures for coal production at Rive-de-Gier are as follows: 1756—640,000 bennes; 1769—480,000; 1777—482,586; 1781—775,762; 1782—829,217; 1783—914,818; 1785—949,692; 1787—1,176,312; 1788—956,000; 1789—825,000. Both M. Rouff, **op. cit.**, 429, and Gras, L. J., **op. cit.**, I, 178, accept these figures which were compiled by an earlier writer whose work I have not found available: Brossard, E., **Le Bassin Houiller de la Loire**, Saint Etienne, 1867. The **benne**, like all Eighteenth-Century measures, was extremely variable, differing at the mine, at Givors, and at Lyon. The benne of Lyon, here probably referred to, is equivalent to 50 kilograms.

[8] Rhône, Arch. Dep., C120, Mémoire pour les concessionnaires, Sept. 1, 1770. **Ibid.**, C122.

operators engaged in a bitter argument to fix the blame for the constantly higher prices.[9]

The government might, however, contemplate the situation with some degree of complacence because, as the dispute became acrimonious, the canal from Givors to Rive-de-Gier, that was to connect Lyon with the mines by an all-water route, neared completion. Proposed in 1751 by a watchmaker of Lyon named Zacharie, the canal was authorized in 1761. As in the case of the mine company, the inhabitants, who made large sums from the hauling of coal, objected so bitterly that ultimately the government placed all law suits arising from the construction under the jurisdiction of the Intendant.[10] Such an action was equivalent to placing the canal directly under the control of the same official who regulated the production of coal and completed his powers over the commodity.

Like the railroad of the following century, the canal enjoyed a practical monopoly over transportation in the area that it served; and the authorities undertook to regulate rates both in the interests of shipper and investor.[11] That the project would repay the outlays of the capitalists and the confidence of the government was demonstrated within a few months of the opening in the spring of 1781.[12] Although the Gier, which supplied water for the canal, occasionally failed during dry seasons,[13] the new means of transportation proved very useful in supplying Lyon with coal, and thus fulfilling the purpose for which it had been authorized.

If the methods pursued by the royal government had solved the basic problems of the output and transport, they nevertheless created a new and serious danger. The establishment of exclusive concessions, which put control of production and carriage in the hands of two companies, opened the way for monopolistic practices that might, by raising prices, have harmed the consumer. As early as 1777 the city, facing a shortage of fuel, appealed to the royal government for help. Bertin, the minister in whose department Lyon lay, obtained an *arret du conseil* ordering the Intendant in Burgundy to exploit certain mines, whose product he was to dispose of in Lyon at cost. This threat—it was nothing more, because even though the Soane provided an artery of transportation, the Burgundian mines could not compete with those more favorably situated in the Loire field—served to bring plentiful supplies from Rive-de-Gier at a comparatively low price.[14] The spectre of com-

---

[9] **Ibid.**, C122.

[10] **Ibid.**, C95. This carton contains all the papers relative to the proposal, its authorization, and the rather prolonged construction. For the order transferring jurisdiction to the Intendant, see **Ibid.**, C96, arrêt du conseil, March 28, 1780.

[11] **Ibid.**, C96, Letters Patent, Aug. 12, 1779. The rates were 2 **sous** per league on a **quintal** (i. e. a cwt.) on the boats of the company and 1 **sous** 6 **deniers** on the boats of others.

[12] **Ibid.**, C96. Rigoud de Terrebasse to de Flesselles, Intendant of Lyon, July 13, 1781. The returns exceeded the best hopes of the investors.

[13] **Ibid.**, C96. Letters Patent in the form of an Edict, Dec. 1788. The company proposed to remedy this defect by the construction of a reservoir at Rive-de-Gier, to cost 1,371,551 **livres**, or more than a third what the project had required from its inception to 1788, 3,062,000 livres. The canal, which was finally abandoned in 1926, may still be seen by the traveler who visits the valley of the Gier.

[14] Lyon, Arch. Mun., AA133, 52, Municipality of Lyon to Bertin, Minister of the Department, Dec. 19, 1777.

petition from a government-operated agency did not, as some of our contemporaries seem to believe, originate with the present decade.

Apparently, however, the Burgundian threat exhausted its possibilities on the first effort; for the authorities did not revive it during the next few years when the need for action had become even more imperative. In January, 1782, the Intendant of Lyon, suspecting secret agreements and other collusive practices as well as a shortage resulting from increased demand, issued a long ordinance to regulate the trade. To step up production, he inserted a provision declaring that, unless the concessionnaires increased their output by 50%, he would allow the surface proprietors to exploit their own subsoil.[15] Upon investigation it had been found that those engaged in hauling the coal from the mines to the canal head at Rive-de-Gier often brought large quantities for a low price at the mine mouth. In order to watch this practice, every carter was obliged to register with the authorities and receive a number to be displayed prominently on all his wagons. Thirdly, the canal company was ordered to store 150,000 *bennes*, nearly a quarter of Lyon's annual consumption,[16] at the Rhone end of the canal so that any interruption of navigation would not prove fatal. Finally, to prevent too great fluctuations, the Intendant fixed maximum prices at the mine, in the village of Rive-de-Gier, at Givors on the Rhone, and finally in Lyon.[17] These provisions, except for the power to fix prices, were intended not so much for actual application as to threaten the producers and the carriers. The Intendant in 1789 revealed that the proprietors had never been permitted to exploit their own holdings because not much but confusion could be expected from a myriad of small producers. Also, he feared to put the canal company into possession of such a large quantity of coal, which it might use to rig the market.[18]

Within a year of its issuance, however, the usefulness of the weapons provided by the ordinance was demonstrated, when in the autumn of 1782 the Intendant found himself caught short. A sudden demand for coal by many industrial consumers, who had formerly used wood, combined with a dry summer and an early cold, both of which hindered navigation on the canal, to exhaust the scanty supply.[19] By raising the price in Lyon from 22 to 27 *sous* a *benne*, sufficient coal was brought into the market to tide over the

---

[15] For this action he had a precedent in the action taken by the concessionnaires themselves in 1772, when a fire forced the temporary closure of many mines. To maintain production they had allowed the proprietors to exploit their subsoil deposits for a period of two months. Rhône, Arch. Dep., Bertin, Minister of the Department, to de Flesselles, Intendant of Lyon, Dec. 23, 1772.

[16] In 1782 the municipality estimated its annual needs at 800,000 bennes (about 40,000 tons). Lyon, Arch. Mun., AA134,149, Municipality of Lyon to Vergennes, Minister of the Department, Oct. 22, 1782. Other sources estimated that from 1785 to 1790 the city used between 600,000 and 700,000 bennes (30,000 to 35,000 tons) yearly. Cited by Rouff, M., op. cit., 429.

[17] Rhône, Arch. Dep., C119, Ordinance of the Intendant, Jan. 22, 1782.

[18] Ibid., C5. Report of Terray, Intendant of Lyon (Aug. 1789).

[19] Lyon, Arch. Mun., AA134, 144, 149, Municipality of Lyon to Vergennes, Minister of the Department, Oct. 16, Oct. 22, 1782. De Flesselles, Intendant of Lyon, to Calonne, Controleur general of finances, March 1, 1784, Ardascheff, P., op. cit., 245.

winter.[20] The following year the Intendant sought to avoid a repetition by putting pressure on the producers and by informing industrial users that, after October first, householders would enjoy preference in the market.[21] These steps taken in time assured the city of enough fuel for the winter, and seem to have sufficed during the following years. The Intendant, through his planning and activities, had overcome the obstacles and done all that could be expected to protect both producer and consumer. Only extraordinary conditions would require further measures.

The growing consumption of coal in Lyon had, however, created one problem that did not fall within the jurisdiction of the royal authorities. The municipality increasingly recognized that lack of storage facilities not only affected prices adversely but also might seriously endanger the people's well-being. In 1782 it proposed the establishment of municipal coal and wood yards but was prevented from doing anything about them by lack of funds, until the winter of 1788-1789, when such provision was made to meet a temporary emergency.[22]

The unusual winter, which caused the establishment of storage facilities in Lyon, saw the canal and the Rhone freeze late in October, a phenomenon without precedent in a region usually blessed with a mild climate. By December 30, the situation had become so desperate that the Intendant and municipal authorities signed a contract with private individuals to bring 800 *bennes* of coal a day to Lyon by wagon. The contracting parties were to receive 20 *sous* transportation charges plus two *sous* bounty on each *benne* delivered. Since the city agreed to store and retail the coal at 27 *sous*, the operation was carried on at a loss. Nevertheless it did save the inhabitants from freezing to death and under the exceptional circumstances was justified.[23]

Such a crisis naturally forced the authorities to take stock of their position during the following summer. The municipality in May called upon all citizens to purchase their fuel early.[24] At the same time, the royal officials went carefully over the whole problem. The sub-delegate general, who assisted the Intendant, visited the mines to form an accurate estimate of the possible output which he felt might be increased from 3000 to 5000 *bennes* a day. Acting on this information, the Intendant drew up for the royal ministers a report reviewing what had been done in the past and what he might do in the future.[25] Finally, in November, the sub-delegate general, in the absence of his superior, issued an ordinance direct-

---

[20] Rhône, Arch. Dep., C122.

[21] See the letter of de Flesselles to Calonne, March 1, 1784, cited in note 19.

[22] Lyon, Arch. Mun., AA134, 156, Municipality of Lyon to Joly de Fleury, Controllor general, Dec. 19, 1782. BB366, Dec. 16, 1784. Bibliothèque Municipale, Fonds Coste 6664.

[23] Rhône, Arch. Dep., C5. This carton contains all the relevant papers. Between January 2 and January 3, the contractors brought 13,552 bennes to Lyon, somewhat under the 800 a day called for in the agreement. As about 9,000 more arrived on private account, the city received a sufficient supply.

[24] **Procès-Verbaux des Séances des corps Municipaux de la Ville de Lyon**, Lyon, 1899, I, 150.

[25] Rhône, Arch. Dep., C121, Report of Bouché, sub-delegate general in Lyon, Aug. 11, 1789. Report by Terray, Intendant of Lyon, (Aug. 1789).

ing the transfer of workers from pits under construction to those in active operation, authorizing the mines to run on Sundays, holidays, and overtime, and offering bounties to anyone who would work on such occasions. Finally, the royal engineer for the province was dispatched to examine the mines and allocate the miners as seemed most likely to increase production.[26] With these measures, designed to complete the control of the Intendant over the exploitation of the mines, the story of supplying Lyon with fuel inevitably came to end. For within a few months the developing revolution swept away the old regime and began the introduction of a new economic system in which governmental interference played a small part indeed.

In conclusion, it is only necessary to reemphasize the problem which presented itself to the authorities. Under existing methods of transportation, only one practicable source of coal existed for the great city of Lyon—the eastern end of the Loire coal field. Secondly, in order to prevent the ruin of the coal deposits and to increase production, it seemed advisable to turn the mines over to those having the capital and skill to exploit them properly. The recognition of this necessity, however, opened the way to monopoly, especially when another company, for advantageous reasons, had acquired exclusive control of the most economical means of transportation. From these basic factors, themselves the outcome of economic forces, grew step by step a complete system of regulation based partly on threats never actually carried out and partly on price fixing. If a pragmatic test is the proper criterion for judging economic policy, the result justified the whole undertaking. One of Europe's largest cities did receive supplies of fuel without which it would have gravely suffered.

Finally, perhaps in this day of planning and regulation, the reader will be tempted to draw an analogy. When one considers the measures designed to improve working conditions or wages, the temptation becomes nearly irresistible. One basic consideration, however, must arise to warn against any too hasty generalization. Today the world has witnessed regulation and planning to maintain profits or increase labor's share in the product of industry, but precious little to help the consumer, whose interest occupied so large a place in the minds of eighteenth-century French officials. In the twentieth century the efforts of government have often been to create scarcity where abundance has existed. In the Eighteenth it sought, if not to create abundance, at least to provide an adequate supply of a needed commodity. If the means sometimes appear the same, it is well to remember that ends were quite different.

---

[26] Ibid., C5, Ordinance of the Sub-delegate General, Nov. 16.

THE PREFERENCE FOR THE BLOND TYPE IN ANCIENT GREECE AND ROME

C. G. BROUZAS

Department of Classics, West Virginia University

IN A PAPER which I read before the Academy at Bethany, a number of opinions were quoted which showed that some modern scholars believe that the Greeks admired blond people because they were themselves blond; while others believe that it was because the Greeks were themselves dark that they admired the blonds. I merely ventured the opinion that the principle that like attracts like should be adopted.[1] Since then a further study of this problem has been made, and part of the results of the investigation are summarized below.

The Cretans, judging from their paintings, were a brunette people, with dark or brown hair and eyes and a brown skin. In all the Cretan monuments found so far, no representation of blond hair and blue eyes has been found. Richardson indeed maintains that the ivory statuettes from Knossus, discovered by Sir Arthur Evans and known as the Bull Leapers, are blond. Of the better preserved head, Richardson says that because the hair is made of copper wire and was probably gold plaited, it represents a blond person. He adds that "the youth was blond, like Achilles." He would put that statue not later than 1500 B. C.[2] But Sir Arthur Evans, the excavator and publisher of these statues, does not classify them as blond. In fact he says that "the passion for color is such a universal characteristic of Minoan Art, that it is probable that the male figures at any rate were originally stained a ruddy hue."[3] According to Richardson's reasoning, the ivory Snake Goddess of the Boston Museum would pass for a blond. Yet all the snake goddesses of faience discovered in Crete have dark hair and dark eyes.

Myres in his latest book on the Greeks discusses the evidence and considers a few other examples which he thinks are portraits of blond people. Among the works purported to portray blond type besides the ivory Bull Leaper, he mentions a Minoan silver bowl,[7] but he does not describe it and does not refer to any illustrations. Consequently I am unable to know which it is that he means. To make matters worse, he refers to page 73 of his book, where he speaks of a Minoan silver cup. A silver bowl, the only one known to me with human figures, is described by Staes[4] and is figured by

[1] Vol. 10:163-176 (1936). See also **Proceedings of the American Philological Association**, 61:26-76 (1930), for an abstract.

[2] Richardson, R. B., **History of Greek Sculpture** (1911), 36.

[3] **Annual of the British School at Athens** 8:72-73 (1901-1902). See also Bossert, Helmuth Th. **Altkreta**, Nos. 122-124 (2d ed. 1923). On p. 23 Bossert lists this statuette as of late Minoan I period.

[4] Stais, V., **Collection Mycenniene du Musee National II.** (2d ed. Athens, 1915) No. 481 pp. 54 and 223-224 for the rhyton, which has been reconstructed from the fragments of the silver vase. On p. 88, number 2489, Stais describes the real Mycenean silver bowl, doubtless referred to by Myres, and gives the following characteristics: "La barbe, les cheveux, et les yeux, ainsique les sourcils, sont indiques sur l' or par des incisions remplies d'une matiere noire (niello)." The same may be found in the English edition (1926) p. 88; "black substance".

Bossert.[5] The former tells us that "the beard, the hair and the eyes, as well as the eyebrows, are indicated over the gold with incisions filled with a black matter" *(niello)*. Be that as it may. Myres argues that the light figure on it represents Odysseus, and has nothing to do with Crete. Without any good reason, Torr thinks that the people in Crete who painted the Cupbearer fresco may not have been of the same race as the Cupbearer.[6]

Myres argues that there were people with fair or golden hair in the population of the later bronze age in Greece: i. e., during the interval between the Minoan and Hellenic times.[7] For the Mycenean times, besides the "Silver Odysseus Bowl", he points to the yellow hair which appears on the fresco from Mycenae, and on one from Orchomenos; likewise to a white male in the fresco from Tiryns. His interpretation cannot be accepted *in toto* until I have examined the evidence. But concerning the fresco in Tiryns, the view that the person with the white skin is a man, was proposed first by Hall.[8] But no one else agreed with this view and Hall himself modified it in a later work.[9] Miss Richter[10] and Miss Swindler[11] take that person with the white skin to be a woman. At any rate, details of the hair are in black. The blondness of the Orchomenos figure is disputed by Rodenwaldt,[12] who thinks that the paint may have been discolored.

During the Mycenaean period, then, we have practically no blond type portrayed either in Crete or in Greece. This is probably owing to the fact that the artists were themselves Minoans, at least in the early part, and also, as some scholars believe, to the fact that the mainland rulers in the Late Helladic I period, at any rate, were Minoans.[13] This, of course, is disputed by many, e. g. by Blegen, who holds that the Greeks began to come to the continent at 1900 B. C.;[14] by Myres, who puts their coming about 2000 B. C.;[15] and by Charbonneaux, who argues with Myres, and according to whom at the end of the 16th century there arrived a newer wave of Greeks, the Achaeans, whom he equates with the Mycenaeans.[16] Karolides believes that the pre-Hellenic peoples of Greece, Crete, and Asia Minor were Pelasgians, whom he considers to have been

---

[5] Bossert, op. cit., Nos. 282-284. On p. 31 he lists the silver bowl from Mycenae as belonging to the Shaft Graves period (Schachtgräberzeit). See also Ephemeris Archaeologike (1888) Plate 7.

[6] Torr, Cecil, Classical Review 16:184 (1912).

[7] Myres, J. L., Who Were the Greeks? (1930) p. 198; 73 and note, 62 (p. 551).

[8] Op. cit., p. 199 and note 79. See also Hall, H. R., Aegean Archaeology (1915) p. 190, who says: "Of the masters (or mistresses) we see two riding in the chariot to the hunt."

[9] In a later work, Bronze Age Civilization (1928) p. 230, Hall merely says, "maidens or young princes." It is possible that Myres talks of a different work which is not accessible to me. In his note 79, cited above, he refers to Wace's article in the Burlington Magazine (Nov.-Dec., 1914) and to Wace's Catalogue of Greek Embroideries (1914), of which is accessible to me.

[10] Richter, Gisela M., Classical Collection of the Metropolitan Museum of Art (1930) p. 42.

[11] Swindler, Mary Hamilton, Ancient Painting (1929) p. 100.

[12] Rodenwaldt, G., Der Fries des Megaron u. s. w. (1921) 69 (A10).

[13] Swindler, op. cit. p. 95.

[14] American Journal of Archaeology 32:153-154 (1928). Swindler, op. cit. p. 94.

[15] Op. cit. p. 523. See also James, E. O., Comparative Religion: An Introductory and Historical Study (1938) p. 122., Child, V. Gordon, Dawn of European Civilization (1925) p. 77.

[16] Charbonneaux, J. L'Art Egéén (1929) p. 5.

Indo-Europeans, or Aryans, akin to the Greeks.[17] Bury likewise is of the same opinion.[18] Tsountas thinks that the Greek mainland was "occupied doubtless by Greeks and Greek—perhaps partly Hellenized—tribes were ruling over the Mycenean acropolis" "about the second half of the third millenium." But it took many centuries to complete the conquest, which was accomplished gradually. He believes that in the early centuries of the second millenium the Greeks became masters of the Peloponnese.[19] It is fairly well established now that about the 12th century B. C. the Dorians destroyed the Pre-Hellenic civilization in the continent and on the islands, and they, no doubt, ushered into Greece the blond element.[19h]

The important thing for us to remember here is the fact that the paintings of the time show pretty uniformly dark hair and dark eyes.

Homer describes the Achaeans as having quick-moving eyes,[20] long hair, and white skin.[21] He does not commit himself as to the color of any group, content to call the Ithacan maids in the palace of Odysseus and the Phaeacian maids in the palace of Alcinous simply white-armed. He calls Sparta the land of fair women and makes Achilles, Agamede, Meleager, Menelaus, and Rhadamanthys blond; Odysseus, partly blond. By implication Ajax, Arete, Briseis, Euphorbus, Helen, Hermione, Nausicaa, Nireus, and Penelope were probably blond, and Agamemnon possibly so. Of the brunettes Homer mentions Eurybates, and Odysseus (partly); probably Clymene, Philomedousa, Melantho, and almost certainly Thersites. Judging from the many references that Homer makes to the white-armed[21] epithet, unless it is merely an *epitheton ornans* (as we find it used in later Greek literature and in that of other peoples), and from his penchant for blond hair in his favorite heroes, we may say that he preferred the blonds. We do not know what he himself was. But he either was thinking of the people long before him when he described the Homeric heroes as blond, or, which is more probable, he had in mind the people of his own time, who may have been predominantly blond, at least among the nobility.

Individuals of the heroic age after Homer are described by various Greek writers; by the *Homeric Hymns,* in which we read that the daughters of Celeos had hair like that of crocus, probably of blond, possibly of brunette color. Hesiod describes Menelaus, Iolea, and Meleager as blond, and speaks of rosy-armed Eunice and

---

[17] Karolides, Paul, in the "Introduction" to his edition of K. Paparrhegopoulos' **History of the Greek Nation** (in Greek) (5th ed. 1926) p. CL and elsewhere in passing.

[18] Bury, James., **A History of Greece** (2d ed. 1924) "Preface" and p. 5.

[19] Tsountas, Chrestos., **History of Greek Art** (in Greek, 1926) p. 63.

[19h] **American Journal of Archaeology** 42:135 (Jan.-March, 1938).

[20] The evidence for this and the other following statements as to the description of the Homeric and later Greeks may be found collected in my doctoral dissertation **Studies on the Blond Type in Ancient Greece**, University of Illinois, 1926. For the word helikops see **Proceedings of the American Philological Association** 61:27-28 (1930) and **West Virginia University Studies, Philological Papers**, vol. 2, pp. 44-56.

[21] **Leukolenos. See Iliad** 1, 572; 3, 121; 5, 711; 6, 371-373; **Odyssey** 18, 198 etc.

Hipponoe. He gives Alcmena black brows and eyes[22] and also Mimas, a centaur who is spoken of as black-haired. The Greeks of Argos, at the time of the Expedition Against Thebes, were blonds, according to Pindar, who may himself have been blond, since he was a Dorian of nobility. The women of Argos, according to Callimachus and Statius and the Argonauts, according to Apollonius Rhodius, were blond. This last is significant, since we know that the Argonauts came from all over Greece. This tradition of blondness among the heroic peoples of Greece passed into the later Greek tradition, and we find many writers, Roman and Greek, describe these heroes as uniformly and indiscriminatingly blond until we reach the Byzantine times, when we find some of them described as brunettes.

When we come to the historical Greeks we find Polemo describing the people of Argos as blonds with white and rosy cheeks, soft and reddish hair, and gladsome, quick-moving eyes which had plenty of light. Theognes describes the people of Argos of his time as blond, but it is apparently only the nobility to whom he addresses himself. Bacchylides calls the Laconian women blond, possibly meaning only the Spartan women. The scholia to Homer, and also Eustathius, tell us that the Spartans admired blondness as being a characteristic of brave persons, quite the opposite of the Athenian idea as expressed by Plato, mentioned below. That there were beautiful women in Sparta even in the fourth century A. D., we learn from Claudian, who tells us that the wife of Alaric, who was herself a blond, had Loconian women as her maids of honor. Philostratus the Elder speaks of the smoothness and whiteness of the Laconians, and Athenaeus vouches for the beauty of the Spartan women.

The Athenians are said by Theophrastus to have had black beard and, consequently, probably black hair and eyes. But the reference is indefinite and may not be characteristic of the whole group. This statement, however, acquires some support from Plato, who tells us that the Athenian sculptors used dark pigment for the eyes. Among the Acropolis statues both black and also dark red eyes as well as dark and reddish hair are found. In another connection Plato assumes that there were, at least in Athens, a number of varieties of people, with snub, aquiline, and regular nose. The dark were considered manly, in opposition to the idea of the Spartans mentioned above; the white, children of the gods, and the sallow as honey pale, palliating their darkness with a sweet name, as Lucretius later on tell us that the Romans did, at least the lovers. We have the statement of the anonymous life of Plato, and also that by Olympidorus, that Plato studied with the painters and learned about the mixture of colors, and he probably could distinguish better than the ordinary writers the differences in the complexion of people. Menander deplores the fact that some of the

[22] White, Evelyn H. E., **Hesiod** (Loeb Lib. 1924) p. 221, translates the word with "dark eyes"; Banks, J., **The Works of Hesiod Callimachus and Theognis** (Bohn Lib. 1909) p. 51, translates with "dark eyelids"; Elton, C. H. **ibid.**, p. 321 with "darkening lashes of her eyes"

Athenian women blondined their hair and regards it as an indication of unchastity (as does Juvenal later), indicating thereby that the Athenian women had rather dark hair. But it doubtless shows that blondness was common enough in Athens as to occasion no surprise at blondining.

The Coan women are described by Antonius Liberalis as having black eyes, and we learn from the same source that they hated Athena because she had grey eyes.

Adamantius, in the fourth century of our era, on the authority of Polemo (?), considers the Ionians to have been pure Greeks with hair inclined to blond, rather soft, and gently curling.

From Hippocrates we learn that in Thasos there were people with whitish skin, straight and dark hair, and dark eyes. He mentions both blonds and brunettes among the Greeks. Those that dwelled on the hollow places were darker; those on high, unfertile, waterless places, were more inclined to blondness. From Aristotle we learn that the fishermen and murex gatherers were blond, a phenomenon which he explains as owing to the effects of sun and sea;[23] and from Philostratus we learn that the fishermen of the Bosphorus, on the Asiatic side, were blond. These last two statements, if correct, show us that there were blond people among the lower classes and that blondness was not confined to the nobility.

Sophocles speaks of the Theban women as worthy of being mothers of the gods. Whether he considers them blond, we do not know. Judging from Plato's remark that the white people are considered children of the gods, we might think that Sophocles took them for blond. In the description of Greece, formerly ascribed to Dicaearchus, but now by some ascribed to Heracleides the Critic, the Theban women are said to have been tall and beautiful, the best-looking in all Hellas. Their hair was blond. This statement would receive countenance from the Tanagra Terracotta figurines which as a rule have auburn hair. Miss Hutton cites this passage of Heracleides, referred to above, to illustrate the statuettes and is of the opinion that on the whole of this passage of Dicaearchus (Heracleides), the statuettes form a most interesting commentary.[24] On the other hand, Miss Moore thinks that the auburn hair portrayed on these figurines was simply the result of dyeing.[25] However it be about the Theban women, Sophocles in the Antigone makes the chorus of the Theban elders remark that their own hair has changed from black to white.[26] Whether Sophocles thought that the Thebans were all dark may be doubted. It may be that he used dark in contrast to white, which is the result of eld. It may be, however,

---

[23] Hippocrates, **On Airs, Waters, etc.**, 24. 13: 24.32. Aristotle, in **Problems** 38.2 asks: "Why is it that fishermen and murex gatherers and those who simply work the sea are red-haired? Is it perhaps because the sea is warm and drying (auchmodes) and they are constantly sprayed with it and are dried by the rays of the sun? Since they experience this, their hair on drying, becomes thinner and reddish." I. Bekkers' edition, Berlin, (1837). This explanation is given independently by the German anthropologist, Von Luschan, in the **Journal of the Royal Anthropological Institute of Great Britain and Ireland** 41:239 (1911).

[24] Hutton, C. H. **Greek Terracotta Statuettes** (1909) pp. 35; 48.

[25] Moore, Mabel., **Days in Hellas** (1909) p. 208.

[26] **Antigone** 1092-1094. The word used is melaines, "black" or very dark. R. Jebb in his edition of this play (1906) translates with "dark", p. 195 **ad locum.**

that since the chorus was actually composed of Athenians, Sophocles had in mind these in describing the Thebans. At any rate, the evidence must not be pressed to include all the Thebans, not even all the Theban elders, in the chorus. Apuleius represents Lucius of Thebes as blond, and the daughter of Pelopidas was blond. We find a nameless woman from Chaeronea, daughter of one Euxenidas, who was blond, according to an inscription. That there was a blond element among the Thebans can hardly be doubted.

Coming now to the individuals, besides the ones given above, we find in the 7th century two persons described as blond by Alcman, the Spartan Hegesichora, and Megalostrata of Lesbos. Sappho says of herself that she is dark, and Alcaeus' *ioplokos*[27] is taken by many to mean dark hair. Ovid speaks of her as being dark, and a papyrus fragment likewise describes her as dark. Alcaeus speaks of his beard as being black, but the evidence is not conclusive, since we do not know whether it actually refers to himself. He had a boy, Lycus, who, according to Horace, had black hair and eyes. This, at any rate, gives us a clue to his preference. Anacreon, like Sappho, speaks of himself as having black hair.

In the sixth century we have possibly a blond in Sappho's daughter, who is likened by her mother to a golden flower, a description which might or might not refer to the color of her hair. Another of Sappho's pupils is spoken of as being more harmonious than harp, more golden than gold, but whether it can be taken to mean blond is doubtful. Solon describes Critias, the Athenian, as having red hair.

For the fifth century we have Aglaos, the Athenian winner of foot races, if that is actually his name, described by Bacchylides as having blond hair. Aspasia, the concubine of the Younger Cyrus, is said by Aelean to have been blond. Agathon, the tragic poet, according to Aristophanes, had a white skin, and according to Lucian, thin curly hair like hyacinth, possibly blond, possibly dark. Aristophanes indeed mentions another Agathon, who had dark skin and strong physique. But the identification is impossible and there are some who think that it was the same one mentioned above. Cephisophon is described by Aristophanes as swarthy; so is Chaerephon, the impetuous friend of Socrates. Charis is described by the scholia to Aristophanes as having dark complexion. Dardanis, the flute girl, according to Aristophanes, had dark hair; but she was possibly not Greek at all, or, at best, half-Greek. Leotrophides, the Athenian dithyrambic poet, had olive skin. Lysicrates had black hair and dark skin and was snub nosed and ugly. He tried to make his hair look darker by dyeing it and is satirized by the comic poets. According to Suidas, however, he dyed his hair black only when it became grey. Myronides, an Athenian of noble birth, is spoken of by Aristophanes as possessing a manly figure, dark and bushy hair. By implication Phormio, an Athenian general, was brunette. To

[27] For a discussion of the word, **ioplokos** see the abstract of my paper in the **Proceedings of the Am. Philol. Ass'n.** 66:45 (1935).

these we may add possibly Socrates as a brunette, though it is not beyond a reasonable doubt.

This about concludes the direct evidence which we have at hand in regard to the Greek people at the end of the 5th century B. C. The question is: When a person is described as blond or brunette, unless we know him to be a historical personage, what are we going to think of it? Is he described so, even if he be a historical person, because he is a rarity, or because it is the usual thing to be so? Or is he described according to his worth with no particular thought as to the importance of his color?

Applying the results we have reached above in regard to the historical persons as groups, we find that the different individuals mentioned above fit the groups to which they belong fairly well: e. g., Dorians more or less blond, Lesbians and Aeolians more or less mixed. Athenians more or less dark.

We may derive some help from the people described in Greek fiction. We have some anonymous persons, of whom five are blond and one brunette, the four blonds coming from the *Palatine Anthology* and the brunette from the *Anacreontea*. Of fictional persons proper with names we have approximately 52 described as blonds and 15 as brunettes. Of the entire ideal types we have 57 blonds and 16 brunettes, or a little more than one-fourth of the entire number of blonds. Of the historical persons we have 40 individuals described as blonds and 30 as brunettes, omitting any dubious cases. This is a far cry of the statement published by Philipp making of the historical Greek persons 96 blonds and only 16 brunettes.[28] As we proceed to more recent date, the brunettes increase. In the papyri the word *xanthos* is never met, although *pyrrhos* is met and also *leukos*.

I have no time to discuss the Romans fully, and moreover, I have not worked out the details completely yet. Professor Oggle has cited many Latin references in his article "The White Hand as a Literary Conceit",[29] which shows an overwhelming majority of blond or auburn hair, and he concludes that the persons so described were meant to be taken for blond. But Propertius' Cynthia, although she was given rosy cheeks and white arms and auburn hair, had black eyes, and the word "white" may be merely a literary conceit and an *epitheton ornans*. In fact the word "white" is used of so many brunettes all over the world, both civilized and barbaric, that no particular significance can be attached to it, as we shall see from the evidence I present below. Moreover, the eyes of Cynthia are praised in the first line of the first poem, and there is no doubt that Propertius admired them; but whether it was for their darkness or for something else, only he could tell. Catullus, it would seem, preferred black eyes, a small nose, and rather long hands. We have

---

[28] Philipp, Hans., in **Philologische Wochenschrift** (September 7, 1929, p. 1087). Of the fictional persons he counts 40 blonds and 7 brunettes. He does not name the individuals, nor does he cite authorities for his information. This problem will be dealt fully in my forthcoming book on the subject.

[29] In **Sewanee Review** 20.467-468 (1912).

Cato's statement that even in his time the Roman women were dyeing their hair red. Juvenal censures the women of his day for wearing periwigs of blond color and suggests that the ones who use such are bad. And the scholiast writes that such a custom was that of a *meritrix*, a complaint that we find in Greece, as we have seen above. The scholiast further states that the Roman matrons had black hair. The scholia to Hesiod state that people blondined their hair only when they were drunken. On the other hand, some people dyed their hair dark, as we find in Athens, and as we see in the *Greek Anthology* where Lucillius accuses Nicollo of dyeing her hair jet black; so does Martial inveigh against this practice. The scholia to Homer's *Iliad* speak of the dark people as being stronger, and Eustathius seconds this opinion. This reminds us of Plato's statement that the dark are manly. We do not know the appearance of many Roman writers, but Vergil is said to have been dark and rustic-looking, though of tall and large build. His own descriptions are mostly those of heroic persons and of those which had been settled by the Greek Epic tradition and by that of the Bucolic poets; so we cannot derive any help from his evidence. Horace is described by Augustus as short and round and was possibly dark. His Pyrrha, Miss Red, was a courtesan and cannot be taken seriously. His preference perhaps is to be seen in Lycus, the boy of Alcaeus, "comely with his black eyes and his black hair" (note the emphasis), and also in his *Ars Poetica*, 37. Plautus apparently was blond; his preference for blondness is marked. Terence also is said to have been dark. He detested red hair and blue or green eyes and considered the red-haired people as ugly.[30]

[30] At a future time I hope to discuss further the principles of the preference of types, drawing examples from many literatures and peoples both those of a uniform type and those of mixed types.

EVIDENCE ON THE PROBLEM OF CLASS SIZE

EARL HUDELSON
College of Education, West Virginia University

WHEN THE PROBLEM IS ACUTE

WHILE CLASS SIZE has been more or less of a problem ever since the inauguration of simultaneous instruction, the issue has tended to become acute only in periods of economic stress and/or rapidly mounting enrollment when harassed school administrators, unable to await the reports of investigators, have been obliged to make a virtue of necessity.

PROMINENCE OF THE PROBLEM

That the questions of class size are recognized as being critical is evidenced by the fact that between 1900 and 1932, 205 books, monographs, and articles were devoted to the problem, 108 of these being of an experimental nature. Since 1932 at least 53 treatments of the subject are on record, approximately one-half of them being reports of experiments.

SIGNIFICANCE OF THE PROBLEM

This is not surprising when one pauses to consider that 75% of the cost of public schools in America goes into teachers' salaries; that for education at all levels, as it is administered today, class size is the greatest single variable determiner of educational cost; and that increasing the size of classes therefore offers an obvious and tempting way to immediate educational economy.

But the question of class size is even more significant for several less obvious reasons. If larger classes prove to be feasible in certain subjects, funds can be diverted to departments in which large sections are impracticable or to attract better instructors or for more adequate facilities.

Of even more fundamental importance is the relation of class size to educational opportunity. The school is indeed fortunate that can boast of more than a few great teachers. A very small proportion of the students, therefore, have an opportunity of coming under the magic spell of great leaders. This unintentional discrimination is hardly consistent with our ideal of equal opportunity, but it appears to be inevitable as long as small classes and current standards of financial support prevail. If it could be proved that all, or even some, of these master teachers can handle larger classes as effectively, or even nearly as effectively, as they handle small ones, a higher percentage of students could come into their rightful educational heritage. Moreover, the accrued savings could be used to hold these master teachers and to attract others.

Closely related to this is the problem of instructional emphasis. At the university level, for example, from 75 to 90% of the teaching is being done in the lower-division courses. This means that only

one-fifth of the resources of most universities is available for instruction at a truly university level. The facilities of the physical plant and the energies of the faculty are being usurped by students before they reach the senior college. To a society which is committed, as ours appears to be, to keeping the educational road open all the way for everybody, this usurpation of funds at any one educational level is of concern to the level above. The universal situation is that schools have just so much money to spend. No progressive school has as much as it thinks it could profitably use. More and more demands are constantly being put upon it by society. How, then, can it, with inadequate funds, most nearly realize all of its ideals? Should it relinquish certain of them in order to attain perfection in others, or should it reconcile itself to a little less than perfection in them all?

Finally, class size is of vital relation to the improvement of instruction. Probably the most significant trend in education today, and particularly at the higher levels, is its growing disposition to attack its internal problems scientifically. Now, this kind of service takes time. Many an instructor, burning with a vision of better service, is too busy to do more than behold the vision. It may well be that the direct losses which could possibly accrue from larger classes would be more than compensated for by affording conscientious, competent, open-minded instructors a part of each day for introspection and modest research.

The issue of class size, then, is no mere local, ephemeral, superficial whim affecting only the externals of educational organization. Educational efficiency, moreover, is a relative, not an absolute, matter. Small classes, if they are to maintain, must justify themselves in terms of the ultimate and complete purpose of education. Every teacher is morally obligated to contribute his part to educational efficiency. If he can teach, or learn to teach, larger classes with little or no loss of effectiveness to his students, neither prejudice, preference, nor tradition should deter him from contributing that much to educational economy; but if after a thorough, thoughtful, sincere trial he finds that he cannot, no amount of pressure should induce him to continue the attempt. He should, instead, contribute his part in other ways; for educational economy consists in each one's doing to his utmost what *he* can do best.

HISTORY AND SUMMARY OF CLASS-SIZE INVESTIGATIONS TO 1930

The history of class-size investigations falls into three periods, the first ending about 1916, the second about 1930. The first period dealt mainly with the relation of class size to such factors as incidence of promotion, marks, withdrawals, classroom management, pupil attention, and general pupil conduct. Occasionally improved tests of unknown validity and reliability were administered to classes of various sizes and the results compared, but usually the criteria were limited to the capricious evidence on report cards or in the office files.

The results of investigations conducted before 1917 indicate that, in general, unless classes exceeded 45 or 50 there was no clear evidence of diminished efficiency. Thus far, however, there had not been taken into consideration a number of factors which may reasonably be expected to affect the results of teaching, such as the aims of education, the native capacity of the students, the ability of the teacher, the physical facilities of the classroom, the nature of the subject matter, the size of classes to which the pupils had been accustomed, the efforts made by the teachers to adapt instruction to the size of the class, and the reliability of the means employed for evaluating teaching ability and pupil accomplishment. No devices were then available for measuring some of these factors. Progress had gone about as far as it had the means of going; consequently, after 1916 there was a lull of several years while educational scientists were deriving, refining, and standardizing intelligence and achievement test materials. When experimentation was resumed about 1920 these powerful instruments were at hand to aid investigators in measuring factors which theretofore they had not been able to control.

These refinements in experimental techniques were soon applied to the problem of the relation of class size to pupil achievement. This second phase may, indeed, be dubbed the period of achievement. With class size, as with nearly everything else in school, the primary, if not the sole, consideration was pupil achievement, which usually meant pupil information (and possibly knowledge). Pupils were paired, to be sure, on every measurable basis that was believed to be influential, as they had not been matched before, but the universal criterion of the effects of the variable of class size was to our present conceptions of the functions of education woefully narrow.

The conclusions of experimental investigators of that period can be summed up in the statements that, by and large, class size is not a critical factor in educational efficiency, measured in terms of student achievement; that while large classes do not appear seriously to handicap any group, they are least advantageous to the weakest students; that if it is likely that certain courses are peculiarly adapted to small classes, it is equally probable that the purposes of other courses can better be realized in large classes; that because teachers apparently vary in their ability to handle large and small classes, each teacher should determine experimentally his optimum class size; and that any changes in class-size policy should be carefully prepared for before they are launched, for they are almost certain to involve so many other educational factors that the necessary adjustments in budgeting, organization, curriculum, schedule, buildings, and instructional procedures can hardly be effected within a single generation of teachers. The evidence supporting these conclusions about the relation of class size to student achievement is so consistent that either few significant differences occurred in whatever was measured or the measuring instruments failed to detect them.

SINCE 1930

Both the experimental and testimonial evidence accumulated before 1930 pointed the way to further fruitful inquiry into class size. The very shortcomings of the earlier research revealed two serious needs. Very little effort had been made to improve small-class teaching, so that most of the experiments compared studied large-class techniques with conventional, jaded small-class procedures. They therefore tended to be merely comparisons of what students *could* achieve in large classes with what they *did* achieve in small classes. If such experiments were not loaded in favor of large classes it was not the fault of the experimenters.

The other need was to evaluate other outcomes than mere student achievement. While there is no substitute for knowledge, it appears altogether likely that knowledge is not a substitute for the other claims for education; so that the whole truth about class size will not be known until every result of the educative process has been measured in classes of various sizes.

Efforts are being made to remedy the second of these shortcomings; that is, to isolate and measure neglected educational factors. Practically nothing has been done, I regret to say, to ascertain whether small-class procedures can be devised which will raise student accomplishment above its present small-class level.

PUPIL SURVIVAL RATES IN WEST VIRGINIA

RICHARD E. HYDE

Director of Research, State Department of Education, Charleston

OF 1,000 WEST VIRGINIANS in the fifth grade in 1924 only 221 reached the twelfth grade in 1931, but of 1,000 pupils in the fifth grade in 1930 there were 319 who reached the twelfth grade in 1937.

The enrollment in the last year of high school increased from 4,893 in 1924 to 13,177 in 1936. Reaching 12,806 in 1932-33, the enrollment of high-school seniors slightly increased each year until 13,709 seniors were enrolled in 1936-37.

A comparison of the survival rates from the eighth to the ninth grade shows the following percentages of eighth-grade pupils continuing to the ninth grade:

Year	Percentage		Year	Percentage	
	W. Va.	U. S.		W. Va.	U. S.
1927	62.4	80.0	1932	74.3	91.4
1928	62.8	82.6	1933	70.5	92.1
1929	66.8	86.2	1934	76.0	
1930	68.8	89.8	1935	78.7	
1931	70.0	94.7	1936	80.9	

The holding power of the eighth grade increased steadily in West Virginia from 1927 to 1933, the last year of the district unit, during which a loss of 3.8% occurred. Since 1933, however, good gains have been made annually. A comparison of the state with the national trend shows West Virginia lagging far behind the country at large. Starting in 1927 with an advantage of 17.6%, the nation increased its lead to 21.6% in 1933. (National data later than 1933 were not available.) Between the eighth and ninth grades is the worst break in the school system of West Virginia. Obviously, the old 8-4 plan of school organization is still considerably in the ascendancy in the state. Moreover, it seems that high-school advantages are not yet available to as many pupils as they should be. Each year about 10,000 eighth-grade enrollees quit school.

Survival Ninth to Tenth Grade

Year	Percentage		Year	Percentage	
	W. Va.	U. S.		W. Va.	U. S.
1928	77.7	75.8	1933	75.8	84.8
1929	76.7	76.8	1934	78.5	
1930	77.7	79.3	1935	80.4	
1931	79.5	81.5	1936	80.0	
1932	81.1	79.7			

The elimination in the tenth grade follows the national trend much more closely than that in the ninth grade. In 1933, however, West Virginia lagged far behind the nation, the difference being 9%. The state has not yet regained the 81.1% recorded in 1932. The holding power of the ninth grade is far superior to that of the eighth.

Survival Tenth to Eleventh

Year	Percentage W. Va.	U. S.	Year	Percentage W. Va.	U. S.
1929	82.3	78.7	1933	85.3	82.5
1930	85.2	81.7	1934	83.1	83.0
1931	89.8	82.7	1935	84.1	
1932	88.4	82.1	1936	85.2	

In West Virginia the survival rates of the tenth grade increased from 82.3% in 1929 to 85.2 in 1936. There is considerable fluctuation in this grade. State and national comparisons illustrate the superior holding power of the state schools in five of the six years shown. In 1934 the state was approximately at the national level. The state survival rates for the tenth grade were far above the national percentages in 1931 and 1932.

Survival Eleventh to Twelfth Grade

Year	Percentage W. Va.	U. S.	Year	Percentage W. Va.	U. S.
1930	90.6	89.3	1934	83.0	88.7
1931	91.2	89.6	1935	85.4	88.8
1932	92.1	87.9	1936	86.6	
1933	84.7	88.3			

During 1930-1932 inclusive, the state survival rates of the eleventh grade were about 91%. Since then the rate has been approximately 85%, about 4% less than the national norm. Nationally, little change is noticeable in the holding power of the eleventh grade since 1930. About 89% go on to the last grade of high school.

Survival Twelfth Grade to Graduation

Year	Percentage W. Va.	U. S.	Year	Percentage W. Va.	U. S.
1930	91.4	86.4	1934	89.2	83.3
1931	88.7	87.3	1935	90.4	
1932	84.2	88.0	1936	88.8	
1933	88.6	85.5			

If a pupil reaches the twelfth grade in West Virginia, the chances are exceedingly good that he will graduate. In 1930 more than 91% of the seniors finished their high-school courses successfully; 1932 was the lowest year when 84.2% graduated. The recent tendency is that 89% of the seniors graduate. Nationally, the peak of 88% in 1932 decreased to 83.3% in 1934. The state makes a much better showing than the nation in its ability to hold seniors for graduation, the advantage at present being about 6%.

Percentage of Eighth-Grade Enrollees Graduating from High School

Year in Fifth grade	Year graduated from high school	Percentage graduated from high school W. Va.	U. S.
1920-21	1928	20.1	24.1
1921-22	1929	17.6	24.5
1922-23	1930	18.8	25.2
1923-24	1931	18.7	27.0
1924-25	1932	20.9	30.2
1925-26	1933	25.5	31.6
1926-27	1934	27.0	33.3
1927-28	1935	27.7	35.8
1928-29	1936	25.1	38.3
1929-30	1937	28.3	

The fifth grade class of 1929-30 graduating from high school in 1937 had the highest survival rate for fifth-grade enrollees continuing through the high school for the period of 1920-30. The most significant annual advance was made by the class of 1925-26 with a survival rate of 25.5% compared with 20.9 for the class of the previous year. Six of the ten fifth-grade classes, herein considered, recorded better survival rates than their predecessors. However, these data for survival for seven-year spans show the state considerably behind the national trend for every year shown, the lag being about three times as bad in recent years as it was in 1928. Since 1934 the national rate has improved perceptibly, but the state rate has changed but little.

County administrators and high-school principals in West Virginia can consider their high schools on a level with the state trend if the survival rates are as follows:

Grade	Year	Survival rate—100 pupils	
		W. Va.	U. S.
Ninth	1932-33	100	100
Tenth	1933-34	76	85
Eleventh	1934-35	63	70
Twelfth	1935-36	54	62
Graduates	1936	44	52

Comparisons with the national trend must use the data headed "United States." At present the retention of pupils in four high-school grades of the state lags about 8% behind the national trend. In West Virginia the senior class in high school retains about 54% of those pupils who enrolled in the ninth grade four years ago.

Data concerning the number of high-school graduates going to college show that the percentage has decreased from 35.7 in 1931 to 23.2 in 1936. The summary is as follows:

Year	Percentage		Year	Percentage	
	W. Va.	U. S.		W. Va.	U. S.
1918	No data	51.8	1934	26.0	33.9
1931	35.7	No data	1935	26.3	No data
1932	33.7	40.4	1936	23.2	No data
1933	24.2	36.4			

This decrease in percentage is to be expected as a result of the large increase in the percentage of the high-school population who are now attending high school. It means that the primary function of the present-day high school is allied with purposes other than college preparation. About 77% of the high-school graduates in West Virginia and about 66% of those in the nation evidently go to high school with that institution in mind as a finishing school—not a preparatory school.

Survival of 1,000 Pupils from the Fifth Grade Through College

	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937
Number in fifth grade	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
High-school graduation	146	139	161	170	191	176	188	202	210	247
College graduation	26	30	35	38	41	40	36	37	38	37

Only 26 persons out of a thousand enrolled in the fifth grade in 1917 survived to complete a college course in 1928. In 1931 38 out of a thousand former fifth graders completed the baccalaureate requirements, and with the exception of a few annual fluctuations, approximately 38 has been the predominant number for seven years in West Virginia. The comparable national figures for college graduation were 56 in 1932, 53 in 1933, and 52 in 1934, the state schools lagging behind the nation in the retention of fifth-grade pupils through college graduation. Parenthetically, it is worth mentioning that the number of West Virginians graduating from college has been corrected for those graduating from colleges situated in other states.

Table 1 gives the survival rates of 1,000 fifth-grade enrollees through high-school graduation. Thus of 1,000 pupils in the fifth grade in 1924, 829 survived to the sixth grade in 1925, 641 to the seventh grade in 1926, 611 to the eighth grade in 1927, 381 to the ninth grade in 1928, etc. As stated elsewhere in this study, the gap between the eighth grade and the ninth grade is the location of the largest amount of pupil elimination in West Virginia. The state is behind the national survival trend for every grade and year shown in Table 1. The fifth-grade class of 1930, which graduated from high school in 1937, was slightly below the national class of 1925 in its survival rate; in other words, the state trend is at present lagging five years behind the national trend.

If the holding power of the schools of West Virginia were equal to that of the nation, the enrollment in 1936-37 would have been 487,435 instead of 454,415, the major part of the increase occurring in the upper grades. The increases in high-school enrollment which have been occurring annually are in accordance with the national trend, but the schools of West Virginia must increase their holding power if their services to the children are to be on a par with the nation's average.

Since 1935 the State Department of Education has been collecting annually data concerning pupil withdrawals as shown in the following summary:

Reasons for pupil withdrawals

Reasons	Pupils 1935-36	Pupils 1936-37	Percentage 1935-36	Percentage 1936-37
A. Granted employment certificate	347	394	3.7	4.0
B. Mental or physical incapacity	2,641	2,609	28.0	26.8
C. Under or above compulsory school age	3,869	3,907	41.1	40.1
D. Within school age but expelled by Board	165	263	1.8	2.7
E. Fourteen or 15 years old and employed at home	2,402	2,575	25.5	26.4
TOTALS	9,424	9,748	100.1	100.0

The reasons are obviously not inclusive, but are undoubtedly important enough to deserve careful consideration. Of course, those pupils whose attendance is not legally required withdraw from school in large numbers. About 2,600 pupils annually withdraw from school because of mental or physical incapacity. With state

institutions crowded, one wonders what eventually becomes of the mentally and physically incapacitated group recruited each year in such large numbers. Employment of children accounts for about 70% of these pupils engaged in "home employment." This latter group is too young to quit school. The compulsory attendance law in West Virginia undoubtedly needs rewriting.

Local school administrators, interested in comparing their schools with state and national trends, will find Table 1 especially helpful for this purpose.

TABLE 1.—*Survival Rates of 1,000 Fifth-Grade Enrollees Through High-School Graduation*

Year in fifth Grade	Fifth	Sixth W. Va.	Sixth U. S.	Seventh W. Va.	Seventh U. S.	Eighth W. Va.	Eighth U. S.	Ninth W. Va.	Ninth U. S.	Tenth W. Va.	Tenth U. S.	Eleventh W. Va.	Eleventh U. S.	Twelfth W. Va.	Twelfth U. S.	Graduates W. Va.	Graduates U. S.	Year of Graduation
1924	1000	829	893	641	782	611	719	381	582	296	441	244	347	221	310	202	270	1931
1925	1000	803	911	657	798	633	741	397	612	305	470	260	384	237	344	210	302	1932
1926	1000	851	911	719	815	682	745	455	642	354	509	318	421	293	370	247	316	1933
1927	1000	887	919	717	824	743	754	511	677	407	552	360	453	305	400	270	333	1934
1928	1000	871	928	730	834	746	779	522	738	429	588	366	485	304	430	271	358	1935
1929	1000	890	939	742	847	765	805	569	736	431	624	359	518	306	460	277	383	1936
1930	1000	901	...	750	...	790	...	557	...	437	...	368	...	319	...	283	...	1937

THE INCIDENCE OF CHEATING AMONG TEACHERS IN TRAINING WHEN SCORING THEIR OWN TEST PAPERS

ARTHUR A. SCHOOLCRAFT

Department of Education, West Virginia Wesleyan College, Buckhannon

THIS PAPER is a report and an interpretation of a study of cheating among teachers in training when scoring their own test papers. The subjects of the study were 53 juniors and seniors in West Virginia Wesleyan College during the first semester, 1937-38. The curricular area covered by the study was three courses, Educational Psychology, Tests and Statistics, and Principles of Teaching in High Schools. The procedure was as follows: Near the end of the semester the class in Educational Psychology was given the Potthoff-Corey Standardized Test in Educational Psychology. These tests were then scored by the investigator without being marked, and each student's score was recorded part by part. At the next session of the class the test papers were returned to the students, each of whom scored his own paper as the instructor slowly read the simple key, and reported his score part by part on a separate sheet of paper. In the same way the class in Principles of Teaching in High Schools was given the Odell Standard Achievement Test on Principles of Teaching in Secondary Schools, and the class in Tests and Statistics the Barrett-Ryan English Test, Form III, and the Odell Standard Achievement Test on Educational Measurement. There was much overlapping among the three classes, so that the 53 students took 114 tests.

Many minor variations of scores reported by students from scores determined by the investigator were construed as unintentional errors. The number and range of such variations are shown in Table 1. Thus 53 reports by students are construed as honest.

TABLE 1.—*Variations of scores reported by students from correct scores, construed as due to error*

Amount of Variation	−3	−2	−1	0	+1	+2	+3
Number of Cases	1	0	4	18	16	7	7

Of these 5 were too low, 18 correct, and 30 too high. Sixty-one reports construed as dishonest were too high by a margin of 4 to 56 points.

The first test used, the Barrett-Ryan English Test, Form III, was taken by 33 students who were told that scores would be recorded for reference, but would not be considered in determining grades made in the course. The other tests were used in the order, and by the number of students, shown in Table 2. In connection with these three tests nothing was said about the use to be made of scores. Students probably assumed that these scores would have some bearing on final grades in the courses. Table 2 shows the prevalence of honesty and dishonesty in all four tests.

TABLE 2.—*Amounts of cheating on various tests*

Name of test	Barrett-Ryan (first)	Odell, Principles (second)	Potthoff-Corey (third)	Odell, Measurements (fourth)
Number of Students	33	30	21	30
Number Honest	23	14	9	7
Number Dishonest	10	16	12	23

Table 3 presents the data of Table 2 in percentages.

TABLE 3.—*Percentage of cheating on various tests*

Name of test	Barrett-Ryan (first)	Odell, Principles (second)	Potthoff-Corey (third)	Odell, Measurements (fourth)
Percent honest	70	47	43	23
Percent dishonest	30	53	57	77

From the data in Tables 2 and 3 two conclusions can be drawn: First, cheating increases as tests become more difficult. The Barrett-Ryan test, designed for use from the seventh grade to the first year of college, seemed easy enough. On the other hand, the Odell Standard Achievement Test on Educational Measurement, sufficiently difficult for graduate students completing a 3-hour course, seemed very difficult to these students, more than two-thirds juniors, who were completing a 2-hour course. Second, cheating increases rapidly when students find that they can cheat without being apprehended and penalized. Many who rank low cheat to improve their relative standing in the class. Others cheat to avoid being outdistanced by their dishonest classmates. Thus on the Barrett-Ryan test, the first and easiest in the series, only 30% cheated, and every cheater was below the median score for the class on this test. But on the Odell Standard Achievement Test on Educational Measurements, the last and most difficult in the series, 77% cheated, including 3 of the 4 who made A grades in the course.

Table 4 indicates the number of cases of dishonesty on the part of students making various final grades in the courses.

TABLE 4.—*Relation of cheating to final grades in courses*

Final grade	A	B	C	D	E	F	Totals
Number honest	7	17	20	5	3	1	53
Number dishonest	5	8	26	11	9	2	61

Table 5 presents the data of Table 4 in percentages.

TABLE 5.—*Percentage of cheating at various grade levels*

Final grade	A	B	C	D	E	F	Totals
Percent honest	58	68	43	31	25	33	46
Percent dishonest	42	32	57	69	75	67	54

A few items in Tables 4 and 5 are informing. The B group is the most honest. This is probably due to their freedom from fear of failure, and to their considering A's unattainable. The A group appears willing to cheat when in danger of losing its coveted classification. These students were 100% honest on the Barrett-Ryan, where there was no risk, but 75% dishonest on the Odell Standard Achievement Test on Educational Measurement, where they felt uneasy. Below the B level dishonesty predominates in every grade and increases as we go down the scale. Thus cheating seems to result in part from a sense of inadequacy. *In toto* there is more dishonesty than honesty.

Table 6 shows the average number of points added to correct scores by dishonest students making various final grades in the courses.

TABLE 6.—*Average quantity of cheating at various grade levels*

Final grade	A	B	C	D	E	F
Average number points dishonestly added	9	10	14	13	16	27

Table 6 makes clear the principle that the lower the grade level of the cheater, the more reckless the cheating tends to become. One specific example may prove instructive. On the Odell Standard Achievement Test on Educational Measurement one student scored 19, 30th in a class of 30, for an F grade. But the same student reported a score of 75, first in a class of 30, which would have merited an A grade. On every test in the series some student on the D level, or lower, reported for himself a score higher than the best score actually made by anyone in the class. When such dishonesty "gets by," the highest grades in a class are awarded not to those who have best mastered the work of the course, but to the cleverest and most daring "crooks."

Of the 53 students who took these tests, 21 took one test only, and 32 took from 2 to 4 tests. Of these 32, 6 were consistently honest, 9 consistently dishonest, and 17 were honest part of the time and dishonest part of the time. Table 7 indicates the final grades made by these three groups.

TABLE 7.—*Relation of consistent honesty, etc., to various grade levels*

Final grade	A	B	C	D	E	F	Number of persons	Percentage of group
Consistently honest	1	3	3	0	0	0	6	19
Consistently dishonest	1	3	9	3	3	0	9	28
Inconsistent with respect to honesty	6	5	13	8	3	2	17	53

Here it appears that only the consistently successful were consistently honest. In several instances the consistently dishonest were (or thought themselves to be) consistently unsuccessful. One

student who cheated on all 4 tests emerged with final grades of D, D, and E in her courses. Another cheated on all 4 tests and emerged with final grades of C, D, and E. On the other hand, a few who made only A and B grades cheated consistently. At every grade level the inconsistent group tends to be the largest of all. Four-fifths of the group studied seem to be deficient in uncompromising Lincolnian loyalty to the principle of strict honesty, and to prefer opportunistically to be honest when that seems safe, and to be dishonest when that seems safer.

In conclusion I offer a few suggestions toward checking and correcting the deplorable condition this study reveals and which certainly exists in most schools at all levels: (1) studies similar to this in other colleges; (2) admission requirements sufficiently high to keep out the incompetents; (3) adequate guidance; (4) development of a scientifically sound testing program; (5) more testing for guidance and less for grading; (6) extreme caution in extension of honor systems to examinations; (7) some well-considered effort to make honesty satisfying and dishonesty dissatisfying, partly by penalties and recognitions, but primarily by development of high ideals and consistent habits of honesty.

RESULTS OF A MENTAL SURVEY IN THE SCHOOLS OF MONONGALIA COUNTY

ELIZABETH M. STALNAKER

Department of Philosophy and Psychology, West Virginia University

THE PURPOSE OF THE SURVEY

THIS SURVEY of representative schools in Monongalia County was undertaken by the Mental Hygiene Committee of Monongalia County in order (1) to discover the amount of feeble-mindedness, (2) to locate the areas where it is most prevalent, and on the basis of the findings to suggest some measures or to make the feeble-minded more desirable socially.

THE SCOPE OF THE SURVEY

The survey was confined to the grades, since there had been no surveys of the elementary schools since that of the Mental Hygiene Commission in 1920 and Caven's School Survey of Type Counties in West Virginia in 1923, which included grades 3 to 8.

It was thought that perhaps the best way to attack the problem was to get some fresh data as to the extent of feeble-mindedness, especially in the primary grades. Because of the educational policy of the Monongalia County School System in not promoting children from the primary to the intermediate grades unless they have a fair mastery of the tool subjects, it was thought that a large percentage of feeble-mindedness would be found in the primary grades.

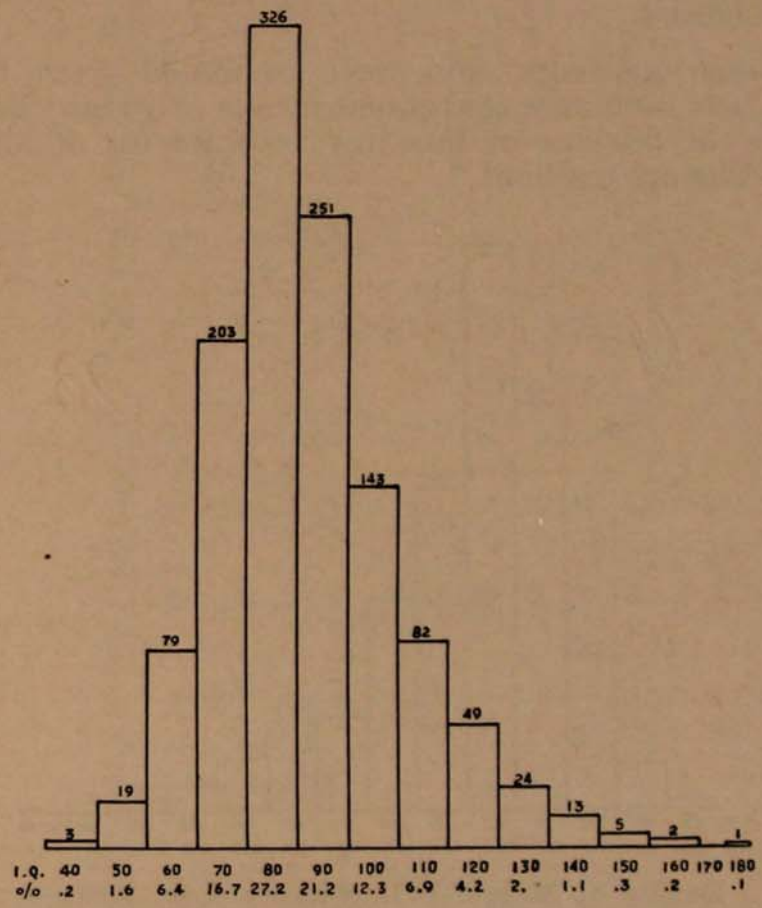
However, it was impossible to test every child in the county because of the expense entailed and of the lack of time and personnel for carrying on the survey; consequently eleven different schools were selected. These were chosen with a view to securing a cross-section of the county which would be representative of the county as a whole. Two schools are located in mining communities, three are in agricultural sections, two are suburban, and four are in Morgantown.

The number of children of each grade tested is as follows:

First grade	229	
Second grade	257	
Third grade	304	
Total of Primary grades		790
Fourth grade	120	
Fifth grade	116	
Sixth grade	142	
Total of Intermediate grades		378
Seventh grade	15	
Eighth grade	17	
	32	
Grand total		1200

THE TESTS CHOSEN AND THEIR ADMINISTRATION

The test chosen for use in the first three grades was the Haggerty Intelligence Examination, Delta I, which has a reliability coefficient of 79. For the remaining grades, Form A of the Otis



Results of Haggerty Intelligence Test, Delta I, given to Primary Grades, and Otis Self-Administering Test of Intelligence given to Upper Grades. Total number of cases, 1200.

Self-Administering test of Intelligence was selected. Its reliability coefficient is .948 P. E. $\pm$ 2.85.

The Haggerty tests were administered by members of a class in mental measurements at the University under the supervision of some member of the Mental Hygiene Committee, and by one teacher in the public-school system.

The Otis tests were given by members of the same class and by several members of the committee.

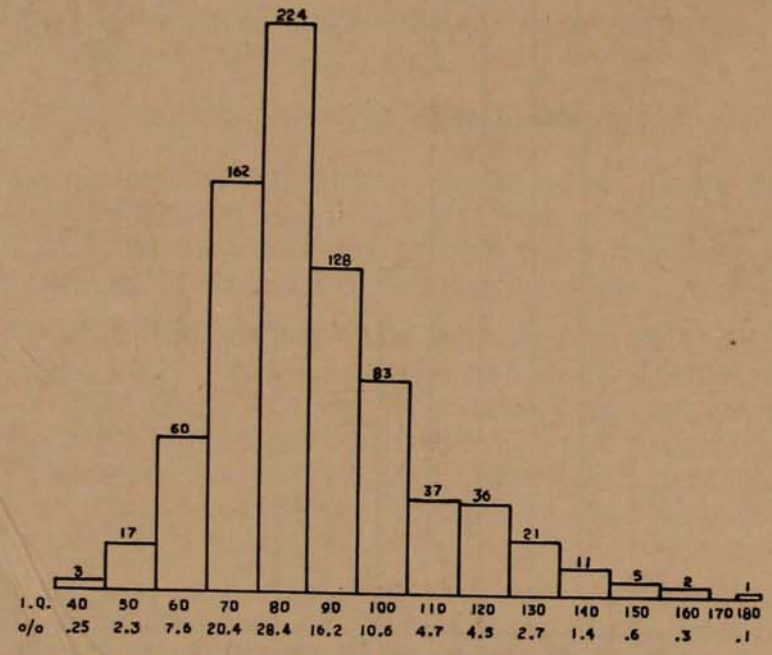
THE TREATMENT OF TEST RESULTS

The tests were scored by the persons who gave them, then checked and rechecked by members of the committee.

The raw scores were converted into mental ages in accordance with the norms furnished by Haggerty and Otis. But since the

Haggerty norms range only from six to ten years, it was found necessary to extend the age norms below six and above ten years. This was done by following the same method used within the six- to ten-year limits; however, all mental ages below six and above ten were considered as "estimated" mental ages, because they had not been standardized.

Intelligence quotients next were computed from the mental ages. This was used as a convenient means of rough classification, and not for the purpose of labeling the child for all time with a specific intelligence quotient.



Results of Haggerty Intelligence Test, Delta I, Primary Grades 1, 2, 3. Total number of cases, 790.

Finally the data thus obtained were expressed in terms of percentage for each intelligence quotient group, and presented in the form of tables and charts. This has been done (1) for each grade separately, (2) for each school but keeping primary and intermediate grades separate because of the two different tests used, and (3) for all grades from all schools or the total group.

Also arithmetic means and standard deviations of intelligence quotients have been computed (1) for each grade, (2) for each school, and (3) for the total group.

DISCUSSION OF TEST RESULTS

The Range of Intelligence Quotients

From the Tables 1, 2, 3 one can see that the intelligence quotients range from 42 to 183; but since the percentage of the intelligence quotients of 40 is less than one percent, as is also the combined percentages of those with intelligence quotients in the 150's, 160's,

TABLE 1—*Distribution of Intelligence Quotients according to school grades expressed in terms of frequency and percentage*

Grade and enrollment	Enrollment	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
First 229	No.	2	7	25	50	89	41	10	1	2	2					
	%	.87	3.06	10.92	21.83	38.86	17.90	4.37	.44	.87	.87					
Second 257	No.	1	5	15	69	83	39	18	12	7	5	2				1
	%	.39	1.95	5.84	26.84	32.29	15.17	7.00	4.67	2.72	1.95	.78				.39
Third 304	No.		5	20	43	52	48	55	24	27	14	9	5	2		
	%		1.65	6.56	14.11	17.11	15.80	18.09	7.90	8.88	4.60	2.96	1.65	.66		
Fourth 120	No.			4	6	27	43	21	14	3	1	1				
	%			3.33	5.00	22.5	35.83	17.5	11.67	2.5	.83	.83				
Fifth 116	No.		1	4	11	33	33	14	12	6	1	1				
	%		.86	3.45	9.48	28.45	28.45	12.07	10.34	5.17	.86	.86				
Sixth 142	No.			10	20	37	37	18	16	3	1					
	%			7.04	14.08	26.06	26.06	12.68	11.27	2.11	.7					
Seventh 15	No.		1	1	2	2	6	1	1	1						
	%		6.66	6.66	13.33	13.33	40.00	6.66	6.66	6.66						
Eighth 17	No.				2	3	4	6	2							
	%				11.76	17.64	23.53	35.19	11.76							
Total 1200	No.	3	19	79	203	326	251	143	82	49	24	13	5	2		1
	%	.25	1.58	6.58	16.9	27.17	20.91	11.91	6.83	4.08	2.	1.08	.42	.17		.08

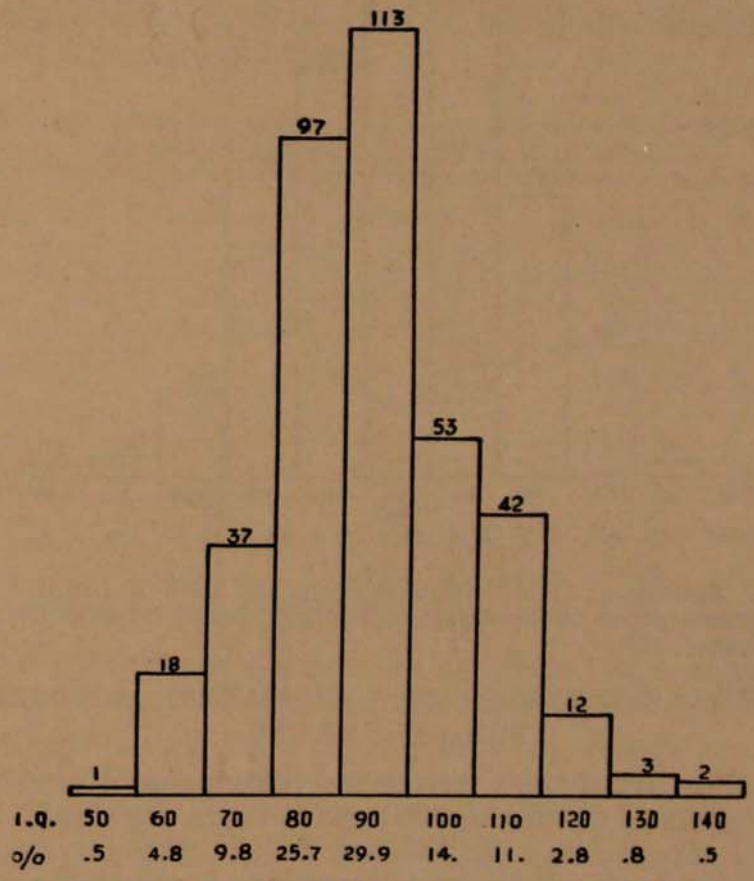
TABLE 2—*Distribution of Intelligence Quotients of Primary grades in the several schools, based on results of Haggerty Tests. Expressed in terms of frequency and percentage*

School	Enrollment	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
Canyon 38	No.			9	8	9	9	1	1	1						
	%			23.68	21.05	23.68	23.68	2.63	2.63	2.63						
Daybrook 60	No.		5	6	13	21	10	4			1					
	%		8.33	9.99	21.66	34.99	16.66	6.66			1.66					
Easton 35	No.			3	4	5	3	4	3	7	2	3		1		
	%			8.57	11.43	14.28	8.57	11.43	8.57	19.99	5.71	8.57		2.86		
Oakgrove 24	No.					2	4	8	6	2	1		1			
	%					8.33	16.66	33.33	24.996	8.33	4.17		4.17			
Osage 89	No.	1	4	11	27	30	7	3	4		1	1				
	%	1.12	4.49	12.36	30.33	33.71	7.87	3.37	4.49		1.12	1.12				
Riverside 67	No.			3	18	17	20	7	1	1						
	%			4.48	26.86	25.37	29.85	10.45	1.49	1.49						
Seneca 71	No.		2	2	13	26	11	8	1	4	2	2				
	%		2.82	2.82	18.30	36.61	15.49	11.26	1.41	5.63	2.82	2.82				
Wadestown 29	No.	1	4	3	7	4	5	3	1		1					
	%	3.45	13.79	10.34	24.14	13.79	17.24	10.34	3.45		3.45					
Woodburn 88	No.	1		9	23	23	14	5	4	7		1	1			
	%	1.14		10.23	26.13	26.13	15.90	5.68	4.54	7.95		1.14	1.14			
First Ward 98	No.			4	14	29	18	16	7	7	2					1
	%			4.08	14.28	29.58	18.36	16.32	7.14	7.14	2.04					1.02
Second Ward 191	No.		2	10	35	58	27	24	9	7	11	4	3	1		
	%		1.05	5.24	18.32	30.36	14.13	12.56	4.71	3.66	5.76	2.04	1.57	.52		
Total 790	No.	3	17	60	162	224	128	83	37	36	21	11	5	2		1
	%	.38	2.15	7.59	20.5	28.35	16.20	10.5	4.68	4.56	2.66	1.39	.63	.25		.13

and 180's, it might be better to consider the limits as ranging from an intelligence quotient of 50 to an intelligence quotient of 140 inclusive.

TABLE 3.—*Distribution of Intelligence Quotients of Intermediate and Junior High (7 and 8) grades in the several schools based on results of the Otis Self-Administering Test expressed in terms of frequency and percentage*

School	Enrollment	50	60	70	80	90	100	110	120	130	140
Daybrook 62	No.	1	4	6	16	20	9	5	1		
	%	1.61	6.44	9.66	25.76	32.20	14.49	8.05	1.61		
Sabraton 112	No.	1	7	15	39	36	9	4	1		
	%	.892	6.24	13.38	34.8	32.11	8.03	3.57	.89		
Second Ward 168	No.		6	13	30	43	32	29	10	3	2
	%		3.57	7.74	17.85	25.59	19.04	17.26	5.95	1.79	1.19
Seneca 68	No.		2	7	17	24	10	7	1		
	%		2.94	10.27	24.99	35.28	14.7	10.29	1.47		
Total 410	No.	2	19	41	102	123	60	45	13	3	2
	%	.4878	4.634	10.	24.88	30.	14.634	10.975	3.17	.7317	.4878

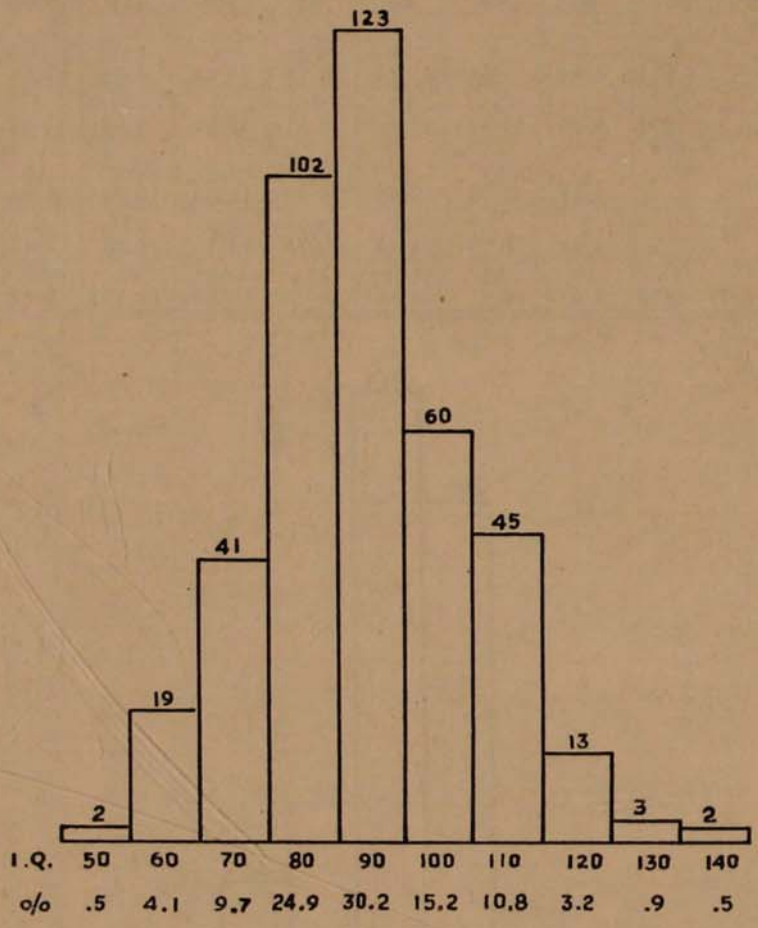


Results of Otis Self-Administering Test of Intelligence given to the Intermediate Grades 4, 5, 6. Total number of cases, 378.

The 11 cases at the extremes are located as follows: two "40" intelligence quotients are found in the first grade; one is in the second grade; the highest "180" intelligence quotient is in the

second grade, and the other 7 cases (five in the 150's and two in the 160's) are in the third grade.

In terms of percentage, 33% come within the generally accepted bounds of normalcy—from "90" to "110" intelligence quotients; 15% are above and 52% are below. Or putting it another way, the combined normal and superior group (48%) is less than the backward group (52%).



Results of Otis Self-Administering Test of Intelligence given to Grades 4, 5, 6, 7, 8. Total number of cases, 410.

THE AVERAGE INTELLIGENCE QUOTIENTS ACCORDING TO SCHOOL GRADES

Table 4 shows that the average intelligence quotient is below the commonly accepted norm of 100; except for the first two grades, where the averages are 82.94 and 87.67 respectively, all other grades have average intelligence quotients in the 90's, which puts them in the low-average group. The highest average intelligence quotients are found in the fourth and eighth grades, where it is 96. The average intelligence quotient for the total group of 1200 is 91.84.

It should be noted that there is a gradual increase in the average intelligence quotient from the first grade up to the fourth, as

follows: 82.94; 87.67; 93.75; 96.32, but there is fluctuation thereafter and not a steady increase.

TABLE 4.—*Mean averages and standard deviations of I. Q's for each grade and total group*

Grade	Enrollment	Mean Average	Standard Deviation
First	229	82.94	13.33
Second	257	87.67	18.63
Third	304	93.75	22.62
Fourth	120	96.32	13.84
Fifth	116	94.48	15.69
Sixth	142	91.90	14.97
Seventh	15	90.33	17.46
Eighth	17	96.76	12.00
Total	1200	91.87	18.40

AVERAGE INTELLIGENCE QUOTIENTS OF THE PRIMARY GRADES ACCORDING TO SCHOOL

Table 5 gives the rank of each of the eleven schools in respect to average intelligence quotient.

TABLE 5.—*Range, mean averages, and standard deviations of I. Q's. for the combined primary grades in each school*

School	Enrollment	Range	Mean	Standard Deviation
Canyon	38	61—117	82.90	14.53
Daybrook	60	51—108	82.17	14.61
Easton	35	67—141	106.14	26.16
Oakgrove (No 1st grade)	24	83—151	109.16	15.25
Osage	89	54—143	81.75	16.06
Riverside	67	66—122	87.53	12.13
Seneca	71	50—148	91.34	18.70
Wadestown	29	40—133	80.18	16.94
Woodburn	88	42—153	89.54	19.99
First Ward	98	64—183	94.90	18.65
Second Ward	191	53—156	94.27	21.43
Total	790	40—183	90.45	19.83

The lowest intelligence quotients are found in schools located in the more remote agricultural and mining sections.

Interestingly enough the intelligence quotients of the schools representative of agricultural sections, where the inhabitants are 100% of native stock, and those in the mining regions, where the population is of foreign-born stock, are about the same. For example, Wadestown and Daybrook are 100% native-born and are agricultural. Their average intelligence quotients are 80.18 and 82.17 respectively. Osage and Canyon are mining regions and the children are from foreign homes. Their average intelligence quotients are 81.75 and 82.90, respectively.

Then comes Riverside, located in a suburban area where there is a mixture of native and foreign-born stock and where the inhabi-

tants either are miners or belong to the working class. Their average intelligence quotient is 87.53.

Next in order of ascendency are the Morgantown schools. *Woodburn,* which is representative chiefly of the native-born middle class with a few foreign-born, has an average intelligence quotient of 84.54. *Seneca,* representing a mixture of native and foreign-born stock, mostly industrial and small business, and a few of the professional group, have an average intelligence quotient of 91.34. *Second Ward,* representing a good cross-section, with native and foreign-born, poor and well to-do, working class, white-collar class, and professional class, has an average intelligence quotient of 94.27. *First Ward* represents a good middle class; mostly the white-collar class, but some foreign-born of the laboring group and a few of the professional group. Their average intelligence quotient is 94.90.

But ranking much higher than the town schools are the schools at Easton and Oak Grove, whose average intelligence quotients are 106.14 and 109.16 respectively.

How to account for their superiority is more or less a conjecture. However, it should be pointed out that the first grade at Oak Grove was not tested, leaving a small group. Moreover, when we remember that the first grade had the lowest average intelligence quotient, its omission may account in part for the high intelligence quotient of this school. Oak Grove is representative of native stock and is chiefly agricultural.

The school at Easton has been used as an educational experimental center for testing out new methods and materials. So perhaps because of that fact the children have become more "test-wise" and can adapt more readily to new procedures than children in the other schools; this may account in part for their high intelligence quotient. Also the number of pupils is relatively small.

TABLE 6.—*Range, mean average, and standard deviation of I. Q's. for the combined upper grades in each school*

School	Enrollment	Range	Mean	Standard Deviation
Daybrook	62	58—127	91.42	14.04
Sabraton	112	58—124	88.38	12.14
Seneca	68	64—121	93.52	12.63
Second Ward	168	60—144	99.03	16.26
Total	410	58—144	94.04	14.98

Easton is classed as a suburban area. The inhabitants are farmers or engaged in business in Morgantown. There are a few miners. They are largely native-born.

THE PERCENTAGE OF FEEBLE-MINDEDNESS IN THE SEPARATE GRADES

In any classification of feeble-mindedness based on the results of tests, the dividing line between feeble-mindedness and dullness

should be stated. If we accept Terman's decision that any intelligence quotient below 70 is diagnostic of feeble-mindedness, we have a much higher percentage than if we adopt the lower intelligence quotient of 60 as is being done in many clinics today.

TABLE 7.—*Percentages of feeble-mindedness in the separate grades derived from Table 1*

Grade	Enrollment	Percentages below 60 I. Q.	Percentages below 70 I. Q.
First	229	3.93	14.85
Second	256	2.33	8.17
Third	304	1.64	8.22
Fourth	120		3.33
Fifth	116	.86	4.31
Sixth	142		7.04
Seventh	15	6.66	13.33
Eighth	17		
Primary	790	2.52	10.12
Intermediate	378	.26	5.03
Intermediate and 7th and 8th	410	.488	5.12
Total	1200	1.83	8.41

Table 7 shows that it is largest for the Primary grades as a whole, and within that group greatest in the first grade. When an intelligence quotient of 60 is the dividing mark we find 3.93 percent in the first grade; 2.33 percent in the second grade and 1.64 percent in the third grade. But if we use an intelligence quotient of 70 as the dividing line then we find 14.85 percent in the first grade, while in the second and third grades it is only about one half that, namely 8.17 and 8.22 percent, respectively.

There is a possibility that these percentages are too high and that feeble-mindedness is not so great as these measures would indicate. The defect may lie in the school, the test, or the tester, and not in the child. The Haggerty test makes a demand for reading ability and if the child has not learned to read he has a handicap. Or the testing procedure may have been so novel to the child he was distracted by it. However, since the tests were given in April, toward the close of the school year, the above factors should have been eliminated or greatly reduced in their force.

On the other hand the large percentage of feeble-mindedness in the first three grades may be explained in part by the policy of the schools which is not to promote children out of the primary grades unless they show educational achievement in the fundamentals. Consequently these grades must be overloaded with a number of repeaters who are evidently included in the 10 percent of this group.

In the Intermediate Grades there is a marked drop. Below the 60 intelligence-quotient line there is only 0.26 percent, and even

below the 70 intelligence-quotient line the percentage drops to 5.03.

For the total group of 1200, 1.83 percent falls below an intelligence quotient of 60 and 8.41 percent below 70 (including the 1.83 percent).

TABLE 8.—*Percentage of feeble-mindedness in the separate schools of primary grades derived from Table 2*

School	Enrollment	Percentage below 60 I. Q.	Percentage below 70 I. Q.
Canyon	38		23.68
Daybrook	60	8.33	18.33
Easton	35		8.57
Oakgrove	24		
Osage	89	5.61	17.97
Riverside	67		4.48
Seneca	71	2.82	5.63
Wadestown	29	17.24	27.58
Woodburn	88	1.14	11.36
First Ward	98		4.08
Second Ward	191	1.05	6.28

Table 8 shows the percentage of feeble-mindedness in the separate schools of the Primary grades. From it we find that the schools having the largest percentages of feeble-minded below the 60 intelligence quotient are Wadestown, Daybrook, and Osage, in the order named. When an intelligence quotient of 70 is taken as the dividing line, the largest percentages are in Wadestown, Canyon, Daybrook, Osage, Woodburn, Easton, Second Ward, Seneca, Riverside, and First Ward, in the order named. Oak Grove had none.

Little difference is found between the schools in mining communities where the population is chiefly foreign born and the schools in the agricultural sections with their 100 percent native-born population. In the two schools in the mining area there is an average percentage of 20.82 below the 70 intelligence quotient, and in the two schools in the agricultural sections the average percent is 22.95 below. When an intelligent quotient of 60 is the upper limit, there is 10 percent more feeble-mindedness among the native stock in rural communities than in the foreign group.

In the two suburban schools where there is a mixture of mining, farming, and working classes, both laboring and white collar, the average percentage below the 70 intelligence quotient drops to 6.52, and there is none below 60.

The average percentage in the Primary grades of the four Morgantown schools is 6.84 below the 70 intelligence quotient, and below the 60 intelligence quotient it is 1.25 percent.

In the upper grades of the Morgantown schools (Table 9) there was none below the 60 line, and the average of the two schools below an intelligence quotient of 70 is 3.25 percent, whereas the

average for the agricultural school (Daybrook) is 8.05 percent below 70 and 1.61 percent below 60, and for the industrial section (Sabraton) it is 7.13 percent below 70 and 0.89 percent below 60.

TABLE 9.—*Percentage of feeble-mindedness in the separate schools of the Intermediate grade and above derived from Table 3*

School	Enrollment	Percentage below 60 I. Q.	Percentage below 70 I. Q.
Daybrook	62	1.61	8.06
Sabraton	112	.89	7.14
Second Ward	168		3.57
Seneca	68		2.94

PERCENTAGES OF SUPERIOR CHILDREN

Although this survey was made for the purpose of determining the amount of feeble-mindedness among the children of Monongalia County, at the same time one cannot be blind to the number of superior children.

TABLE 10.—*Percentage of superior children in the separate grades derived from Table 1*

Grade	Enrollment	Above 120 I. Q.	Above 110 I. Q.
First	229	1.74	2.18
Second	257	5.84	10.51
Third	304	18.75	26.64
Fourth	120	4.17	15.83
Fifth	116	6.89	17.24
Sixth	142	2.81	14.08
Seventh	15	6.66	13.33
Eighth	17		11.76
Total	1200	7.83	14.66

TABLE 11.—*Percentages of superior students in the primary grades of the separate schools derived from Table 2*

School	Enrollment	Above 120 I. Q.	Above 110 I. Q.
Canyon	38	2.63	5.26
Daybrook	60	1.66	1.66
Easton	35	37.14	45.71
Oakgrove	24	16.67	41.66
Osage	89	2.25	6.74
Riverside	67	1.49	2.98
Seneca	71	11.27	12.68
Wadestown	29	3.45	6.90
Woodburn	88	10.23	14.79
First Ward	98	10.20	17.35
Second Ward	191	13.61	18.32
Total	790	19.62	14.30

TABLE 12.—*Percentage of superior children in the upper grades of the separate schools derived from Table 3*

School	Enrollment	Above 120 I. Q.	Above 110 I. Q.
Daybrook	62	1.61	9.67
Sabraton	112	.89	4.46
Second Ward	168	8.93	26.19
Seneca	68	1.47	11.76
Total	410	4.39	15.37

Tables 10, 11, and 12 show that for the group as a whole, 7.83 percent have intelligence quotients above 120; the larger percentage is found in the primary group, where it is 19.62 percent, while it is only 4.39 percent in the upper grades.

SUMMARY

This study shows that:

A. In regard to *Range of Intelligence* there is (1) a very wide range extending from 42 to 183; (2) the range is greater in the Primary than in Intermediate grades; (3) from the fourth grade up the range is from 50 to 140 inclusive, and (4) the lower end of the curve is heavily loaded, as a larger percentage is below "normal" than above.

B. In regard to *Mean Intelligence Quotients,* (1) the average intelligence quotient is below 100, but comes within the range of normalcy when the whole group is considered; (2) the average intelligence quotient of the first and second grades places them below normal, pushing them down into the dull or backward group; (3) with each higher grade there is an increase in the average intelligence quotient up to the fourth grade, where it reaches 96.32, and after that there is fluctuation within the 90's; (4) when considering the average intelligence quotient of the different schools we find, the farther away from a cultural center, the lower the intelligence quotient; (5) no differences of any consequence are noted between the 100 percent native and foreign-born stock.

C. In regard to the *Extent of Feeble-mindedness,* (1) The largest percentage of feeble-mindedness is located in the first grade, (2) The percentage in the Primary grades is approximately twice as high as that of the Intermediate grades. (This is due in large part to the policy of the schools.) (3) When an intelligence quotient of 60 is accepted as marking the upper limit of feeble-mindedness, the percentage of the total group of 1200 is slightly less than the usually reported percentage of the school population, that is, it is 1.83%, whereas the figure generally given is 2%; however, if an intelligence quotient of 70 is the accepted limit, the percentage for this group is much higher, reaching a total of 8.41 percent.

The West Virginia Mental Hygiene Commission in 1920 stated that 2 to 3% of school children examined were feeble-minded. At

that time the 70 intelligence quotient was the accepted limit. Anderson (1922) reported 6.1 percent in a Minnesota County, and Loutitt[1] (1933) reports 1.28 percent fall below the 60 intelligence quotient and 5.72 percent below the 70 line making a total of 7 percent feeble-minded.

Feeble-mindedness is about equally prevalent among native and foreign-born stock when the 70 intelligence quotient is accepted as the limit, but if 60 is taken, more is found among the native-born children of the group. In other words there are more of the native-born stock who are feeble-minded than the foreign born when feeble-mindedness is a matter of degree, (5) The percentage of feeble-mindedness decreases with proximity to cultural centers, and with an increase of the professional class in the group.

D. In regard to *Superior Intelligence*, (1) the percentage (7.83) is large enough to warrant special attention to this group as well as to the inferior group. (2) The percentage is greater in the primary grades than in the upper grades. Perhaps the majority of bright pupils have settled down to a dull mediocrity by the time they reach the Intermediate grades, due to poor study habits or lack of guidance and stimulation.

COMMENTS AND SUGGESTIONS

The relatively large percentage of feeble-minded and of mentally retarded children in our schools is certainly a challenge to West Virginia and to the schools. Why should the public schools in West Virginia show a greater percentage of feeble-minded and dull children than the schools of other states? There is one obvious answer to that question, namely that many of the children who pull down our average would be in institutions, either public or private, or in special schools or classes, if they were in other states. They would not be in our public schools.

In West Virginia we have only one state school planned and designed to care for the feeble-minded. That is the Bradley Training School for the feeble-minded at St. Mary's. The capacity of Bradley is about eighty. Actually 83 are now enrolled there and there is a waiting list of 700, according to an unofficial report from the Department of Public Assistance.

And unfortunately there are no private institutions for the care of the feeble-minded in the state. Many parents are able and willing to pay for the care of their children and yet the very fact that they are able to pay bars their children from being accepted in a public institution even if there were room.

So there is definite need for more or larger state institutions, and a no less real need for a self-supporting or even profit-making private institution which would take care of many cases with whom the schools are now hopelessly struggling.

---

[1] Murchinson, C. Handbook of Child Psychology—22nd Ed. 1933.

While it is admitted that intellectual subnormality alone cannot be accepted as a safe criterion of mental deficiency and that a social inadequacy must be considered, the estimates in the study I believe have been conservative enough to justify the statement that there are in the Monongalia County schools about 1.83% who should be carefully examined with a view to removing them from the schools and placing them in institutions.

The lower-grade feeble-minded children generally show industrial incompetence in later life. Society must treat them always as children and should plan to care for them as such. In an institution some of them may be useful, but at large in society they may be a menace to others and a detriment to their own well-being. Some of them may be trainable, but none is educable in the traditional sense. Why then attempt the impossible by keeping them in the schools? This contributes nothing to their happiness or future success, and yet at the same time their presence there may be responsible for the retardation of other children, because of the time spent vainly upon them. Would it not be better to place them in institutions where they can have tasks suited to their capacity and where they can be happy?

Among the other 6.58 percent there are no doubt many who can never profit from the common-school instruction even to the point of learning to read and write their name. Of course some few can, but even for those who can, the time taken for learning will be much greater than for the average child, and the ordinary school room is scarcely the proper place for him to learn.

For the majority of this group, training and not the traditional school education is clearly indicated. And if that is to be accomplished there must be furnished a place where it can be done. Special classes, or special schools as a part of the public-school system, would furnish the proper facilities for giving these children the kind of education they can use. Why should we continue at great expense to consume their energies along lines of education suitable for normal children, which they are not, and deprive them of the benefits of the training which could be useful to them? In other words why deprive them of democracy's greatest gift—an opportunity to develop their God-given potentialities? As it is we are hindering them instead of helping them.

Sweden has met a similar situation by establishing 37 school homes, 40 work-shop homes where the higher grades are trained, and 50 asylums for the lower-grade feeble-minded who need institutional care.

What will this mean to the State? It will mean that the State will be relieved of the financial burden entailed in dealing with much juvenile delinquency and later adult crime. What will it mean to the schools? It will give teachers more time to devote to the education of those children who can be educated, with the possible result of lifting the average level of intelligence, which is

now shown to be below that of children more favorably situated in other states. What will it mean to the mentally deficient themselves? It will mean greater happiness and a possible opportunity to learn a useful trade or become proficient in some form of factory or domestic work which may make them self-supporting.

Would it not be feasible, now that we have our county unit and bus transportation, to develop special vocational schools for those "non-academic" children who do not belong in institutions but who are simply marking time in our present schools?

Or would it not be possible to use for such purposes some of the school buildings that have been abandoned since the introduction of the county unit?

But it cannot be too strongly impressed upon school boards and state officials that the average teacher, even though a good one, is not equipped or trained to take charge of the training of the mental defective. Whether it be in an institution or in a special room, a specially trained teacher is absolutely essential.

Moreover, care should be exercised in the selection of children for institutional care and for enrollment in special classes. Children should not be placed there until they have been adequately examined by persons qualified to determine their capacity. This might best be accomplished by means of some central agency in the state to which all mental defectives could be referred for examination.

MIMEOGRAPH AND DICTATION METHODS OF GIVING AN OBJECTIVE TEST

ROY C. WOODS

Department of Education, Marshall College, Huntington

THE QUESTION often has occurred to me in giving tests by the dictation method, have I contributed by this method to pupils' difficulty and consequently low scores? In education courses designed to teach beginning teachers modern test methods the statement often was made that certain of the objective tests in the absence of mimeograph could be dictated having the pupils respond on slips of paper or especially prepared cards. This was especially true in two answer type of statements such as true-false, or yes-no, which may have contributed to the widespread popularity of these types. Even with their obvious guessing hazard they were conveniently within reach of all who wished to be free of the subjective element of essay tests.

Persistently, however, students complained to me that they were of the opinion that dictated tests acted as a definite handicap to them. If this handicap was real it might take two forms: (1) Individual differences which probably would be distributed about equally and in a controlled experiment should balance itself on class averages but still penalize individual students. (2) A definite traceable hazard would remain constant and thus show itself in class averages. With the intention of studying this factor the present experiment was conducted and is being reported here for what value it may have to instructors who conduct objective tests.

A series of four objective tests containing 100 items each were prepared in both my sophomore and senior classes at Marshall College. These tests were given to several classes until most of the subjective factors had been eliminated by revision. The tests were not standardized, and had they been, the standards would have been worthless since two methods were to be used in giving the tests. Over a period of years these tests were given half the time by dictation and half by mimeograph. To offset the memory factor the order of the tests was reversed so that half the time the dictated tests were given first and the other half the mimeograph tests came first. The same teacher taught each class and administered the tests. The data were then treated in the usual statistical manner and the facts tabulated into the following table for study. In this study the grading system of West Virginia State Board of Education was used, i. e., 7 A's, 23 B's, 40 C's, 23 D's, and 7 F's for a typical group of 100 college students.

TABLE 1.—*Combined data over a period of years*

Class level	Median Dictation Method	Scores	Pupils	Medians Mimeograph Method	remarks
Sophomores	53.46	584	146	56.8	noticeable improvement
Seniors	48.71	592	148	49.4	slight improvement

TABLE 2.—*Grade letter effects of scores made on tests*

Item indicating pupils shifting up or down when method of giving tests is changed from mimeograph to oral method	Sophomore level	Senior level
Number who made no change	49	70
Lowered one letter	46	43
Lowered two letters	24	5
Lowered three letters	2	1
Lowered four letters	0	0
Number of pupils who lowered rating	72	49
Number of letters lowered	100	56
Number raised one letter	22	25
Number raised two letters	3	4
Number raised three letters	0	0
Number raised four letters	0	0
Number pupils who raised rating	25	29
Number of letters raised	28	33

The data shown in the above tables seem to justify the following conclusions in so far as data collected at one college can be considered typical.

1. On the sophomore level 146 students gained by the mimeograph method as shown by the median rising from 53.46 to 56.80. (Table 1).

2. On the senior level 148 students showed slight gain. The median rose from 48.71 to 49.40. Experience in college may have trained them to "earmindedness" since we are prone to use the lecture method widely. (Table 1).

3. On the sophomore level 49 students were unaffected by change in method. Of the 72 whose score ratings were changed, 46 were lowered one letter, 24 two letters, and 2, three letters; and 22 raised their grades one letter and 3, two letters. (Table 2).

4. On the senior level 70 students were unaffected. Of those whose ratings were changed, 43 lowered them one letter, 5, two letters, and 1, three letters; and 25 raised their letter ratings one letter, and 4, two letters. (Table 2).

5. On both levels the students who were penalized by the oral method exceeded those who were unaffected.

6. The varied shifting of individual scores indicated advisability of using both methods in caring for individual differences. (Table 2).

7. A probable explanation of the lack of median variation in the upper levels may be had from the papers delivered by Bowers

and Woods at the Academy meetings in 1937 and 1938, in which experience was shown to be a deciding factor among beginning freshmen but to disappear with experience in taking tests. Or it may mean that as students become older, they become more adaptable to different instructors and their varied methods of presenting subject matter.