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PROCEEDINGS
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Volume 5

August, 1931

Eighth Annual Session

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Brown, A. Coleman, Director Religious Education, M. E. Church, Huntington.
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*Cook, Rolla V., Prof. Physics, Bethany College, Bethany.

Cook, William A., State Superintendent of Schools, Charleston.
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*Dodds, Gideon S., Prof. Histology, W. V. U., Morgantown.
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*Fromme, Fred Denton, Dean College Agriculture, W. V. U., Morgantown.
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*Harris, C. J., Prof. Biology, Morris-Harvey College, Barboursville.
*Harris, T. L., Prof. Sociology, W. V. U., Morgantown.
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*McKinney, H. T., Prof. Education, Bethany College, Bethany.
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*Phelps, Edward P., Prof. Chemistry, Marshall College, Huntington.
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*Spangler, R. C., Prof. Botany, W. V. U., Morgantown.
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Staab, W. A., Prof. Mining Engineering, W. V. U., Morgantown.
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Stayman, Joseph W., Pres. Potomac St. School, Keyser.
Stout, Wilbur, Geological Survey, Columbus, Ohio.

*Straley, H. W., III, Strahlehurst, Princeton.
*Strausbaugh, Perry D., Prof. Botany, W. V. U., Morgantown.
Sumpstine, Wilbur J., Prof. Biology, Bethany College, Bethany.
Talbot, S. Benton, Prof. Biology, Davis & Elkins College, Elkins.
*Taylor, Leland H., Prof. Zoology, W. V. U., Morgantown.
Terrill, T. E., Prof. English, Bethany College, Bethany.
*Tucker, R. C., Geological Survey, Box 265, Morgantown.
*Turner, B. M., Prof. Mathematics, W. V. U., Morgantown.
Turner. John Roscoe, Pres. W. V. U., Morgantown.
*Utterback, W. I., Prof. Zoology, Marshall College, Huntington.
Vachon, Chemistry Teacher, High School, Athens.
Vehse, C. H., Prof. Mathematics, W. V. U., Morgantown.
*Vest, Lewis, Dept, Mathematics, W. V. U., Morgantown.
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Wagner, John R., Glenville.
Ward, J. B., Beverly.
Weakley, Charles E., Jr., Chemist, Agr. Exp. Sta., W. V. U., Morgantown.
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Weimer, Fredrick G., 42 Heiskell St., Wheeling.
Welch, George B., Prof. Physics, Marshall College, Huntington.
White, Bennett S., Prof. Drawing & Designing, W. V. U., Morgantown.
White, Frank S., Prof. Psychology & Education, Fairmont St. Teachers College, Fairmont.
White, Ryland, Fairmont St. Teachers College, Fairmont.
Williamson, S. G., Prof. Physics, Concord St. Teachers College, Athens.
*Wilson, Dorothy, Prof. Mathematics, Potomac St. School, Keyser.
*Wingerter, Charles A., Physician, Birch Lynn, Wheeling.
*Winter, John E., Prof, Psychology, W. V. U., Morgantown.
*Woods, Roy C., 1640 Sixth Ave., Huntington.
Woolery, W. K., Prof. Amer. History, Bethany College, Bethany.
*Workman, Albert C., Dean Bethany College, Bethany.
Zucchero, P. J., Weston.

*Members of the American Association for the Advancement of Science.

CONSTITUTION OF THE WEST VIRGINIA ACADEMY OF SCIENCE

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

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

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

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

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

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

Corresponding members are exempt from dues. (As enacted by the Academy at the Elkins meeting, May 19, 1928).

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

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

The secretary and treasurer only shall be eligible to re-election for consecutive terms. The term of the secretary shall be three years. (Provided for in amendment to constitution authorized by the Academy at West Virginia University meeting November 26, 1927).

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

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

A Committee on Publications consisting of the President, Secretary, and a third member choosen annually by the Academy.

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

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

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

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

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

BY-LAWS

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

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

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

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

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

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

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

The financial year shall end at 9 o'clock in the morning of the first day of the annual meeting after which time the books shall be available to the Auditing Committee. (Enacted by the Academy at the Charleston meeting, April 27, 1929).

In case a section adjourns without electing a chairman for the succeeding meeting, or in case the chairmanship of a section becomes vacant between meetings through removal of the chairman from the state or otherwise, the President of the Academy shall appoint the chairman for the next meeting of the section, and do so at as early a date as possible. (By action of the Academy at West Virginia University meeting November 26, 1927).

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

ARRANGEMENT BY SECTIONS

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

Chemistry. Chemistry, Chemical Engineering, Pharmacy.

Geology and Mining. Geology, Coal and Engineering, Road Commission, Building Material.

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

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

MINUTES OF THE EIGHTH ANNUAL MEETING

The Eighth Annual Meeting of the West Virginia Academy of Science was held at West Virginia Wesleyan College, Buckhannon, April 24-25, 1931.

The Academy convened for the first session of the meeting at one o'clock, April 24, in the Atkinson Chapel of West Virginia Wesleyan College, with President A. B. Brooks presiding. President Homer E. Ward of West Virginia Wesleyan College was introduced and extended a cordial welcome to the members of the Academy.

The minutes of the 1930 meeting were read and approved.

The Treasurer, Professor Carl G. Campbell, was called upon, and gave the following report:

Cash Received from H. T. McKinney, retiring	$408.40
Receipts for Current Year: From Dues and Initiations	191.50
	$599.90
Disbursements:	
To redeem check of R. B. Purdum	$ 2.00
P. D. Strausbaugh, Postage	3.18
H. A. Davis, Postage	10.00
Morgantown Printing and Binding Co.,	
3000 letterheads	18.50
2000 envelopes	13.00
1000 statement cards	7.75
	$ 54.43
Balance in bank now	$545.47
	$599.90

Respectfully submitted,

CARL G. CAMPBELL, Treasurer.

The Secretary then read the following report of the Executive Committee:

Your committee recommends;

1. That a Committee be appointed by the President to investigate the possibilities of securing appropriations from the State Legislature for publishing the **Proceedings** of the Academy.

2. That inasmuch as the State University no longer furnishes free reprints of articles in the **Proceedings**, that the Academy pay one half

the cost of the first fifty reprints for authors who desire them, and that the authors assume the remaining cost.

3. That the following persons be elected to membership in the Academy:

John Palmer, Rock Ledge, Wheeling.

Dr. Charles Wingerter, Birch Lynn, Wheeling.

Fredrick G. Weimer, Assistant in Mathematics, W. V. U., Morgantown.

C. H. Vehse, Prof. of Mathematics, W. V. U., Morgantown.

S. O. Garder, Grad. Student, W. V. U., Morgantown.

W. A. Hallam, Prof. of Mathematics, W. Va. Wesleyan College, Buckhannon.

R. Ray Scott, Prof. of Education, W. Va. Wesleyan College, Buckhannon.

H. A. Bauer, Prof. of Geography, New River State College, Montgomery.

Wallace Smith, Prof. of Mathematics, New River State College, Montgomery.

G. H. Bretnall, Prof. of Biology, Shepherd State College, Shepherdstown.

H. A. Shutts, Dept. of Mathematics, Fairmont State College, Fairmont.

Dr. T. E. Terril, Bethany College, Bethany.

Prof. Dawson, Bethany College, Bethany.

James F. Ferry, Grad. Student, W. V. U., Morgantown.

A. E. McGuire, Prof. of Education, Concord State College, Athens.

S G. Williamson, Prof. of Physics, Concord State College, Athens.

C. H. Archer, Registrar, Concord State College, Athens.

Miss Lida L. Davis, Prof. of Geography, Concord State College, Athens.

Joe Vachon, Teacher of Chemistry, High School, Athens.

R. E. Klingensmith, Principal, High School, Athens.

M. C. Holmes, Prof. of Physics, W. V. U., Morgantown.

4. That we accept the invitation of Concord State College to meet at Athens in 1932, such meeting to be held on the last Friday and Saturday of April.

5. That Maurice Brooks, with B. R. Weimer as alternate, be elected to represent the Academy at the American Association for the Advancement of Science meeting at New Orleans, La., in December, 1931.

Signed:

A. B. BROOKS
P. D. STRAUSBAUGH
H. A. DAVIS
CARL G. CAMPBELL
H. F. ROGERS

The Report was adopted as a whole.
The Secretary then read the following:

ACADEMY CONFERENCE REPORT
of the
CLEVELAND MEETING
of the
AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

The Academy Conference of the American Association for the Advancement of Science met in the Main Building of Adellert College Cleveland, Ohio, December 29, 1930, at 3:55 P. M. Dr. D. W. Moorehouse, chairman of the conference called the meeting to order, and Dr. Chancey Juday called the names of the members and these responded by rising. As the minutes of last year had already been printed and distributed, these were not read.

Then followed the election of a new Secretary. Nominations were made from the floor. Mr. George E. Johnson of Kansas and Dr. S. W. Bilsing of Texas were nominated. A Count of the ballots showed the election of Dr. Bilsing who immediately took Dr. Juday's place as Secretary and the latter, automatically becoming the new president of the conference, assumed charge of the meeting.

Then followed the reading of the papers on the program as previously announced. The first of these was a paper by Dr. E. C. L. Miller of Virginia on the subject, "State Academy Libraries and the interchange of Academy Publications". In this paper Dr. Miller presented the facts gleaned from a qestionaire which he submitted to the secretaries of the various state academies. His first suggesion is that the library of each academy should contain copies of the Proceedings of the other state academies. The second suggestion is that each academy should have copies of the books written by its members and also reprints of their articles. Third, if an academy has funds by which it subsidizes investigations, a copy of any publication which result from such research should be deposited with the academy. If an academy offers a prize for good work, a copy of the prize paper should be deposited with the academy. Fourth, an academy can establish exchange relations with various scientific bodies both here and abroad and thus increase its library. Fifth, books may be bequeathed to the Academy library and these should be accepted. Sixth, books may be purchased, although there are probably more useful ways to spend our money. There is also a brief discussion of some methods of caring for the Academy library.

Dr. Miller makes one excellent suggestion viz. that some member be designated as a more or less permanent librarian with whom exchanges are made. Our secretary who usually receives all exchanges holds office for only 3 years, and at the expiration of each 3 years the address changes and this gives rise to some difficulties. The further suggestion is made that each academy librarian be provided with the official list of persons to whom publications are to be sent. The complete text of Dr. Miller's paper is appended.

The next paper was read by Dr. John F. McGill of the Tennessee Academy. The subject of Dr. McGill's paper was "How can the work of the various science clubs in Tennessee be correlated with that of the State Academy"? In replies to a letter sent to some 25 or 30 members of the Tennessee Academy, Dr. McGill found an endorsement of the proposal that as a beginning the Academy have a standing committee to inaugurate the organization of science clubs at such points, and of such kinds as seem auspicious to facilitate cooperation with the Academy and with one another. Dr. McGill then read excepts from the replies obtained from various clubs expressing views concerning the affiliation of such clubs with the State Academy. The full text of Dr. McGill's paper is appended.

The final paper on the program, "The Illinois Junior Academy—Its Achievements and Prospects", was read by Miss S. Aleta McEvoy of the Rockford High School Faculty, Rockford, Illinois. Miss MvEvoy presented in a most enthusiastic manner the story of the Illinois Junior Academy and expressed her unqualified endorsement of, and confidence in this movement, as an asset to the general program of High School work. An abstract of Miss McEvoy's paper is appended.

The decided emphasis in the Conference program on the development of Junior Academies and the affiliation of other science clubs with the state Academies, is a bit of finger-pointing in the direction that is being taken by the current progress in some of the older, more vigorous state academies. Your conference delegate repeats his assertion made a year ago, that it would seem the part of wisdom for us to take cognizance of this movement, and to provide the machinery for an investigation of the possibilities of organizing such clubs within our state, and if it is deemed advisable to undertake the task of affecting such organizations.

An example of the cooperation of the office of the Permanent Secretary of the American Association for the Advancement of Science with the various State Academies may be seen in the fact that mimeographed copies of the papers read at the conference were prepared by the office force for each delegate in order that the contents of these papers might be reported to the Academies without the loss of a single word.

At the close of the discussion following Miss McEvoy's paper the Conference adjourned. An hour later the members of the Conference reassembled in one of the dining rooms of the Statler Hotel to enjoy a social hour and the Complimentary Dinner given by the Permanent Secretary of the American Association for the Advancement of Science, Dr. Burton E. Livingston. At the close of the Dinner a vote of thanks was extended to Dr. Livingston and with that act the Academy Conference of 1930 passed into history.

Signed:
P. D. STRAUSBAUGH
Delegate for the West Virginia
Academy of Science.

President Brooks next appointed the following Committees:

Membership Committee	R. E. Saleski, Chairman
	E. M. McNeil
	Frank S. White
Resolutions Committee	H. T. McKinney, Chairman
	C. E. Lauterbach
	F. E. Clark
Nominating Committee	Fred E. Brooks, Chairman
	Frank Cutright
	R. P. Hron
Auditing Committee	Dean C. E. Albert, Chairman
	E. C. H. Davies
	J. E. Judson
Legislative Committee	Claude Maxwell, Chairman
	John Palmer
	Phil Conley

Vice President P. D. Strausbaugh took the chair while President Brooks gave his address, "Science Reserves". It dealt with the proposed organization by the Academy of Junior Academies of Science in the various high schools of the state. Following the President's Address Miss Lucille Stalnaker, a student in Upshur Co. High School, read a brief paper encouraging the organization of Junior Academies.

The meeting adjourned and the members reassembled at the various sectional meetings in Science Hall.

The Academy convened for a second general session at 8:30 A. M., Saturday, April 25, in Atkinson Chapel.

The following persons were elected to membership in the Academy:

P. J. Zucchero, Weston.

Carl L. Hornor, Mining Eng. and Coal Operator, Clarksburg.

Thomas Connell, Jr., Fairmont Aluminum Co., Fairmont.

E. P. Deatrick, Prof. of Agronomy, W. V. U., Morgantown.

Charles E. Weakley, Jr., Chemist, Agr. Exp. Sta., W. V. U., Morgantown.

Carmen E. Levine, Grad. Student, Elkins.

A. Coleman Brown, Director Religious Education, M. E. Church, Huntington.

Newton Anderson, Social Science Teacher, Upshur Co. High School, Buckhannon.

Miss Rosavelta Karickhoff, Teacher of Chemistry, Upshur Co. High School, Buckhannon.

B. A. Hall, Principal Upshur Co. High School, Buckhannon.

A motion was made and passed that the Academy support the Washington Bi-Centennial Movement to plant trees, and that a printed statement be made to that effect.

The Auditing Committee reported as follows:

We the Auditing Committee hereby certify that we have audited the accounts of the Treasurer up to and including April 24, 1931 and have found them correct.

Signed:

CHAS. E. ALBERT
J. EDWARD JUDSON
EARL C. H. DAVIES

This report was approved.

The following report was given by the Committee on Resolutions:

Believing that this has been one of the most successful meetings that the West Virginia Academy of Science has held, it is fitting that some recognition should be shown all who have contributed to this end. Therefore, Be it resolved;

1. that we extend our thanks to President A. B. Brooks and to other officers and to chairmen of sections for the excellent program;

2. that we express to Dr. Wark, President of West Virginia Wesleyan College, and to his faculty our sincere appreciation of the detailed way in which we were received, entertained, and given every utmost courtesy;

3. that we mention in a special way our appreciation to the Chamber of Commerce, the Rotary and the Lions Club, of the pleasurable entertainment they afforded us;

4. that we express to the many homes and rooming houses our recognition of their consideration of our comforts;

5. that we express our appreciation of the part played by the local press and to the members of the Benzine Ring who contributed to make our meeting a success;

6. and that we express our hearty approval of the learned address of Dr. Roy Dorcus, the speaker of the evening session.

7. Be it further resolved, that our Academy feels a heavy loss in the death of Dr. John L. Tilton who was for two years President of the Academy. It was largely his untiring efforts that lifted our organization to its present high plane and his presence shall continue to be missed by us all.

Signed:
H. T. McKINNEY
F. E. CLARK
C. E. LAUTERBACH

This report was accepted. It was voted that a copy of the resolutions be sent to Mrs. Tilton.

The Committee on Nominations reported:

For President . . . . P. D. Strausbaugh.
For Vice-President . . . . Carl G. Campbell.
For Treasurer . . . . C. E. Albert.

Signed:
FRED E. BROOKS
FRANK CUTRIGHT
R. P. HRON

This report was accepted and the Secretary was instructed to cast the ballot of the Academy for the names proposed.

President elect Strausbaugh took the chair for a short talk.

The section chairmen reported as follows:

Maurice Brooks, Chairman of the Biology section, reported an attendance of seventy-five, and J. E. Judson was elected chairman.

W. W. Hodge, Chairman of the Chemistry Section, reported an attendance of seventy, and Samuel Morris was elected chairman.

D. B. Reger, Chairman of the Geology and Mining Section, reported an attendance of twenty, and D. B. Reger was elected chairman.

W. A. Hallam, Chairman of the Mathematics and Physics Section, reported an attendance of twenty-four, and Wallace Smith was elected chairman.

C. E. Lauterbach, Chairman of the Social Science Section, reported an attendance of forty, and H. T. McKinney was elected chairman.

It was suggested that the best routes to Athens from the various parts of the State be distributed to members with the programs of the next meeting. Professor Frank Cutright volunteered to supply such information to the Secretary.

Maurice Brooks made some announcements concerning the proposd trip to the State Game Farm and through the Brooks' Nature Trails at French Creek. D. B. Reger announced that those interested in Geology would leave the main party at the State Game Farm and visit the near-by gas fields.

The meeting adjourned.

H. A. DAVIS, Secretary

PROGRAM FOR THE BUCKHANNON MEETING

Friday, April 24, 1931.

1:00 P. M.—Greeting, President Homer E. Wark, West Virginia Wesleyan College.

Reply, A. B. Brooks, President of the West Virginia Academy of Science.

Business of the Academy, Open Session.

Reports of Officers.

Report of Executive Committee.

Reports of Standing Committees.

Election of Members.

Appointment of Special Committees.

Other Business.

1:30 P. M.—President's Address: Science Reserves.

PAPERS

Meetings by Sections:

Biology

(Botany, Zoology, Physiology, Medicine, Agriculture)

MAURICE BROOKS, Chairman.

W. J. Sumpstine: Notes on the Origin of Tissues in the Rhizome of Onoclea Sensibilis. 10 min.

W. I. Utterback: Sex Behavior Among Naiades. 10 min.

J. E. Judson and L. B. Hart: Studies on the Decomposition Bacteria of the Human Body.

D. A. Shaw: Catalase in Relation to Percentage of Growth in the Tomato Fruit.

Paul R. Cutright: Mammalian Chromosomes. 15 min.

Paul R. Cutright: Reading with a Zoological Purpose. 10 min.

Robert T. Hance: Certain X-Ray Effects upon Paromoecium. 10 min.

Robert T. Hance: Cooperation between University and College.

G. H. Bretnall: The Irritating Factors in So-Called Bad Air.

Earl L. Core: Herbarium Organization at West Virginia University.

A. M. Reese: Potassium Permanganate and Snake-Bite.

B. R. Weimer: Note on Termite Destructiveness in Northern West Virginia.

A. J. Dadisman: Forest or Farm Lands.

R. C. Spangler. The Sequoias. 20 min.

Maurice Brooks: A Glimpse of the Gaspe Peninsula. 15 min.

Frank A. Gilbert: The Cultivation of Slime Moulds for Laboratory Use.

Chemistry

(Chemistry, Chemical Engieering, Pharmacy)

W. W. HODGE, Chairman.

Friend E. Clark: History of the Manufacture of Gunpowder. 15 min.

E. S. Tisdale: The Effect Upon Public Water Supplies, Public Health, and Industry of the Great Drought of 1930. 20 min.

S. P. Burke: Some Aspects of the Combustion of Natural Gas for Industrial Purposes. 20 min.

M. G. Geiger: Development of Chlorine and Chlorine Products in Southern West Virginia. 30 min.

Randolph C. Specht: Barium, Barium Minerals, and Barium Chemicals. 25 min.

Samuel Morris and Alva Headlee: Lecture Experiments in General Chemistry. 30 min.

Lorenz Hansen: Some Reaction Tests on Aldehyde and Ketones with a Series of Compounds Containing the Methylene Group. 20 min.

Clyde C. Porter: Advancement of Science Applied to Well Shooting. 15 min.

Walter A. Dew: High Pressure Synthesis in West Virginia. 25 min.

L. K. Herndon: A Study of the Sewage Pollution of the West Fork River at Weston, West Virginia. 20 min.

C. A. Jacobson: An Improvement on the Berl-Ranis Method for Determining the Components of the Ternary Mixture Ethyl Alcohol Methyl Alcohol and Water.

Geology and Mining

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

DAVID B. REGER, Chairman.

Charles E. Krebs: Coal Resources of Upshur County.

Claude W. Maxwell: The Sewell Coal Field of Randolph and Webster Counties.

Paul H. Price: Erratic Boulders in Sewell Coal of West Virginia.

S. L. Galpin: Probable Volcanic Ash Deposits in the Pennsylvanian of Northern West Virginia.

James D. Sisler and John W. Galpin: Mechanics of Oil and Gas Sand Correlation.

Walter L. Smith: Pulpstone Industry in West Virginia.

B. F. King: The Mineral Composition of Sands from the Monongahela, Allegheny and Ohio Rivers.

John P. Nolting: Drainage Changes in the Headwater Region of Deckers Creek.

Carl Guthe: National Research Council and Anthropological Museum, Ann Arbor, Michigan: General Archeology.

Mathematics and Physics

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

W. A. HALLAM, Chairman.

C. R. Jones: The Relation of Science and Invention.

H. A. Bauer: Tides.

M. J. Kelly: Determining the Astronomical Unit.

R. P. Hron: The Theory, Production and Uses of Ultra-Violet Rays.

C. H. Vehse: Deflections of a Square Plate Loaded on the Circumference of a Circle.

Wallace Smith: The Solution of $2x^2+2x+1=y^2$.

J. A. Eiesland: The V_4^4 in S_5 Associated with a Schläfli Hexad.

H. A. Davis: A Problem in Cremona Space Transformations.

Social Sciences

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

C. E. LAUTERBACH, Chairman.

W. E. Fairman: The Left-hand vs. the Changed-hand Writer. 15 min.

T. L. Harris: The New Profession of Social Work. 20 min.

Augustus W. Hayes: Social Conflicts of the Adolescent. 20 min.

Robert J. Largent: The Background of Civil Service Reform. 15 min.

Rex Crouser (Sponsored by C. E. Lauterbach): Temperature as a Sensation Clue in the Perception of Moisture. 15 min.

H. T. McKinney: What Constitutes Modern Practice in Education. 20 min.

R. E. Saleski: The Principle of Form in Historical and Psychological Linguistics. 25 min.

R. Ray Scott: Gestalt Explanation of Stimulus Response. 20 min.

J. B. Shouse: Simplified Treatments for Two Common Statistical Devices 20 min.

T. Edward Terrill: Is Meter Necessary to a True Definition of Poetry? 20 min.

John E. Winter: An Experimental Study of the Effect on Learning of Supervised and Unsupervised Study Among College Fresmen. 20 min.

Frank S. White: How Should a Composite Score be Made from a Battery of Tests? 15 min.

Roy C. Woods: A Study of the Effects of Sampling Fiscal Data Education. 15 min.

Evening Program

6:00 P. M. Dinner, Rotary Club rooms, $1.00. Tickets must be purchased at the time of registration to insure reservation.

8:00 P. M. Address, Dr. Roy Dorcus, John Hopkins University. Experimental Evidence Which Shows Thinking and Ideation as Forms of Muscular Activity.

Saturday, April 25.

7:30 A. M. Business Meeting.
- Unfinished Business.
- New Business.
- Reports of Committees.
  - Auditing Committee.
  - Committee on Resolutions.
  - Committee on Nominations.
- Election of Officers.
- Remaining Papers.

9:00 A. M. Excursions, under the Management of a local committee. A trip to a near-by oil field, and another of especial interest to biologists are being arranged.

SCIENCE RESERVES*

By
A. B. BROOKS,
Park Naturalist, Oglebay Park, Wheeling.

The West Virginia Academy of Science, since its organization, has been actively interested in the present generation of young scientists. This interest, in 1929 and 1930, took the form of an essay contest sponsored by the Academy and offered to high school pupils. Twenty-five dollars was given for the best essay written on the subject, "The Out-of-Doors Where I Live", the winning essay to be read at a general session of the annual meeting and printed in the organization's proceedings. Some encouraging results were achieved through this effort and considerable stimulus was given to careful observation and record-keeping by students of the high schools throughout the State.

The number of persons participating in the essay contest, however, was not satisfactory. It was felt that something with a more comprehensive reach must be substituted. Therefore at the annual meeting of the Academy, held in Keyser, April 25 and 26, 1930, the following recommendation was adopted: "Your Committee recommends that the policy of providing for a high school essay contest be discontinued and that the executive committee for the coming year be authorized to proceed with the organization and development of a junior academy of science."

What is a junior academy of science? I believe that question has been practically answered by the Illinois Academy of Science, although the full significance of it is doubtless not yet apparent. The Illinois State Academy is sponsor for the Junior Academy of Science organized two years ago. The steps which led to this included the organization of a high school science section of the senior academy, mainly for high school science teachers. The results of work through this section are reported as not having been satisfactory. The teachers would not attend.

Encouragement was also given to the organization of high school science clubs with the hope that the interest created would lead to an increase in the membership of the state academy. But no marked increase in the number of members from this source was noted. An opportunity for club affiliation with the state academy was given but only a few took advantage of it.

An appeal was finally made to the student body through the formulation of a plan for the organization of the junior academy, which is made up of the affiliated high school and junior high school science clubs. Such a club may be a biology club, geology club, radio club,

*President's Address.

aviation club, astronomy club, chemistry club, etc., or it may be a combination of any of these. The club is under the supervision of one or more faculty sponsors.

In order to become a member of the junior academy any club has only to pay the treasurer of the state academy one dollar initiation fee and annual dues of one dollar, and adopt and live up to its constitution and by-laws. The officers are usually chosen from the upper classmen. Most clubs require each member to pay small weekly or monthly dues which may be used to pay the affiliation fee. All members are entitled to purchase and wear a pin bearing the state insignia and a guard bearing the letters of the school or club.

The club programs are in the hands of a committee of students who arrange for each meeting and secure the approval of the club sponsors. Some of the programs consist of lectures by well-known scientists, short talks by students, educational movies, trips to industrial plants, field trips for nature study, and demonstration of equipment or display of natural history collections by the students.

Annual meetings of the junior academy are held in conjunction with the state academy meetings, the delegates being thus privileged to hear scientists of note, to compete for state awards in exhibits, posters and project work. "In giving the students state-wide contacts with scientists and scientific work", say the sponsors of this movement, "we are doing for a curricular subject what the various extra-curricular activities have been doing for a considerable length of time."

A magazine entitled "Illinois Junior Science", is issued monthly, the first number being dated December, 1930.

A neighboring state, therefore, has pioneered and experimented in this scientific youth movement and has made plain the way for others to follow. A number of states are just now entering upon this work.

The executive committee of the West Virginia Academy of Science, while it has attempted no actual organization work, has taken stock of our situation, has collected data, has secured expressions of interest and cooperation, and believes the time is opportune for setting up a definite program of procedure for the organization of a West Virginia Junior Academy of Science. It will be our privilege and responsibility in this connection to prepare a model constitution and program outline which will state specifically the conditions of organization and affiliation. The aim in this set-up should be toward simplicity so as not to involve science clubs in such detail as to discourage organization and work. There should be provision for the working together of the senior and junior academies in such relationship as will encourage junior members after leaving school to become members of the State academy.

Our day is one in which not only the scientific habit is taking a deepening hold, but one in which the more important scientific spirit is becoming fully awake. The possessors of this spirit themselves have release from the handicaps of narrowness, and become also the agents for severing the remaining bonds of such human slavery of body and mind as results from a wrong or excessive use of the equipment thrust by a mechanical age into our hands. Thomas Edison, with nearly 1,500 patents in his own name, and still working, is quoted as saying that in the next forty years there will be more inventions and discoveries than in the past four hundred years. Many of these discoveries, he says, will tend toward lengthening of the span of human life and the increasing of happiness. The young men and women now in high schools will be the experimenters and discoverers in the forty-year period referred to. The responsibilities of high school teachers and all adult scientists of the present time, therefore, have a weight never before paralleled.

The enrollment in the senior high schools of West Virginia is now 59,380 and in the junior high schools, 18,756, making a total of 78,130. These constitute our science reserves. There are many young scientists in this large group of students and we can safely predict that in such a state as our own, with its wealth of natural resources, developing industries, and changing social conditions, many will find an opportunity here to place their names deservedly high in helpful scientific achievement. The leaders among this group will help a generation which has temporarily lost its way, its possession of self, and its knowledge of the use of spare time, to find and follow the normal road.

The West Virginia Academy of Science may well work through this project for a junior branch in every high school of the state, and for a mutually helpful correlation of senior and junior activities.

SOME EXPERIMENTAL EVIDENCE WHICH SHOWS THINKING AND IMAGINATION ARE FORMS OF MUSCULAR ACTIVITY*

By
ROY M. DORCUS,

Psychological Laboratory
The Johns Hopkins University.

The problem of how we think and what an idea really is, has been a basis of speculation for several thousand years. The Greek philosophers followed later by those in France, Germany and England, have attempted to provide adequate explanations. The range of these explanations has varied all the way from the assumption that speaking or thinking occurs in one's stomach to that of a psychic entity, independent of a physiological organism, and capable of carrying on these processes without interference from the organism. A relatively recent explanation that has received serious consideration is that advanced in 1887 by F. Max Muller (12) in a treatise entitled "The Science of Thought," in which he stated "Even those who use sober and subdued language about everything else, break out into raptous strains when they speak about the intellect and all that has been achieved by that old wizard. Our divine reason is nothing more than human language."

"I hold thinking is nothing but speaking minus (articulate) words." Juller further states that "thought is identical with language:" "The word is not the dress of thought, but its very incarnation."

Muller has stated the case rather succinctly and is so far as he went he has anticipated what seems to me, at least, the most tenable theory of thought.

Before elaborating further the theory which I am going to espouse allow me to present another historical statement which bears a little more directly upon the relation between muscular activity and thinking and imagination. In 1900 Munsterberg (13, 14) set forth his action theory for explaining consciousness and thought. In his theory, he maintains that a passage from stimulation to discharge must take place in the cortex of the brain. He denies that ideas exist in us, in a manner entirely independent of our actions. His point of view seems to have furnished the basis for the reaction hypothesis as set forth by Dunlap (3, 4, 5,) and is essentially the foundation on which this discussion will be elaborated.

Dunlap maintains the perceptual consciousness or awareness involves or is accompanied, neurologically, by these phenomena:

*The address of the visiting speaker.

1. Stimulation of a receptor organ, such as the eye, ear, or warm spot.

2. Arousal of afferent current, which passes through the peripheral nervous system toward the brain.

3. Activation of the central nervous system, consisting of the brain and spinal cord which operates in somewhat the same manner as an automatic telephone switch board.

4. Arousal of efferent current leading the neural impulse toward the muscular or glandular system which is to produce the terminal effect.

5. The action of the specific neural or glandular system.

In other words, the perceptional process does not take place until a reaction of the muscular or glandular system occurs.

If I take a specific illustration, it will help to clarify the situation. Suppose that some one approaches the tip of your finger with a lighted match and your hand is withdrawn. How does this fit into the various aspects of the reaction hypothesis? The lighted match moving toward the finger affords the physical stimuli in either ether waves or molar heat vibration which impinge on the nerve endings for warmth in the skin or on the rod and cone cells in the retina. These sense organs arouse nervous impulses which travel toward the cerebral cortex in which they are in turn switched onto the proper efferent pathway leading to the muscles which contract, so that the arm is withdrawn.

The example which I have just given is a simple type of reaction. Usually the stimuli which are presented to an individual are manifold and hence if a reaction was made to each particular stimulus the reaction would be quite confused or would involve a sequence of many reactions. What actually occurs is that the stimuli are received as a pattern and a single reaction or a simplified reaction is made. This is accomplished in the cortex by having the appropriate incoming neural impulses shunted out on the same motor pathway. I have said that the organism is subjected to manifold physical stimuli such as heat, cold, color, smell and so on and in addition it is subject to physiological stimuli arising from within the organism such as pain, fullness, muscular movement and circulation changes. These also add to the stimulus pattern and play a decided role in the reaction of the individual.

Dunlap (6) has modified his point of view recently to provide a short circuiting mechanism for conscious responses. In his present point of view, he assumes that the complete response, including muscular activity, is basic in thinking; that it occurs in almost all adults; and that, perhaps, in infancy and early childhood it is without exception. Also, in learning new ways of thinking or new thought sequences, it is of great importance.

With development of the invidual, the thinking response more and more substitutes the cerebellum for the muscular response, although never completely. In this paper, however, we are concerned only with the original statement of the theory and proof of the function of the cerebellum cannot be established until the first assumptions are proven.

So far only the reactions have been considered when perception is involved; that is when either a physiological or physical stimulus initiates a reaction. You may contend that in thinking or imagining no physical or physiological stimuli initiates a response and further that no response occurs under these conditions. Exactly what is the difference between perceiving an apple, imagining an apple and having an idea of an apple? If these differences are primarily a matter of terminology then we may proceed to show that imagination, ideation, and perception take place in almost the same manner.

I place the apple on the table before me and I see the apple. The process involved in seeing the apple is similar to the example of the lighted match which was used and is usually referred to as perceiving. If I close my eyes and still get a picture of the apple the process that occurs is usually referred to as imagining. If I think of the apple (with my eyes still closed) as having a fragrant odor, as being on the table, as being good to eat, and as having the possibility of giving me indigestion, then I have the idea of the apple. Dunlap characterizes the difference between imagination and ideation by the difference between the two terms "think of " and "think about." In ideation there enters the matter of relationship with the object imagined and the rest of its environment.

The image and idea differ from the percept in that the physical or physiological stimulus is no longer present. It can be shown, however, that the arousal of the image and idea follow definite lines of association, which have a physiological basis in contrast with the point of view sometimes held that images and ideas are "mental mechanisms" arising in the brain and cortex and terminating their activity there. If we assume that the arousal of the idea or image can be satisfactorily explained, how does the total process compare with the total perceptional process? In the following discussion, I shall endeavor to show that muscular activity of one kind or another is a definite part of the to'al process of imagination and ideation.

The experimental evidence which supports the thesis that imagination and ideation are forms of muscular activity follows several difinite lines. We have first what might be termed pseudo scientific evidence. If you will try to imagine that you are holding your breath or that your eyes are closing, you will find that there is a tendency for these reactions to occur. Or if you carry the process a step further and imagine that you are smelling a fragrant rose you will find it quite difficult to get an olfactory image as long as you hold your breath and that the image will be obtained as soon as inhalation or a slight snuffing takes place. You might also try to secure an image of the word Margaret and analyze what is happening. In all probability you will find that your eyes are making slight movements such as would occur when seeing the word or you will vocalize the word, although it is inaudible. Hellen Keller and Laura Bridgeman are reputed to have no visual imagery. If imagery were purely a phenomenon of the "brain" we might expect, in spite of their loss of vision and the experiences that go along with it, that visual imagery would be possible.

Jastrow (9) in trying to find an explanation for muscle reading, ouija board, and table tipping phenomena, has shown by means of the automatograph that the hands tend to follow the movements of the eyes in exploring rows of object or colors, and further that the hands tend to move toward a number or letter about which the individual is thinking.

For some of Oliver Lodge's experiments on thought transference, if we accept them as legitimate experiments, the explanation is to be found in muscular activity accompanying thinking. In having a subject guess a number or card that another individual is thinking about, he obtained more correct responses than could be expected if chance alone were responsible. This statement holds only when the receiver and the agent have their hands in contact. Tucker corroborated the findings of Jastrow; he concluded that there is a tendency for the body and arms to follow a given direction when an individual thinks of performing a certain act.

Curtis (2), Reed (16), and Clark (1) have attempted to measure implicit muscular movements of the tongue and larnyx when an individual is thinking. By applying capsules to the larnyx or to tip of the tongue these investigators have shown that involuntary movements of these organs do occur during thinking although there is considerable variability from individual to individual.

More recently work dealing with the topic has been followed in the psychological laboratory of the Johns Hopkins University. One investigation carried out by Totten (17) has successfully demonstrated that eye movements do occur during visual imagery. In this work Totten employed certain reactors that did not know what the nature of her experiments were. She gave them instructions to imagine various objects such as a cross, a railroad train and a tall monument. During the time the subjects were imagining these objects, photographs were obtained of the movements of an illuminated spot attached to the cornea of the eye. The following figures will give you an adequate idea of the results obtained.

Figure 1.

Shows picture of eye movements obtained while the subject imagined that he saw a long train.

Figure 2.

Shows picture of eye movements obtained while the subject imagined he saw a cross.

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

Fig. 6

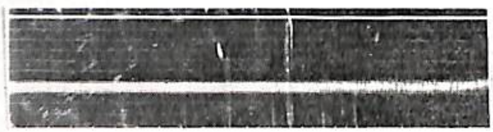

Fig. 7

Figure 3.

Shows picture of eye movements obtained while the subject actually examined a cross after the other experiments were ended.

Figure 4.

Shows picture of eye movements obtained while the subject imagined the Washington monument in a horizontal plane.

Figure 5.

Shows picture of eye movements obtained while the subjects actually examined a vertical line after the other experiments were ended.

These figures are sampies taken from Totten's original material and as yet unpublished but it is rather obvious that during visual imagery eye movements do occur. It is also obvious that the direction of the movements correspond to the general outline of the objects imagined.

Other investigators including Perky (15) and Judd (10) antedated the work of Totten. Since their results were not as clear cut and since their work was not as adequately controlled, I need only mention them as workers in the field.

A distinctly different kind of investigation has been pursued by Max (11) of Hopkins and Jacobson (7, 8) of Chicago, in their efforts to demonstrate that thinking and imagining result in muscular activity. Physiologists have shown that whenever a muscle contracts in making a movement, a slight amount of electrical energy is discharged. With the aid of a string galvanometer this energy can be measured. We may argue that if every time a muscle contracts electrical energy can be detected, then every time electrical energy arising from the muscle can be measured a contraction of the muscle must have occurred.

Max and Jacobson have shown that the hypothesis just stated was correct although their results can not be said to be more than indicative. They may have shown that while thinking of certain things or of performing certain acts, discharges do occur in certain muscles even though they are unable to detect the movement in any other way. To state it in another way, it has been shown that implicit muscular activity occurs during thinking although there is visible or overt muscular activity.

The electro myograms in the following figures show the electrical changes which occur during overt muscular activity as well as implicit muscular activity. Figure 6 shows (left curve) a picture of the string at rest and the fluctuation of the string when a dynamometer was gripped. The right curve shows the disturbance when the following suggestion was given by Max. Imagine yourself holding a powerful snake by the neck just behind the head, your grip must be firm enough to keep the snake from biting and thus poisoning you. In this case the deflection of the string occurs although it is not as marked as in the gripping of the dynamometer.

Figure 7 shows the electro myogram when the following instructions were given to the subject. You are to think about each finger of your hand in turn as though you were tracing a pattern about the hand. This record also shows string deflection under these circumstances.

Figure 8 shows the tracings made under the following conditions:

Upper curve. Electrodes were applied to the right arm of subject

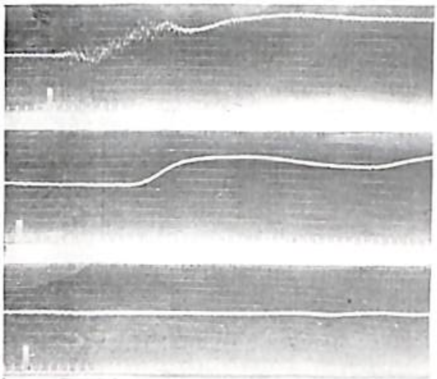

Fig. 8

Fig. 9

(A) and he was required to lift a 20 pound weight with the right arm.

Middle curve. Electrodes were applied to the left arm of the same subject and the weight was lifted with the left arm.

Lower curve. Electrodes were applied to the right arm and the subject was to imagine that he was lifting the 20 pound weight with that arm.

Figure 9 shows the tracings made under slightly different conditions by the same subject.

Upper curve. Upper curve shows deflection when a dynamometer was sqeezed with the right hand; the electrodes were applied to the right arm.

Middle curve. Conditions were the same as for the upper except that the dynamometer was squeezed with the left hand.

Lower curve on left. Dynamometers were squeezed with both hands. Note the wide deflection of the string first to the right and then to the left.

Lower curve on right. Subject imagined he was squeezing dynamometer with right hand.

Figure 10 shows tracings made by subject (B) under the same conditions as those for figure 8.

Figure 11. This figure was taken from an article entitled "Electrical measurements of neuro muscular states during mental activities," by Edmund Jacobson of the University of Chicago. The original of this figure appears in the American Journal of Physiology, 1930, 91, 566-607.

The upper curve shows the string deflection for subject I. G. during imagination. In this case the subject was to imagine that he was bending his arm.

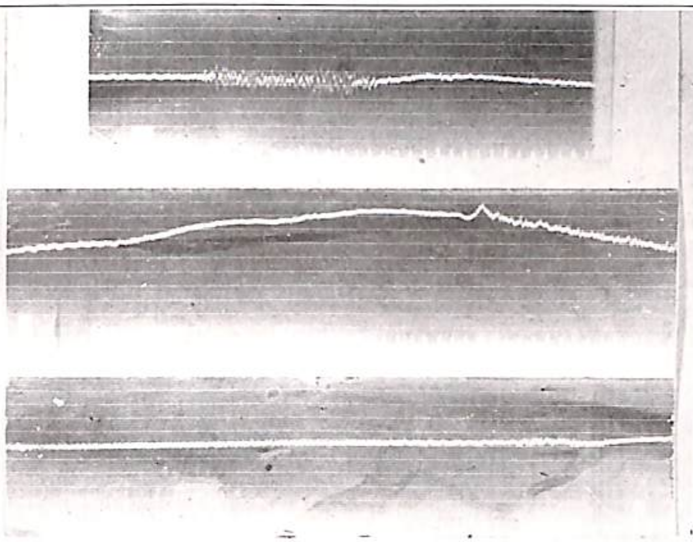

Fig.10

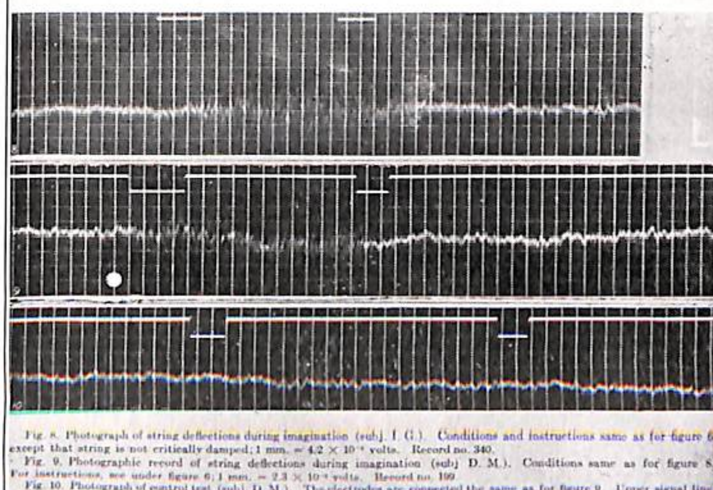

Fig. 8. Photograph of string deflections during imagination (subj. I. G.). Conditions and instructions same as for figure 6, except that string is not critically damped; 1 mm. = $4.2 \times 10^{-\text{[illegible]}}$ volts. Record no. 340.

Fig. 9. Photographic record of string deflections during imagination (subj. D. M.). Conditions same as for figure 8. For instructions, see under figure 6; 1 mm. = $2.3 \times 10^{-\text{[illegible]}}$ volts. Record no. 199.

Fig. 10. Photograph of control test (subj. D. M.). The electrodes are connected the same as for figure 9. Upper signal line: first break indicates the signal to "imagine bending the left arm;" second break indicates the signal to relax muscularly. Under conditions otherwise the same as for figure 9, no electrical change in the right biceps is recorded following the first signal. Record no. 199.

Fig.11

The middle curve shows the string deflection for subject D. M. during imagination.

The lower curve shows the string deflection under control conditions for subject D. M. In this case the subject was to disregard the signal to imagine that he was bending his arm.

From the evidence presented there are definite indications that neuro-muscular activity does accompany imagination. Although the activity is unobservable and undetectable except with a very specialized and refined technique. Just how far the analysis of this activity can be made, remains to be discovered. It is one of the lines of work that has been initiated at Hopkins and further research which is being conducted should offer additional information which will justify the hypothesis stated at the beginning of the paper.

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ORIGIN AND DEVELOPMENT OF THE TISSUES IN THE RHIZOME OF ONOCLEA SENSIBILIS

By

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Introduction

The purpose of this particular investigation was to determine as accurately as possible the origin of some of the outstanding tissues in the rhizome of this interesting fern. No attempt was made to trace the origin of all of the structures arising in the stem, this work being planned for some time in the future when it is hoped a more complete study of the plant may be pursued.

The material used in this investigation was collected during the months of June and July, at which time the plant appears in vigorous growth, and was taken from the edges of the marshes and lagoons in the semi-dune region, several miles south-east of Hammond, Indiana. Here the plant grows in relative abundance, and a constant supply of material was available at all times. Both young and old stems were collected for study. Identification was made by Dr. W. J. G. Land of the University of Chicago, under whose competent guidance this investigation was conducted.

Although much has been written about the closely related O. Struthiopteris, a search of the literature reveals that little work other than general habit descriptions have ever been made on O. sensibilis, so that the need for critical studies is apparent. Little can be added to the general observations of others except that there seems to be some doubt as to the origin of the generic name of this form. Clute (2) discusses this problem and quotes the German botanist Sprengel as having proved that this fern will wilt when brought in contact with human bodies, thus deriving the name sensibilis. Clute also quotes from Britten's European Ferns; ". . . . That the barren fronds are so thin and delicate in texture that they will wither, even when growing, if drawn once or twice through the hand." Many trials of stroking and drawing of fronds through the hands of the writer has proved that this fern has no more predisposition to wilt than many of our other common forms when touched or handled.

An expected correlation was observed between the water content of the soil in which the plant was growing, and the depth of the rhizome. Where the soil was merely damp and the water content rather low, the stems frequently grew two or three inches under the soil surface, but along the edges of pools, or in swamps where the soils were practically saturated, the rhizomes grew on top with a covering of a few decayed leaves or rotting twigs.

Gross Anatomy of the Rhizome

The rhizome branches freely, apparently dichotomously, and gives rise to many roots and a limited numer of leaves and sterile spikes. The roots branch freely and no root hairs were observed on any of the material examined.

The stems are usually found with the concave surface located dorsally to the main axis, although some material was collected in which this depression was lateral. This feature was utilized in a general way for orientation of the stems for microtome sectioning.

Some difficulty was at first experienced in sectioning due to the presence of soil particles held in the numerous scales, mucilage hairs and mucilage of the stem tip. Every stem was carefully washed with a camel hair brush to remove this material before it was fixed and imbedded.

Apical Cell and Derivatives

All of the tissues arise from segments cut from the three inner faces of a rather large pyramidal apical cell, being cut off apparently in serial order. This apical cell in O. sensibilis takes the form of a triangular pyramid, with its longest axis almost exactly in line with the main axis of the stem. After careful measurements it was found that the average depth of this cell along the stem axis was seventy microns. Difficulty was experienced in securing good transverse sections of the stem tip showing an anterior view of this cell, but one good section demonstrated that in front view its appearance was almost the same as in longitudinal section, practically making the cell an isodiametric triangular pyramid. This difficulty was due to the fact that these rapidly dividing meristematic cells are very thin walled and are quite watery in cell content.

The outer or anterior face cuts of no segments and is protected in a pit formed by the onpushing new leaves, sterile spikes and the presence of many scales and mucilage hairs.

Although this cell is enclosed in a pit, due to segmentation with the formation of underlying and lateral tissue, it is pushed somewhat above its neighboring cells, so that transverse sections reveal it surrounded by only five or six cell generations.

Both anticlinal and periclinal divisions occur in the second cell generation of this apical cell. One case was noted where periclinal division took place in the first segment, although this occurance was not common, and frequently two or three anticlinal planes intervened before periclinal segmentation took place.

The cells resulting from the outer half of the first periclinal division always remain parechymatous, forming the cortex and an epidermis which arises rather late.

The inner half of this periclinal division gives rise to the desmogen strand with its subsequent tissues and the central parenchyma or pith. The desmogen strand could be traced to within five or six cells of the apical cell, its elongate cells with their large nuclei and fine granular structure standing out from the surrounding tissues. Lichtgrün and safranin gave good differentiation in this region, the desmogen strand taking the green and the red predominating in the other tissues.

A little lower down, the strand is joined by other strands from the roots and leaves.

Endodermis and Pericycle

A definite endodermis is present in the bundle, the Casparian thickenings appearing rather late. Identification of this endodermis by means of the strips or thickenings was only possible at distances of six to eight mm. from the stem apex, although at this distance they appeared in both transverse and longitudinal sections. Due to the large size of this particular rhizome, with its many intervening cell generations between the apical cell and cells which might designated as a definite endodermis, it was impossible to trace its origin with any degree of certainty. From general reactions, the elongate shape of the cells, and the juncture of the young endodermal cells with the outermost layer of the desmogen strand, we might presuppose that the endodermis is stelar in origin. This however, is not sufficient evidence as to its origin and leaves the question open to further study.

A pericycle two or three cells in thickness is present in the mature bundle. No attempt was made to trace its origin but its development seems to follow closely that of the endodermis and may have some significance as to its origin. Chang (3) in his excellent work on Pteris aquilina, suggests the probability that both endodermis and pericycle are descendents of a common mother cell, although he was not able to definitely prove the statement.

Phloem

The phloem is the first tissue to arise in the young bundle and is recognized by its position and its dark staining qualities. It stands out in both transverse and longitudinal sections. At .5 of a mm. from the stem apex it can be differentiated from its neighboring cells, and at .7 of a mm. lateral seive plates could be discerned in the young bundle. These plates, characteristic of the phloem elements of the ferns are very conspicuous in the older bundles. The walls of the seive tubes of these elder bundles also show this deep staining reaction and we therefore believe that the development of the phloem slightly precedes that of the protoxylem.

Xylem

The young bundles show two protoxylem points, one strand at each end of the ovate bundle. Cases were observed in which three protoxylem strands were present, but this condition was not common. These protoxylem strands arise shortly after the first indication of the seive tubes and the first indication of spiral deposition occurs about 1.1 mm. from the apex. This is shortly after the rise of the phloem element as pointed out in the foregoing paragraph.

Traced anteriorly into the younger tissues of the desmogen strand, we find that the cells giving rise to the protoxylem are more elongate and of less diameter than the surrounding cells.

The metaxylem arises much later than the protoxylem, the cells being of great caliber and showing the characteristic scalariform pitting. Chang finds in the bundle of Pteris aquilina, that the metaxylem are the earliest to differentiate and the last to mature. In O. sensibilis these cells also are the last to mature. In transverse sections, .6 of a mm. from the stem apex, the protoxylem cells can be seen surrounded by thin walled cells with rarified contents. These are the undifferentiated metaxylem elements which take on the scalariform structure after maturation of all the other tissues in the bundle has occured. The mature metaxylem cells are very elongate and this condition has been brought about by their relative few periclinal divisions, and their attempt to keep pace with the elongation and division of the other cells on their periphery.

Roots

The root arises from the segments cut from the four faces of a large triangular apical cell which resembles closely that of the stem. The three inner faces of the cell give rise to the tissues of the proper while the products from the anterior face form the root cap.

This cell arises very early and apparently is a product of the desmogen strand. The large pyramidal cell, already beginning to cut off segments is recognizable about the same time that differentiation of the plerome occurs. The disintergration of the parenchyma cells of the cortex before the advancing apical cell of this young root seems to indicate that it may be liberated by some type of digestive enzyme, accompanied by the natural pressure of the growing tissues.

As mentioned before, no root hairs were observed on any of the material studied.

No attempt was made to trace the subsequent development of the tissues of the root, but it is evident that they arise as the products of this large pyramidal cell previously mentioned. A transverse section revealed one bundle in each root. This bundle was composed of two large metaxylem cells and three or four protoxylem cells at each end of the bundle adjacent to the metaxylem. Surrounding the xylem is a layer of phloem two or three cells in thickness, bounded on its periphery by a one cell layer of pericycle, with an endodermis-like layer surrounding it. Casparian thickenings were not observed.

Discussion

In O. sensibilis we have a fern which is dominated throughout its life by a terminal apical cell of the pyramidal type. Cross (5) in his work on Osmunda cinnamomea, concludes that the changing from a single apical cell to a meristematic group, composed of two or three cells represents a step forward in phylogenetic development. If such is true, then O. sensibilis, based on the apical cell alone is still rather low phylogenetically and is still on a level with the bryophytes, if we consider only apical cells. If such is an indication of low phylogenetic development then it might be well to look for other significant characteristics of the same order. Dorsiventral structures are supposed to be significant when exhibited by higher types. Chang points out that P. aquilina shows definite dorsiventral structure of rhizome with a type of apical cell usually associated with such methods of growth, namely a modified form of the dolabrate type found in the anacrogynous Jungermanniaceae.

O. sensibilis seems to have gone one step forward, for if any remains of dorsiventral structure be present, it is denoted by the concave depression on the dorsal side of the rhizome and is not exhibited by the apical cell itself. As pointed out before, this depression has a tendency to wander laterally, or even be missing altogether. If we then have a fern with an apical cell not characteristic of dorsiventral structures, with a holdover of a problematical dorsal depression on the rhizome which in some cases is missing entirely, then we might conclude that we are a step in advance of the Pteris type, but still lower than the Osmundaceae.

Insufficient evidence was collected relative to the origin of the endodermis and pericycle, and their rise remains an open question. The work done seems to indicate that the endodermis is stelar in origin and the pericycle is closely related to its development. Chang suggests that both arose from a common mother cell, but absolute proof could not be obtained until mitotic figures were studied. Cross concludes that the endodermis and pericycle of O. cinnamomea have independent origins, although decisive evidence was lacking. The writer does not feel inclined to assign the endodermis of O. sensibilis to any one layer in its origin, since it arises very late, and is far removed from the early segments of the apical cell of the rhizome.

From evidence collected, it appears that the adventitious roots arise in close relationship to the desmogen strand. Bower (1) makes the statement that the attachment of the roots in most ferns is commonly upon the stele or meristeles of the axis; but it may also be upon the basal part of the leaf supply, especially where the leaves are crowded.

He states that these characters give little help in comparative study. In O. sensibilis the smooth outline of the desmogen strand is destroyed and the root tissues seem to be an integral part of the desmogen which leads us to conclude that it arises in the outer part of the strand and not in the cortex.

Summary

1. All the tissues of the rhizome have their origin in a rather large pyramidal apical cell which persists throughout the life of the fern.

2. The plant is no more sensitive to tough than many of our other common forms.

3. The desmogen strand which gives rise to the bundle, has its origin in the inner half of the first periclinal division of the segments of the apical cell. The products of the outer half remain parenchymatous and give rise to the scales, mucilage hairs, cortex, and a late appearing epidermis.

4. The development of the phloem slightly precedes that of the xylem.

5. Roots arise very early as products of the outer part of the desmogen strand.

6. The tissues of the desmogen strand differentiates very late, making the tracing of cell lineage a difficult problem.

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SEX BEHAVIOR AMONG NAIADES

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While doing graduate work in the University of Missouri on the problem of preparing a descriptive and illustrated catalogue on the **Naiades*** and also while collecting data as a Scientific Investigator for the benefit of the Pearl Button Industry under the direction of the U. S. Bureau of Fisheries† the writer had occasion to make some unusual observations of sex behavior among **Naiades,** commonly known as Freshwater Mussels.

Most of the observations mentioned in this paper are those made in the laboratory and in nature for **Lampsilis cardium (Rafinesque),** often known as **Lampsilis ventricosa (Barnes),** or in the trade as "Pocket Book". This species of Freshwater Mussel is the highest type of the next highest generic group of **Naiades,** the **Lampsilis.** This genus of Rafinesque is especially characterized in the female by profuse tentacles and papillae arranged around both the branchial and anal openings on the margin of the mantle which is doubled posteriorly and is extended down to the lowest post-ventral point on the mantle edges of both sides anteroventrad to the incurrent opening as two long ribboned flaps.

This special character of fringed mantle flaps bearing eye-spots, together with unusually large marsupia with some thirty large bulging ovi-sacs, gives this type of mussel high rank in taxonomy because of its survival and minimum mortality due to the best advantage for the aeration of the embryos up to the glochidial stage. This adaptability resulting in the best advantage for the embryos is seen in all forms of life.

Because of this tentacular structure of both the incurrent and excurrent siphons and also because of the undulating ribbon-like flaps on the mantle margins below the branchial opening, together with the immense marsupia at the posterior ends of the outer gills, the shells of the female are greatly inflated and decidedly blunted at the posterior end.

Also through the action of these mantle flaps water currents are so created as as to draw the sperm of the male into the branchial chamber as well as to direct an excess supply of oxygen through the thin ovi-sacs to the early embryos contained in membranous masses termed conglutinates.

These conglutinated masses in our type for study, **Lampsils cardium,** are in the shape of in-soles and are actually discharged from the swollen

*THE NAIADES OF MISSOURI, American Midland Naturalist, Vol. 4, No's. 1-10, with Plates I-XXIX, (1915-1916).

†MUSSEL RESOURCES OF MISSOURI, U. S. Bureau of Fisheries, Economic Circular, No. 10.

beaded margins of the marsupium by processes of rupture through the thin postero-ventral walls. The writer has observed this discharge of late embryos both in the acquarium and in nature and thus has been able to verify the observations of other workers.

The writer, however, has observed the discharge of the sperm of the male and the intake by the female,—an observation not recorded before as far as he has been able to ascertain through a complete bibliography on the **Naiades** secured after four years of study of this very interesting group of Mollusks.

Besides making observations of this sex behavior in the laboratory and in nature for **Lampsilis cardium,** the writer has also been able to record three other instances of the male discharging sperm,—one for **Lasmigona complanata** and one for **Utterbackia ohiensis*** .—all in the laboratory acquarium. However, in the case of **Lampsilis cardium** this behavior for both sexes was observed in both the acquarium and the clear shallow water of the river.

The sperm discharge was observed as a tiny stream of milky white cysts from the anal, or excurrent siphon. Upon examination with a lens magnifying 385 diameters these cysts were seen to be hollow globular masses of sperm revolving clock-wise in the water by means of flagella thrust through a matrix from hundreds of individual sperm-cells, much in the same manner as in the Colonial Protozoön, **Volvox globator.**

This rotary motion of the sperm masses, together with that of the late embryos of the **Naiades,** may not be the eccentricity as claimed by some workers in this group of Mollusks since this physiological character may be expected in all mussels,—in fact this ingrained tendency to move in circles is characteristic of all forms of life, especially in the gametes and in all stages of the embryonic development.

One of the most important revelations made in the field of Zoology at the last Meeting of the American Association for the Advancement of Science was the relation of this circling tendency to that of sex as applied alike to plants and animals.† After twelve years of research work Dr. Schaeffer, now of the Department of Zoology in the University of Kansas, has made thousands of tests for various animal and plant types,—especially for the ameba,—to find that the right and left spiraling propensities are involved in the determination of sex in that the positive, or clock-wise spiraling accompanies forms reproducing **sexually** and the negative, or anti-clock-wise spiraling as characteristic of forms reproducing **asexually** as seen among the lower forms of life.

Among the higher sexual forms, as seen among the **Naiades,** whatever causes the differences in this rotary motion in the germ cells, as well as in the pre- and post-embryos, we would ascribe to indentical differences in sex. Be that cause what it may we know from observing

*Proceedings of the West Virginia Academy of Science, Vol. IV.

results as seen in the globular sperm masses of mussels that the etiology for the male gamete would indicate that its sex is determined in a molecular way by the left-to-right **stereoisomer,** as we may term this hypothetical causation.

The presence of these right and left stereoisomers, as causal factors for male and female, would only be accompanying factors in the chromosome theory of sex determination in that the presence of the idiosome determines the male offspring and the absence of such odd chromosome predestines the female.

The writer has also observed the rotary motion in late embryos of that peculiar species of mussel, **Utterbackia ohiensis (Raf.)** These were observed to be revolving,—some right and some left,—around one axis at the rate of fifty times a minute. This phenomenon is seldom seen because of its short duration and seems to be a necessary movement in the final development into the glochidial (larval) stage.

The interesting behavior of the female **Lampsilis cardium** was noted by the writer on many instances to be buried in the gravelly bottom of clear shallow water with only the siphons, mantle flaps and two black ovi-sacs exposed. The ribbon-like flaps waved to and fro in an undulating manner and occasionally a white leaf-like conglutinate would be discharged. Not far away was another female with open siphons and waving flaps sucking in sperm from a male of the same species which was discharging milt from the anal opening in a tiny white stream making the water milky white for some distance around. Most of the other females located at this station were found at that time to have empty marsupia and receptive for the sperm of the active male **cardium.**

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†From a paper, "MOLECULAR ORGANIZATION OF PROTOPLASM IN AMEBAE". By Dr. A. A. Schaeffer, Department of Zoology, University of Kansas.

CATALASE IN RELATION TO PERCENTAGE OF GROWTH IN THE TOMATO FRUIT*

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The investigations dealing with Catalase have in the past been concerned with the changes in the metabolic processes and the factors influencing its activity. From what has been done, one would naturally suppose that the Catalse activity would increase as the growth increased. This investigation was planned with this idea in view.

Review of Literature

The opinion of the nature of Catalase and its relation to oxidation processes have been reviewed in a number of papers. Rhine, (1924) stated that the most plausible theory of Catalase formation in plants seem to be that it is formed as an enzyme—according to the theory of need.

Heincke (1923), working on the factors influencing Catalase, and its activity in the apple-leaf tissue showed that the terminal leaves were more active than the basal leaves. In 1924, his data on Catalase Activity in Dormant Apple Twigs, seem to afford a basis for the suggestion that the presence of growth producing substances favor Catalase activity, while substances tending to inhibit vegatative activity have a retarding influence on the Catalysis by Hydrogen Peroxide.

With regard to the effect of temperature and light on the Catalase of Spirogyra porticalis, (Burge and Burge) in 1924 explained that Catalase activity was higher in light than in dark, at the same temperature. They quote Bonnier and Manquin (1884) as stating that light independent of heat effect produces an increase in the respiratory metabolism of the plant.

Wilmer E. Davis (1926) determined the viability of seeds by measuring the Catalase Activity.

In relation to growth Ezell and Crist (1927) found that Catalase activity increased with growth of spinach and lettuce plants but did not parallel with growth in size.

Knot (1923) showed that Catalase activity of apicial sixty milligrams from which all but the smallest leaves had been removed, decreases as the plant changes from a vegetative to a reproductive type of growth, suggesting a very localized response to the lower daylight period. The amount of this decrease is closely correlated with the increase in the height of the seed stalk. The data also showed that the younger and

*Complete data are being published in another paper.

older leaves of spinach and celery are usually low in Catalase activity, while those intermediate in age have a higher and approximately the equal activity.

Estimation of Catalase Activity

The method used with this was similar to that of Appleman, (1910). The tomatoes were sliced and dipped in calcium carbonate. The slices were then run through a meat grinder. The ground tomatoes were

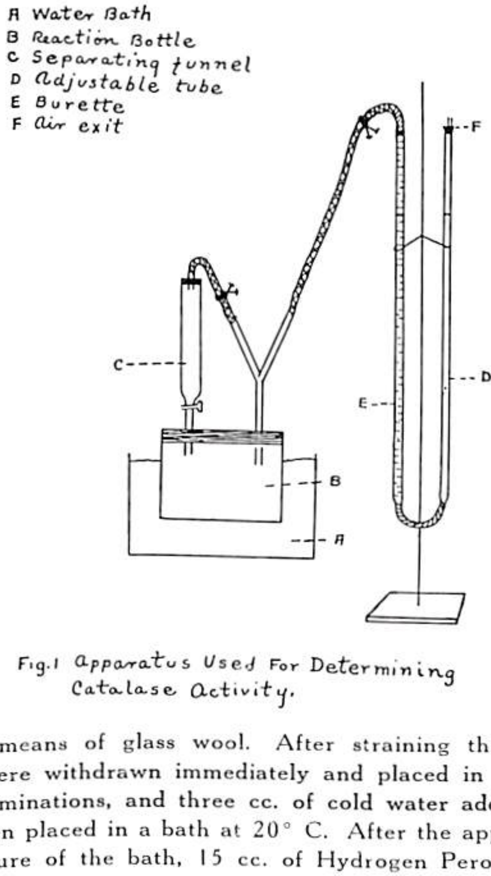

Fig. 1 Apparatus Used For Determining Catalase Activity.

strained by means of glass wool. After straining three (3) cc. of juice they were withdrawn immediately and placed in the bottle used for the determinations, and three cc. of cold water added. The apparatus was then placed in a bath at 20° C. After the apparatus attained the temperature of the bath, 15 cc. of Hydrogen Peroxide was added through a separating funnel. The stop-cock was opened fifteen seconds before the minute. On the minute, shaking begun and continued until the experiment ended. On the quarter of the minute, the stop-cock leading to the burette was opened. Readings were made every minute for five minutes.

Measurement of Fruit

The tomato blooms were pollinated and data taken so the age of the fruit could be procured. As soon as the tomatoes were one centimeter in diameter, the measurements began. Two diameters were taken for each fruit and the average calculated. The measurements were taken at regular intervals and the percentage of growth calculated when a fruit was selected for a test.

Selection of Fruit

Green tomatoes were selected for the various percentages of growth. This was done so that the activity for the various percentages of growth ranging from zero to the highest rate that could be procured. Fruit was also selected for the different degrees of ripeness.

Discussion

There was no correlation between the size of the tomato fruit and Catalase activity. The growth practically stopped when the fruit began to turn, resulting in the lower catalase activity. The Catalase activity was highest in the younger and intermediate growth. Age did not seem to effect the catalase activity as some of the older fruits were as active as the younger. In all the fruits that had high percentages of growth, the Catalase activity was high. This showed that as the percentages of growth increased, the Catalase activity increased. When the data were plotted a curve was secured that steadily increased from 0 percentage of growth to the highest percentage obtainable. In some cases, however, the Catalase activity did not parallel the percentage of growth. But the usual thing is that there is an accompanied increase in Catalase activity with increase in percentage of growth.

MAMMALIAN CHROMOSOMES

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Chromosomes are only fifty-six years old. Although they appeared in the figures of Schneider (1873) they were first adequately described by the botanist, Strasburger, in 1875. It is interesting to note that Charles Darwin knew nothing of chromosomes, and in spite of the prodigious amount of writing done b yhim, there is no reference to them and, in only a place or two, do we find statements relative to the cell.

Since the time of Strasburger the chromosome literature produced has been sufficient to warm the heart of the most ardent of bibliophiles, if it were convertible into biography, history, and fiction. In 1884 and 1885 Hertwig, Weismann, and Strasburger concluded independently and almost simultaneously that the nucleus was the vehicle of heredity and from then on cytologists from every part of the world turned their microscopes on the deeply staining interior portions of the cells and assiduously maintained the focus for year after year. It is only recently that the cytoplasm came into existence. The idea that the nucleus played a part in heredity acted as a thigmotropic irritant that touched every cytological investigator and the irritaton is still much in evidence to-day. As a matter of fact, it is this study, more than any other, which can be said to characterize the work of our modern period.

After an era of more or less intensive study covering some fifty odd years what can we say definitely about chromosomes? Practically all of our knowledge is morphological and all else is a matter of deduction. The chromosome number has been reported for a large number of animals which runs all the way from two, in one of the round worms, up to two hundred and eight, a questionable count which has been given for a certain species of crayfish. In the house fly the number is twelve, in the rat it is 42, and in man 48. The number for all forms, within limits, is constant. We know that the indivdual chromosomes have a more or less definite size and shape in each species. We know the exactness of division in mitosos and the presence in diploid groups of paternal and maternal homologues in synapsis and we know of their disjunction in reduction division. We are relatively certain that identical twins, which are practically mirror images of each other, owe their great similarities to identical sets of chromosomes. Literally millions of chromosomes have been counted, measured, and drawn. We know the morphology of the chromosomes and from this knowledge we deduce, as did Hertwig, Weismann, and Strasburger in 1885, that they are the vehicles of heredity; at least we know of no other satisfactory vehicle.

It is unfortunate that a great many people have gone to extremes as a result of our discoveries and insist upon a sort of omnipotence for the chromosomes. They declare that they are responsible for everything from strabismus to house-maid's knee. On the other hand there is another group that is equally rabid in favor of the environment as a molder of physical and mental characteristics. The consensus of opinion among those most qualified to judge is that both are powerful agents but that heredity is probably the more so.

Although our knowledge of chromosomes is not meagre, there is much that we do not know; many questions remain to be answered. In closely related forms may the chromosomes be considered as having the same genetic make-up? Why are the chromosomes of different sizes in different cells? Is there any easily recognizable type number, in mammals, for example and, if so, can deviation from this be explained on the basis of an end-to-end fusion or to a breaking up (transverse fragmentation) of one or more of the chromosome pairs? Do related species have similar chromosome complexes because they are inherited from a common ancestor? Do the chromosomes represent directly or indirectly the physical nature of the genes? Is there a shifting of chromatin within the chromosomes, or between non-homologous chromosomes, which would greatly affect the arrangement of genes without altering them in a quantitative way, an dwould this be sufficient to account for new species and the evolution of new forms?

About a year ago I began a study of the chromosomes of the mouse with the idea in mind of throwing some light on one or more of the questions just propounded or of attempting to answer others which would arise as the work proceeded.

Quite a few investigators have already worked on the mouse but their efforts have been confined almost entirely to spermatogenesis, although a few have studied oogenesis. The haploid chromosome number reported has varied all the way from twelve to twenty and no diploid count was made until 1926 when Cox reported the number as forty.

During the past few months I have studied spermatogenesis rather thoroughly and have made considerable progress with a study of the somatic chromosomes as found in the mouse embryos. As soon as this is completed I hope to include oogenesis and then make comparisons between the three tissues.

I have been able to count forty chromosomes in several spermatagonial cells and this number coincides with that reported by Cox and Painter. These are rather short, heavy rods and in only the longer ones is there any bending or hooking and even in these it is not pronounced. When an alinement was made twenty pairs were distinguishable; in nineteen of these the elements of each were practically identical, but the twentieth consisted of a long rod and a very short one. The long one is evidently the X-chromosome and the short one the Y-chromosome.

The forty chromosomes then consist of nineteen plus an X, which came from the female parent, and nineteen plus a Y which came from the male parent. The X-Y combination, in mammals, results in a male. Later on from a study of the ovary we expect to demonstrate the presence of the 2X combination, with the absence of the Y, resulting in a female. We believe that the X and Y-chromosomes are the main agents in sex determination, although the work of other investigators, particularly Riddle, have thrown some physiological monkey wrenches into the machinations of the theory.

In the primary spermatocytes twenty elements have been counted in cell after cell; these elements are seen to be double and resemble somewhat an enlarged diplococcis bacterium. One of these diplococci is made up of a large half and a small one, and here again is undoubtedly the X-Y combination.

If we are correct in our assumption we should expect to find, in the division of the first spermatocyte, the large element, or X-chromosome, going into one of the secondary spermatocytes, and the smaller one, the Y, going into the other; and this is exactly what we do find. In other words in half of the sperms ultimately to be formed there will be an X and in the other half there will be a Y. The morphology and behavior of the sex chromosomes of the mouse, then, is similar to that described by Painter for other mammals, including man.

Previous investigators have been unable to locate many secondary spermatocytes. Only two counts were made by Cox. I have found several that could be drawn without difficulty and all of them contained twenty chromosomes. In two of these there was an odd-shaped, elongated chromosome. With only this amount of material I hesitate to conclude that this is the X-chromosome.

In the embryos figures occur abundantly everywhere. They are most numerous in the nervous tissues where an unusual amount of activity is taking place in those cells lining the ventricles of the brain and the spinal canal. However a surprising numer of metaphase plates may be found in the connective tissues and the blood cells. As a matter of fact the most remarkable feature noted up to the present is the extremely large number of cells undergoing division in every part of the embryo. The possibility of making diploid counts here as compared with the spermatagonia is much greater. There is a great variation in the size of the chromosomes in the different tissues. Blood cells are the largest and they contain the largest chromosomes; the cells of the connective tissues are smaller and the chromosomes are correspondingly smaller; and nerve cells are smaller still with a resultant diminution in size of the chromosomes. There has been no satisfactory explanation for this. Enough work has been done to convince me that the reduction or increase in size occurs equally in all the chromosomes.

READING WITH A ZOOLOGICAL PURPOSE

By
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It is common knowledge to a zoologist that the lobster has an exoskeleton of chitin and five pairs of walking legs and that the sartorius muscle in the leg of the frog is next door to the triceps extensor femoris. We, of course, regularly present these facts to the students and, just as regularly, raise a pedagogical eyebrow if the information has not been incorporated. It seems to me, however, that this type of knowledge is not the ultimate goal of a general course in zoology and efforts should be made at all times to introduce new features that will alleviate in the present stock of students some of the ills that were steadfastly and courageously borne by former aspirants of zoological knowledge.

One way in which I believe we have achieved some measure of success at the University of Pittsburgh is in the operation of a definite reading program.

At the time when I was taking my first course in zoology I was fortunate in having as an instructor a man who had a remarkable acquaintance with books and, what is more, an eagerness to impart his knowledge of them on the slightest indication of interest. One day quite aprapos of nothing I found myself carrying home a copy of Darwin's Voyage of the Beagle which he had lent me. I found it fascinating and spent the better part of two nights reading it. The experiences and observations as related in this, the classic of all books of scientific travel and exploration, are fairly clear in my mind to this day. With a book of this type in ones hands the map of the world ceases to be a blank; it becomes a picture full of the most varied and animated figures. I recall with delight the discovery of fossilized bones on the pampas of Argentina; the contact with the primitive inhabitants of Tierra del Fuego; the behavior of the giant tortoises on the Galapagos; and the description of coral reefs. When I returned this volume he introduced me to Vallery-Radot's Life of Pasteur, the most inspirational biography I have ever read and. following this, to Alfred Russell Wallace's Malay Archipelago, and Hornaday's Two Years in the Jungle. These were followed by many others and I became acquainted with Bates, Fabre, Hudson, Huxley, Lankester, Gilbert White, and Roosevelt. What could possibly be more delightful and more stimulating to a beginning zoologist than to while away the days on the Amazon with Bates observing the myriad forms of animal and plant life, or to be with Wallace and the Birds of Paradise in New Guinea, or with Hornaday in Borneo paddling along a narrow river between two dark walls of forest in search of the orang utan.

This introduction served as a stepping stone to an acquaintanceship with many other authors and their works. As the years have passed I have had much enjoyment and profit from Jungle Peace and Galapagos by Beebe, On The Trail of Ancient Man by Roy Chapman Andrews, Microbe Hunters by DeKruif, Possible Worlds by Haldane, A Naturalist on Lake Victoria by Carpenter, Why We Behave Like Human Beings by Dorsey, and The Mind in the Making by Robinson.

Zoology was a fascinating subject but with the collateral reading it became doubly so. Where at first there was only width and breadth there was now depth; the subject became tangible, became alive. I could not possibly have the love I possess for Zoology as a science if I had not traveled to Africa in imagination with Cumming and seen the hordes of wildebeeste, Tommies, and eland as they existed in 1840; if I had not been with Belt in the jungles of Nicaragua as he unraveled the mysteries of the parasol ants; if I had not been with Andrews in the heart of Mongolia when he discovered Dinosaur eggs and the shovel-tusked Mastodon.

After a year or two of teaching, I was not satisfied with the zoology course which seemed to be too stereotyped. It was then the idea of a reading program came into my mind. Why not benefit by my undergraduate experience and make the reading of such books a definite part of the course?

The making of a reading list is not easy. There is such a vast field of highly interesting, as well as important biological literature, that the preparation is attended with about the same amount of difficulty as the formation of the annual All-American football team and, needless to say, received in about the same manner. Furthermore, I have had to depend on my own readings and observations, and the similar experiences of a few others, just as the football moguls have done. Naturally there are shortcomings in both cases and, just as many football heroes have their praises unsung, so do many books pass into oblivion without receiving their just desserts. Books do live longer than people and some of them are rediscovered as were the works of Mendel and Herman Melville.

To be as brief as possible we have included books from all the zoological fields, namely, genetics, physiology, evolution, ecology, and entomology. There are only a few in these fields that would be read easily by a freshman and to offset this, books on scientific travel, biological essays, semipopular treatises of scientific interests along many lines, and even one book of fiction, have been added. There is so much to choose from that we saw no reason for including any book that might be termed dull or difficult. To make our point clear, if a student should wish to read about heredity why subject him to Babcock and Clausen's Genetics in Relation to Agriculture which is a highly valuable text-book, but extremely laborious, when he can read and absorb with little difficulty such works as Altenburg's How We Inherit and Jenning's The Biological Basis of Human Nature.

The reading lists are issued at the beginning of the year and each student is required to read one book sometime during the semester. The reports are oral and are given at various times in one of the laboratory sessions. In this way some twenty reports are given by as many students in each laboratory by mid-year and as a result each becomes more or less familar with the contents of approximately the same number of books. An attempt is made to have the students report on different works so there will be no duplication. In the second semester the plan is repeated and by the end of the year each student should have a general knowledge of a majority of the books on the list.

The succeess thus far has been sufficient to make us highly optimistic. The students are encouraged to read more than one volume and many of them read two and three and some even four and five. A great many are enthusiastic. We are confident the horizons have been broadened for all and for a certain few illimitably. The ultimate success, so far as the individual is concerned, will never be known. In my own personal experience, a portion of which I have already recounted, the value of the early guidance along these lines has been invaluable.

Should we be satisfied as teachers in drilling into formative minds classification, general characteristics, fundamentals of metabolism and irritability? Is that sufficient? Is the knowledge of the sartorius lying beside the triceps extensor femoris illustrative of what zoology should be? As a conclusion to this paper I think it fitting to ask the question that George K. Cherrie, a veteran explorer of South America and an accompanist of Roosevelt down the River of Doubt, raises in his recent book, Dark Trails, "Shouldn't we be interested in more than the size, color, and habits of the animals which surround us? Shouldn't we, rather, think of them in terms of the universe and wonder what part each and every creature plays in the great scheme of things"?

THE READING LIST

Akeley	In Brightest Africa
Altenburg	How We Inherit
Andrews	On The Trail of Ancient Man; Ends of the Earth
Baker	Wild Beasts and Their Ways
Bates	A Naturalist on the River Amazon
Beebe	Jungle Peace; Galapagos; and others
Belt	The Naturalist in Nicaaragua
Brownell	The New Universe
Carpenter	A Naturalist on Lake Victoria
Chemistry in Medicine	Chemical Foundation

Clendenning	The Human Body
Cumming	A Hunter's Life in Africa
Cushing	Life of Osler
Darwin	Origin of Species; Voyage of the Beagle
DeKruif	Microbe Hunters
Dorsey	Why We Behave Like Human Beings
Fabre	The Life of the Bee
Haldane	Daedalus; Possible Worlds
Herrick	Brains of Rats and Men
Hingston	A Naturalist in the Himalayas
Holmes	The Trend of the Race
Hornaday	Two Years in the Jungle; Campfires in the Canadian Rockies
Hudson	A Naturalist in La Plata
Huxley, J.	Essays in Popular Science
Huxley, T.	Man's Place in Nature
Jennings	Prometheus; The Biological Basis of Human Nature
Johnson	Safari
Jordan and Kellogg	Evolution and Animal Life
Keith	Concerning Man's Origin
Lankester	Kingdom of Man
Lumholz	Among Cannibals
Lull	Ancient Man
Melville	Moby Dick
Miller	In the Wilds of South America
Pike	The Barren Grounds of Northern Canada
Newman et al	The Nature of the World and of Man
Robinson	The Mind in the Making
Roosevelt	African Game Trails; Through the Brazilian Wilderness
Scott	The Theory of Evolution; Land Mammals of the Western Hemisphere
Thomson, J. A.	Selected Volumes
Vallery-Radot	Life of Pasteur
Whitehead	Science and the Modern World
Wallace	The Malay Archipelago; Island Life
Ward	Life of Darwin
White	Natural History of Selborne
Yerkes	Almost Human; The Great Apes

CERTAIN X-RAY EFFECTS UPON PARAMOECIUM

By
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Some years ago in an attempt to find out some of the biological effects of x-ray paramoecium was selected for experimentation. This was done because it was thought that any possible influence that this physical force might have would not be complicated by a multicellular organization. This turned out to be so seemingly true that it was problematical for quite awhile whether there was any effect produced. A small but doubtful increase in the division rate seemed to occasionally result in radiated specimens but was by no means constant.

Attention was turned to possible changes of permeability that x-rays might have induced. This was tested by a method that has been considerably used by Harvey and Packard. It consists of staining the paramoecium in a dilute solution of neutral red for a given period. The animals take up the stain and it is concentrated in the food vacuoles. They are next placed in a very dilute ammonium solution and watched under a binocular. The time taken for the ammonium to penetrate and to decolorize the neutral red stained food vacuoles is the index for the permeability of the paramoecium to ammonium.

At first very real changes between the permeability of the control and of the x-rayed paramoecium were noted. Doubt, however, was soon cast on these observations because no consistency of response could be obtained. Later work showed that animals taken from old cultures were very much more apt to give similar results through out the day than were the animals in fresh and actively dividing cultures. Inasmuch as the new cultures were likely to show difference of permeability between morning and afternoon tests while the old cultures were more regular in their reactions suggested that the age of the cell might be a factor in its response to x-rays.

Consequently animals were isolated and were observed until they divided. Their age was dated from this time. The expectation of an age permeability relation proved to be correct and the reason for the contrariness of material taken from stock cultures became apparent. When it was definitely determined that age was a factor in permeability changes in response to x-rays only animals of known ages were used.

The principle experiment here reported is one on the similarity of permeability changes produced by x-rays of different voltages but of comparable ionizing power. Hard and soft rays were used but the time of exposure and the distance of the material from the target were so adjusted as to have similar ionizing effects. When paramoecium were x-rayed under these conditions their permeability was uniformly increased over that of the controls and increased to very closely the same degree. When the ionizing power of the x-rays was increased six times the permeability of the rayed cells decreased by 20% over that of the controls.

The observations indicate the correctness for biological material of the claim of the physicists that the essential difference between hard and soft rays was their relative power to ionize.

COOPERATION BETWEEN UNIVERSITY AND COLLEGE

By
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Zoological Laboratory—University of Pittsburgh.

There is a deal of pother these days about the something that is wrong with our institutions of higher education. This plan or that plan or the other plan is financed and makes its modest bow as the ultimate panacea that will turn the heretofore rocky trail into a royal highway to learning that amounts to something. Admittedly all these plans have their merits—in the hands of those who originated them and in all likelihood will not outlive their sponsors if indeed they endure that long. Equally admittedly there has been no educational cure-all devised yet that any college or university, not completely hide bound by tradition, cannot put into operation along side of its usual curriculum. Indeed in most institutions all the administrative machinery for such practices is available. A system of teaching based on the personal abilities of one or even of several men is not likely to be able to endure very long. The weak and strong links alike in the educational chain will always be in the future, as in the past, the individual teacher and it is not at all likely that coming generations will have any more successful methods for the creation of silk purses from sow's ears than we have at present.

If the above has even a grain of truth in it anything that we can do to foster the development of the individual teacher is a step in advance. Agassiz is said to have taught by slapping a dead fish in front of a graduate student and telling him to find out all he could. That method worked for an Agassiz but I doubt whether either you or I could be successful in inspiring biological enthusiasm with a similar technique. Since those of us here represent the laboratory method of acquiring information it goes without saying that we also believe that the way to learn to teach is by practice. How can we contribute to this end and perhaps at the same time kill more than one bird with the same missile?

Most universities now employ graduate students as laboratory assistants. The future college instructor serves an apprenticeship of several years in this way and if well guided, lays a sound foundation for his teaching career at this time. In addition to these opportunities on the Campus of the University of Pittsburgh, the establishment of three Junior College Branches during the last four years at centers ranging from fifty to one hundred and fifty miles from Pittsburgh have made more positions of this sort available. In each Center there is one mature assistant professor or instructor in charge of the subject. When the number of students justify it a graduate assistant is sent from the main Campus. This would work a hardship on the graduate were he expected to stay at the Branch the entire year. The Campus assistant works half time for the entire year but the assistant at the Branch works full time for one semester and then returns to the Campus where he has the next semester free for study. Another assistant takes his place at the Center. In this way these men keep their contact with their professors and their enthusiasm is not dampened by isolation. Since our assistants are paid $800.00 and tuition it can be seen that two assistants will cost almost as much as an average instructor but because these men stay at the Center but four months at a time, we feel that the Center gets a much fresher and more enthusiastic teacher.

So successful has been this plan that it has accurred to me as equally applicable to the colleges that usually surround a university. It further offers the Colleges a real chance to contribute to the training of academic teachers and at the same time should reduce their cost of instruction. Each College as a rule has a well-trained and able man at the head of each department. When, however, others are needed to assist in the departmental teaching it is not always easy to secure the type of men desired for the money available. It is to fill these instructorial positions that the cooperative plan of securing graduate assistants on a part-time basis from the neighboring university is proposed. Briefly this plan and its advantages may be outlined as follows:

1. To fill the secondary positions in its various departments the College will secure two half-time graduate assistants from the University. One will teach full time one semester and then return to his studies. The second man will replace him having had the first semester free for study.

2. The cost will be approximately $1600.00 for both men. The University should be willing to provide graduate scholarships for these men as its contribution to the plan.

3. The University will send out only assistants who have been under its wing for at least a year and in this way will be reasonably certain of their abilities. Should one or both prove misfits for the College involved they will only remain with the College for one semester or indeed may be withdrawn at once. In any case this is a very short time to keep an inadequate teacher compared with the tenure of an instructor without other connections. Institutions are usually soft-hearted about releasing incompetants and the graduate assistant plan would take this responsibility from them.

4. Inasmuch as the character of the teaching at the College in many cases would be more important than is usually possible to assign the assistant in the University, the College would be making a very real contribution to teacher training.

5. The University would profit through the additions to its ranks of graduate students whose work would thus be subsidized by the College.

6. The cooperation between the two institutions should make avail-

able to the college the occasional use of equipment possessed by the University and the permanent acquisition of which is usually not justified by the nature of the work of the College.

7. Such cooperation should also bring the two faculties into much more helpful association.

HERBARIUM ORGANIZATION AT WEST VIRGINIA UNIVERSITY

By
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Introduction

Some sort of an herbarium is admittedly a valuable, even essential feature of every botanical department. There are many ways of handling preserved specimens of plants so that they may be available for study and comparison. And naturally, there are certain methods that are more advantageous than others. In the short history of the Herbarium at West Virginia University, our technique has been and still is in a developmental stage. The herbarium was organized in 1924 and at that time no member of the staff was specially trained in herbarium management. It was but natural, then, that certain methods would be adopted, given a trial and then rejected in favor of other means of procedure, while others would prove a success and be maintained. In presenting this paper to the public the author has no idea that the practices discussed are the best possible ones. The object is rather to assemble methods that have been found more successful here and put them in a form that will be available to others, who, like us, may be attempting to get together a usable plant collection.

With the growth in size there has come a corresponding increase in the breadth of the aims of the herbarium. At first it was the desire merely to file for ready reference a specimen of each species known to occur in the state. Later it was decided that the herbarium should represent the total known distribution by counties of all species growing without cultivation. To that end at least one specimen of each species should be collected from each county where it is found. Next, West Virginia's location near the middle of the Appalchian mountain region, making it a meeting place for northern and southern species, suggested the idea of building up at this central point a general collection of Appalachian plants which may or may not be found within the bounds of our state. The term Appalachian as used in this connection, is interpreted as including in a general way the eastern portion of the North American continent, from the Arctic ocean to the Gulf of Mexico. Finally it is believed that certain species typical of important families not represented in this flora should be included.

Sources of Materal

A considerable number of specimens in the herbarium have been collected by members of the staff of the botany department during the last seven years. A few hundred sheets stored in attics or other out-of-the-way places in the past half-century have been brought to light and many historically valuable specimens have in this manner been salvaged. Among these may be mentioned a priceless remnant of the famous collection of Dr. Charles F. Millspaugh, every specimen of which is cited in the state checklist published in 1913; several hundred numbers of lichens, mosses and liverworts collected by Dr. John L. Sheldon; and a collection of 150 sheets brought together by Dr. Lee C. Corbett from New York, West Virginia and South Dakota.

Several hundred specimens have come to the herbarium as the result of the work of students working on special groups or special areas. In this manner the collections of Bryophytes, Pteridophytes, grasses, sedges, and composites have become much more complete than the collections of most other groups. More or less complete collections of the plants of Monongalia, Ritchie, and certain other counties have come as aresult of such student undertakings.

A number of interesting collections have been secured through exchanges with other institutions or individuals.

But no herbarium depends for its growth solely upon the efforts of its own staff. Its greatest source of material must ever be the incorporation of herbaria of individual collectors, secured either by gift or purchase. The most important contribution yet made to the Herbarium of West Virginia University was the gift of Mr. L. W. Nuttall, formerly a prominent coal operator of Fayette county, now residing in San Diego, California. This donation, received in 1927, consisted of about 1000 numbers of vascular plants, together with about 3000 or 4000 packets of fungi. The vascular plants were mostly collected by Mr. Nuttall in Fayette county between 1890 and 1898. The fungi, turned over to the Department of Plant Pathology, formed the basis of a herbarium which has been developed by that department into one of the more valuable collections of its kind in the country.

Another very important donation to the herbarium was the gift of the Rev. Dr. Fred W. Gray, a minister of Marlinton, Pocahontas county. This herbarium was composed of several hundred species of lichens, liverworts, and mosses, collected by Dr. Gray in the Appalachian region or secured by him from his exchanges which have become international in their scope.

Method of Handling Specimens Received

Accession

When a specimen or group of specimens is received at the herbarium it is first entered on an accession card, such as is shown in Fig. 1. If the collection is not to be filed immediately, it is stored away with the accession card, so that there can be no danger of it becoming mixed with another collection, or of losing the information relating to its acquisition.

Labels

Some plants reach the herbarium with a carefully written label ready to be attached to the mounted sheet. Others, however, are accompanied

WEST VIRGINIA UNIVERSITY
HERBARIUM
ACCESSION CARD

Collector . . . .
Locality of collection . . . .
Date of collection . . . .
Date of Accession . . . .
How secured . . . .
Number of specimens . . . .
Date filed . . . .

Fig. 1. Type of Accession Card used by the Herbarium of West Virginia University.

merely by field notes or by numbers which refer to a notebook and in this case it is necessary to prepare a label to be filed with the plant. Two forms of labels are in use here. The first, a card 4¼x2 inches, reads at the top "Flora of West Virginia" and sufficient space is provided to give the necessary collecting data (Fig. 2). This label is prepared on gummed paper, which requires only moistening when it is ready to be attached to the sheet of mounting paper. For plants collected

FLORA OF WEST VIRGINIA

Fig. 2. Type of label card used for Specimen Sheets.

outside the state a card of the same size is used reading "Herbarium of West Virginia University". When the specimen is to be sent to another institution, gummed labels are not used, since it is found that they are apt to stick to the specimens or to the papers in which the specimens are shipped. The label should show at least the following information: the scientific name of the plant, the place of its collection, the date of its collection, and the name of the collector. It is also quite convenient to give the name of the family to which the plant belongs, or at least an abbreviation of it, since this serves as a guide in filing.

Poisoning

Usually it is necessary to treat the plants in some manner to prevent attacks by insect pests. The three methods more commonly employed are: 1. dipping the specimens before mounting in an alcoholic solution of corrosive sublimate; 2. sprinkling napthalene powder on the specimens after mounting or keeping sticks or balls of napthalène in the cases; 3. fumigating the specimens in an air-tight box with carbon bisulphide or paradichlorbenzene.

Mounting

When a plant is to be filed, it is first mounted on heavy white paper, the usual size of the sheets being 11½x16½ inches. This paper is available in various grades but that adopted here is the type known as National Herbarium Mounting Paper, weighing 30 lbs. per ream. It is supplied by the Cambridge Botanical Supply Company.

The plants are attached to the sheets by one of two methods or the two methods may be used in combination. By the first method a sheet of plate glass, about 22 by 14 inches, is provided and covered by a mixture of glue and water. Dennison's No. 24 Glue has been found satisfactory by this Herbarium but there are many others that may be used. Every herbarium has adopted its own preparation, some preferring a home-made paste. The glue, mixed with an equal amount of water, is applied to the glass with a narrow paint brush. It is desirable to keep a tumbler of water at hand so that the brush, when not in use, may be kept in water. It has likewise been found advantageous to place under the glass a sheet of mounting paper of the size in use, so that one can always see that a sufficient area of glass is kept covered with glue and yet no great excess be applied. When all materials are in readiness the technician takes her place at the table with the glass directly in front of her. On the right is the stack of specimens to be mounted; on the left the paper to which they are to be attached. The specimen is raised gently and dropped upon the glue-covered glass. It is then manipulated in such a manner as to insure the under surface being well coated with glue. The next step consists of raising it carefully with tweezers or teasing needles and dropping it in the proper place on the mounting paper. Ordinarily, the specimen is so placed that it will occupy as nearly as possible the central part of the sheet, with the roots downward. Dr. E. D. Merrill, however, has called attention to the fact that, since the bulkiest portion of the plant is usually at the base, mounting in this fashion builds up stacks of sheets which soon slope so steeply toward the upper end that further stacking is prohibited. To correct this defect, Dr. Merrill advises mounting some of the specimens with the bulky portion at the upper end of the sheet, so that the stack of mounted specimens is always kept level on top.

When the plant parts are so narrow as to present but a small area to the glue, as in the case of a majority of the grasses, sedges, etc., no attempt is made to glue them to the sheets, but they are fastened on by means of narrow strips of tape. We have found Dennison's Mending Tape No. 3 to be quite satisfactory for the purpose, although it is necessary to trim it into narrower strips, since it is secured in ¾-inch widths. It is often advisable to go over the specimens which have been glued on the sheets and tie down with tape any parts that were not held by the glue

After the specimen has been fastened to the sheet, the label should be attached, preferably to the lower right hand corner, so that it can be easily seen. The official stamp of the herbarium is then affixed. This stamp is quite necessary, as it designates the ownership of the sheet. The labels have no value in this direction, since sheets bearing the label of this herbarium, through exchange have become scattered throughout dozens of the world's herbaria in both hemispheres. The design of this stamp is shown in Fig. 3.

WEST VIRGINIA
HERBARIUM
UNIVERSITY

Fig. 3. Stamp used for designating ownership of herbarium sheets.

Filing

After the glue is dry the sheets are ready for filing. Ordinarily they are held until a few hundred accumulate and are then placed in four stacks according to the alphabetical arrangement of the families. We have found the stacks are nearly equal if they are limited as follows: No. 1, A-C; No. 2, D-K; No. 3, L-Q; No. 4, R-Z. Stack No 1 is then taken and the families sorted into those under A, those under B, and those under C. The stack of A's is then sorted into the various families and the sheets are ready for distribution in the herbarium.

In some institutions, each specimen reaching the herbarium is given a number. To my mind there is no particular advantage in this, aside from the fact that the number of sheets in the herbarium is always known. In the Herbarium of West Virginia University each species is numbered and the name entered in a record book kept for that purpose. By this method it is always possible to tell the exact number of species in the herbarium, which is, to us, of greater interest than the total number of sheets.

There are various methods of filing pressed and mounted specimens of plants so that they may be available for ready reference. The simplest method is the alphabetic arrangement throughout. Many botanists, however, believe that related families, such as the Salicaceae, Betulaceae, etc., should be filed in the herbarium near each other. In some herbaria the phylogenetic arrangement is maintained throughout, even to genera and species. This, however, entails several difficulties. In the first place, filing has to be done by experts, in order that the specimens may be placed in their proper relative positions within the larger groups. With the appearance of new monographs it is always necessary to revise the old arrangement. Filing always requires a much longer time and it naturally follows that it takes longer for the student to find the sheet he is hunting. When sheets get out of place they can only be replaced by a specialist and not by the regular herbarium technician.

In order to avoid the various difficulties mentioned above, this Herbarium has adopted a kind of a compromise method, whereby the families are filed in a phylogenetic arrangement but genera and species in an alphabetic arrangement.

The arrangement of families is essentially that of Engler-Prantl, with a few variations to conform with the order followed by Gray's Manual. The following is a complete list of the families of Spermatophytes, showing their arrangement in this Herbarium:

1. Cycadaceae
2. Ginkgoaceae
3. Taxaceae
4. Pinaceae
5. Gnetaceae
6. Typhaceae
7. Pandanaceae
8. Sparganiaceae
9. Potamogetonaceae
10. Najadaceae
11. Aponogetonaceae
12. Juncaginaceae
13. Alismaceae
14. Butomaceae
15. Triuridaceae
16. Hydrocharitaceae
17. Gramineae
18. Cyperaceae
19. Palmae
20. Cyclanthaceae
21. Araceae
22. Lemnaceae
23. Flagellariaceae
24. Restionaceae
25. Centrolepidaceae
26. Eriocaulaceae
27. Xyridaceae
28. Mayacaceae
29. Rapateaceae
30. Commelinaceae
31. Bromeliaceae
32. Pontederiaceae
33. Philydraceae
34. Juncaceae
35. Stemonaceae
36. Liliaceae
37. Haemodoraceae
38. Dioscoreaceae
39. Velloziaceae
40. Taccaceae

41. Amaryllidaceae
42. Iridaceae
43. Musaceae
44. Zingiberaceae
45. Cannaceae
46. Marantaceae
47. Burmanniaceae
48. Orchidaceae
49. Saururaceae
50. Piperaceae
51. Chloranthaceae
52. Lacistemaceae
53. Casuarinaceae
54. Salicaceae
55. Myricaceae
56. Leitneriaceae
57. Juglandaceae
58. Betulaceae
59. Fagaceae
60. Urticaceae
61. Proteaceae
62. Santalaceae
63. Myzodendraceae
64. Opiliaceae
65. Loranthaceae
66. Grubbiaceae
67. Olacaceae
68. Balanophoraceae
69. Aristolochiaceae
70. Rafflesiaceae
71. Hydnoraceae
72. Polygonaceae
73. Chenopodiaceae
74. Amaranthaceae
75. Batidaceae
76. Cynocrambaceae
77. Basellaceae
78. Phytolaccaceae
79. Nyctaginaceae
80. Illecebraceae
81. Aizoaceae
82. Caryophyllaceae
83. Portulacaceae
84. Ceratophyllaceae
85. Nymphaeaceae
86. Lactoridaceae
87. Trochodendraceae
88. Ranunculaceae
89. Lardizabalaceae
90. Magnoliaceae
91. Calycanthaceae
92. Anonaceae
93. Menispermaceae
94. Berberidaceae
95. Myristicaceae
96. Gomortegaceae
97. Monimiaceae
98. Lauraceae
99. Hernandiaceae
100. Papaveraceae
101. Fumariaceae
102. Cruciferae
103. Tovariaceae
104. Capparidaceae
105. Resedaceae
106. Moringaceae
107. Sarraceniaceae
108. Nepenthaceae
109. Droseraceae
110. Podostemaceae
111. Hydrostachyaceae
112. Crassulaceae
113. Cephalotaceae
114. Saxifragaceae
115. Pittosporaceae
116. Brunelliaceae
117. Cunoniaceae
118. Myrothamnaceae
119. Bruniaceae
120. Hamamelidaceae
121. Platanaceae
122. Crossosomataceae
123. Rosaceae
124. Connaraceae
125. Leguminosae
126. Linaceae
127. Oxalidaceae
128. Geraniaceae

129. Tropaeolaceae
130. Humiriaceae
131. Erythroxylaceae
132. Zygophyllaceae
133. Cneoraceae
134. Rutaceae
135. Simarubaceae
136. Burseraceae
137. Meliaceae
138. Malpighiaceae
139. Trigoniaceae
140. Vochysiaceae
141. Tremandraceae
142. Polygalaceae
143. Dichapetalaceae
144. Euphorbiaceae
145. Callitrichaceae
146. Buxaceae
147. Coriaraceae
148. Empetraceae
149. Limnanthaceae
150. Anacardiaceae
151. Cyrillaceae
152. Pentaphylacaceae
153. Corynocarpaceae
154. Aquifoliaceae
155. Celastraceae
156. Hippocrateaceae
157. Stackhousiaceae
158. Staphyleaceae
159. Icacinaceae
160. Aceraceae
161. (Part of Sapindaceae)
162. Sapindaceae
163. Sabiaceae
164. Melianthaceae
165. Balsaminaceae
166. Rhamnaceae
167. Vitaceae
168. Elaeocarpaceae
169. Chlaenaceae
170. Gonystylaceae
171. Tiliaceae
172. Malvaceae
173. Triplochitonaceae
174. Bombacaceae
175. Sterculiaceae
176. Scytopetalaceae
177. Dilleniaceae
178. Eucryphiaceae
179. Ochnaceae
180. Caryocaraceae
181. Marcgraviaceae
182. Quiinaceae
183. Theaceae
184. Hypericaceae
185. Dipterocarpaceae
186. Elatinaceae
187. Frankeniaceae
188. Tamaricaceae
189. Fouquieriaceae
190. Cistaceae
191. Bixaceae
192. Cochlorspermaceae
193. Koeberliniaceae
194. Canellaceae
195. Violaceae
196. Flacourtiaceae
197. Stachyuraceae
198. Turneraceae
199. Malesherbiaceae
200. Passifloraceae
201. Achariaceae
202. Caricaceae
203. Loasaceae
204. Datiscaceae
205. Begoniaceae
206. Ancistrocladaceae
207. Cactaceae
208. Geissolomataceae
209. Penaeaceae
210. Oliniaceae
211. Thymelaeaceae
212. Elaeagnaceae
213. Lythraceae
214. Sonneratiaceae
215. Crypteroniaceae
216. Punicaceae

217. Lecythidaceae
218. Rhizophoraceae
219. Combretaceae
220. Myrtaceae
221. Melastomaceae
222. Onagraceae
223. Hydrocaryaceae
224. Haloragidaceae
225. Cynomoriaceae
226. Araliaceae
227. Umbelliferae
228. Cornaceae
229. (part of Ericaceae)
230. (part of Ericaceae)
231. Lennoaceae
232. Ericaceae
233. Epacridaceae
234. Diapensiaceae
235. Theophrastaceae
236. Myrsinaceae
237. Plumbaginaceae
238. Primulaceae
239. Sapotaceae
240. Ebenaceae
241. Styracaceae
242. Symplocaceae
243. Oleaceae
244. Salvadoraceae
245. Loganiaceae
246. Gentianaceae
247. Apocynaceae
248. Asclepiadaceae
249. Convolvulaceae
250. Polemoniaceae
251. Hydrophyllaceae
252. Boraginaceae
253. Verbenaceae
254. Labiatae
255. Nolanaceae
256. Solanaceae
257. Scrophulariaceae
258. Lentibulariaceae
259. Orobanchaceae
260. Bignoniaceae
261. Pedaliaceae
262. Martyniaceae
263. Gesneraceae
264. Columelliaceae
265. Globulariaceae
266. Acanthaceae
267. Myoporaceae
268. Phrymaceae
269. Plantaginaceae
270. Rubiaceae
271. Caprifoliaceae
272. Adoxaceae
273. Valerianaceae
274. Dipsacaceae
275. Cucurbitaceae
276. Campanulaceae
277. Lobeliaceae
278. Goodeniaceae
279. Stylidiaceae
280. Calyceraceae
281. Compositae

Two lists of the families, one in alphabetic arrangement, the other in numerical sequence, are posted in a conspicuous place in the herbarium.

Some attempt is made in this Herbarium to separate plants belonging to different geographical regions. Three groups are recognized: 1. (and this group includes about 90% of the plants in the herbarium) plants of the Appalachian region. These are filed in ordinary manila genus covers. Plants of western North America, of South America, and of the West Indies, etc., in effect, all of the western hemisphere not included under Group 1. These are filed in red genus covers. 3. Plants of the Old World, filed in canary yellow covers. This arrangement requires but a very small amount of extra supplies and it has the distinct advantage of segregating plants of foreign countries, so that it is not necessary to handle them when the student is concerned only with the local flora.

The specimen sheets are filed in the herbarium in genus covers made of a tough stock 16$\frac{5}{8}$x24 inches, folded 16$\frac{5}{8}$x12 inches. The folder used for Appalachian plants is that known as the Gray Herbarium Genus Cover, with a ream weight of 80 lbs. It is obtained from the Cambridge Botanical Supply Company. It is not furnished in colors, however, so the red and canary folders are made from a stock known as 3-ply Duro Folding Bristol, secured from the Central Ohio Paper Company. For ease of reference, the name of the genus is stamped at the lower left hand corner of the cover by means of a small labelling machine which is a part of the herbarium equipment (Fig. 4). Besides the name of the genus, there appears in this space the number and

18 CYP
CAREX

Fig. 4. Information printed on outside of genus covers.

abbreviation of the family to which the genus belongs. This is of advantage in replacing a genus cover in the exact place from which it was taken. In case all the specimens cannot be contained in a single genus cover, additional covers are used and on each is marked the alphabetic limits, as A to C, D to H, etc. These letters are written in pencil as they must be changed from time to time with the arrival of additional specimens. For some large genera as many as 10 genus covers are required to handle our specimens.

Within the genus covers, the various species are separated from each other by being enclosed in species covers, made of Falcon Manila 23x 16$\frac{1}{4}$ in., folded 16$\frac{1}{4}$x11$\frac{1}{2}$ in. These covers are cut from sheets 24x 36 inches, with a weight of 80 lbs. per thousand sheets. They are supplied by the Crescent Printing House, Morgantown, W. Va. This use of species covers permits the removal o fall the specimens (of one species) without disturbing the others. The initial letter of the genus and the full name of the species is written, in pencil, at the lower left hand corner of the cover.

After the species in each genus cover there are filed in an extra cover the specimens on hand belonging to that genus but whose specific identity is unknown. This cover is marked simply with the initial letter of the genus.

Summary

To summarize, then, the families are arranged in phylogenetic order, according to the Engler-Prantl sequence, No. 1 appearing first, followed by No. 2 and so on to No. 281. Within each family the genera are arranged in alphabetic order, as are also the species within each genus.

To Find A Specimen in the Herbarium

I shall now outline the very brief process required to locate a specimen in the herbarium. Suppose a student desires to see our sheets of Trillum grandiflorum. In case he knows this plant belongs to the Liliaceae he notes in the alphabetic list of the families the number of the Liliaceae and then opens the herbarium case containing that family. Having found the family he runs down through the genera, alphabetically arranged, until he comes to Trillium. He then pulls out that genus cover, being careful to leave a noticeable offset to indicate the place from which it was removed. Opening the folder the student sorts through the species covers, alphabetically arranged, until he comes to T. grandiflorum. If the name of the family to which the genus belongs is unknown to the student, he quickly determines it by reference to Willis' Dictionary of Flowering Plants and Ferns, a copy of which is kept in the Herbarium library.

Cryptogamic Herbarium

Emphasis has largely been placed on the vascular plants but a collection of non-vascular plants forms an important part of the herbarium. In the collection there are about 200 species of mosses, 125 species of liverworts, and 500 species of lichens. The collections of fungi, numbering several thousand sheets, is in the possession of the Plant Pathology Department. No systematic collection of algae is at present maintained at the University.

It is naturally impractical to attempt mounting lichens, mosses, etc., on a sheet as is done in case of the vascular plants. It has been found more satisfactory in this case to simply enclose them in packets of heavy paper, with the label pasted on the face. These packets are made by folding sheets of brown paper into packets 3x5 inches. They are then filed in boxes of the proper size, with index information on the outside of the box.

NOTE ON TERMITE DESTRUCTIVENESS IN NORTHERN WEST VIRGINIA

By

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Most termites or so-called 'white ants' are tropical but some few species are found in the temperate zone. These insects are social and in each colony there are found a number of distict castes—more than in the social bees, social wasps and ants.

Owing to the delicacy of their cuticula and the danger of it drying up if exposed to the air, termites build covered passage ways from their colony and nests to whatever places they wish to go. Termites in the temperate zones do not build exposed nests. The genus Reticulitermes found in this region burrows in the ground and extends its passage ways into the region to be infected. These termites are found often in the woodwork of buildings and will feed on any organic matter, eating out the interior, usually following the grain of the wood leaving a thin shell on the outside. It is the worker caste which causes the damage. Their presence is made known by the sudden collapse of the outer shell of wood remaining in the structure.

In December 1929 the maple flooring in the gymnasium at Bethany College began to show 'rotten places'. On investigation is was found that the destruction was due to termites. The places increased in number and the damage became so extensive that it was necessary to remove and replace some of the flooring as well as a flight of steps. The steps led down to a lower floor where the swimming pool is located and thus plenty of moisture was present at all times.

This December (1930) repairs and replacements had to be made to the building at a cost of approximately $150. The maple wood used in replacement was treated with commercial floor oil. Other areas of the floor were tested for termites by driving nails here and there but the above seemed to be the extent of the damage.

The apparent means of access of the termites to the upper floor of the building was through a series of covered passage ways up the concrete wall back of the steps mentioned above. These tubes were destroyed and the place of entrance to the building blocked.

Instances of termite destruction are fairly common in the tropics of the world and in the southern and Pacific coast region of the United States but seem to be of such rarity in the east and particularly West Virginia that this brief note is warranted.

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FOREST OR FARM LAND

By
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There is a large area in the Appalachian States where the most economical utilization of land resources is a puzzling problem. It is assumed that the land will be used for producing agricultural or forest products. During the last half century agriculture and forestry have been closely linked together in this region—forest activities have furnished both work for farm laborers and a market for surplus farm products. With the decline in forest areas the burden of carrying cut-over land and supporting social institutions is pressing heavily upon the owners.

Much of this area was settled more than a hundred years ago, and since that time the population has been slowly increasing. Farmers in the region have supplemented their incomes from lumbering activities, but now that the timber has mostly been cut and little work off the farms is afforded, farm incomes are low. With declining property values deficits in general county and school revenues are becoming common. These sections are no longer self-supporting. The question naturally arises as to whether the land should longer remain in farms or be restored to forests.

Webster and Nicholas counties are typical of a large area in West Virginia and the Appalachian States that may be classed as border land. In West Virginia a net income of $1200 has been set up as the minimum requirement for the support of an average family. If the farmer's net income can be expected to average more than $1200 the land may be called agricultural, if not it is submarginal for agricultural purposes. In Webster and Nicholas counties recently a detailed business analysis was made of 174 farms to determine the net income as an indication at least of agricultural possibilities. The economic and physical factors must be analyzed to determine possible utilization of the land.

A marked tendency exists on the part of the young people to leave these farms so that they are occupied largely by older persons. So long as the existing houses and outbuildings remain it is likely that some persons will continue to make their homes in these non-agricultural areas and that some farming will be carried on.

In West Virginia in 1900, the land in farms comprised 10,600,000 acres; in 1930 it totaled 8,840,444 acres; that is, the farm land decreased 1,760,000 acres or nearly 18 percent in thirty years. This indicates that more land has been cleared and used for agricultural purposes than is necessary under present conditions.

Our land utilization problem is one of finding how to derive the greatest net income from the land, or how to utilize any given area so that it will return the greatest continuous net income. It is certain that a great deal of land has been farmed that should have remained in forests. Large areas have been farmed in such a way that the soil fertility has been consumed by farming or erosion and the land has been turned back to forests.

In the mountainous districts some years ago lumbering operations offered a good opportunity for many men, interested in that type of work, to earn a good living. These men gradually acquired small tracts of land, planted gardens and truck patches, bought a few cows, and with the additional income from labor in the woods, were able to rear their families and maintain a fairly good standard of living. Gradually the timber was harvested, the saw-mills moved on, but the men felt that they had too much at stake to leave, consequently they stayed where they were and tried to eke out a living from their little farms. Some of the farmers later would have moved on but they found the expense prohibitive and so they remained. Now, as a result, one finds in our mountainous sections a large number of small farms, well isolated, with incomes insufficient to support the families properly. Farming no longer pays on much of the land, and many fields are being abandoned.

There is a considerable area over which farming and forestry will contend for another generation. The use to which such land will be put will depend upon the future trends in profits derived from growing farm and forest products.

If the farm income is not sufficient to support a satisfactory standard of living the land is sub-marginal for farming and will eventually be devoted to some non-agricultural use. If the net income now obtained by farmers in this region is more than adequate to support the standard of living which people of similar ability can secure in agricultural regions clearly super-marginal or in industrial employment, the land is super-marginal for farming and may be expected to remain in agricultural use so long as there are no substantial departures from the economic situation which now seems most likely to prevail in the region.

A detailed farm income analysis was made of each of 174 farms among the various soil types and topographic conformations in Webster and Nicholas counties. Four soil types comprising 95 percent of the area of the two counties were correlated with farm income and the factors which affect economy. These soil types were the Dekalb and Atkins silt loams in combination, Dekalb silt loam alone, Dekalb loam, and Dekalb stony silt loam.

The largest farm incomes were most frequently found on the combination of Atkins and Dekalb silt loams. The next largest incomes were found on the Dekalb loam, followed in order by the Dekalb silt loam and the Dekalb stony silt loam. The relationship between soil type and

income cannot, however, be attributed to the influence of soil type alone.
On the Dekalb and Atkins silt loams 22 out of a total of 24 farms yielded a return in excess of $1200. The Dekalb and Atkins silt loam combination, on the basis of its present performance and in view of its economic productivity, is included within the zone of agricultural use. Of the Dekalb silt loam farms only one out of 69 containing fewer than 100 acres returned an income of $1200. On the other hand, 18 of the 19 farms containing more than 100 acres yielded incomes in excess of $1200. It seems safe to say, therefore, that where the topography is such that tracts of Dekalb silt loam in excess of 100 acres can be brought under a single management, farming can be depended upon to continue indefinitely provided, however, that the land is sufficiently level to permit the use of farm machinery and that the land lies in contiguous areas large enough to support the necessary community institutions. Not one of the 25 Dekalb stony silt loam farms, regardless of size, returned $1200 net income.

In the rougher areas the cost of schools and roads per farm was considered excessive. These areas were not able to support schools and roads, except through state aid and heavy taxes on land.

In certain areas soil type and topography are favorable for agriculture but there is not enough good farm land to support communities of normal size. The cost of the roads and schools is so high per occupied farm that it would be cheaper for the county and state to buy the farms and eliminate the needs for schools and roads.

About 35 percent of all farms in the area were found on soils designated as non-agricultural. These soils occupy about 73 percent of the area. In contrast, 65 percent of the farms were found on soils designated as agricultural.

But little income may be expected by the farmers living on non-agricultural soils from the declining lumber and allied industries and the coal mines within the next few decades.

As an economic problem, regional planning in mountainous areas concerns itself with promoting that relationship between population and land resources which will allow a standard of living comparable with that enjoyed by people in the better farming regions. Mature timber, the resource at present giving the greatest employment to labor, seems certain to be practically exhausted within a relatively short time. Where the timber has been cut, large areas are already in economic decay. There are abandoned mill towns and a serious lack of local markets for farm products and a dearth of employment for surplus farm labor with which to supplement the small incomes of the farms.

To raise the standard of economic well-being there must be a movement of population from the area. Already the young people are leaving the two counties because of a lack of economic opportunity. The decline in lumbering will compel the migration of some of the laborers and their families. Most of the farmers on non-agricultural soils are making incomes inadequate to support their families even with considerable earnings from employment off the farm.

Increased production during the World War indicates that the present farms within the United States could increase their production 50 percent within a period of three years if the price of farm products warranted such an increase. Approximately 75,000,000 acres have been added to the area for food production since the War. With present trends of increased population, what is now sub-marginal land for crop and livestock production in the Appalachian region will not be needed for agricultural purposes during the present century. Such lands probably should be turned to the production of forest products.

THE CULTIVATION OF SLIME MOULDS FOR LABORATORY USE*

By

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The majority of instructors of Botany not having time to collect every type of organism used in class, are dependent on purchased preserved material which is only occasionally supplemented by fresh specimens brought in or grown in the laboratory. Some of the better known biological supply companies give excellent service and have a very complete stock, but in a good many cases, material for all stages in a life history is not available for laboratory study. This is especially true with regard to the Slime Moulds, in the life history of which there are four important stages or developments to be observed; the germination of the spores; the development of the swarm cells; the movements and feeding habits of the plasmodium and, the mature fructification. Of these, it is only the last stage that is ordinarily seen by the student, while the interesting and important feeding or animal phases are given minor consideration. Although spores capable of germination, and plasmodium, are not to be obtained by purchase, so far as can be ascertained, recent developments in the technique of growing Slime Moulds have made it possible for the instructor to demonstrate to his classes all of the above mentioned stages in the life history.

For spore germination, nearly any species of the Physaraceae and Didymiaceae is satisfactory but the best results have been obtained with **Reticularia lycoperdon,** a species found to be common on decayed trees and stumps in the spring, in eastern United States, and widely distributed throughout the temperate regions (4). The spores of this species give rise to swarm cells in from ten to fifteen minutes and a fructification is of sufficient size to provide material for germination a number of years for hundreds of students. **Fuligo, Leocarpus,** and **Didymium** are of equal value except that germination does not occur so soon after wetting the spores. Germination will take place in distilled, spring, or tap water, providing that the specimens have been allowed to ripen naturally (2) and are not too old. A recent worker (6) has found Slime Mould spores germinating after thirty years in the herbarium but this apparently is unusual and the majority of spores do not give satisfactory results after they have been kept for more than four or five years. Syracuse glasses are most convenient receptacles for the study of spore germination since they may be placed directly on the stage of the micro-

*Contribution No. 2 from the Botany Department of Marshall College.

scope, a few dozen spores placed in the bottom of the dish, a little water added, and the culture is ready for observation.

The behavior of the swarm cells is observed in the same dishes and their feeding habits may be watched by pipetting bacteria or small fungous spores (1) into the culture. Small plasmodia may develop after a fusion of the swarm cells and occasionally the process of fusion may be observed, but usually, due to some unfavorable condition, the swarm cells form cysts before this stage is reached in the dishes.

In studying the plasmodium stage, best results have been obtained by collecting well developed plasmodia in the field. They may be found at nearly any season of the year when the temperature is above freezing and are most common in damp places as under the loose bark of decaying logs. If the weather is too cold and the plasmodia have formed sclerotia, these with part of the substratum may be brought into the laboratory where the active stage will be resumed if the material is left in a damp chamber away from the sunlight.

The writer, by adding fresh bits of substratum as the old became covered by waste material of the plasmodium, has kept the latter alive for as long as eight months while others report even better results (5). It is possible to transfer parts of plasmodia to agar plates where they may be kept alive for a sufficient length of time for convenient study.

Slightly acidified corn meal agar is good for the purpose, oatmeal agar and mushroom decoction agar have also given excellent results (3), while others have used carrot gelatin, Knop's agar, bean agar and a host of other media, with varying degrees of success. In preparing corn meal agar, an infusion is made by adding a liter of boiling water to fifty grams of cornmeal and filtering after it cools. In this is dissolved one and one half per cent of agar and the mixture is autoclaved at fifteen pounds pressure for fifteen minutes. A few spores of **Didymium nigripes** sown on this agar will form plasmodia and fruit in about three weeks unless the culture is badly contaminated with bacteria. Sporangia of **Arcyria denudata** and **Physarella oblonga** also have been obtained in this manner in a few cases and the sown spores of **Fuligo septica** have developed plasmodia, but **Didymium nigripes** gives by far the best results.

It may be expected with further investigation that the cultural requirements of many more species of Slime Moulds will be found and it will be a comparatively simple matter to follow the entire development from spore to sporangium, but since the environmental requirements differ to some extent for each species, probably no one method of procedure will suffice. Sufficient is known at present however, so that any instructor with a little time and effort can demonstrate to his classes all of the stages in a life history.

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THE UNUSUAL 1930 DROUGHT WITH THE ACCOMPANYING STREAM POLLUTION PROBLEMS

By
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The 1930 drought, the effects of which we are still feeling, serves to bring into distinct focus many of the public water supply deficiencies in our state. Pollution matters hitherto hardly noticeable were raised to the n'th power and the effect upon public health and industry of the water in the streams which became heavily polluted with domestic sewage and industrial wastes, was dramatically set forth and became front page news for many days and months.

The phenomenal rainfall deficiency for the State of West Virginia—only 59 percent of the normal—made lay people everywhere recognize that the public health was about to be effected and they could see clearly that the pollution of the streams in many instances had progressed too far and remedial action must be taken.

The 1925 drought was responsible for a marked typhoid fever increase in the death rate from this disease in West Virginia, raising to 20.2 per 100,000 persons. By 1929 this had been brought back to 11.4 per 100,000. With the onset of the drought it was anticipated that another big jump in the death rate would take place. However, thanks to the great care which water purification plant operators exercised and to the chlorine disinfection plants operating regularly to protect the smaller water supplies throughout the state, the typhoid death rate increased only to 12.1 per 100,000; that is, less than 1 percent, despite the use of many emergency water supplies.

Since the public water supplies in all parts of the state were profoundly effected, brief mention will be made of certain typical defects.

Fairmont: Fairmont, which has a modern water purification plant, experienced water supply troubles not of a bacterial nature but rather from the very high concentration of minerals and mineral acids in the water. It was estimated by one large power plant using the river water that their loss would total nearly $50,000 due to their inability to prepare the water properly for use in the boilers. The Monongahela River went from a hardness of about 40 P. P. M. to nearly 600 P. P. M. The appearance of the river water was thick, greenish and oily-looking. On some occasions is was necessary to add as high as two tons of lime a day to two million gallons at the water purification plant to neutralize the mineral acidity. So heavy did the floc become in the sedimentation basins that the precipitated mineral matters had to be cleaned out weekly toward the end of the drought.

Moundsville: Moundsville is an Ohio River city deriving its water from wells in the sand bars in the river. No taste had ever before been noted in the water. However, so intense became the concentration of chemicals in the Ohio River pools back of the locks and dams that this water impregnated the sands coming through into the ground water to the city system causing nauseating flavors to appear which caused a loud popular outcry. It took emergency action by the State Health Department to promptly provide an ammonia apparatus which, when placed in operation overcame the taste troubles immediately. Ohio River cities in both West Virginia and Ohio were detrimentally affected when the river water, which had lain in these quiet pools for nine months, finally began to move down stream in December. Cincinnati, Ohio; Louisville, Ky.; Huntington, W. Va., and Ashland, Ky., all using the Ohio River as a source of water supply, bore testimony as to the intensity of the taste troubles and also to a mysterious intestinal disorder which made its appearance in January.

Charleston: The capital city of West Virginia was perhaps more seriously affected than any other for the pollution of the Elk River pool at the water works intake was so gross that all methods of water purifications failed to produce a palatable drcinking water. Nauseating odors and tastes prevailed for several months resulting in a popular outcry against the water supply. However, when the source of the city water supply—Elk River—dried up the sewage and grossly polluted Kanawha River backed up stream, bringing the worst conditions ever known in West Virginia water supply history. Nevertheless, aeration put back some of the necessary oxygen, prechlorination killed the disease-producing bacteria and activated carbon treatment absorbed some of the objectionable flavors. No serious illness developed in Charleston. Remedial measures are now under way to provide a permanent new water intake away from the polluted zone in the Elk River pool.

Some of the Signs of A New Day: I would call to your attention some of the developments in our largest cities and in our neighboring states to show the trend of the times with respect to stream pollution control.

I will then speak briefly of the work and progress of the State Water Commission in West Virginia. Whether this is a reasonable and practical way to deal with stream pollution matters will be defintely proven during the next few years.

Let us look first at our two large cities—New York and Chicago. Abel Wolman comments editorially in the March, 1931, issue of Municipal Sanitation on "A Milestone in Sewage Disposal". He brings out that after seventeen long years of study New York City, under its newly created Department of Sanitation, opened bids about two weeks ago on the first project costing approximately seven million dollars, of the ultimately thirty million dollar sewage disposal development on Ward's Island. The Department of Sanitation's comprehensive plan for disposal of New York City's sewage calls for 33 plants at an estimated cost of $377,000,000. Not a small item to improve the sanitary conditions of New York harbor which has become almost intolerable.

Our second city in the country—Chicago—which for many years withdrew increasing amounts of water from Lake Michigan in order to dilute the sewage below the nuisance point before she pumped it into the Chicago drainage canal, is now under orders of the U. S. War Department to complete her sewage disposal program within certain definite time limits, thus reducing the amount of dilution water necessary to be withdrawn from Lake Michigan. Both the North Side sewage disposal plant and the new Ward's Island plant will operate on the activated sludge process principle which has been developed in the last decade. This North Side sewerage plant treats upwards of a hundred millions of gallons of sewage daily but it will take second place in magnitude when the Ward's Island plant, designed to purify 180,000,000 gallons of sewage daily, is completed.

It is being frankly recognized by all of our large cities that sewage disposal is necessary in our modern urban life with a concentration of large population in the cities. Our neighboring state of Ohio has in the last few years completed modern sewage treatment plants in Cleveland, Dayton and Canton and is now about to spend six million dollars for a modern sewage disposal plant at Columbus. In West Virginia there are but few sewage disposal plants at the present time but these few, some of them located at Martinsburg, White Sulphur Springs, Weston State Hospital and Jackson's Mill, are being properly operated. The cities in the future must make definite provision for disposal of their sewage and it is better to undertake these improvements gradually than to wait until an emergency comes and then thrust a large tax suddenly upon the community.

Phenol Waste Control On the Ohio River Watershed: It may be of interest to point out briefly a recent progressive step in stream pollution control over an entire river system. This is probably the only instance of the sort in this country and it indicates the way in which a cooperative project has been worked out to meet a common trade waste problem when the necessity arose of serving the public water supplies located in several states in the Ohio River Basin. In 1924 the State Health Departments of Ohio, Pennsylvania and West Virginia sent their representatives to Pittsburgh and there formulated and adopted a compact looking toward stream conservation since the public water supplies were about to be irreparably damaged. For instance, in West Virginia tarry wastes containing phenol at Fairmont were being discharged into the Monongahela River and at Follansbee and Weirton were being discharged into the Ohio River. Likewise in Pennsylvania and Ohio plants were discharging similar wastes to tributaries of the Ohio and the total affect was that the public water supplies in Wheeling and other large Ohio River cities such as Cincinnati and Louisville were being detrimentally affected and federal legislation was being proposed in Congress The three states—Pennsylvania, Ohio and West Virginia in 1924, met with the representatives of the steel industry and set forth the new doctrine —that this industry must satisfactorily dispose of its taste-producing wastes from by-product coke plants and that the states would agree to a uniform policy to be applied equally and in the same manner in each state. The interstate stream conservation agreement which was signed in 1924 was finally accepted by eleven State Health Departments of as many states in the Ohio River Basin. This plan has been responsible for 100 percent of the plants caring for their phenol wastes. During the fall of 1930 the Weirton Steel Company and the Wheeling Steel Corporation completed their phenol recovery plants and they have been in satisfactory operation ever since. Another forward step has been taken in that a prompt notification system to cover accidental spills of these wastes has been adopted and is now in operation up and down the river.

The State Water Commission, through an act of the West Virginia Legislature two years ago, was created. It now serves as a clearing house to which organizations interested in conservation of wild life, individuals, cities and corporations may bring their complaints with reference to stream pollution matters and have them impartially investigated. Three State Commissions having to do with this control of water,—the heads of the Health, Fish and Game, and Public Service Departments of West Virginia,— have been consolidated to hear complaints, render decisions and issue corrective orders. A graduate chemical engineer is in charge of field work. With his training he is able to visualize the public health and sanitation features and to get the industrial viewpoint and is in a better position to make the necessary adjustments in the field and recommend remedial measures to the Commission.

Different Types of Work Before Water Commission

Sewage Disposal: During the last two years many questions of faulty sewage disposal have come to the attention of the Water Commission The pollution of the West Fork River at Weston and Clarksburg is perhaps the most glaring example of misuse of a stream and sewage disposal plants are necessary at both these cities. The Commission should require the gradual building of these disposal plants, as well as at several other places in West Virginia where detrimental pollution by sewage wastes has gone on too long.

Tannery Wastes Disposal: In the short time the Water Commission has been at work, major improvements in tannery wastes disposal have resulted. The Wild Life League in Kanawha County were responsible for starting better tannery wastes disposal at Richwood several years ago, but at Parsons, Elkins, and Durbin new tannery treatment plants were completed last year, through Chemical Engineer Herndon's work with the State Water Commission.

Wastes from Coal Mining: One of West Virginia's biggest problems is disposal of acid coal mine drainage and the black wastes from coal laundries. The Water Commission was able to serve as the clearing house for working out troubles on Coal River in Boone County where a new coal laundry was placed in operation in 1929 by a large industrial company.

The Cheat River and Lake Lynn in 1929 was the subject of study by both the State Water Commission and the Engineering School at West Virginia University. Only a part of the recommendations of this survey have been carried out but some connective measures should be applied during 1931 and 1932.

The West Fork River, a badly polluted stream in central West Virginia not only from sewage but also with acid mine drainage, has been studied by the Water Commission, and some remedial measures should be started. The City of Weston, the State Hospital and the water company are now planning to work jointly to relieve the pollution on the river pool from which **city** and **state** takes water for the public water supply.

West Virginia is in many respects an industrial state. It is growing more so. Is it not timely to set up machinery to check up on the increasing pollution of the streams before it is too late? Wisconsin, Virginia, New York, Pennsylvania, Illinois, Ohio, Michigan, Maryland, Iowa, California, Indiana, Connecticut are doing it and West Virginia should not lag behind. In many states it is done by the State Health Department alone, in others a joint program like the Connecticut, Wisconsin and West Virginia plan is going forward. Wherever it is the State Health organization is the predominating force, it being recognized by the courts that public health must be given first consideration. Our streams must be kept fit for use for public water supplies. Industry should recognize the economic importance of clean streams and cooperate so that she can get an ample amount of reasonably clean water of proper temperature for industrial purposes.

Then finally and of great importance the streams are a major asset to attract tourists to the beautiful mountain scenery. Economically speaking, this means money and it will pay the state to conserve beauty. This stream might be in West Virginia.

"A Stream"

A singer of a stream I'd be
As Kilmer sang about a tree,
A stream that has its source on high
Mid snow capped peaks that reach the sky,
That dashes down its rocky way,
And fills the earth and air with spray.
Or comes from a secluded glen
And flows through forest, field and fen
And in whose waters fish can hide,
That mirrors back the morning sun
And cools the air when day is done.
How sad it is that—so it seems,
We must pollute our glorious streams.

Joseph S. Goodman.

DEVELOPMENT OF CHLORINE AND CHLORINE PRODUCTS IN SOUTHERN WEST VIRGINIA

By

M. G. GEIGER,

Resident Manager, Westvaco Chlorine Products, Inc. Charleston.

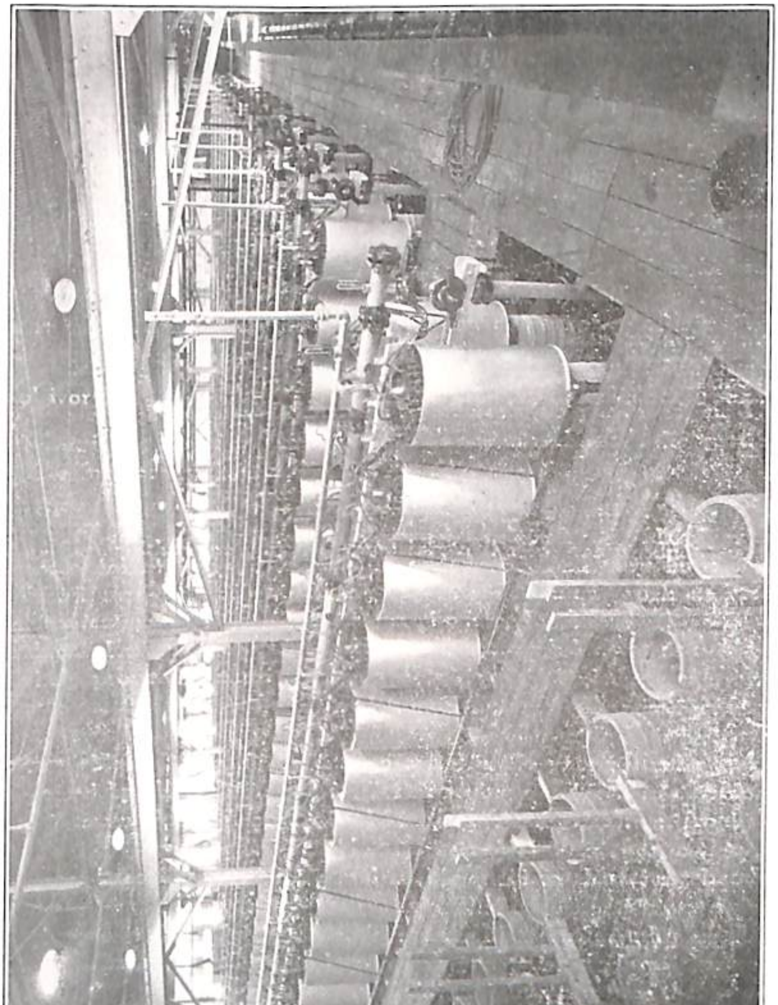
Let us briefly trace the development of the raw materials used in the manufacture of chlorine and caustic soda electrically, in Southern West Virginia. It is necessary of course, that cheap sources of fuel and in large quantities be ready at hand as well as a plentious supply of salt in some form, preferably as a nomial weak solution of salt water or brine. All of these materials are close at hand. In fact with the present equipment of a modern plant practically no raw materials but fuel are required which is in abundance. Thus, we will endeavor to describe very rapidly the development over a period of a century and a quarter of the raw materials.

In the year of 1808 a forward step was taken in the production of salt in the Kanawha Valley. A kettle furnace was put into operation and the price of salt was reduced to the unheard of price of $80.00 per ton. Many rapidly began to dig wells and probably 30 wells were dug varying from 50 to 100 feet.

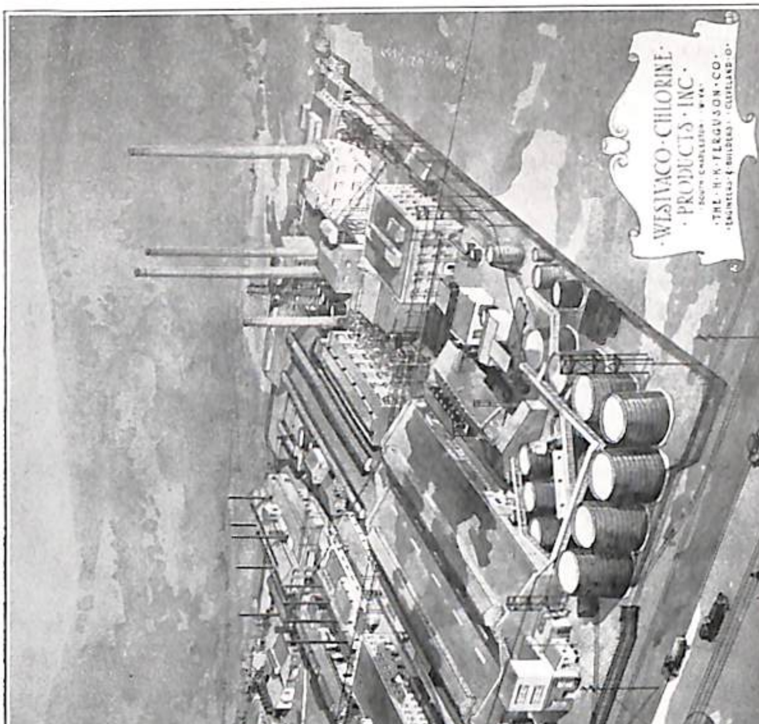
Later in this year, perhaps, one of the greatest development for this valley was to take place. Until now the fuel used for the evaporation consisted entirely of wood. All the lands were stripped of timber to give the necessary fuel supply. One David Ruffner found coal. A fuel that was to make West Virginia an important industrial state nearly 100 years later. While it is very simple today to burn this fuel many failures were the results of these early pioneers. It was, however, firmly established as the economical fuel and remained so until the discovery of oil and gas.

Until this period the tubing in the wells consisted of hollow logs. A local tinner conceived the idea of making tin pipe and solderng the joints as screw fittings were as yet not used. This soon gave way to copper and finally iron and screwed fittings. Another interesting feature employed at this period and which the writer has seen used in the last few years in casing off fresh water in salt wells was the use of flax seed bags. Bags of the same diameter of the tubing were made of calf skin and filled with flax seed which were placed in the wells at the proper places to shut off the fresh water when they swelled.

The brine was simply lifted from the wells by use of a bucket, a swape, and a man until a mechanical pump of a fashion was developed However, the steam engine displaced all of these very quickly. In 1831 William Morris invented a tool which gave a new impetus to this industry. His invention is still used today and is known as the slips or pins in drilling. This was never patented. It was the beginning of deep well boring and wells 500, 1000, 1500 and 2000 feet were drilled. Up until the present day it was considered futile to drill further than this as brines were not found at these depths. Recently wells have been drilled to 5500 feet and one is in progress for a depth of 8500 feet. Brine of an



Diagonal View of New Cell Room Containing 1120 Vorce Cells.



View of Plant of the Westvaco Chlorine Products Inc. South Charleston, W. Va.

unusual quality is expected by the geologists. Well drillers for all types of drilling were trained here for work in later years.

From the time of Washington's surveys a famous spot called Burning Springs was known. Here if a match were struck the gas off the springs water would burn. Other than this little attention was placed on the fact until in 1841 in drilling natural gas was struck. Gas and salt water spouted forth. It was collected and gas became an important fuel along with coal. Many amusing stories are told in connection with this. In fact for many years its value was not known and in the east it was only a curiosity. Of course, today its value is known to all.

Thus, we have three of West Virginia's natural resources found very closely together. The various phases of development one is dependent on the other. Aside from its use in Southern West Virginia as Commercial salt no stress was laid to the commercial value of its component parts.

Early in the nineteen hundreds two eastern manufacturers were in need of chlorine and caustic soda. By special arrangement after an intensive survey of the United States, it was decided to locate near Charleston West Virginia. The brines in this territory were well suited for the manufacture of chlorine and caustic soda by the electrochemical process.

It is probably in order to give at this point a discussion of the early attempts to manufacture profitably chlorine by electrolytic methods. Until 1895 no material was available to use as an anode. Carbon could be used but its life was too short. Graphite was now being produced with the result that Allen, Moore and several others about whom we hear of later were all attempting to produce an electrolytic caustic and chlorine cell at Rumford Falls, Maine.

Four distinct lines of development were pursued in attempting to find the proper method to separate the products of decomposition.

1. By the insertion of a permeable diaphragm between the anode and cathode.

2. By employing a mercury cathode.

3. By placing cathode under anode and depending on stratification of the electrolyte which occurs due to different densities of the brine solution, and caustic solution surrounding the immersed cathode.

4. By the use of a fused salt electrolyte and a molten lead cathode.

Of all these types only the mercury cathode and the diaphragm types have survived and only the diaphragm type will be considered here because of the fact that no mercury installations are made in this country at this time due to the high price of mercury.

Diaphragm cells must be classed into two groups. First, the submerged diaphragm and cathode and secondly the unsubmerged or where the electrolyte comes in contact with only the face of the cathode. Under the unsubmerged type belong two classes, the permeable diaphragm and the unpermeable. The Vorce cell is of the permeable class and the Hargreaves-Bird of the unpermeable. We will only consider the permeable type as in the unpermeable only sodium carbonate is produced.

All permeable diaphragms for both the submerged and unsubmerged group of cells use asbestos paper which is so used in them so as to make two separate and distinct compartments, the anode and the cathode. Several difficulties present themselves in the submerged type such as an intermingling of the electrolyte and the caustic produced. This is eliminated in the partially unsubmerged method. Migration of the caustic ions is greatly reduced, thus cutting down the action on the graphite and prolonging its life. The cathode liquor is withdrawn as formed so there is no building up in the cathode. The diaphragm is kept moist by the evaporation of water from the electrolyte. This keeps the diaphragm in very good condition.

By the use of some slides, we will now show you the largest development of this type of cell in Southern West Virginia. In fact this is the largest operating chlorine plant in the world.

You are perhaps now interested wherein all of the chlorine produced is used as it is well known where the major lot of the caustic is consumed.

When liquefied chlorine is shipped and used in the purification of water and the treatment of sewage. Many chlorides of the metals are made and one in particular iron chloride is used in the treatment of sewage wastes by large cities. Many others such as antimony trichloride are used as catalyzers. It is used in making sulphur mono-chloride for rubber curing or vulcanization. The sulphur dichloride is used in one step of the artificial silk process as well as a step in the making of aspirin. It finds its use as aluminum chloride in practically all Friedel-Craft reactions.

As the main component of carbon tetrachloride, it is finding a large use as an oil solvent, dry cleaning fluid and fire extinguisher. With certain other chemicals this field is expanding with tremedous impetus.

As the component parts of natural gas are being separated and chlorinated a new field has opened up and we get products for paint and furniture, automobile and aeroplane antifreeze, new solvents, thinners and new substitutes for glass and china that will not break when dropped on the floor.

New chlorination methods for the separation of metals in the mining industry are being developed. Now the best anti-knock gasoline depends on bromine for its properties which is obtained by the use of chlorine in this country.

Thus, we have only scratched the surface and undoubtedly our research units will bring forth many new developments in the future.

BARIUM, BARIUM MINERALS AND BARIUM CHEMICALS

By
RANDOLPH C. SPECHT,
Chief Chemist, Barium Reduction Corporation, Charleston.

Barium At. Wt. 137.37, At. No. 56, M. P. 850° C, B. P. 1140°C, Sp. Gr. 3.5 at 20° C.

The element barium gets its name from the Greek word, Barote, meaning heavy. It is a metallic element, soft and silvery white like lead; it belongs to the alkaline earth group resembling calcium chemically and is found only in combination with other elements, chiefly in heavy spar or barytes (sulfate) and witherite (carbonate). The metal is prepared from the molten chloride by electrolysis and was discovered by Sir Humphrey Davy in 1808.

The commercial use of Barium as a metal has been limited until recent years but it has now found use in the manufacture of special types of sound transmission tubes where it is used as a deoxidizer after evacuation.

The most important compounds of barium are the sulfate, carbonate, peroxide, chloride, nitrate and chlorate.

Barytes, Sp. Gr. 4.5, Hardness 3

The mineral barytes, called barite, heavy spar, cawk or tiff, is the chief source of barium in the United States. It contains, when pure, 65.7 percent BaO and 24.3 percent SO_3. Much of the crude barytes ore mined contains impurities, notably sulphate or carbonate of lime, silica, alumina, calcium, fluoride, strontium sulfate and iron oxide. It may contain sulfide ores such as galena, chalcopyrite, sphalerite and pyrite.

Barytes is a heavy, white, opaque or translucent mineral with a specific gravity of about 4.5. It varies in hardness, the average being about 3. It is frequently found in well developed crystals, which vary considerably in their appearance and habit. They possess a perfect cleavage parallel to the base, and perpendicular to the base are two prismatic clevages parallel to the faces of the primitive rhombic prism.

In the trade two types of crude barytes are recognized, the "hard crystalline" variety and the "soft" variety. The hard variety has a glossy appearance, whereas the soft has a milky one. The soft variety can be crumbled in the hand but the hard variety cannot. The soft type is preferred by grinders because, on account of its texture it produces the highest grade of ground barytes and because the impurities can usually be removed by an acid wash. This grade causes less wear on the gears and it roasts better than the hard variety. The hard variety can be used to a better advantage in the barium chemical and lithopone industries than in the manufacture of ground barytes.

Mode of Occurence

Barytes most commonly is found in ore veins formed at shallow depths, associated with weathered limestone and dolomite. In the eastern and central parts of the United States it is found near the surface in comparatively small lumps but in the western deposits it is found in veins.

Geographic Distribution

Until 1914 about 65% of the domestic output of the ore was mined in Missouri but after that time, due to the cessatinn of imports of chemicals from Germany the output shifted to Georgia. Now the majority of ore is mined in the states of Georgia, Tennessee and Virginia due to the fact that it can be removed from the deposit by means of steam shovels, and that there are lower freight rates to the present markets.

Uses Barytes

Barytes as mined in the southern fields is washed and jigged to remove earthly materials and sold as such. It may be ground and washed further with sulphuric acid for bleaching for special trade requiring a white product, such as for fillers in heavy paper and in white paints. Otherwise it is ground and sold as "off color" or "unbleached" for certain varities of paint, heavy paper, linoleum, rubber goods and artificial ivory or for other purposes where a heavy white filler is needed. It is also used in artificial marbles, asbestos products colors (lakes), explosives, fireworks, insulating (x-ray) materials, phonograph records, printer's ink, sealing wax, cloth textiles, soap, tiles and ceramics and in titanium pigments. The precipitated barium sulfate or blanc fixe is rapidly replacing the ground barytes in most of the products mentioned.

History

In 1779 Guyton de Morveau gave the name of barote to the mineral known as heavy spar. It was later changed by Lavoisier to Baryta. Because of its inertness it was first used as an adulterant and as a result, in several countries it is forbidden to be used in food products and some laws yet prohibit its use in other products. But such laws that are not applicable to present use are and have been more or less repealed, modified or disregarded. Later the product was used in the industry, most notably in the manufacture of lithopone and now has come to be used in the manufacture of barium chemicals.

The most important producers of barite today are United States, Germany and England. Because of the nature of deposits Germany was at first the source of world supply, however since 1914 there has been a rapid increase in the domestic production.

Mining

The ore as mined in California from the veins requires no washing but that from the southern fields must be washed free of clay and treated more or less according to the requirement of the consumer.

World's Production

The United States started production of barytes in 1882. The output increased very little until 1915 when the industry throughout the world began to increase. The following table shows the production in the United States from 1882 to 1928 and the world's production since 1908.

PRODUCTION BARYTES*
IN
SHORT TONS

YEAR	DOMESTIC	WORLD PRODUCTION
1882	22,400	
1883	30,240	
1884	28,000	
1885	16,800	
1886	11,200	
1887	16,800	
1888	22,300	
1889	21,470	
1890	21,911	
1891	31,069	
1892	32,108	
1893	28,970	
1894	23,335	
1895	21,529	
1896	17,068	
1897	26,042	
1898	31,306	
1899	41,894	
1900	67,680	
1901	49,070	
1902	61,668	
1903	50,397	
1904	65,727	
1905	48,235	
1906	50,231	
1907	89,621	
1908	38,527	178,129
1909	61,945	213,928

*X-I note.

YEAR	DOMESTIC	WORLD PRODUCTION
1910	42,975	170,131
1911	38,445	187,960
1912	37,478	202,969
1913	45,298	233,383
1914	52,747	145,862
1915	108,547	211,683
1916	221,952	359,058
1917	206,888	328,579
1918	255,368	262,805
1919	209,330	399,861
1920	228,113	499,048
1921	66,369	267,120
1922	155,040	456,229
1923	214,183	487,880
1924	196,332	536,977
1925	228,063	591,000
1926	237,875	580,718
1927	254,265	559,940
1928	269,544	272,406

From a study of production of various countries it will be seen that the United States is now the leading source of the supply of barytes. Since the world war the domestic production has been 40% of the total, with Germany next with 32%. Great Britian and Italy are the only other large producers of barium minerals with 10% and 6% of the total production respectively.

Industry Uses

The crude barytes is used by three principal industries, namely; lithopone, ground barytes and barium chemicals. The following table shows the percentage used by each of the three groups.

PER CENT BARYTES USED IN INDUSTRY
IN THE UNITED STATES*

YEAR	GROUND BARYTES	LITHOPONE	BARIUM CHEMICALS
1915	50%	41%	9%
1916	41	39	20
1917	31	44	25
1918	34	46	20
1919	32	52	16
1920	35	49	16
1921	28	61	11

*X-I note.

YEAR	GROUND BARYTES	LITHOPONE	BARIUM CHEMICALS
1922	29	56	15
1923	23	61	16
1924	20	64	16
1925	24	63	13
1926	24	64	12
1927	22	68	10
1928	22	63	15

Ground Barytes

In the ground barytes industry it has been estimated that from 50 to 70 percent of the production is consumed by the paper and rubber industries. The principal use is as a filler and because it is chemically inert, white and heavy it is admirably fitted for this purpose.

As a rubber filler it is only used in soft rubber where strength and resistance to abrasion is NOT required. In paper it is used where a high finish heavy paper is needed, such as Bristol Board, playing cards and plate paper. It is also used in certain grades of cheap paints and as a loader and base for lake colors. Other minor uses are in X-ray insulation, seals for oil and gas well drilling and in the manufacture of artificial ivory.

Lithopone

In the lithopone industry the barytes is reduced with coal to the sulfide and is then purified and treated with zinc sulfate by a patented process to form the lithopone. Recent developments have made a so-called Super-lithopone which is superior to the former product.

Manufacture Lithopone

The raw materials used in the manufacture of lithopone are ground barytes, carbon in the form of coal or coke or petroleum breeze, zinc, sulfuric acid and minor quantities of ferric oxide, alumina, lime and mangnesia. As in the barium chemical industry a large amount of clean soft water is used in washing the product.

The manufacture requires the preliminary production of solutions of barium sulfide and zinc sulfate.

For the production of barium sulfide the crude barytes is crushed and ground and mixed with crushed coal or coke. The different manufacturers use various proportions but usually it is four parts of the ore and one part of coal. The mixture is then dumped into a revolving furnace and roasted for approximately four hours. The resultant ash contains from 65% to 80% barium sulfide.

The ash is then dumped from the furnace and transferred to a lixiviation tank where it is "lixed" with hot water. The supernated liquor is then drawn off and allowed to settle before it is used.

The zinc solution is prepared by treating the zinc material in the form of ash, scrap, skimmings or zinc slab, with sulfuric acid in special solution tanks. The resultant zinc sulfate liquor is then treated in purification tanks to remove even traces of cobalt, copper, manganese, iron and cadium, which would form colored products on treatment with barium sulfide. Some of the compounds thus removed are recovered and placed on the market. The purification of the sulfate liquor is one of the most closely guarded and careful steps in the manufacture.

After the purification the sulfate is filtered and the filtrate is then ready for reaction with the barium sulfide liquor.

Definite quantities of the sulfate and sulfide liquors are then run into a precipitation or reaction tank. From there the precipitated material is taken to filters and is then dried. After the crude lithopone is dried it is calcined at about 500 degrees Centigrade and then quenched in water. After the quenching the material is ground into a pulp and washed with a very good water, filtered, dried and then disintergrated.

Composition Lithopono

Until recently the composition of lithopone was approximately 1-3% zinc oxide; 26-28% zinc sulfate and 70% barium sulfate. With recent developments the zinc sulfide content has been raised to 50% or better, so some of the manufacturers claim. This produces a so-called superlithopone which gives a much higher covering power than the lower content zinc sulfide.

Lithopone is used where the trade requires a pigment that is brilliant white, with an extremely fine texture and one that at the same time must have strength and hiding power. It cannot be excelled for body, duribility, hardness, fineness and ease of application. It is used most extensively as a white pigment in flat and enamel wall paints for interior use. It is also used in a large quantity as a filler in rubber goods, paper, lineoleum, oilcloth and in window shade cloth. Lithopone is not used extensively as an outside paint because of the fact that it darkens on exposure to sunlight or excessive moisture. It usually becomes white again, however upon drying out and several companies in recent years have placed a lithopone on the market that is said to withstand exposure to sunlight and moisture.

The following table shows the amount of lithopone, in short tons, used in the United States from 1913 to 1928.

LITHOPONE USED IN THE UNITED STATES*

YEAR	DOMESTIC	IMPORTED
1913	29,685	2,363
1914	32,819	3,990
1915	46,494	2,044
1916	51,291	2,341
1917	63,713	224
1918	62,403	. . .
1919	78,365	739
1920	89,373	1,714
1921	55,016	5,247
1922	83,360	10,763
1923	98,199	10,440
1924	109,469	6,830
1925	145,019	6,330
1926	159,931	8,686
1927	176,994	7,979
1928	200,468	9,885

Barium Chemicals

The most important of the barium chemicals that have important industrial uses in the United States are as follows: Blanc fixe, or precipitated barium sulfate, barium carbonate, chloride, nitrate, hydroxide and dioxide.

Both barytes and witherite are used as a raw material for barium chemicals. The amount of witherite used in the United States is very small and is largely imported from England. The manufacturers of barium chemicals prefer to use the washed, high grade of soft barytes, but they can and do use barytes which could not be used in the preparation of the highest grade of ground barytes.

Bar. Sulfide BaS

Barium sulfide is used as the starting point for barium chemicals. It is prepared by roasting a mixture of crude barytes and some form of carbon according to the same proceedure as described under lithopone.

Bar. Carbonate Ba CO_3

Barium carbonate is precipitated from a solution of barium sulfide with sodium carbonate (soda ash) solution, obtaining as a by-product the sodium sulfide. It can also be prepared by passing carbon dioxide gas through the sulfide solution but this requires definite control to obtain a good product. The carbonate produced by this method has certain physical characteristics which are somewhat different from that produced by precipitation with soda ash solutions. After the precipi-

*X-1 note.

tation the carbonate is washed and filtered, then dried and disintergrated and packed in suitable packages for shipment.

Blanc Fixe Ba SO_4

The method of producing blanc fixe depends upon the physical properties which may be desired for the finished product. It was formerly made only by treating a solution of barium chloride with sodium sulfate or sulphuric acid but now it is usually made by precipitation from a solution of barium sulfide by means of salt cake solution (sodium sulfate). This method produces a denser product than that produced from the chloride and in addition produces a valuable by-product of sodium sulfide. It is also made as a by-product of the hydrogen peroxide industry when barium peroxide is treated with sulfuric acid. For certain trade the sulfate is precipitated from hot concentrated solutions to form a crystalline product which is a valuable base for the manufacture of very brilliant colors. Other methods produce a so-called amorphous product which is valuable for the rubber and ink trades.

After the blanc fixe has been precipitated it is washed with water to remove the sulfides or chlorides, as the case may be. It is then filtered, dried, disintergrated and packed in suitable packages for the various customers.

Bar. Chloride $BaCl_2$

Barium chloride may be produced by treating witherite (natural barium carbonate) with hydrochloride acid. It is usually produced in this country directly from crude barytes by roasting with coal and calcium chloride. It may also be prepared by treating a solution of barium sulfide with calcium chloride or hydrochloric acid. After the chloride is obtained it is purified by crystallization and may or may not be dried. By using calcium chloride, as one of the raw materials, a by-product of calcium sulfide is obtained whereas with hydrochloric acid the hydrogen sulfide is a by-product.

Bar. Nitrate $Ba(NO_3)_2$

Barium nitrate is produced by dissolving witherite in nitric acid. The usual method is by addding a soluton of sodium nitrate (Chili Saltpeter) to a solution of barium chloride or barium sulfide. The solution is concentrated by evaporation and then purified by crystallization. The nitrate can be converted to the oxide, dioxide or hydroxide.

Bar. Hydroxide $Ba(OH)_2$

Barium hydroxide is prepared by heating barium sulfide in earthenware retorts into which a current of moist carbonic acid is passed, after which superheated steam is passed over the resultant carbonate. It may also be made by dissolving the oxide in water. It is concentrated by evaporation and crystallization.

Bar. Oxide BaO

Barium monoxide is made by roasting the carbonate with carbon or by heating the nitrate. The material thus produced may or may not be pulverized for the trade.

Bar. Peroxide BaO_2

Barium peroxide or dioxide, is prepared from the oxide by heating at about 700 degrees Centigrade in a current of air or oxygen free from carbon dioxide and moisture. The material is pulverized and packed in suitable metal containers.

BARIUM CHEMICALS

Blanc Fixe $BaSO_4$

Blanc Fixe, the precipitated barium sulfate, is the best grade of barium sulfate for pigment purposes, both as to whiteness and fineness of product. It is largely used where a pure white pigment or filler is desired, as in paints, rubber goods, linoleum, oil cloth and glazed paper. It is also used in lithographic ink and as a base for lake colors. The battleship gray used by the United States Navy contains about 45% of blanc fixe. As chemically pure barium sulfate it is used as an indicator in X-ray photography. In the manufacture of rubber inner-tubes for automobile tires it is used extensively as a resistor to wear, giving the tube more resiliency and strength.

Blanc fixe is placed on the market in pulp form and as a dry powder. The pulp contains approximately 30% of water and is used chiefly by the paper manufacturers. The dry powder is used for the other purposes.

$BaCO_3$

Barium carbonate is coming into use more and more. Its largest use is in the ceramic industry where it is used to prevent scum and efflorescence in brick, tile and heavy clay wares. The carbonate unites with soluble sulfates in the clay forming the insoluble barium sulfate and in the case of calcium, which is the chief scum forming ingredient, the insoluble calcium carbonate. A recent patent using the Barium Bicarbonate, which is made from the barium carbonate, has proven a great success for scum treatment. The carbonate is also used extensively in the manufacture of sanitary ware. It forms a valuable flux and enamels are said to be much harder and more brilliant when the carbonate is used. Recent developments in steel treating demand a good grade of the carbonate.

In flat wall paints it is used to give a velvety finish. It is used up to 45% in these paints. It also finds use in enamel ware, acting in the same manner as in the manufacture of sanitary ware.

Barium carbonate is used in the manufacture of other barium chemicals, notably the oxide and peroxide, in rat poisons, optical glass, foundry core compounds, marble substitutes, dyes, rubber, chemical reagents, beet sugar and water purification. In water purification it is rapidly becoming a favorite for treatment of acid waters. In beet sugar it is used most extensively in Italy, the price prohibiting its use in America or on the Continent. Barium carbonate is far superior to the calcium used and there remains to be found a cheap method of producing the carbonate before it can be used in this country.

$BaCl_2$

Barium chloride is a white barium salt fairly soluble in water. It is usually sold in the crystalline or powder form. It is used in the manufacture of blanc fixe, color lakes, leather tanning and finishing, rat poison, pigments, in drugs for treatment of fever, textiles such as mordant, weighing and calico printing, water softeners, boiler compounds, chemical reagents and in the manufacture of certain photographic chemicals.

$Ba(NO_3)_2$

Barium nitrate is also a soluble salt and it is used principally for the manufacture of barium oxide. It is also used in pyrotechnics, certain explosives and in medicine.

$Ba(OH)_2$

Barium hydroxide has little use commercially in the United States. It has been used as a substitute for caustic potash during periods of high price of that commodity. It is used to some extent in the refining of beet sugar but due to its high cost it is replaced by lime.

BaO

Barium oxide is used in the manufacture of barium peroxide and in Europe in the manufacture of beet sugar. It is used in certain grades of optical glass.

BaO_2

Barium peroxide is used in the manufacture of hydrogen peroxide.

BaS

Barium sulfide is the intermediate compound from which the majority of other barium chemicals are made, and is one of the necessary materials in the manufacture of lithopone. It is also used with lime as a depilatory.

$BaCrO_4$

Barium chromate, lemon yellow or ultramarine yellow, is used as a yellow pigment.

$Ba(ClO_3)_2$ $2H_2O$

Barium chlorate is used in pyrotechnics and in dyeing.

$Ba\ Mn\ O_4$

Barium manganate has been used to some extent as a green pigment.

BLANC FIXE SOLD IN THE UNITED STATES*
(IN SHORT TONS)

YEAR	DOMESTIC	IMPORTED
1913		2441
1914		1424
1915		722
1916	3337	338
1917	6314	114
1918	9522	. . .
1919	5227	½
1920	8046	165
1921	2471	769
1922	7349	2187
1923	6791	587
1924	7796	1047
1925	11748	1996
1926	?	2973
1927	13395	2400
1928	?	3680
1929	?	3501

*Mineral Resources of the United States 1921 Part II.
*Mineral Resources of the United States 1929 Part II.

BARIUM CARBONATE SOLD IN THE UNITED STATES*
(SHORT TONS)

YEAR	DOMESTIC	IMPORTED
1913		2043
1914		1532
1915	2476	143
1916	6844	. . .
1917	8238	53
1918	7661	. . .
1919	7135	4
1920	7484	476
1921	1956	2237
1922	2281	5212
1923	6362	1901
1924	6058	3752
1925	4962	7188
1926	5394	9224
1927	5060	4918
1928	7626	5222
1929	7902	3206

*From: Mineral Resources of the United States 1921-1929. Part II.

BARIUM CHLORIDE SOLD IN THE UNITED STATES*
(SHORT TONS)

YEAR	DOMESTIC	IMPORTED
1913		1863
1914		2960
1915	2016	1280
1916	3643	3
1917	4870	. . .
1918	4530	. . .
1919	4509	550
1920	3084	1595
1921	?	2186
1922	2022	1962
1923	3301	1278
1924	3859	2330
1925	?	2167
1926	4592	1773
1927	3708	1577
1928	5224	1172
1929	6545	78

*From: Mineral Resources of the United States 1921-1929. Part II.

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Department of Commerce, Mineral Resources of the U. S.

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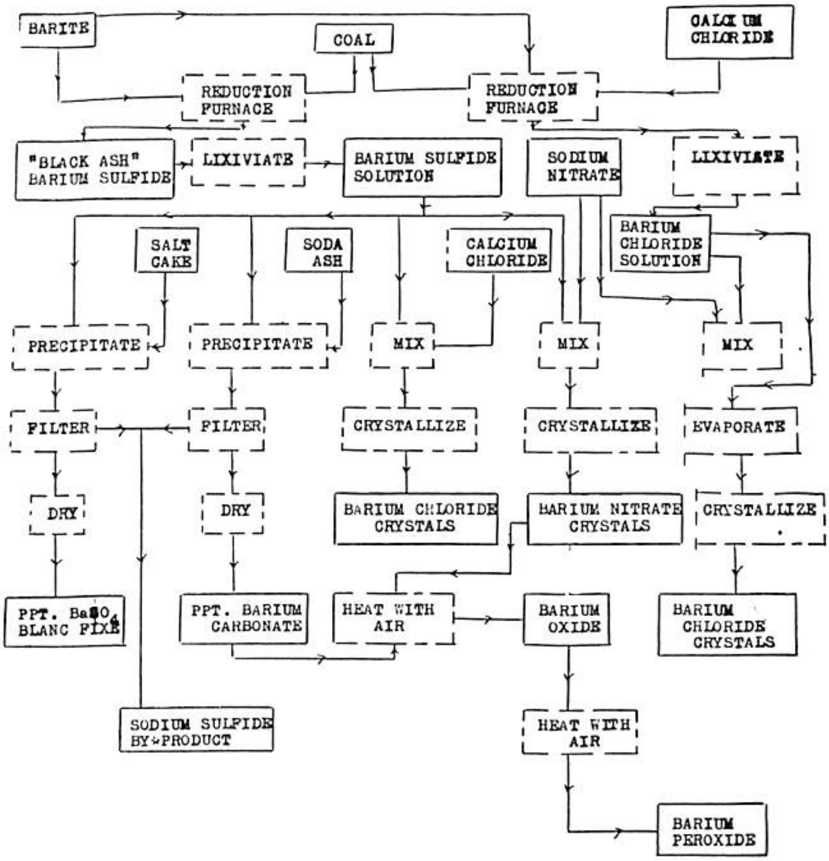
BARIUM CHEMICAL INDUSTRY *



Solid lines: Raw, intermediate or finished products
Broken lines: Apparatus or steps in process

*X-1 note.

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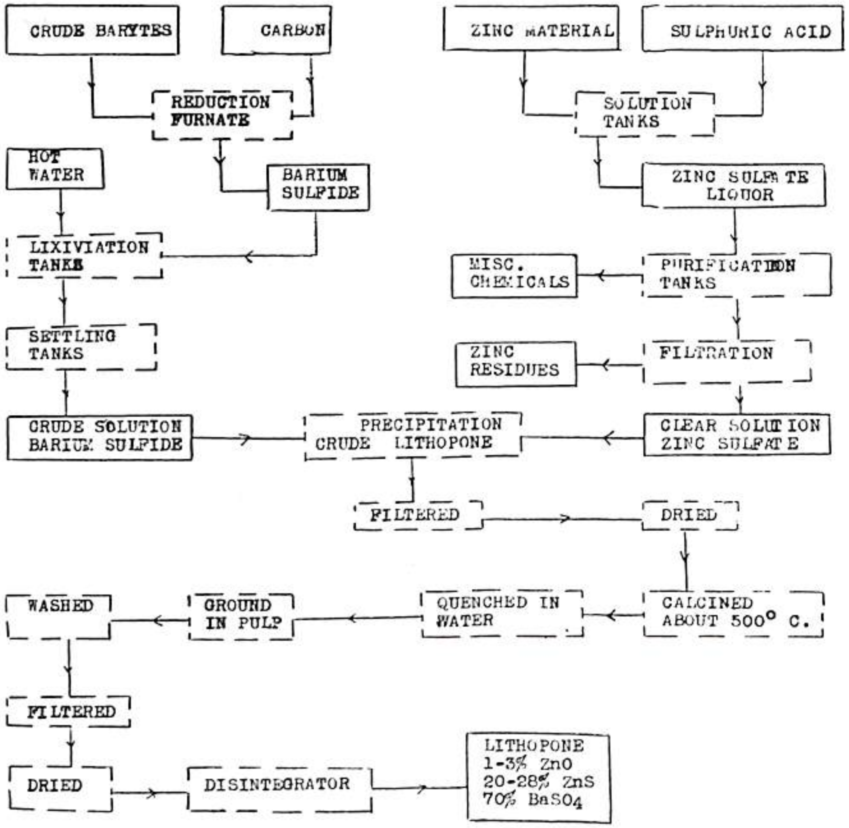
LITHOPONE MANUFACTURE *



Solid lines: Raw, intermediate or finished products

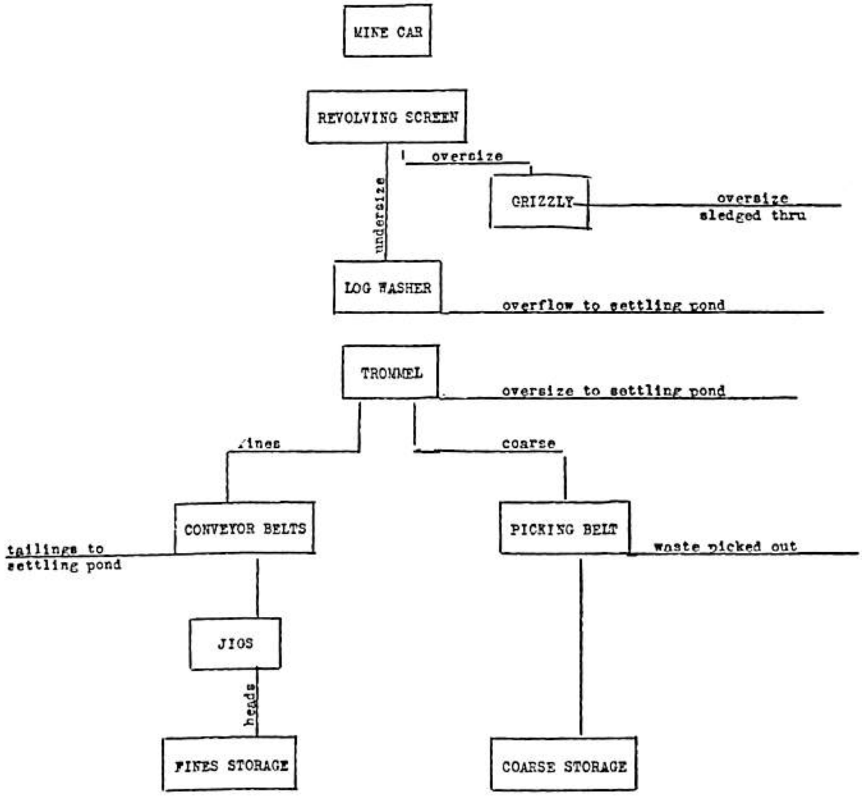
Broken lines: Apparatus, or steps in process

*X-1 note

-3-

FLOW SHEET*

BARYTES WASHING PLANT



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COLOR REACTIONS TESTS OF SOME ALDEHYDES AND KETONES WITH A SERIES OF COMPOUNDS WHICH CONTAIN THE METHYLENE GROUP

By

LORENZ HANSEN,

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(Abstract)

Series of aromatic and aliphatic aldehydes, of aromatic, aliphatic and mixed ketones were tested for color reactions with a series of compounds which contain a methylene group. The tests were carried out in solutions of absolute alcohol in contact with concentrated sulfuric acid. The sensitivity of the various compounds tested was determined by the maximum dilution in which tests were positive, that is, in which a distinctive color reaction was produced.

The following is a list of the compounds which were tested:

(a) **Aldehydes.** Furfuraldehyde, benzaldehyde, salicylaldehyde (o-hydroxy benzaldehyde), p-hydroxy benzaldehyde, anisaldehyde, vanillin, veratraldehyde, piperonal, B-resorylaldehyde dimethylether, p-dimethylamino benzaldehyde, o-chlorobenzaldehyde, p-chlorobenzaldehyde, o-tolualdehyde, p-tolualdehyde, cinnamic aldehyde, hydrocinnamic aldehyde, paraldehyde, propionaldehyde, n-butyraldehyde, n-valeraldehyde, isovaleraldehyde, n-heptaldehyde, crotonaldehyde.

(b) **Ketones.** Benzophenone, methyl p-tolylketone, acetophenone, propiophenone, phenyl p-tolylketone, benzil (dibenzoyl) cyclohexanone, dibenzyl ketone, methyl n-butyl ketone, methyl n-hexyl ketone, methyl undecyl ketone.

(c) **Methylene compounds.** Acetone, acetyl acetone, ethyl aceto acetate, cyclohexanone, ploroglucinol, diethylmalonate, thiobarbituric acid, acetophenone, fluorene, acenaphthene.

The object of the investigation was to secure data (1) on the relative sensitivity of various aldehydes and ketones and (2) on the relative sensitivity of the compounds containing the more or less active methylene groups. Data seem to show that aldehydes are considerably more sensitive than ketones, aromatic aldehydes are on the whole more sensitive than alphatic aldehydes, butyraldehyde and probably to a lesser degree propionaldehyde excepted. The difference in sensitivity between aromatic and alphatic ketones are not very greatly pronounced. In the series of compounds with the methylene group, acetone and compounds closely related were least sensitive. The least sensitive of all were ethyl aceto acetate and acenaphthene. The most sensitive were phloroglucinol and thiobarbituric acid with fluorene and cyclohexanone lagging somewhat behind.

ADVANCEMENT OF SCIENCE APPLIED TO WELL SHOOTING

By
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The Sureshot Torpedo Company.

Well shooting, through its use of explosives, entails some chemistry, but it is far from a purely chemical endeavor.

Ever since the first well was shot with black powder, by lowering a bottle full on the end of some small pipe, and dropping a red hot iron through the pipe to detonate it, Torpedo Companies have met the demands placed upon them for more advanced methods, until things in use today would have startled and seemed foolish to our fathers, while the things I mention for tomorrow will startle and seem foolish to most of us today.

In case some of you are not familar with the term "well shooting" and "torpedo companies"; the former is the act of placing a charge of high explosives at the exact spot down in an oil or gas welll where the oil or gas is encountered in drilling the well, and detonating this charge to increase the flow of oil or gas; while the latter are the legitimate agencies employed to carry out the former. These "spots" where the oil or gas is encountered, are rock formations of the earth's crust and the theory is that the shooting of these formations cracks and shatters them, creating fissures back for some distance, and greatly increasing the sepage area, bringing about the desired result—"the maximum production possible from the formation".

Considering the subject under the two main headings of: First, the present advancements in use today; and Second, the possible advancements for tomorrow; with sub-headings under the first of (a) Ethylene Glycol, (b) rubber boots, (c) time bombs, (d) patent bridges, (e) reinforced shells, (f) copper cans, (g) neutralizing solution, (h) coloring agent to tell when shot detonated, (i) washing free of acid, (j) other explosives; and sub-headings under the second of (a) reel, (b) line, (c) shells, (d) cans, (e) transporting by air, (f) reproducing shot experimentally above ground, (g) photographic data of shot-hole, (h) new explosives, (i) points of detonation, (j) explosive accompaniment, (k) shooting under pressure or vacuum; we will proceed.

You are all familar with Ethylene Glycol or Prestone, and we feel safe in saying that its use in the manufacturing of nitro-glycerin for well shooting, is, for us, the greatest advancement of all time. Ordinarily NG freezes at 46 degrees F, but the addition of Ethylene Glycol to the nitrating mixture lowers the freezing point to any desired figure. This sample of the first we made about four years ago, began to crystalize at 13 degrees below zero F. Formerly, in the winter time, it was necessary to thaw the NG in the transporting container or can, so it could be poured into the round tin shell to be lowered into the well. This being done at the well, the method was necessarily very crude, making use of what ever they had at the well, which was usually a wooden barrell and hot water. The cans of NG were suspended in this by strings tied to nails driven in the top rim of the barrel. The advent of the steel drum increased the hazard, because of not having any place to drive nails, and necessiating the placing of sticks across the top of the drum to tie the can to. Hot water came from the boiler used in drilling the well, and there have been cases of steam being turned into the barrel containing the cans of NG. When you consider the fact that heat, friction, or the least jar will detonate the extremely sensitive and unstable NG, it is easy to see why there was considerable loss of life and destruction of property under this method. A preliminary step to eliminate this hazard was the use of the hot magazine where NG was stored, but most of the time it would freeze on the way to the well from the magazine. Then, many hot magazines became too hot, and blew up. We were just beginning to use a portable canvass bag for thawing at the well, when Ethylene Glycol came into use. However, our greatest worry and hazard is at an end, now that Ethylene Glycol is with us. It also makes the NG slightly less sensitive and harder to put off.

What is called a "rubber boot" is another great safety factor in use. As you see, it is merely a thick rubber case for the can of NG to be placed in for transporting. No friction can be imparted to the can in this and if a can leaks, the boot will hold the NG, keeping it from running out between springs, on exhaust pipes, etc., resulting in loss of life and property. The less sensitive NG made with Ethylene Glycol, and the rubber boot, account for the miraculous tales you hear of a truck load of NG being wrecked without going off.

The Time Bomb, especially the Zero Hour Bomb I have here, has helped us solve some very difficult shooting problems. Where the casing is set close to the producing formation, necessitating its being pulled out after the shot is placed, and causing the shot to be covered up with cavings, the old electric wire method was uncertain. Where there is a large quantity of fluid in the hole, necessitating the use of the firing-head to detonate the shot, it was very uncertain and there was danger of the firing-head going off any time, since the least little tap on the plunger would put it off. Where it was desired to tamp the shot with sand or gravel and still permit it blowing out the top of the hole, it was impossible. The Zero Hour Bomb, the most certain and scientific in use, has eliminated these and many more hazards, uncertainties, and impossibilities.

This patent bridge has been of material aid to us in many cases. It is especially useful in bridging the hole when it is desired to shoot a formation above another gas producing formation. The old fashioned forked stick and stone bridge will usually shut the gas off, causing it to eventually rock up to the point where it may blow both bridge and shot out of the hole ahead of time. Even if it does not do this, when it is knocked out with the drilling tools to clean the hole, there is danger of loosing the tools. This bridge will hold up a string of tools (3300 lbs.) but a quick blow breaks it, so that when the shot goes off, it is blown up and out of the way. We have successfully used this bridge, interspaced in a large shot to take up the weight, prevent settling, and the resultant premature explosion. However, for the latter, reinforced shells are in general use.

This section of a reinforced shell I have here will hold up three ton or more. Where the producing formation is several hundred feet in thickness and large quantities of NG are used in shooting, any settling of the shot from the great weight, would cause enough friction to put the shot off prematurely with resultant loss of life and property.

As previously mentioned, the danger of a leaky can while transporting NG is not so great now, still, the use of a copper can further decreases the danger, because it will not start leaking as quickly as the tin can usually used. However, it is difficult to keep copper cans because of boot-leggers breaking in and taking the empty one.

Once in a great while, NG is spilled, and gets where it should not be. As a matter of precaution, we always wash the shell after filling it at the well, having a bucket of a specially prepared solution to put the cork in while pouring from the can into the shell, and washing the floor with this solution upon leaving. This solution decomposes NG and eliminates the danger of an escaped drop causing damage.

It is sometimes difficult to tell when a shot has exploded. Take for instance, a small shot in a deep hole, under several hundred feet of fluid. No perceptable sign of an explosion takes place at the top of the hole. We have a bottled coloring agent which we place in the explosive, which, when freed by the explosion, colors the fluid and indicates the shot has gone off. The bailer is run to extract a sample of the fluid for the test.

Many explosions occured in the past without any apparent cause, suchas magazines blowing up with no one around, etc. This was undoubtedly due to the fact that the NG was not washed free from acid. Any acid left would set up spontaneous combustion. There have been cases of a can bursting into flame when the cork was pulled, and then blowing up. No matter how long it takes, all traces of acid should be washed out. The use of soda ash as a neutralizing agent is effective for this.

Hope was at first aroused when the less sensitive explosives, such as dynamite, blasting gelatin, and solidified NG were brought out. But too many conditions in connection with their use in shooting wells, soon proved them unsuccessful for such use. Only in rare cases is anything but liquid NG used, over 90% of all wells shot, using it. It is true that blasting gelatin has come into extensive use in shooting the shale gas formation, but cost of shooting has been the predominating factor in its favor.

Now, we have become slightly acquainted with some of the Present Advancements of Science Applied to Well Shooting and are ready to delve into the great beyond—the Possible Advancements, and as we firmly believe "anything is possible", we are ready to accept the most ridiculous statement or thought as the one holding the greatest opportunities for us. If I were to reveal my inner-most thoughts you would probably consider me unsafe to be running loose, I will attempt to confine myself to suggestions that have some reasoning to them, and of necessity, will have to keep quiet about some things we are now working on.

In connection with my previous statement that blasting gelatin had come into use in shooting the shale formation, our equipment for its use is not as adequate as it should be. To lower explosive in a well, a reel, line and hook are used. The hook detaches itself from the bail of the shell of explosive when placed on bottom and is pulled out by the line being wound up on the reel by the engine used in drilling the well. The less sensitive blasting gelatin can be placed in the well by the use of the brake on the reel, and such braking system could be better. Along with the braking system, a better lubricating arrangement is needed. A great disadvantage is that the metal reel used becomes hot and burns the manila line used, rendering it unsafe. We are at present considering means of eliminating this, desiring a metal of extremenly low thermal conductvity for making the reel. Ramet is one metal, but the manner in which it is made, makes it unpracticable for our use.

If a heat resisting manila line were available, part of our worries, would be at an end. Twisted wire line has not proven satisfactory. The ideal line would also have to resist certain chemicals which are frequently encountered in drillng wells, which eat up both wire and manila lines. Such a line would also be without stretch, or at least have a stretch that could be calculated, so one could meter the line as it went into the hole, thus obtaining a correct measurement of the point the explosive reached.

It is often the case that the well owner desires to shoot a well in the same place in which it has previously been shot. Of course, the original shot created a cavity, or shot hole, and any shells of explosives placed there will fall over into it. A specially constructed shell to eliminate this is one of the problems we are working on. The sample shell section you see here is quite heavy and contains a considerable quantity of material. One to serve the same purpose, but light, and containing less material is yet to be found.

Glass cans for transporting NG would have their advantages. A glass which would break from a blow just below that required to detonate the NG would be the kind to make them from. Then, if a careless man happened to strike a can against something while carrying it, he would not kill himself and everyone around, but merely loose his NG. These cans could also be kept cleaner and the customer could see what he was getting. They would undoubtedly be required for air transportation, since a forced landing resulting in their being broken would not cause an explosion.

Some day, you may gaze sky-ward and recognize the high explosive plane and start running for shelter. Then it will be a great day for us shooters, for we will have no enemies. It will be too easy for us to fly over and drop a can. I have personally been entertaining this air idea for over seven years, and still cherish the encouragement given my idea by the then Chief of Army Air Service, Mason M. Patrick upon interviewing him at the close of a talk he gave at M. I. T. while I was there. A plane would come in handy in carry out another thought, that of reproducing above ground, the shot that takes place in the well.

Some time ago, the Bureau of Mines at Bartlesville, Okla, met with disaster in attempting to reproduce underground conditions for a reproduction experiment, and they were not using high explosives. So mixing the two, would create a double hazard. However, subjecting the samples of the formation to be shot to experimental shots before hand, would be of material assistance in determining the proper procedure in the actual shooting of the well.

If one had a picture of the formation after it is shot, much interesting data would be available. We thought we had a camera for this purpose at one time, but it did not prove feasible for use in deep wells.

The basic principle of explosives is that of giving off heat upon being detonated. It is this very heat that is of some disadvantage in well shooting, since it fuses the formation, sealing up the pores. However, this part usually breaks off as cavings to clean out after the shot. A cheap explosive, not giving off heat would have its advantages. We investigated nitro-guanadine, but the cost was prohibitive. The ideal explosive would be one that could be mixed at the bottom of the well, thus eliminating all hazard. Part of it could be placed in the well, and then the rest added to vitalize it, or make the explosive, after which, it could be detonated.

There is a question whether or not setting up the detonating force at different places in the charge of explosive, would change results. However, it could easily be done with the time bomb.

Another thought is that of placing something with the charge of explosive which the explosion would effect in such a manner as to be of advantage in increasing production. Something shot back into the formation might do the trick. This is getting us into the study of high temperatures and pressures.

Shooting under pressure or vacuum is still conjecture, but with the proper control features at the top of the well, such practice would be carried out. A control head of tested breaking strength could be installed the shot placed and a time bomb with it, the proper pressure or vacuum applied, and when the shot went off the difference in pressure created would break the control head, permitting the shot to come out as is desired.

So end the ramifications of a dreamy shooter.

A STUDY OF THE SEWAGE POLLUTION OF THE WEST FORK RIVER AT WESTON, W. VA.

By
L. KERMIT HERNDON,
Chemical Engineer, State Water Commission.

The investigation carried on by the State Water Commission during the summer of 1930 in the West Fork River Basin revealed that gross sewage pollution of that stream exists at Weston. For the dry portion of the year nuisance conditions obtain at this point.

In addition the two creeks. Polk and Stone Coal, are but little better

than open sewers. Intolerable conditions exist in these creeks within the city limits throughout the greater part of the year.

There is a serious situation created by the discharge of raw sewage from a part of the city's population into the river a short distance above the intake of their water supply. It is clearly evident that a direct menace to public health is present yet the State Health Department and the Weston Water Company carefully watched and maintained a bacteriologically safe water supply there. The drought seriously curtailed the water supply and the taste and odor were impaired but it was felt advisable to continue the use of this supply until other sources could be tested and proven safe.

The writer in his report to the State Water Commission recommended that the City of Weston should proceed with plans to construct and operate intercepting sewers and a sewage disposal works that would be adequate and satisfactory. It was also recommended that the Weston Water Company and the State Hospital should plan for a more adequate supply of water and also a less contaminated source of raw water supply.

Weston

Weston, the county seat of Lewis County, is located on the headwaters of the West Fork River at the point where Stone Coal and Polk Creeks enter the river. It is located in a rich agricultural area and has several glass and lumber industries as well as the shops of the B. & O. Railroad. The State Hospital for the Insane is also located here. There are several small coal mines operating in this area and there is an extensive natural gas development.

The population of the city has increased as shown by the U. S. Census Reports:

TABLE I

YEAR	POPULATION	PERCENT INCREASE
1860	820	...
1870	1110	36.0
1880	1516	36.4
1890	2143	41.4
1900	2560	19.4
1910	2213	13.5
1920	5701	157.5
1930	8646	51.6

The increase noted in the last two figures are due to annexation of the surrounding territory but nevertheless are a good indication of the growth of the city.

Water Supply: The water supply for the city and for the State Hospital is drawn from the West Fork River. Two dams have been located in the river, one within the city limits and the other about 2.5 miles above. The storage afforded here is usually sufficient to carry over the ordinary period of dry weather.

The Weston Water Company has about 1500 connections with an average consumption of 330,000 gallons per day, or about 45 gallons per capita per day. Provision is made in these figures for only the population of Weston and is not inclusive of the State Hospital inmates and attendants.

Attention should be called here to the fact that a portion of the sewage from the city is discharged into their own water supply above the dam and only about 150 feet from the intake of the hospital. It is a matter of vital importance that this sewage be diverted through an intercepting sewer down stream. The storm drainage from the streets should be carried below the dam. It is a recognized fact that the first drainage from streets after a shower is usually as dangerous to public health as domestic sewage.

A partial analysis of the water in the West Fork River at the Weston intake was conducted by Mr. Wm. A. Thornhill under the writer's direction in September, 1930. This analysis indicated the following:

Total solids upon evaporation	139 p. p. m.
Residue on ignition	81
Volatile material on ignition	58
Silica SiO_2	8.0
Iron and alumina Fe_2O_3 Al_2O_3	4.2
Calcium CaO	24.4
Magnesium—MgO	3.47
Sulfate SO_3	8.1
Dissolved oxygen % sat.	80.0
pH	7.5

An analysis of the city tap water of Weston was made by Lewis V. Carpenter* from a sample taken July 28, 1930. His results were:

Free Ammonia	2.3 p. p. m.
Albuminoid ammonia	0.8
Nitrates	0.6
Nitrites	0.0
Chlorides	26.0
Hardness	60.0
Total Solids	131.0
Silica—SiO_2	1.6
Iron and Alumina $Fe_2O_3Al_2O_3$	86.0
Calcium CaO	33.1
Magnesium MgO	3.8
Sodium Na_2O	8.9
Sulfates SO_3	26.4
Organic & Volatile material	6.2
Dissolved Oxygen	3.9
pH Value	7.6
Taste and odor	Organic
Turbidity	0
Color	0
Alkalinity	
Phenolphthalein	0
Methyl Orange	60

Report to the City of Weston on Sewage Disposal, L. V. Carpenter, 1930.

These samples were taken at a time during the drought when there was no water flowing over the dam. The effect of the sewage is readily noted in the very high ammonia content. Examination of the records of the Weston Water Company and of the State Health Department indicates that the water supply at Weston has held a consistently safe record from a bacteriological standpoint. Hence, the erection of "Safe Water" signs at the edge of the city was undoubtedly justified. During the extreme drought when the conditions that were intolerable even in normal seasons within the city limits became so much worse, a more careful supervision of the quality was maintained. Undoubtedly the pollution load was nearing the capacity of the plant to handle it and yet produce a safe water. It was only by vigilance upon the part of those mentioned that disaster was averted. The responsibility of using a heavily polluted raw water is very great and is in fact greater than a plant should assume. Further information regarding these conditions will be given below.

Sewage Conditions

The conditions that result from the discharge of Weston's sewage into the West Fork River are intolerable during the hot, dry months. The river practically ceases flowing part of the year and in fact did so during the drought of 1930. Gross pollution exists to such an extent that large standing pools of sewage remain within the city. There is a distinct menace to public health that should be corrected. Polk Creek, Stonecoal Creek and Town Run are open sewers of the worst sort.

For the purpose of making tests at Weston, the following sampling stations were selected:

1. West Fork River—Bridge at Cox Addition.
2. West Fork River—At Weston Hospital intake.
3. Town Run at mouth.
4. West Fork River—under bridge at lower end of hospital.
5. Polk Creek—concrete bridge below Stasel's Store.
6. Polk Creek—Foot bridge just above Dodge Garage.
7. Polk Creek—mouth.
8. West Fork River—at street bridge above mouth of Stone Coal.
9. Stone Coal Creek—at Hope Lumber Company bridge.
10. Stone Coal Creek at Court Street bridge.
11. Stone Coal Creek at mouth.
12. West Fork River—at B. & O. Bridge below Weston.

TABLE II—WESTON SURVEY

	pH			Bacteria per c. c.			B. Coli in		
Station	July 29	Aug. 5	Aug. 12	July 29	Aug. 5	Aug. 12	July 29	Aug. 5	Aug. 12
1.	7.2	7.8	7.1	650	1,150	200	1.0 cc	0.01 cc	.01 cc
2.	7.3	7.9	7.1	2,700	7,000	1,000	.01	.01	.01
3.	7.3	7.3	8.9	130,000	400,000	1,260,000	.01	.01	.01
4.	7.9	7.9	7.2	70,000	500,000	270,000	.01	.01	.01
5.	..	..	8.7	...	..	1,000	..	..	.01
6.	7.1	7.1	..	600	675,000	...	1.0	.01	..
7.	8.3	7.9	7.3	140,000	200,000	50,000	.01	.01	.1
8.	7.3	7.1	7.5	190,000	950,000	500,000	.1	.01	.01
9.	7.7	7.9	7.5	70,000	10,000	30,000	.01	.1	.01
10.	7.0	7.5	7.0	410,000	1,200,000	700,000	.01	.01	.01
11.	7.4	7.4	7.0	120,000	1,000,000	250,000	.01	.01	.01
12.	7.5	7.9	7.2	550,000	2,700,000	1,750,000	.01	.01	.01

Station 5 was dry on the first two occasions and Station 6 had a thick coating of sewage scum on August 12.

Three sets of samples were taken as indicated in Table II by Mr. Wm. A. Thornhill under the writer's supervision. All of these analyses indicate gross pollution. The B. Coli determinations were practically all positive in 0.01 c. c., indicating a large number of these organisms.

During the summer of 1930 Prof. L. V. Carpenter of West Virginia University ran some analyses of sewage at Weston.* These analyses indicate a strong fresh sewage and, as he states, one that would not be hard to treat in a sewage disposal plant. His analyses are given here:

TABLE III

Analysis of Sewage, Weston, W. Va. L. V. Carpenter.

Sample was obtained by collecting hourly samples over a period of 16 hours from a sewer emptying into Stonecoal Creek between Lynn and Court Streets, August 4th, 1930. Another sample was collected August 11th, 1930.

Constituent	Aug. 4, 1930	Aug. 11, 1930
Nitrogen as Organic Nitrogen	22.8 p. p. m.	20.0 p. p. m.
Free Ammonia	28.4	21.7
Nitrites	0.1	0.1
Nitrates	0.0	0.0
Oxygen consumed	110	100
Biochemical Oxygen Demand	286	312
Chlorides	96	84
Solids—Total	2480	2100
Solids—Suspended	1131	1100
Solids—Volatile	1622	1520
Solids—Settleable (2 hrs. Imhoff cone)	964	820

*Report to the City of Weston on Sewage Disposal. L. V. Carpenter, 1930.

Constituent	Aug. 4, 1930	Aug. 11, 1930
Alkalinity	186	172
Fats	27	22
pH	7.8	7.6
Dissolved Oxygen	3.0	2.2
Temperature	25° C	24.5° C

TABLE IV

Amount of settling solids as measured by Imhoff cone readings during various time intervals.

No. 1 Monday, August 4, 1930 9:30 A. M.
No. 2 Monday, August 4, 1930 1:00 P. M.
No. 3 Monday, August 4, 1930 3:00 P. M.

Source—same as other samples—Table III. L. V. Carpenter Report.

Elapsed time in Minutes	Settling Solids in Parts per Million No. 1	No. 2	No. 3
5	80	90	60
10	170	350	180
15	500	500	400
20	650	630	400
25	900	750	580
30	1000	750	920
35	1050	780	980
40	1100	800	985
45	1110	810	1000
50	1130	810	1000
55	1130	850	1000
60	1130	850	1000
120	1130	865	1000
180	1130	865	1000
240	1130	865	1000

State Hospital Sewage Plant

The State Hospital for the Insane has a sewage disposal system consisting of sumps, pumping equipment, screens, Imhoff tank, sprinkling filters, sludge disposal beds, secondary sedimentation and chlorination. This plant was built to eliminate part of the pollution load upon the West Fork River. This system is an excellent example to the citizens of Weston of a sewage disposal system. Chemical and bacteriological tests indicate that the treated effluent from the plant is safe, non-putrescible and harmless.

Professor Carpenter's analysis of the effluent is given in Table V.

TABLE V

Analysis of the effluent from the sewage disposal plant of the State Hospital at Weston, W. Va., August 4, 1930—L. V. Carpenter.

Relative Stability Number	98
Dissolved Oxygen	6.0 p. p. m.
Temperature	26° C
Residual chlorine	0.4 p. p. m.
Total Solids	406
Organic Matter	182
Biochemical Oxygen Demand	2
Nitrates	0.3
Nitrites	0
Suspended Solids	21.2
pH Value	6.6

Stream Surveys

The writer conducted a series of river surveys starting at the Bendale Dam above Weston and continuing down the river to Fairmont. For the consideration of the situation at Weston only those samples near Weston will be tabulated.

TABLE VI

	Bacteria per c. c.			
	July 18	July 22	Aug. 21	Sept. 1
1. Bendale Dam	300	1000	300	1200
2. Cox Addition Bridge	1800	1100	3700	4000
3. Hospital Intake	600	750	3100	2500
4. B. & O. Bridge	130000	19500	1000000	1050000
5. Swinging Bridge 1.5 miles below	1000	33000	9000	20000

TABLE VII

Station	B. Coli present in c. c.			
	July 18	July 22	Aug. 21	Sept. 1
1. Bendale Dam	1.0 c. c.	1.0 c. c.	10.0 c. c.	1.0 c. c.
2. Cox Addition Bridge	0.1 c. c.	0.1 c. c.	0.01	0.01
3. Hospital Intake	0.1	10.	0.01	0.01
4. B. & O. Bridge	0.01	0.01	0.01	0.01
5. Swinging Bridge	10.0	10.0	10.0	0.1

TABLE VIII

	Dissolved Oxygen % saturation			
	July 25	July 18	July 22	Aug. 21
1. Bendale Dam	75.5	74.5	48.4	57.3
2. Cox Addition Bridge	80.1	68.5	48.4	48.9
3. Hospital Intake	92.6	90.0	80.0	42.9
4. B. & O. Bridge	0.0	9.0	31.3	0.0
5. Swinging Bridge	27.9	53.9	44.2	54.9

TABLE IX

Station	pH Readings				
	June 25	July 18	July 22	Aug. 21	Sept 1
1. Bendale Dam	6.9	7.5	7.2	7.5	7.1
2. Cox Addition Bridge	6.7	7.5	7.3	7.7	7.2
3. Hospital Intake	6.9	7.5	7.4	7.5	7.3
4. B. & O. Bridge	6.8	7.3	7.3	7.1	7.2
5. Swinging Bridge	6.8	7.3	7.5	7.2	7.4

All of the samples for dissolved oxygen were taken at 3 foot depths with a displacement sampler. A field kit used in making the chemical determinations and the laboratory of the Clarksburg Water Board was used for the bacteriological work.

The analyses at the sampling stations show the effect of the increasing pollution load upon the stream and also the effect of the drought in retaining the greater portion of the pollution within the city limits. The effect of the dam at the hospital intake is noted in that in the quiet pool some sedimentation takes place lowering the bacterial counts somewhat at this point. With a little more flow in the river the sewage from above would be carried more directly to the intake. Some dilution would of course take place.

The appearance of the stream shows some of the effects of the sewage pollution. During the drought the water at the Bendale Dam was brown with a musty odor. At the Cox Addition Bridge the odor of some sewage could be detected. The appearance and odor of the water of the intake of the State Hospital was much worse. Below the dam and along the stream bed in the center of Weston were large septic pools of sewage. Near the sewer outlets could be noted the grayish white color of the fresh sewage that changed to black farther out in the pool. Considerable growth was present on the surface of the water and some solid material was floating. During the hot weather the odor was noticeable throughout the city. The creeks were open sewers with pools of septic sewage and resultant nuisance conditions. Below the mouth of Stonecoal Creek the conditions were intolerable. There was nothing in the stream bed but sewage wastes. The mosquito nuisance became almost intolerable at times, breeding being intensified by the sewage conditions.

Stream Flow by the U. S. Geological Survey

The records of flow in the West Fork River are obtained by the U. S. Geological Survey from a station at Butcherville about a mile below Weston. These records of course include the flow due to sewage wastes. While 1930 was an exceptional year yet the records indicate that there is a dry period with a very low flow each year. The river is quite flashy in character, rising rapidly after a rain and falling with almost equal rapidity. From 60 to 90 days every year the flow is less than 10 second feet. On a basis of a dilution of 6 cu. ft. of flow per 1000 second feet. On a basis of a dilution of 6 cu. ft. of flow per 1000 contributing population, about **120 days of the year have less than the flow required.** A flow of about one-half this is needed to prevent nuisance conditions. The normal year has about 90 days that have a flow less than this. Thus it is readily seen that even in the normal year critical conditions requiring proper sewage disposal persist.

The City of Weston was cited by the State Water Commission to appear before it and ordered to have the necessary engineering studies made to determine the general plan of intercepting sewers and treatment works with the costs. This work has been completed. It is now up to the city of Weston to realize its civic duty and proceed with the installation of suitable interceptors and disposal works to alleviate this menace to public health and intolerable nuisance on a stream which, a short distance below Weston, passes the State 4-H Recreational Camp.

In Conclusion: The conditions arising in the vicinity of Weston by reason of the discharge of untreated sewage into the West Fork River and its tributaries, have been discussed in some detail from observations and studies made during the summer of 1930. Not only is a situation created that has intolerable nuisance condition present but there is a direct menace to the health of the city and constructive steps should be taken to correct the evil. It has been shown that this can be done at a reasonable cost to the community.

AN IMPROVEMENT ON THE BERL-RANIS METHOD FOR DETERMINING THE COMPONENTS OF THE TERNARY MIXTURE ETHYL ALCOHOL METHYL ALCOHOL AND WATER

By

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Since the vapor pressures of ethyl alcohol and methyl alcohol are very nearly the same, it is practically impossible to separate these two alcohols from one another by distillation. If it becomes necessary to determine the amount of the two, when present in a mixture together with water, one must resort to other means. Half a hundred or more methods have been proposed to accomplish this end, but none of then entirely practical, so that reliable results can be obtained easily and quickly.

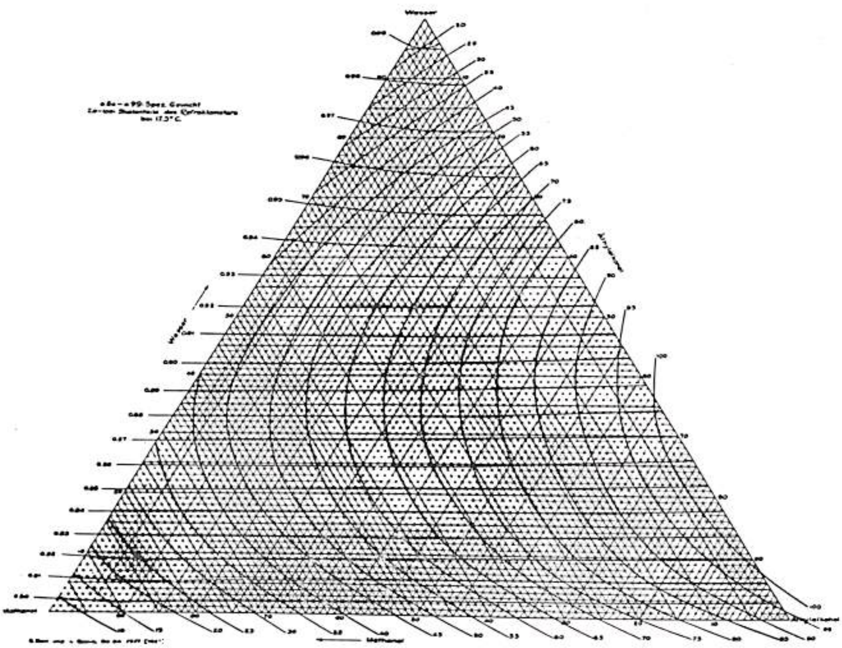
In the author's opinion the two best methods recorded are the following: Chapin's improvement (J. Ind. & Eng. Chem. Vol. 13, p. 543) on Deniges method (Compt. rend. Vol. 150, p. 832); and Berl & Ranis improvement (Ber. Vol. 60, p. 2225) on Lange & Reif's method (Zeit. Unters. Nahr. u. Genussmittel Vol. 41, p. 216).

Chapin prepares color standards in Nessler tubes with small but definite amounts of methyl alcohol, in which the color is produced by adding five different reagents. The unknown sample is then diluted to approximately the same concentration as the standards, and the percentage of alcohol obtained by a comparison of colors.

Berl and Ranis' method is based upon the fact that the index of refraction of mixtures of ethyl alcohol and water is very different from the index of refraction of the same concentrations of methyl alcohol and water. The specific gravities of like mixtures of ethyl alcohol and water, and methyl alcohol and water do not vary much, especially at concentrations of fifty percent of each component.

On the basis that the three components, ethyl alcohol, methyl alcohol, and water by weight shall add up to 100, recourse was made to Willard Gibbs' triangle in recording the percentage of one component on each side of the triangle, which is divided into equal spaces from 0 to 100. The triangle is also ruled with three sets of parallel lines, one set parallel to each side, as shown in the accompanying cut.

The construction of two sets of curves on the above mentioned ruled triangle was accomplished by preparing a very large series of ternary mixtures containing the components in question in varying proportions. A point is located on the triangular coordinate chart in such a way that its composition is read on the three sides.



The specific gravities and the indices of refraction at 17.5° Centigrade, are obtained for all the mixtures. Then a set of lines connecting all points having the same gravity are constructed, and another set connecting all points having the same index of refraction, until the entire triangle is covered with the two sets of lines at small but definite distances apart. The specific gravity curves so constructed are nearly straight lines, parallel to the base of the triangle. The curves representing indices of refraction are segments of hyperbolas, having greater and greater curvatures from right to left over the triangle.

Consequently, in order to determine the composition of any mixture of ethyl alcohol, methyl alcohol and water the process only involves three simple operations, namely: To bring the solution to a temperature of 17.5 degrees Centigrade, and to determine its specific gravity with an accurately calibrated pycnometer, and its index of refraction with the dipping refractometer. The point on the chart representing the intersection of the respective gravity and index curves gives on the sides of the triangle, the composition of the ternary mixture.

The original equilateral triangle used by Berl and Ranis is only eight inches on the side, so that considerable error arises in locating a given point on it, which results in too great discrepancies in the final readings.

At the suggestion of the author, Professor George Grow of our own Engineering School constructed an enlarged drawing of the same triangle, making the new one more than two feet on the side. Blue prints of the drawing were also made so that lines and dots can be made on them for the readings, without spoiling the original drawing.

To increase still more the accuracy of reading off the composition from the chart we employed proportional dividers which enabled us to locate the exact distance from the known gravity lines as well as from the index lines. This was impossible without the use of the proportional dividers.

There are other methods that give the composition of alcohol mixtures more accurately, but they are long and tedious to carry out. The present method seems to be by far the simplest and easiest one to use in arriving at the composition of a ternary mixture of ethyl alcohol methyl alcohol and water with a fair degree of accuracy.

Our students in advanced quantative analysis carry out this determination as one of their exercises. The following table has been constructed from values obtained by two students, and shows the degree of accuracy that may be obtained by experimenters who have had little or no experience with this type of work.

With this method any chemist with a little experience would be able to analyze a ternary alcohol mixture in one half to one third the time that is ordinarily spent on such determinations, and with considerable accuracy.

TABLE

Solution Tested	Calculated		Found	Solution Tested	Calculated		Found
Gates	EtOH	74.59%	74.2%	Gates	EtOH	10.00%	9.7%
Prepared	MeOH	20.55%	21.2%	Prepared	MeOH	75.02%	74.8%
Mixture	H_2O	5.08%	4.6%	Mixture	H_2O	14.98%	15.5%
Gates	EtOH	74.25%	74.1%	Wotrings	EtOH	95.89%	95.8%
Prepared	MeOH	15.03%	15.7%	Prepared	MeOH	1.60%	2.0%
Mixture	H_2O	10.70%	10.2%	Mixture	H_2O	2.52%	3.2%
Gates	EtOH	74.9%	75.2%	Wotrings	EtOH	80.16%	79.2%
Prepared	MeOH	9.86%	9.8%	Prepared	MeOH	9.85%	10.3%
Mixture	H_2O	15.24%	15.0%	Mixture	H_2O	9.99%	10.7%

Gates	EtOH	73.6%	74.2%	Wotrings	EtOH	46.77%	46.4%
Prepared	MeOH	3.2%	3.08%	Prepared	MeOH	47.26%	47.2%
Mixture	H_2O	23.2%	22.75%	Mixture	H_2O	5.97%	6.4%
Gates	EtOH	75.0%	74.5%	Wotrings	EtOH	52.26%	53.3%
Prepared	MeOH	2.03%	2.0%	Prepared	MeOH	41.33%	41.0%
Mixture	H_2O	22.8%	22.5%	Mixture	H_2O	6.41%	5.9%
Gates	EtOH	20.05%	20.0%	Wotrings	EtOH	35.99%	35.4%
Prepared	MeOH	74.90%	75.0%	Prepared	MeOH	31.88%	32.6%
Mixture	H_2O	5.01%	5.0%	Mixture	H_2O	32.13%	33.6%
Gates	EtOH	16.0%	15.55%	Wotrings	EtOH	0.0%	0.0%
Prepared	MeOH	74.51%	74.2%	Prepared	MeOH	90.06%	90.0%
Mixture	H_2O	9.93%	9.8%	Mixture	H_2O	9.94%	10.0%

	Gravity Method		New Method	
Sheriff	EtOH	30.55%	EtOH	30.2%
Johnsons	MeOH	0.%	MeOH	0.%
Moonshine	H_2O	69.45%	H_2O	69.8%
Sheriff	EtOH	35.44%	EtOH	35.56%
Johnsons	MeOH	0.0%	MeOH	0.0%
Moonshine	H_2O	64.56%	H_2O	64.44%
Sheriff	EtOH	36.29%	EtOH	36.60%
Johnsons	MeOH	0.0%	MeOH	0.0%
Moonshine	H_2O	63.71%	H_2O	63.40%
City	EtOH	32.76%	EtOH	32.17%
Police	MeOH	0.0%	MeOH	0.0%
Moonshine	H_2O	67.24%	H_2O	67.83%
City	EtOH	33.29%	EtOH	32.65%
Police	MeOH	0.0%	MeOH	0.0%
Moonshine	H_2O	66.71%	H_2O	67.34%

COAL RESOURCES OF UPSHUR COUNTY, WEST VIRGINIA

By
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Upshur County, West Virginia, lies northeast of the center of the state and contains 350.83 square miles. Its surface varies from 1038 feet above sea level at its lowest elevation on the Little Kanawha River on the Lewis-Upshur County line at Ingo and rises to its highest elevation of 3050 feet at its southeast corner making a total difference of elevation of 2012 feet. Geologically the surface on the northwestern edge is in the Monongahela Series. The strata rise faster than the surface to the southeast so that at its southeast corner the Pottsville Series comes to the surface. Thus the surface varies from the Monongahela down through the Conemaugh, Allegheny and into the Pottsville Series, the upper series having been eroded away to the south. The greater portion of the surface of the county is agricultural and grazing land.

Coal Resources

The coal resources are those found in the Pennsylvanian Group. The coals range from a splint coal on the northwestern part of the county to a gas, by-product and smokeless coal in the southeastern part of the county. The fixed carbon varies from 49% in the Monongahela Series to 65% in the Lower Pottsville Measures. Its ash varies from 4% to 13% in the northern part and from 3½% to 10% in the southern part of the county, while the sulphur runs anywhere from 1% to 4% in the county. The low sulphur coal occurs near the bottom of the Pottsville where the sulphur runs from 1% to 1½% while the high sulphur coals occur in the northern part of the county.

Coal Seams

According to the West Virginia Geological Survey in the detailed report of Upshur County there are fifteen seams of merchantable coal in the county. Beginning with the topmost seams and in descending order, they are as follows:

Redstone
Pittsburgh
Elk Lick
Upper Freeport
Upper Kittanning
Middle and Lower Kittanning (No. 5 Block)
Clarion
Upper Mercer

Lower Mercer (Stockton-Lewiston)
Quakertown
Campbells Creek (No. 2 Gas)
Eagle
Gilbert
Hughes Ferry
Castle
Sewell

The estimated tonnages of these coals in the county will be given later on succeeding pages of this paper.

Adaptability of Coals

The coals are well adapted for steam and locomotive fuel; also for domestic fuel. Some of the lower measures which have low sulphur units can be used for by-product purposes. But owing to the high sulphur the coals are not all adapted for by-product purposes though they may have the other constituents.

In the future, if mechanical means can be found by which the Sulphur can be separated from the coals at a low cost, quite an area of the coal in the central and southern part of the County can be prepared for by-product uses and for coking purposes.

The Redstone and Pittsbugh coals in Warren District in the northern part of the county and in a portion of Buckhannon District make excellent domestic fuel, breaking into large black glossy lumps. The Redstone Coal makes an excellent fuel for locomotives. It has high Volatile content and burns with a long flame which can be utilized without much wastage.

The Freeport and Kittanning Coals in the central and southern part of the County contain considerable slate and are to some extent irregular varying very much in the thickness of their bed and are not of uniform deposit. These coals will be valuable in the future when the thicker and purer coals have been exhausted, but at the present time the high cost of mining and cleaning makes it impossible to produce these coals in normal times at a cost low enough to compete in the market with the thicker and purer coals.

Estimate Coal Tonnage

The coal tonnage has been estimated by the West Virginia Geological Survey in its Detailed Report of Upshur County. Making this estimate, the minimum thickness of the coal used is 24". At 24" thickness of clean coal, which is assumed to be merchantable and calculated on that basis, the amount of merchantable coal as given by the said Survey, is as follows:

Coal Seams	Mines and Prospects Listed On Maps II or IV and Described in Chapter IX	Barbour County Net Ton (2000 lbs.)	Upshur County Net Ton (2000 lbs.)	Western Portion of Randolph County Net Ton (2000 lbs.)
Redstone	2– 75	101,603,397	164,092,262	
Pittsburgh	76– 179	297,236,016	63,339,725	
Elk Lick	206– 250	35,907,379	124,449,177	
Bakerstown	275– 325	130,247,885		
Upper Freeport	347– 454	417,729,945	225,759,283	
Upper Kittanning	474– 549	597,712,896	421,298,380	26,595,994
Middle and Lower Kitanning	550– 818	1,089,153,330	1,091,996,928	193,197,312
Clarion	818–A 838	336,380,774	131,474,534	83,635,200
Upper Mercer	839– 868	568,384,820	630,609,408	165,597,696
Lower Mercer (Stockton)	869– 887A		95,009,587	129,467,289
Quakertown	888– 905		59,771,290	35,572,838
Campbell Creek (No. 2 Gas)	913– 976		135,042,969	294,646,810
Eagle	987–1002		123,780,096	283,431,347
Gilbert	1003–1016			276,888,269
Hughes Ferry	1017–1027A		114,524,467	436,352,717
Castle	1028–1035B		78,059,520	386,617,651
Sewell (Sharon)	1038–1087	11,262,874	95,344,128	810,825,840
Totals		3,585,619,298	3,554,551,754	3,112,828,963
Total for Area..				10,253,000,015

If we assume that a coal that is merchantable at this time should be 36" in thickness having a clean section with good roof conditions, the total amount of recoverable coal would be about 40% of this amount or approximately 1,500,000,000 tons of coal.

Quality of the Coals

The average analyses of these coals as given by the West Virginia Geological Survey are as follows:

	Moisture	Vol. Mat.	Fixed Carbon	Phos.	Ash	Sulp.
Redstone	1.02	38.27	53.38	0.032	7.23	2.47
Pittsburgh	1.16	37.31	55.23	0.007	6.30	2.58
Elk Lick	1.08	37.94	50.60	0.012	10.38	1.69
Bakerstown	0.75	33.26	58.45	0.009	7.54	2.42
Upper Freeport	0.95	35.84	53.75	0.011	9.46	2.97
Upper Kitanning	1.27	32.23	55.34	0.017	11.16	3.08
Middle and Lower Kitanning	0.91	31.43	57.87	0.025	9.79	1.62

Clarion	0.84	31.84	57.86	0.014	9.46	2.41
Upper Mercer	0.54	34.40	57.45	0.005	7.61	1.61
Lower Mercer (Stockton)	1.25	35.29	53.17	0.004	10.29	0.69
Campbell Creek (No. 2 Gas)	0.96	32.89	59.58	0.005	6.57	0.93
Eagle	1.46	30.92	62.00	0.002	5.62	1.18
Hughes Ferry	0.77	31.28	62.29	0.005	5.66	1.19
Sewell	0.94	30.35	61.80	0.015	6.91	0.85

Coal Production

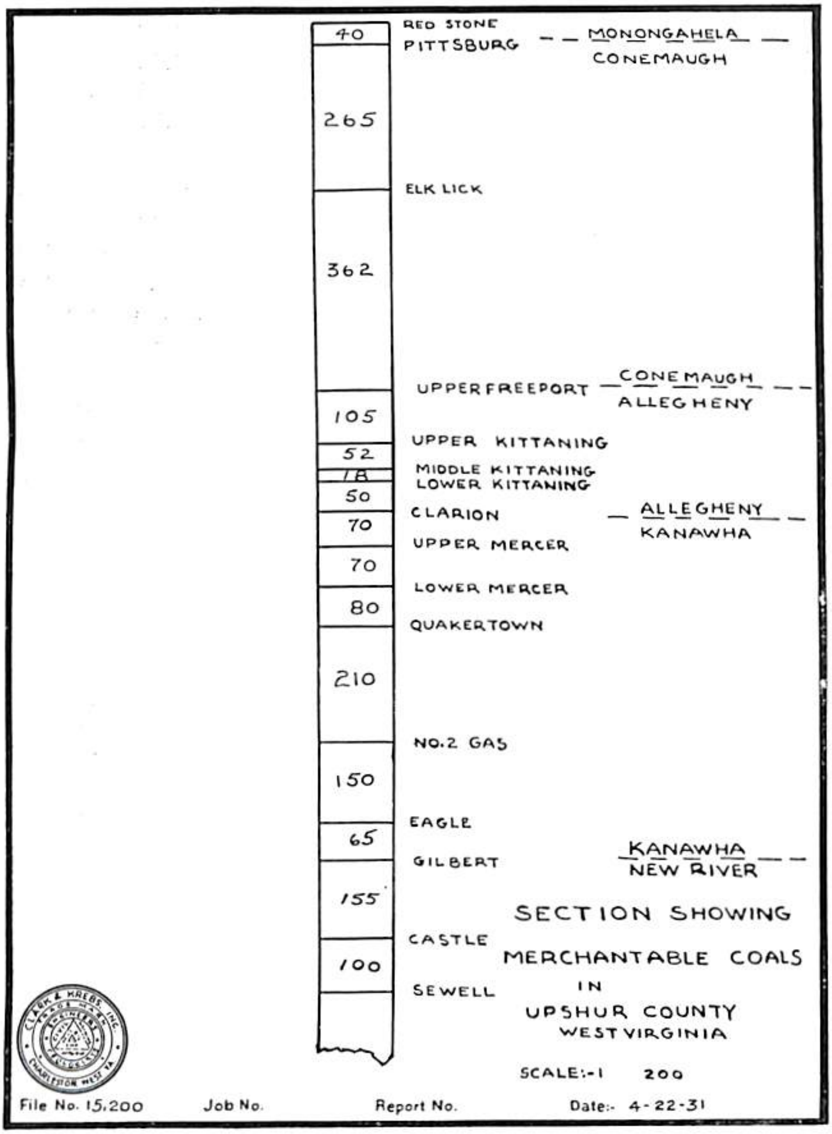
According to the statistics from the office of the Chief of the Department of Mines of West Virginia, Upshur County began shipping coal in a commercial way in 1906 and making coke in 1907. The following are the coal tonnages for the fiscal years of 1906 to 1924, incl., and the calendar years from 1924 to 1929: The coal and coke is in net tons.

	Coal	Coke
1906	6,507 Tons	
1907	44,242 Tons	2,100 Tons
1908	85,985 Tons	4,010 Tons
1909	67,860 Tons	
1910	78,844 Tons	
1911	62,932 Tons	
1912	41,542 Tons	
1913	66,166 Tons	10,626 Tons
1914	109,170 Tons	10,560 Tons
1915	110,324 Tons	2,274 Tons
1916	156,815 Tons	18,629 Tons
1917	164,373 Tons	9,193 Tons
1918	317,451 Tons	15,272 Tons
1919	474,670 Tons	8,103 Tons
1920	590,219 Tons	6,581 Tons
1921	671,255 Tons	4,502 Tons
1922	588,621 Tons	
1923	890,428 Tons	7,403 Tons
1924	758,862 Tons	
*1925	1,066,442 Tons	
1926	851,729 Tons	
1927	877,442 Tons	
1928	620,246 Tons	
1929	365,853 Tons	
Totals.....	9,067,978 Tons	99,253 Tons

*Includes last half of 1924 and all of 1925.

It will be noted that in the year 1923 the county reached its peak production of coal and in the year 1926 its peak production of coke. Since 1923 no coke has been produced in the county.

The amount of coal mined is less than one-tenth of 1% of the



amount of coal estimated by the West Virginia Geological Survey in the different seams in the County so that the coal in Upshur County has scarcely been touched in a commercial way.

The railroad facilities of this county are on par with any of the adjacent counties and when the thicker and purer seams of coal have been mined out in the other portions of the State, there is no reason why this coal will not become merchantable and that large mines with the latest improved machinery will be installed. Thus it is seen that the coal of Upshur County will become a valuable future asset to the resources of the county.

Maps

A map of Upshur County showing the districts is herewith attached. This map is made up of the topographic sheets published by the U. S. Geological Survey.

Also a section showing the occurrence of the merchantable coal and the intervals between is herewith attached.

THE SEWELL COAL OF RANDOLPH AND WEBSTER COUNTIES

By

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The greatest treasure house in nature is not oil wells, or precious metal mines, but the Pottsville coal measures of West Virginia. All other deposits sink into insignifiance when compared with this vast storehouse of wealth.

This tremedously valuable deposit of low sulphur, high fusing point coal, lies on the extreme eastern part of the coal bearing area of the state and largely on the west side of the highest mountain section. It is hard to mine and hard to reach with transportation, and, like most of the much wanted things in the world, is expensive.

This coal deposit becomes valuable near Elkins and extends southward across the state and there is a large per cent of it in Randolph and Webster Counties.

The best of these coals is the Sewell and lies immediately on top of the Pottsville sandstone, a very thick and conglomerate sandstone, so hard that a diamond drill contractor will dodge a contract to cut through it, if he can.

The Sewell coal, when first deposited was of very extensive area. In Randolph County it extended from the top of Rich Mountain eastward to Job, a distance of about twenty-five miles. This has all been eroded but a few high hill tops, and a few thousand acres in the Georges Creek Syncline on Shavers Fork. Probably three-fourths of this very fine coal has been eroded, and carried away by the waters and winds.

However, much is left and it has been a long hard struggle to get acquainted with this coal, and to get it mined, and to get people to know that there is a coal in this state that is a pleasure to burn.

Much of the coal that has been left, owes its present existence to the hard pebbly sandstone that is its base. This rock has resisted the winds and frosts, and has kept the mountains from wasting away. Nearly all the tops of the mountains in these two counties are capped with Pottsville Conglomerate. It has been said that no boy ever graduated from the State University who was reared on a farm where this stone was the only source of soil. This is true because there is no poorer land on earth outside of a desert, but while it is a poor place to grow boys, this same rock has been the sustaining force that has kept the mountains in this section and has saved the purest and best coal of all, for the present generation.

The study and discovery of the Sewell coal has been a long and slow process. I had the pleasure of being the first person to begin the exploration of this coal, as it was about all we had in our county, and as I had learned at the University a few elementary principles of rock formation, I spent my spare time investigating these coals.

About this time one of the large steel companies that specialize in fine quality products employed a man to make a complete examination of all the coals in the entire Appalachian coal area that would make coke. Sulphur has always been a big problem in steel making and a coal that was low in sulphur was much needed. This man spent six years, with a chemist and a laboratory on a wagon that was hauled from northern Pennsylvania to Alabama. After this work had been done the analyses of the coal from Randolph and Webster Counties were found to be the best that was found for coke. This company sent this man back to this section and he spent two years making tests and examinations and the work was never completed on account of the World War. I got all this information and was thoroughly convinced that the coals in this country were needed for furnace coke; and that coal less than one per cent in sulphur was scarce and that the largest area of very low sulphur coals being from one-half to three-fourths of one per cent, were in these two counties; and that this coal was needed in modern steel manufacturing and the time would come when this same coal would be used as a substitute for hard coal.

About 1916 this coal had been sufficiently studied to convince the State Geological Survey that it was an important asset and the reports of western Randolph and Webster Counties were made and published. This work was largely done by Mr. David Reger and for the first time the facts about this wonderful area of pure coal were made public.

About 1926 some prospecting was done on Shavers Fork near Bemis and from this work I was satisfied that there was merchantable Sewell coal. I interested the Geological Survey and they sent Mr. Reger to make an examination and after a time, owing to the importance of the coal, a map and bulletin were issued, the only special one ever issued by the Survey, and mining operations were soon started.

This survey and the new exploration in the county caused the Geological Survey to make additional investigations and as a result a second report was made on Randolph County, the only county in the state to have two reports and one extra. The great value of the Sewell coal was the cause of this extra work.

The demand for the low sulphur, high fusing point coals caused the Western Maryland to buy the logging railroad of the West Virginia Pulp and Paper Company and this road has been put in operation and now they are hauling, at times, as much as 3500 tons a day from Upper Elk.

The first development of this coal was made by Moore, Keppel and Company, at Cassity, in 1917. As is usual new coal fields are developed by amateurs and while they made many mistakes and were often discouraged, they kept on plodding and now have a fine mine and a very profitable operation.

The next operation was the Walkers New River Mining Company at Flint, on the Western Maryland. This mine is still in operation and they find a ready market in the New England States for their product. This coal is from 22 to 24 volatile and 72 to 74 carbon. Many of the other mines are getting coal around 30 volatile and 64 to 68 carbon. However the sulphur remains from .5 to .7 and the fusing point around 2800° F.

The coal operation in Webster County are large and expanding and under normal conditions will reach 5000 tons a day by fall. These mines are well managed and well financed and have added a very large sum to the income of this section. The total tonnage during the winter from this field is now about 4000 tons a day. By fall it will be 6000 tons a day or more. There will be added to the wages and community income, where there was nothing prior to 1927, over $10,000.00 a day. This will increase many times and while the effort to find out the coal formation has been expensive, and has taken years, and operators and railroad executives have been fearful of any kind of coal, the present development has been rapid and profitable to the railroads and to the community.

There is an old saying that it takes ten years to develop a coal field. This may be true but this one has been developed in three years and long before the ten years have passed this will be a great coal producing area.

This coal has a ready market as it is a special as well as a general utility coal. The present market is for copper smelting, by-product coke and burning in powdered form.

The rapid use of powdered coal has caused a demand for the Sewell as it appears to give better results than any other coal. This will be one of the great markets of the future. From present indication and plans there is no doubt but that in a very few years this matchless coal will be mined at the rate of five million tons a year and these two counties will have a new income of five million dollars in wages and an equal amount spent by the railroad companies in moving the coal from the mine to the main lines.

You often hear persons who are thinking of pennies and not of dollars, who object to the expense of the State Geological Survey. If it had not been for the Survey and the extraordinary work of Mr. Reger this coal field would have been largely unknown and the $3,000,000.00 a year that will be paid out here, would be spent some place else. This coal discovery and development has paid back in one year to this section many times the entire cost of the Survey from the beginning to this date, and the financial return to these two counties has just started.

PROBABLE VOLCANIC ASH DEPOSITS IN THE PENNSYLVANIAN OF NORTHERN WEST VIRGINIA

By
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(Abstract)

The Conemaugh rocks of northern West Virginia contain several layers, unique in appearance and physical properties, which show many of the features ascribed to volcanic ash.

The layers individually vary in thickness from a few inches to as much as six feet, and in purity. One bed found near the base of the Pittsburgh Red Shales, seems cleaner than others.

With the aid of Mr. J. P. Nolting, this bed has been traced from the Pennsylvania line south and southeast at least forty miles. The greatest thickness (6 feet) was found near Morgantown.

The crops are characterized by a peculiar, yellow color, and a finely, irregularly cracked surface. There is little tendency toward lamination, and the fracture is distinctly conchoidal. Slaking, as exhibited by most clays and shales is wanting, although water is rapidly absorbed.

Fresh specimens of the rock show an apparently homogenous, porcelain-textured material of the color and lustre of beeswax. The apparent specific gravity is slightly under 2.6. The hardness, except for impurities, is about that of the finger nail.

Through the kindness of Mr. Homer Hoskins, the chemical composition was determined. It was like that of a fairly pure clay.

Microscopically, the rock is composed almost wholly of crystalline material, but of pronounced textural irregularity. Oval and elongate curved patches are quite numerous, and splinter-and-shred-like pieces occasional.

Microscopic examination shows the presence of two minerals in abundance. One is quartz in grains up to the size of fine sand, the other, a mineral of micaceous habit which seems to be kaolinite. Zircon, limonite, pyrite, siderite (?), and mica are present, but not abundant.

The belief that this material is made up largely of volcanic ash is based mainly upon the heterogenous micro-texture, and the presence of what seem to be altered pumiciform fragments.

THE MECHANICS OF OIL AND GAS SAND CORRELATION

By
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Introduction

One need not be a geologist to see the changes in strata in every locality. Railroad cuts, road excavations, and exposures along deeply entrenched streams give ample evidence even to the untrained eye of the variation in rock deposition. Sandstones change to shale, shales become sandstones, both thicken and thin. Limestones appear in the section, only to lens out in a short distance; coal beds here are thick, and of good quality; there thin and impure. These variations are prevalent in each and every area of sedimentary rocks. It is the problem of the geologist, who is working in areal geology, to correlate the various rock strata by every possible means. It is the geologist's problem, when he is working in oil and gas geology, to correlate in a similar manner the strata which do not outcrop. To accurately map surface geology, one must have a high degree of training in the proper methods and familiarity with the region.

Surface correlation of rocks is established through the identification of mutual relationships among the rocks. These correlations are principally paleontologic and stratigraphic. The petroleum geologist in the Appalachian field can depend only upon stratigraphic relationships to identify oil and gas sands which are sandstones that have been more or less definitely named on their outcrop. Paleontologic evidence is meager if not entirely absent. He must depend upon the color of the rocks, their position in the geologic column and their relative position to one another; their thickness, their hardness as determined by the action of the drill bit, and finally, and most important, their relative position above and below a definite key horizon which can be more or less readily identified throughout a large area. A key horizon must be persistent, fairly readily recognizable and preferably one which outcrops at near-by points. In the Appalachian region the principal key rocks are, in descending geologic order: Pittsburgh coal, Upper Freeport coal, Vanport limestone, Big Injun sand, the base of the Catskill "red beds", and the top of the Chemung Group or "pink rock". To say that these key rocks are readily identified is not to tell the entire story. They, like the various strata above, below and between them, also vary in their occurrence. The Pittsburgh coal is not present north of Indiana County, Pennsylvania, nor west of the Belmont field of Ohio, nor south of Kanawha County, West Virginia; it thins and becomes so sporadic in its occurrence that it is often mistaken in a well log for the Redstone or the Sewickley coal.

The Upper Freeport coal is a key rock only in local areas: the Vanport limestone is readily recognizable in well logs only in western Pennsylvania and eastern Ohio. The Big Injun sand, or the Burgoon sandstone of the Pocono group, is the most persistent of all key horizons. It is found in thousands of well logs, but even this sandstone is variable in its occurrence. North of Allegheny County, Pennsylvania, an unconformity has removed several hundred feet of rocks and at places it has removed part of the Burgoon sandstone itself, so that the Little Lime, Pencil Cave, and Big Lime, are entirely absent and the true top of the Big Injun is no longer persistent in this region; sandstones which comprise the group of Gas and Salt sands lie in immediate contact with the top of the Big Injun sand with the result that 600 to 700 feet of sandstone is often present in the section and the top of the Big Injun can not be definitely identified. This sand is remarkably regular in its thickness and occurrence in Washington and Greene Counties Pennsylvania, and Wetzel and Monongalia Counties, West Virginia. Fortunately it is so, because many oil and gas sands have their type locality in these four Counties and can be traced readily from there to distant points through their stratigraphic relationship to the Big Injun sand. However, at the southern Wetzel County line the Big Injun thins, becomes divided into two or more members and its top loses its value as a base line of correlation. The top of the Catskill Group is an important line of correlation in southwestern Pennsylvania, (but in all other parts of the Eastern Fields it is less valuable.)

Likewise, the same fact is true of the base of the Chemung Group; in northern and northeastern Pennsylvania it is an infallible key horizon; in other localities it can be used only with much care.

All of these facts would make it appear that subsurface correlation of oil and gas sands is impossible, and if such correlation is made, the results have little value; but this is not the case. It is quite possible to correlate oil and gas sands accurately. The method which was used by the writer in Pennsylvania is the result of many years of experience and study, and it appears to be the only satisfactory method of correlating oil and gas sands with the meager data and unsatisfactory well logs which are characteristic of the eastern oil and gas fields. This method is now being used with excellent results by the West Virginia Geological Survey. The first county to be correlated in this manner is Wetzel. It was chosen because of its proximity to Greene County, Pennsylvania, and so that the correlation of sands could be continued southward in an unbroken succession from Pennsylvania where the identity of the oil and gas sands has been very accurately established.

Preliminary Studies

Before a geologist begins his correlation he should study and review all previous literature concerning the area. If possible the same geologist who is correlating the sands should collect all the well records.

The familiarity with the subject which the geologist will gain from field work is indispensable in visualizing the correlations which are to be made later. He should familiarize himself with the stratigraphy, structure, and the physical and chemical characteristics of all the rocks. After he has completed a review of the literature he should carefully segregate the salient and indisputable facts, and approach his work with an open and unprejudiced mind. He should not allow himself to be awed by the names of geologists who have preceded him. He must keep in mind that since former work was done more subsurface evidence is available through more drilling; more surface observations can be made because new highways and possibly railroads have been constructed through the territory which have uncovered more rocks.

Well Records

The first difficult task is that of collecting numerous accurate and complete well logs. It has only been in the last few years that companies have been keeping well logs which can be used with success in correlation. In former years at least 75 per cent of the well logs contained only a notation of the producing sands. No elevations were run to the top of the well, and no observations were made of the color of the strata between the producing sands. In former years companies were secretive and did not care to give information concerning the wells. Fortunately this attitude has changed and it is now possible to collect any information which is desired.

To accurately correlate oil and gas sands, for instance in Wetzel County, West Virginia, it is necessary to collect several thousand records, in fact three or four times the number which is to be eventually used in the actual correlation of sands. A greater number of these records will prove to be of no value; others will contain one or more salient features which may be good in the correlation, but are not good enough to take their place in the correlating graph which is to be constructed. After a sufficient number of well records are collected they should be minutely scrutinized and arranged in proper order, either by pools or in a certain direction across the country, which direction is determined by structure of the rocks and thickening and thinning of the strata.

Mechanics of Correlation

The first step in correlation is to plot all well records on a well record strip which contains all pertinent information at the top and a skeleton section on a scale of 1 inch equals 100 feet at the bottom. The sands should be plotted in a distinctive color, for instance orange. Shale should be given another color, limestone another, and coal still another. The same system of color should be carried throughout all well records.

The next step is to eliminate at least 50 per cent of the well records. Inferior ones are discarded with a proper notation on each record of any good or salient point which might be contained in it. They are filed for future reference. The remaining records are then classified into townships, districts or pools, according to the discretion of the geologist, in a manner which he deems the proper one for correlation in that particular area. Usually the township or district boundary is selected as a unit of correlation. Although it is an unnatural boundary it is the best unit for discussion of correlation in the text which is written to accompany the graphs. Pool outlines are constantly changing, not only in outline but in name.

Assume then, that the remaining records which are good, and which are probably half of the original number which has been plotted, have been grouped into townships or districts. The next operation is to arrange them into a satisfactory manner; east to west, north to south, or in an oblique direction as long as the direction is constant. The direction of the sequence is governed by the thickening and thinning of the strata or by structure of the rocks. The records are then laid out side by side on a long drawing table. They are carefully studied, and since there are still too many records to work with it is necessary to discard more of them. A careful study reveals, for instance, that several records on a certain lease are practically identical. One record out of four or five which appears to be representative of a small local area is chosen to represent that area. The remaining records are withdrawn, in order, and laid aside for future reference. If there is any particular variation at any point in these records a note is made of it. Through this operation of selective segregation the number of original records has been reduced to approximately 25 per cent of the original number, and now the geologist has enough representative records to properly correlate the sands in a small space which is usually available for the purpose of correlation. The records, which may number several hundred, are then laid side by side on a long table. They are studied carefully and a base line is chosen. This base line is the most readily recognizable and most persisten stratum which occurs in the greatest number of well logs; for instance in Wetzel County, West Virginia, that stratum is the Pittsburgh coal. A thin stout string is then stretched tightly across the table and represents the base line of correlation. All well records are then pushed up or down until the base of the Pittsburgh coal lies beneath this string. If certain well records do not contain the Pittsburgh coal, they are placed in a relative position to other well logs which have a definitely established base line and they remain in that position until all of the sands in the logs which have a definite base have been correlated. They then can be placed in an accurate position.

There may be several horizons common to a great number of records, for instance, some records may contain the Pittsburgh coal, the top of the Big Injun sand, or the top of another persistent sand, possibly the Thirty Foot, and between these sands a "red bed" may appear. All of these minor effects have their bearing upon proper correlation of the sands. The trial and error method must be used in properly placing the records in reference to the major base line; they must be shifted up and down, until the majority of the sands appear to correlate. After the geologist is satisfied with this preliminary correlation a notation should be made on the record after every sand as to its probable identity. This identity should be compared with the correlation given by the company on the original record and a note made of any variations which appear.

After all of the well logs seem to be in proper position, more strings are stretched across the board. Each string represents the average position of the top of a sand in reference to the base line, for instance, a line is stretched across the table at a point which seems to represent the top of the Big Injun sand in the majority of records in relation to the position of the Pittsburgh coal bed; another string represents the position of the average top of the Gordon sand. Several strings are stretched across the table until the approximate position of the major sands is fairly well established. A blank well record sheet is then slipped under the cords at the end of the table; the average top and bottom of each sand in reference to the Pittsburgh coal is projected upon this blank record from the position of the sands. The space between the lines which represents the average top and bottom is then colored. This space does not represent the average thickness of the sand but it does represent the stratigraphic space in which the sand occurs or the stratigraphic variation which is characteristic of each sand. The writer calls the resulting section a "preliminary composite section". It shows graphically the position of the average top and bottom of each sand, whether it be productive or non-productive, in reference to one or more key horizons.

In order to make a very definite check upon the preliminary correlation another and final procedure is necessary. The records are plotted on 1/10 inch cross section paper in the order in which they are laid on the table. The scale on the cross section paper is 1 inch equals 100 feet which is the same scale that was used in plotting the original well logs. The well logs are plotted in order from left to right by placing dots on the graph which represents the top and bottom of each sand. The base line which has been chosen is a level line and various sands above and below it change in their vertical position as the strata thicken and thin. The dots are joined by a vertical pencil line which represents the thickness of the sand, which can be read directly from the cross section graph. The dots which represent the top are joined by a pencil line and then the dots which represent the bottom are joined in a similar manner. This procedure results in a mechanical figure which shows the relative positions of the top and bottom of the sands and the thickening and thinning of each sand. Each well record is numbered at the top and a corresponding number is placed on a topographic map, so that not only the variations is position and in thickness of the sands can be quickly determined at various points on the map, but the changes which take place in these characteristics can be traced from locality to locality, and from well to well. After a definite figure has been established for each sand another composite section should be drawn alongside the figures in the following manner; the mean position of the average top and average bottom of each sand is determined by placing a draftman's transparent triangle in a position so that equal parts of the area between the highest top and lowest top lie respectively above and below the line of the edge of the triangle. This point is projected to the right and plotted. It represents the position of the average top of the sand. The same procedure is followed in establishing the average bottom of the sand. After the average top and the average bottom of the sand have been established and projected to the right in a vertical column, the space between the dots is colored in, and represents the average stratigraphic occurrence of the top and bottom of the sand above and below an established base line. This composite section is compared with the original and if adjustments are necessary they are made at this point in the procedure. The sands in the composite section are then named according to their stratigraphic position and given the names which they have at the type locality. For instance, the Gordon Sand was named from the Gordon farm near Washington, Pennsylvania. It is possible by the procedure which has been outlined to trace this sand through Washington and Greene Counties, Pennsylvania, to Wetzel County, West Virginia.

After correlation is complete in each township or district of a county, a number of composite sections are the result. Each township or district has its own composite section. In order to obtain a composite section of the entire county, it is necessary to plot each composite section and determine by the same procedure as was used in individual well records the average top and bottom of each sand for the entire county. The composite county section which results, has value only in giving to the casual reader a broader idea of the stratigraphic relationship of the various sands. This section will be at variance at certain points with each and every composite township section, but it should be constructed because of its general merits.

Conclusions

A geologist can rarely look at a well log and say, "this particular sand is the same sand that occurs 100 miles north of this point". This statement is not possible because very few sands are continuous for that distance, but he can say this; "here is a sand that is in the approximate geologic position of such and such a sand 100 miles north of this point. Its deposition was probably contemporaneous with that sand".

Oil and gas is produced from 50 or 60 horizons in 6000 feet of strata in the Appalachian district. Sands of approximate geologic age are producing in New York State and in West Virginia; in Pennsylvania and Ohio. If it were not possible to identify these sands operators would have no means of telling when they had passed through horizons they expect to be productive. Some of the most important operations in oil and gas production depend upon the correlation of oil and gas sands. The point of search, the depth of drilling, the position of casing and the depth of plugging depend upon intimate knowledge of underground stratigraphy. The closer the correlations are made, the more accurate are these operations. Time and money are saved by the operator who knows about the correlation of the sands in his property. Money and energy is uselessly expended by operators who drill for oil and gas in regions where they could not possibly be found. Many miles of hole have been drilled in search for sands which do not exist and many more miles have been drilled by operators who wish to be sure that they have passed through the sand for which they are searching.

The only way in which the correlation of oil and gas sands can be made more accurate is by core drilling at various strategic points. The cores can then be examined for paleontologic evidence; the composition of the various oil and gas sands can be examined and compared both chemically and physically. The limitations of geologic science are well recognized and a geologist must call upon mechanical devices to aid him in his search for definite conclusions.

THE PULPSTONE INDUSTRY OF WEST VIRGINIA

By
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Introduction

The greatly increased production of pulp in North America in the past 25 years has created a new industry for West Virginia which equals, or possibly exceeds, in quantity and value, the same industry in all other states.

The production of pulp has more than doubled since 1905. The tremendous increase in production of pulp has also increased the demand for pulpstones. West Virginia is now supplying over 1500 pulpstones a year and could supply many times that number of stones each year for an almost unlimited time.

The quarrying of pulpstones is at the present time centralized along the Monongahela River between Morgantown and Fairmont. The strata from which they are quarried are the Buffalo and Connellsville sandstones of the Conemaugh series of Pennsylvanian Age. A quarry was formerly operated at Uffington in the Mahoning sandstone at the base of the Conemaugh series.

Source of Pulpstones

The Buffalo sandstone. The Buffalo sandstone is massive, grayish and locally pebbly and contains occasional traces of organic material. It is hard and quite resistant to weathering. Occasionally cross-bedding and very thin layers of mica are found in it which makes it difficult to obtain a good pulpstone. This sandstone ranges from 10 to 100 feet in thickness and averages about 45 feet. It lies about 500 feet below the Pittsburgh coal. The sand grains are fairly angular and usually grade from the finest grains at the top to the coarser ones at the bottom. The Buffalo sandstone has been used with success as a building stone in Monongalia County. The quarries opposite Uffington and at Tice operate in this sandstone.

The Connellsville sandstone. The Connellsville sandstone lies 75 to 140 feet below the Pittsburgh coal. It is massive, blue gray, and is locally pebbly. Ordinarily it weathers to a brown color. The lower portion of the sandstone is usually darker than the top portion and contains a larger quantity of iron compounds.

Plant remains and small pieces of grahamite or solidified oil are found in it. Two quarries at Opekiska work in this stratum.

Size and Specification of a Pulpstone

The increase in pulp manufacturing and the change from water power to electrically equipped plants has changed the requirements for pulp grinders. Formerly the stones were small, soft, poorly cemented, and the sand grains were fairly large. The change has made such stones obsolete.

Standard Size of Stones

Diameter Inches	Cutting face Inches	Weight Tons
67	54	7–½
54	66	
54	62	
35	54	
27	60	2–½

The standard size of stones has changed from a stone 48 to 50 inches in diameter with an 18 to 20 inch cutting face to a stone 54 inches in diameter with a 54 inch cutting face. A magazine stone 67 inches in diameter with a cutting face of 54 inches is commonly used. The size of the stone determines the thickness which can be worn away before the stone is discarded. This thickness ranges from 6 to 14 inches. Different sizes of stone are used for different grades of paper. The large magazine grinder is used for the coarse grained pulp and the small stones are used for the fine grained pulp, however, the quality of the pulp does not depend upon the size of the stone. The size of stone has direct influence upon the amount of water used in cutting the pulp. A stream of water 8 inches in diameter is played upon the surface of the larger stone when it is cutting at high speed, while the amount of water used on the smaller stone is in proportion to its size.

Specification. The sand grains should not be too angular, otherwise they will pull out of the stone. They should not be so rounded that they will not cut fast and cause the surface of the stone to become gummed or glazed. The cementing material which holds the grains together should be strong and evenly distributed and of the same chemical composition throughout the stone. It must wear away from the grains of sand in such a manner as to give the grains a fresh cutting face. If the cementing material wears too rapidly the sand grain will be carried away in the pulp and the life of the stone lessened. The cementing material must be of uniform chemical composition since it is essential that the stone have the same hardness and strength throughout. If the stone is not of the same hardness and strength throughout it will wear too rapidly on one side or perhaps break. The cementing material which has proved the best contains a large per cent of iron compounds and it appears to conform to the qualities demanded of it.

The stones must be able to withstand nearly twice the pressure applied to the stones which were formerly used. They must operate against a pressure of 800 to 1200 pounds per square inch and as high as 250 revolutions a minute. The pressure against the stone is not constant. It may be grinding on one side and not upon the other. This demands a well cemented stone because unequal pressure applied to the stone may cause the stone to break and cause great damage in the mill; in this event the mill must shut down the broken grinder to replace it with a new one. Time is thus lost and the damage is sometimes great. Very often the stone breaks along cross-bedding planes or along thin layers of mica. Plant remains are often the cause of breakage.

Cost of Production

The average cost of producing a stone is approximately $200.00. The cost varies with the amount of overburden, the number of fissures and cross-bedding, the ease with which the stone is finished, and the amount of mica, organic and clayey material present. If too much of such material is present the stone must be discarded for it will be weakened by their presence. Mica, organic and clayey material are easily dislodged and carried away in the pulp and thus causing the paper to be gritty when finished. Another article of expense occurs each spring if the quarry is subjected to freezing. The face of the ledge must be cut back to fresh rock that has not been frozen during the winter months. The cost of curing a stone or storing it depends upon the stone. It seems that some stones must be cured or subjected to heat in order to complete the cementation of the material and to drive off the "sap water". Other stones appear to be cured or cemented to the proper degree for immediate use. The degree of cementation is indeed a hard problem to be confronted with. At the present time there is practically no way of determining whether or not the stone is of the desired hardness other than by actually inserting the grinder in the mill and using it. This process often costs the quarry a good customer for the stone may not perform as it should and the pulp mill may not wish to buy of that quarry even though the quarry may be able to remedy the properties which are not desirable. When all the factors in producing a stone are considered it is easily understood why the cost of producing a stone is sometimes enormous. A small chip knocked from the edge of the stone often causes it to be discarded. The stone may be cut down to a smaller size but $200 to $400 is lost in doing so.

Some stones have been used 24 hours a day for 400 days and have cut between 3,000 to 7,000 tons of pulp. This record is unusual for stones are seldom so durable. A few stones have made a better record which was most likely due to the pulp wood which was used instead of the durability of the stone.

The quality of the paper depends upon the stone, the quality of the pulp wood, and upon the process which is used in finishing the paper. Coarse grained stones are generally used in cutting coarse paper such as newspaper and box paper. Finer or smaller grained stones are used in grinding fine or smooth paper. Coarse grained stones are usually larger than the fine grained stones.

Manufacture of Pulpstones

After the overburden is cleared off a solid ledge of sandstone a channeling machine cuts a channel on the upper surface 10 to 12 feet deep. Cross channels are then cut on three sides of a solid block of stone about 15 to 20 feet square. It is then jarred loose by the explosion of dynamite or black powder in horizontal holes. This operation is followed by the splitting of the large block into patterns by wedges and explosives. The pattern is roughly square and is only 2 or 3 inches larger than the finished stone. The pattern is hoisted to the "scabbling" yard where the stone is chipped down to a rough cylindrical shape slightly larger than the finished product. The "scabbling" is done by means of a compressed air trip chisel operated by one man.

The stone is next placed on a lathe and cut to the desired shape and size. This operation is usually done by hand, because the operator can ordinarily tell the quality of the stone by the manner in which it cuts. The operations are truly marvelous because of the skill and ease in which the men make the finished product.

West Virginia pulpstones find a ready market in most any pulp producing area on the North American Continent, and wherever the West Virginia product is mentioned it is with high respect. Many stones are shipped to Oregon and compete with the Washington stone. The most popular markets for the West Virginia product are Maine, Quebec, New York, Vermont, New Hampshire, Wisconsin, Michigan, Oregon, Washington, and several other portions of Canada besides Quebec.

The companies operating along Monongahela River in Monongalia County are the Uffington Pulp Stone Company, the West Virginia Pulp Stone Corporation of Cleveland, Ohio, operating at Tice, The General Stone Company and the Smallwood Stone Company of Steubenville, Ohio, operating at Opekiska. The first two companies are using the Buffalo sandstone and the last two are using the Connellsville sandstone. The American Stone Company of Wheeling, W. Va., was one of the largest producers in West Virginia during the World War, but the quarry is now closed. The quarry was located at Littleton, Wetzel County.

The International Pulp Stone Company had its quarries at Jeffreys, Boone County. It placed quite a lot of fine grade stones on the market. Pulpstone companies have had considerable competition from Ohio, and Washington. A stone produced in England and the Norton Artificial Stone have also been popular. West Virginia probably produces more pulpstones than the rest of its competitors. The industry is crowded and some of the smaller companies have been forced to cease operating.

The Norton Artifical Stone is the only stone which gives the natural pulpstone quarrier any concern. It will be a strong competitor if the grinder can be made to withstand the heat as successfully as the natural pulpstone does. The English stone is thought to be better than those produced in America but the records of the stone do not show it to be better than those produced in the United States. The tariff on mineral products imported into the United States will keep the English stone from being a strong competitor. The fact that some companies have made maximum profits of $350,000 a year led to large investments in the industry which resulted in over-production and losses. The recent business depression has caused some of the companies to cease operating and the remainder are not working at capacity. During the World War large stones sold for as much as $2000 while the average price obtained for the stone at the present time is $1000.

The pulpstone industry will probably improve with business and become an important industry in West Virginia.

THE MINERAL COMPOSITION OF SANDS FROM THE MONONGAHELA, ALLEGHENY, AND OHIO RIVERS

By
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(Abstract)

This paper gives the results of the study of sands deposited in these rivers and concerns the mineral composition and the source of the sand grains.

For this examination sand samples were taken from the Allegheny, Monongahela, Ohio Rivers and their tributaries. These rivers drain an area which consists of sandstone, shale, and limestone of the Paleozoic Age. Many different minerals are found by these analyses but it is known that quartz forms the greatest amount of these sediments. It is supposed that all these sands are derived from sedimentary deposits but the minerals found in the samples taken from the Allegheny and Ohio Rivers show a more nearly direct derivation from igneous and metamorphic rock for the mineral content includes epidote, cyanite, hornblende, garnet, sillimanite, titanite, and larger amounts of tourmaline, muscovite, ilmenite and feldspar than samples from the Monongahela and Cheat Rivers. Leucoxene, both pure and impure varities, it is found most extensively in the Monongahela and Cheat River sands.

This abundance of leucoxene is a noticeable factor to be considered in the comparison of these stream deposits since this alteration mineral is not due to any action of the stream water for it is found quite plentifully in the rocks of this region.*

Morainal deposits in the northern part of Pennsylvania and of Ohio supply the abundance of heavy minerals in the Allegheny and Ohio Rivers while the sulphuric acid which contaminates the waters of the Monongahela River probably accounts for the lack of carbonate minerals in its deposits.

The more weathered condition of the rocks in the Monongahela and Cheat Rivers may also account for a great loss of minerals in these sands A greater part of the sediments of these rivers is from the residual soils caused by this increased weathering of the country rock.

*Dr. James H. C. Martens—Personal communication and comparison of our studies.

DRAINAGE CHANGES IN THE HEADWATER REGION OF DECKERS CREEK*

By
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West Virginia University.

Introduction and Acknowledgments

The purpose of this paper is to determine the origin of Deckers Creek in its present form. It has long been considered an antecedent stream, but I shall attempt to show that it is a relatively young stream which owes its present size and importance to the fact that it robbed the Tygart River of part of the latter's headwaters.

I wish to acknowledge the advice and help of Dr. S. L. Galpin, head of the Department of Geology at West Virginia University, who brought the subject to my attention; and Dr. H. M. Fridley, Assistant Professor of Geology at West Virginia University, under whose direction the work was carried on.

Stream Gradient

The profile of a naturally developed stream should show a steep descent along its upper course, with a gradually decreasing fall toward its lower course.

This however is not the case with respect to Deckers Creek, as may readily be seen in the accompanying diagram. An ideal curve has been dotted in for the sake of comparison.

Deckers Creek has two sections of steep gradient, a normal one where its headwaters descend from the hills onto a plain with an elevation of about 1750 feet above sea level; and a second just west of Cascade where the "plain" portion of Deckers Creek drops down into the older portion which flows normally into the Monongahela River.

The following figures, which show this change in gradient, were taken from the W. Va. Geological Survey Report on Monongalia County, page 43:

Extent	Total Fall	Total Dist.	Rate of Fall per Mile
Mouth to Dellslow	191	5.9	32.4
Dellslow to Falls Run	650	5.6	116.1
Falls Run to Reedsville	45	5.0	9.0

Tributaries

Deckers Creek tributaries are divisible into two rough classes. Those to the west of the Chestnut Ridge uplift and those to the east of it.

*Published with the permission of the State Geologist.

The former all seem to enter the creek in a normal manner, that is, pointing downstream at the junction or else entering at right angles to the main stream.

The second class of tributaries is however more abnormal. Most of them, except the smaller more recent ones, are either "barbed" or show evidence of having been barbed. That is they enter the main stream in an "upstream" direction.

A few good examples of "barbed" tributaries to Deckers Creek follow:

Falls Run
Glady Run
Slabcamp Run
Laurel Run
Swamp Run

In connection with the tributaries it might be well to mention the fact that the main valley of Deckers Creek widens generally from about Cascade southeast towards Brown's Mills in Preston County.

Alluvium

North of Brown's Mills, between the headwaters of Deckers Creek and the east fork of Stony Run, occurs an area of alluvial material resembling a former flood plain of a meandering stream. This alluvial material must have been deposited by the action of water.

"Reconstruction"

It is impossible to determine the course and extent of Deckers Creek before the uplift of Chestnut Ridge. However, shortly after the uplift Deckers Creek probably had its source on the flanks of the ridge.

For a distance of about a half mile below Sturgisson, Deckers Creek flows along the strike of the rocks through the Mauch Chunk shales and the Greenbrier limestone. These non-resistant rocks enabled it to cut down rapidly, making the grade from Sturgission to the top of Chestnut Ridge very steep. This ridge, capped by the relatively resistant, but rather loosely cemented Pottsville sandstones, is composed largely of Mauch Chunk and Greenbrier shales and limestones, easily attacked by both corrosion and corrasion.

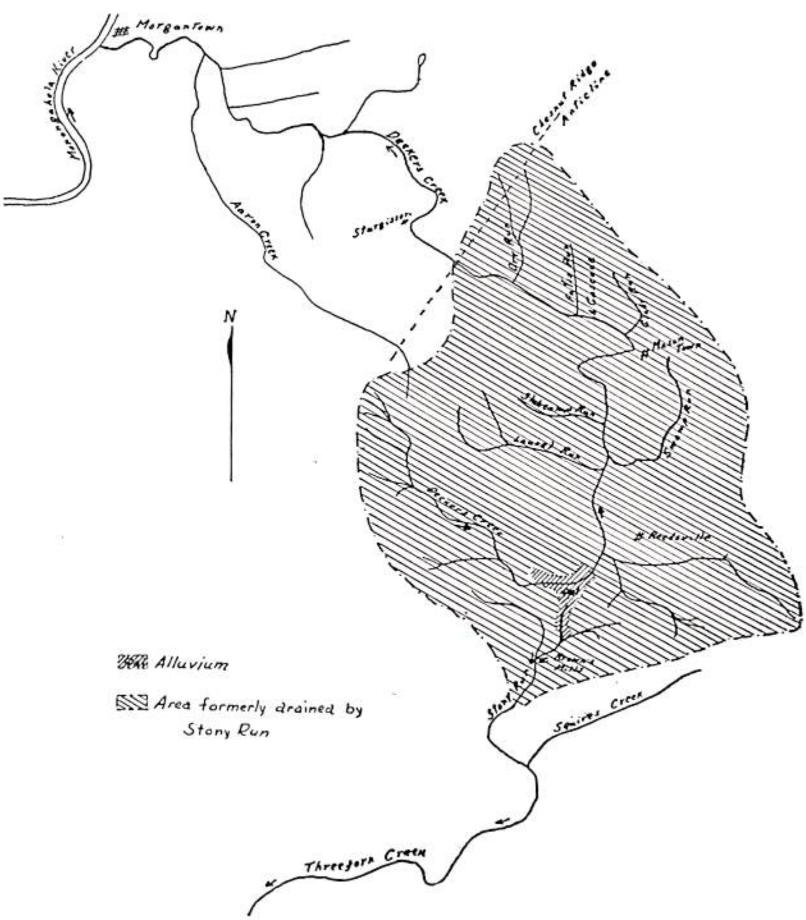
This rapid headwater erosion quickly enabled Deckers Creek to work back through the ridge and tap the headwaters of Stony Run, a tributary of Threefork Creek and part of the Tygart River system, which meandered over a plain in the vicinity of Reedsville and Mason Town. This plain had an elevation of from 1700 to 2000 feet above sea level. The run followed a meandering course very close to 1750 feet in elevation for many miles. The widened valley of this stream is still in evidence.

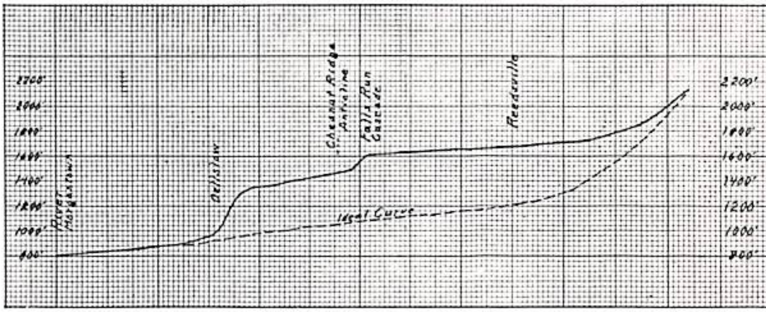
A slight ridge has been left between Reedsville and Brown's Mills as a divide, but this is covered with alluvium, showing the previous existence of a stream.

Conclusions

The "pirate" origin of Deckers Creek is shown by its peculiar gradient, its barbed tributaries east of Chestnut Ridge, the widened valley and the presence of alluvium between it and Stony Run.

Deckers Creek stream piracy did not take place by the migration of the divide, as is so often the case, but rather due to the fact that the Chestnut Ridge anticline so weakened the rocks and increased the gradient that the old Deckers Creek headwaters were enabled to cut back into and through the mountain formed by the uplift.




River
Morgantown
Dellslow
Chestnut Ridge
Anticline
Falls Run
Cascade
Reedsville
Ideal Curve
2200'
2000'
1800'
1600'
1400'
1200'
1000'
800'

ARCHAEOLOGY

By

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Archaeology is one of several methods used by students of Anthropology in their attempt to clarify the problems associated with the development and variation of the human animal and his cultures. The data of archaeology are those physical records which have been unintentionally preserved by natural agencies. Its purpose is to reconstruct the story of extinct human cultures by means of an interpretation of these records. Although a great deal has been accomplished in the past century, much still remains to be done.

In addressing a group such as this, composed of individuals interested in geology, it may be assumed that a knowledge of the past is admittedly one of the general aims of science. Paleontology, a division of geology, seeks .o arrive at the story of life through time by an interpretation of the records found within the various deposits laid down by the forces of nature, and sometimes disarranged and altered at a later period. These records consist almost entirely of the complete and fragmentary imprints or fossilized bodies of animals and plants. By a study of the association of records within the strata, and of the relations of the various strata to each other, it has been possible to construct a chronological outline of the development of life which is accepted by paleotologists, in spite of the fact that the time periods involved are almost incomprehensible to the layman. Moreover, because of the technical field processes developed in order to secure and preserve satisfactory data, and because of the detailed knowledge of biological variations required, a long period of training and study is demanded of all paleontologists.

Archaeology may be described in almost identical terms. It deals with the temporal aspects of Anthropology. It seeks to arrive at the story of the life of a single genus of animal, through time, by an interpretation of the records laid down in various deposits by the forces of nature. These records consist not only of the remains of the animal itself, but also of those objects which that animal fashioned from the environment about him. By a comparative study of the association of records, and of the relations of the strata in which they occur, archaeologists have come to agree upon an outline of human history, which is not well known to the layman. The development of a technique of excavation and preservation, and the necessary comparative knowledge of the cultural objects encountered, make it essential that an archaeologist spend several years in training and study.

In spite of this close similarity in the aims and methods of paleontology and archaeology, there are a few noteworthy differences in the data used. Because of the tremendous time element involved and the diversity of life, the paleontologist uses records of great variety found in rocks as well as soils. The archaeologist deals only with a single genus of animal which appeared upon the earth in geologically recent times. All of the stratigraphic record of man's story is, therefore, confined to the Quarternary period, and, as in paleontology, the record becomes more complex as time passes. The major part of it is found in the Recent epoch. The archaeologist therefore confines his studies to the strata in the surface soil, and is not concerned with those in the rocks below it.

The other point of difference is in the kind of records found. The paleontologist is concerned only with the biological changes which have occured in the forms of animals and plants. Were the archaeologist interested in only the morphological changes in man, the story would be simple and very vague. However, man is the only animal that has learned to alter the objects in his environment to suit his purposes, and to transmit these inventions to others, thereby creating a progressive and continuous development in this trait. The changes which occur in such man-made objects take place at frequent intervals, so that it is possible to trace through them the forces which have affected human development. Since archaeology has the same methods as paleontology, but is concerned only with a single genus of animal and with much shorter time periods, it might be considered, from this viewpoint, as a specialized form of paleontology.

Yet history is another field of research which also seeks to interpret the story of man through time. Through force of circumstance and mutual agreement, the bulk of the data used by historians is of documentary nature. But the invention of writing is a comparatively recent achievement of mankind, and therefore documentary history cannot go back to the beginnings of culture. Those historians who concern themselves with the pre-writing stages of the cultures which later become historic, must use the archaeological method in securing data. It can be and is used to verify documentary evidence, through the excavation of historic sites. Archaeology therefore stands in much the same relationship to history as paleontology does to archaeology. It is the connecting link between the two disciplines. Neither can entirely ignore it, nor desire to do so. Paleontology plays an important part, and is vitally concerned in the interpretation of the earlier data of archaeology. Similarly, history is just as intimately interested in the later phases of such data. However, since the principal subject matter of each is not of an archaeological nature, and since archaeology in its turn deals with data included in neither paleontology nor history, there must be a definite field for this branch of the science of Anthropology.

It is almost an axiom that where man has lived, there will be found archaeological data. The discoveries of **Pithecanthropus erectus** in Java, of the Mauer Jaw in Germany, and of the Piltdown skull in England, when studied in the light of associated known paleontological evidence, prove that man existed during the early part of the Pleistocene as a separate genus of animal. The many discoveries during the latter part of the 19th century in Europe demonstrated that this animal had already begun to make use of his environment before the close of the Pleistocene, a conclusion which is being supported by current finds in Europe. Similar archaeological explorations in the river gravels, on the hill tops, and in the lake bottoms, have made possible a synoptic story of the progress of culture in Europe from the close of the Pleistocene, through the Neolithic, Bronze and Iron Ages in Central Europe to the dawn of recorded history in that area some twenty centuries ago.

Further south, in the Mediterranean basin, archaeologists have been able to fill some of the gaps in recorded history. Witness the Cretan chronology based on the ceramic studies of Sir Arthur Evans. Mr. Wooley, working at Ur, Flinders Petrie and Breasted in Egypt, and many others have each added their share to the verification of recorded and semi-mythological history through the discovery and interpretation by archaeological methods, of unintentional records.

A similar story can be told of the gradual unravelling of the pageant of New World history prior to the sixteenth century. It has been found that the spectacular civilization encountered by the first Spaniards on the west coast of South America was but the last of a series of cultures, each of which contributed its share to the development which has since become famous for its weaving and pottery.

We now know that in Mexico and Central America agriculture was invented approximately six thousand years ago, and that the ancestor of the famous Maya civilization became the fountain head of American agricultural civilizations. Here in Guatemala is the only New World group which invented hieroglyphic writing. It has the further distinction of being the first group in the world to invent a symbol for zero or completion, and a positional notation of numbers.

As one moves northward from this center, the cultures become less complex and therefore less spectacular. In our own southwestern states, the Peublo Indians developed a sufficiently interesting culture to be dubbed the "Cliff-dwellers", about which queer fables have been invented. Archaeologists have outlined the history of these people over a period of about thirty centuries, and recent studies of tree rings have led to the definite knowledge that the famous cliff villages of the Mesa Verde

National Park and surrounding regions were inhabited between the tenth and thirteenth centuries of our era.

Similar progress has been made in the eastern part of our country. The old term "Mound Builders", while it still has a popular meaning, no longer refers to a wonderful, mysterious race of human beings, but to a number of Indian groups living in a variety of cultures throughout the length and breadth of the Mississippi Valley. Archaeological work in Arkansas, Alabama, and Georgia in the south; in Wisconsin, Illinois and Iowa, in the north, has done much to bring out the interesting details of the pre-Columbian history of these regions. In New York state, the devoted labors of archaeologists have given us an outline of the early history of the Algonkian and Iroquoian peoples.

The Mississippi Valley neighbors of West Virginia have done much in archaeology. For over forty years, systematic research has been carried forward in Ohio. This state heads the list of archaeologically-minded states of the Valley. It was the first to publish an archaeological atlas, the first to define Indian cultures within its borders, the most famous of which is the Hopewell culture, and the first to take advantage of its archaeological sites by creating parks to be used for adult education and recreation.

Kentucky, through the efforts of university officials, is making good progress in determining the archaeological assets of its hills and valleys, and in characterizing its Indian cultures.

Last year in Pennsylvania, a Society for Pennsylvania Archaeology was formed as the result of several years' effort by local enthusiasts. Field parties were sent out to supplement the information secured through a state-wide survey by mail, and this state now has the distiction of being the locality in which the most valuable scientific field work in the northeastern states was done last year. I refer to the discoveries made near Safe Harbor on the Susquehanna River.

And, finally, after this hasty glance at archaeology in Europe and the New World, let me bring the record to your very doorstep by reminding you of the excavation of a mound last summer by the Museum of the University of Pennsylvania at Beech Bottom, near Wheeling, made possible through the interest of business men of that city.

It is clear, then, that wherever man has lived, there he has left records, usually quite unintentionally. In North America alone, during the calendar year 1930, fifty-three recognized institutions sent seventy-five archaeological expeditions into various parts of the continent. The interest of the scientist and of the public in the pre-Columbian development of human life in North America is increasing every year. Yet the public interest is not as great as might be expected. There are at least two factors in the possible cause for this condition.

Because of the spectacular archaeological finds made in Mesopotamia, Egypt, and Central America, and the attendant publicity, many individuals associate romance with archaeology, and this romance is confused with the desire to travel and see new regions. Therefore, many associate archaeology with distant places and fail to realize that the story of man's past is at their very door as well as on the other side of the world. The romance lies only in the mind of the modern interpreter of the evidence found in the ground.

The other factor is the activity of curio collectors who style themselves archaeologists. An interest in collecting records of the past is a natural and laudable one. It may lead either to a commercialization of these objects or to an intelligent interest in their story. Unfortunately there has developed in North America a commerce in "Indian curios", which has led to vandalism and the placing of fictitious monetary values upon objects which once had historic value, but which, when sold and traded, soon become worthless. The hobby of collecting "Indian relics" is actually of less value than collecting postage stamps or cigar bands, for the latter at least have marks of indentification upon them, while the "relics" do not. This hobby is not only valueless, but also vicious, for it leads to the wanton destruction and consequent irreparable loss of historical records. Trained archaeologists cannot deal with this class of amateur.

There is, however, the other type of amateur with whom all natural scientists are acquainted—that is, the person who makes a science an avocation by means of which, through cooperation with proper authorities, he renders a unique service. An intimate knowledge of a restricted collecting area, combined with an appreciation of the scientific problems involved, equips such an amateur with a means of supplying data which otherwise might never be found. It is one of the duties of the scientist to encourage such amateur interest.

The popular conception of archaeology as a romantic scientific occupation in distant lands, and the activities of uninformed and often vicious amateurs, has belittled the importance of local archaeology in public opinion, without, however, in any way affecting the value of the proper study of the unintentional records of that group of mankind which occupied our country before the arrival of the Europeans.

Local archaeology should have the support of the geologists because it completes the record of life in the region and supplies pertinent data for the Pleistocene specialist and the physiographer working in Recent deposits. The methods and techniques of the archaeologist, because of their similarity to those of the paleontologist, create an added bond between these two disciplines.

The historian should also be interested in local archaeology. By means of research in this field, a knowledge may be secured of the civilizations preceding our own in the region. The Indians who were in the

New World before us gave us not only the land which we call home, but also the major routes of travel through the region, the sites for most of our towns and cities, and such farm products as corn, potatoes, cotton, beans, squashes and tobacco, which we have come to take so for granted that we overlook their origin. Just as a history of Europe begins with those cultures which contributed to the creation of 16th century Europe, so the history of the United States must begin with the story of the Indian civilizations which have left their imprint upon 20th century North America. The human history of a community is the story of man in that region, not the story of only one of his civilizations.

Archaeology should also interest those business men who are concerned with the development of their community. It is a part of the historic record, which becomes the community's memory if adequately preserved in parks and museums. A knowledge of former conditions and problems tends to create wise leadership by those in power, intelligent pride in the community on the part of the residents, loyalty to the group among the growing children, and an interest in the region by visitors. A community that knows not its past cannot judge its present problems wisely.

If I have succeeded in what I undertook to present, it is safe to assert that an interest in the archaeology of a community, whether it be a river valley or a state, is a logical part of the scientific life of that community.

In fostering such an interest, it is first necessary to make a survey of the assets of the community for archaeological research. These are of two kinds, namely, the data and the interested personnel. The data consists of documentary evidence of Indian life in journals, histories, surveyors' and military records; of localities which still possess Indian remains, such as village sites, burial grounds, and mounds; and of existing collections of Indian materials which may prove to have historical value.

In making such a survey, a knowledge of the interested personnel will inevitably be obtained. A preliminary survey of the materials can best be made by means of a circular letter or questionnaire addressed to officials who might be interested, such as County School superintendents, County surveyors, High School principals, newspaper editors, etc. Through these channels the names of the local amateurs would be secured, who could then be visited, and by personal observation sorted into groups on the basis of usefulness. When the preliminary survey of the region is completed, then those in charge will be able to judge of the best places to carry on intensive archaeological research—that is, excavations.

Such is the logical method of inaugurating an archaeological study of a state. Unfortunately, in some instances, public opinion demands exciting returns from such research. It may be necessary, therefore, to do some excavating each year, even if the preliminary survey does occupy eight years, as it did in Iowa. Excavations should be carried out by trained archaeologists.

Such a program cannot be consummated by a private citizen, no matter how enthusiastic or wealthy he may be, or how strong amateur interest may seem. A public service, even in science, must have the endorsement of some recognized organization to win public support. Yet no matter what agency supports the work, its guiding force must be one or more enthusiastic scientists. No research work can function without a leader.

It is, of course, preferable to have an archaeological survey sponsored by some existing state or local organization, such as a State Museum, a State Department of History, or of Conservation, a State Institution of higher learning, or a research department. If all of these prove uninterested, then it may be advisable to create a private, or semi-public organization.

Let us see what some of the other states have done. In Ohio and New Jersey, the archaeological work is carried forward by State Museums, which in the former state is under the direction of the State Historical Society. In Indiana, Wisconsin, and Iowa, the State Historical divisions conduct the work. In Michigan, Kentucky, and Illinois, the State Universities carry on this research. In New York, there is a State Archaeological Society, and in Pennsylvania, a Society for Pennsylvania Archaeology. In Illinois, the University of Chicago, an endowed institution, does archaeological field work. In New York and Wisconsin, Municipal Museums at Rochester and Milwaukee are also doing archaeological research. I have mentioned the organization of the work in those states containing approximately the same archaeological assets as West Virginia. Research in this subject was done last year in twenty-five states and Alaska and Canada.

It is clear then, that there is a field for archaeological research in your state, and that most of the surrounding states are already carrying forward such researches. I hope that the Academy, and especially this Section of it, will become interested in furthering this branch of science within the borders of West Virgina.

THE RELATION OF SCIENCE AND INVENTION

By

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Modern civilization is the product of many factors. Capital and labor, administrative genius and salesmanship; educational, governmental, social welfare and religious agencies; law, journalism, art and literature have all made essential contributions. It is my privilege to-day to speak of two basic factors without which civilization could not have advanced beyond its primitive stage—science and invention. Without invention mankind could not have survived the ravages of the beasts of the jungle and the rigors of the seasons. Without science, civilization would have remained in a primitive state. They are the tools with which mankind has wrought in all his forward movements. Of these inventions came first and still remains the essential link which connects scientific discoveries with their practical application.

It seems to be the popular impression that all the scientist has to do is to shut himself up in a musty laboratory with his microscopes and test tubes and presto he makes a discovery which creates a new industry or transforms an old industry almost over night. Many of our industries are based on the sporadic discoveries of the lone scientist working aimlessly in his attempt to discover some new law or new compound, but in most instances such discoveries have lain dormant for decades before a useful application has been found and then by some inventor other than the scientist himself. This was the old method when the scientist was disassociated from industry and still had its place in the exploration of unknown fields not covered by industry.

However, the discoveries which excite the imagination and which immediately revolutionize previous industrial practices are those that have been undertaken as definite projects to supply a definite human need.

Restating these two methods of scientific procedure, they are:

1. Independent pure scientific research intended to enlarge the scope of human knowledge without reference to the application of the results.
2. Cooperative and individual research on well defined projects with a definite end in view.

The results of research that has been undertaken without a definite purpose in mind cannot be made useful until after invention and long and tedious investigations of a semi-commercial character. Let me give you two examples. The fundamental principles underlying the generation of electric current were discovered by Michael Farraday a little over a hundred years ago, but the dynamo as a useful factor in industry is a product of the last fifty years. The wave theory and the theories underlying the transmission of sound had been known for many years by the physicist, but it was not until Marconi invented wireless telegraphy that these principles were harnessed for the benefit of society. In the main, the entire electrical industry is based upon and grew out of the fundamental scientific discoveries of Farraday and others, but without invention our knowledge of electricity would be confined to a few fundamental principles, interesting but useless.

The second class of scientific investigation is that which comes as the result of invention or previous discovery. In contrast with the electrical industries the mechanical industries are mainly based on invention. The electrical discoveries called forth the best inventive genius of all times, to harness them for man's use, the mechanical inventions called for army after army of engineers and scientists for their development and adaptation to the ever growing needs of the industries. Without invention the scientist would probably have still remained a magician or an alchemist. Without subsequent scientific research and development the inventor would not have advanced much beyond the stage of the toymaker. In the main, the inventor has opened the way for the scientist and has provided him with the problems to be solved, the materials and instruments for his research.

Again a few examples will serve to illustrate the points involved. Unless fire should be considered the two epoch making inventions that I believe have meant more to humanity than any other are the printing press and the steam engine. Neither could have attained their present development without the other and, without subsequent scientific development, engineering design and the other forces which go to make up our industrial progress, they would have remained in a crude state. Both were invented by mechanics, and were the outgrowth of a human need rather than a by-product of scientific research. The mere mention of the printing press carries with it its claim for importance but few realize the importance of the steam engine. James Watt in inventing the steam engine wrote the emancipation proclamation for the serf and the slave. Industrial revolution brings in its wake social revolution, lagging behind, it is true, but none the less sure to follow. For thousands of years the productive work of the world has been done by slaves and serfs, but with the most primitive equipment and facilities. The steam engine in less than fifty years after its development had found such a wide application in shop and factory, in navigation, transportation and mining that it had largely taken the place of the slave and the serf. Wherever the steam engine has penetrated, slavery and serfdom have vanished. Its ultimate mission is to abolish poverty and want.

The good old days, except for the few, were days of privation and of unremitting toil for the bare necessities of life—days of abject slavery for the needs of the body. The steam engine inaugurated the "age of power". It has given to each man, woman and child in this country the equivalent of perhaps a hundred slaves. It made possible the automatic machine, mass production, electrical service, higher wages and leisure hours for the workman. Today there are few families which do not have an automobile and a radio and who do not have leisure hours for recreation. Secretary of Labor James J. Davis says: "I hail the present day, with its labor saving machinery and mass production as the greatest that has dawned in the annals of man. To determine that all men shall have enough to eat and wear and a comfortable house in which to live may not be the highest ideal of which humanity is capable, but I believe that this ideal may be realized before any other ideal can be." Secretary Davis believed that this ideal for the United States was near at hand, but this was written before the present depression.

In tracing the relationship between invention and science, it should be noted that most of the great epoch making inventions, especially those of a hundred or more years ago, were the creations of men who were neither scientists nor engineers.

Watt, the inventor of the steam engine, was an instrument maker. Of those who followed Watt in extending the use of the steam engine, Stephenson, who developed the locomotive, was a fireman; Awkright, the inventor of the spinning frame, a barber; Cartwright, who invented the power loom, was a clergyman; Robert Fulton, who built the first commercially successful steam boat, was a portrait painter; Bessemer, who invented the Bessemer process for making steel, a type founder; and coming down to modern times, Wilbur and Orville Wright, who built the first successful aeroplane, were mechanics. It should be admitted, however, that all these pioneer inventors, so far as I have been able to learn, in developing their respective discoveries, became through wide reading, study and research the foremost engineers of their times in their respective lines and knew all there was to know about the sciences underlying their inventions. If the older inventors had not been able to put their inventions into practical use and to attract capital, their discoveries would have lain dormant like many others because there were no trained body of scientists and engineers to do the work for them.

The case of the development of the aeroplane is somewhat different. It may be fairly said that the invention of the aeroplane grew out of scientific investigation though the first successful plane was built by mechanics. Langley, the real pioneer in the development of air craft, deserved to succeed, but invention and design had not progressed far enough at the time of his investigations to enable him to design and install suitable motive power for a heavier than air flying machine. The development of the automobile motor paved the way for the aeroplane and when the Wrights began their work many of the problems which confronted Langley had already been partially solved—motors had been developed that could be adapted to flying machines, better materials and enlarged and improved manufacturing facilities were available, more was known about the related sciences and there was a much larger body of trained scientists and engineers ready to carry the work forward. The military needs of the times created the demand.

The Bessemer process is often spoken of as a triumph of chemistry, as a matter of fact the inventor was not a chemist, but his process created or recreated the metallurgical science and as in the case of the steam engine which called forth thousands upon thousands of scientists and engineers, capitalists and mechanics for its further development and for its application. The Bessemer process created a rich field for the chemist and the metallurgist in the further development of steel making.

The coming of the steam engine and its subsequent developments does not mark the beginning of science or engineering, but it robbed science of its mysticism and transformed it into a humanitarian agency. At the same time it transformed engineering from a sort of secret guild to an exact scientific profession. The developments following the introduction of the steam engine, rapid as they actually were, seem slow to us to-day when capital and manufacturing facilities are at hand and ready to utilize a discovery. The process of developing a new industry even with existing facilities is not, however, as simple as it sounds.

The automobile was late in coming. All of the materials, mechanical movements, motive power, equipment, fuels, lubricants and process necessary for its development were apparently at hand. Only the idea and a harmonious combination of the materials and parts were lacking. We know better now. We are surprised that we knew so little thirty years ago. Springs snapped, axles bent or broke, tires blew up, ignition was uncertain and everything about the new cars was imperfect. Those who operated automobiles in the early days spent most of their time cranking, pumping up tires, carrying water or in walking for a team to pull them out of a mud hole.

In passing from the stage of invention to that of design and utilization the new industry demanded complete changes in design, new and specially adapted materials, new accessories, and called into being another new army of engineers, metallurgists and scientists to solve its problems. The result as you know was another revolution in the steel, rubber, petroleum, and painting industries, new fabrics, new electrical industries, new methods of mass production, new anti-freeze compounds, new non-shattering plate glass and so on, covered by thousands of patents, to say nothing of new mechanisms, changes in design, the subsequent rebuilding of highways and the vast investment in garages and other facilities necessary to produce and make use of the automobile in its various forms. The full significance of the automombile has not yet been realized. If you want to know more about this development read the new book, "Men, Money and Motors". A review of this book in the Sunday papers gave a most interesting account of the tragic romance of the self-starter which affords a typical example of how the research engineer builds up an invention from untried scientific data to meet an urgent need.

"Publication of the book, "Men, Money and Motors", reveals for the first time the story behind the development of the self-starter. The authors, Theodore F. MacManus, Detroit advertising man indentified with the automobile industry for 25 years, and Norman Beasley, say this invention, more than any other single development in the industry has been the motivating force behind the vast popularity the motor car has achieved.

"It is a morning early in 1910. The scene is in the office of Henry M. Leland, then president of the Cadillac Motor Car Co. Charles F. Kettering an electrical engineer, and even then a man who had assumed a dominant role in the inventive phase of the automobile business, was telling Leland of his idea for a self-starter. Leland after listening, began discussing the death of a dear friend.

" 'He was driving across the Belle Isle Bridge, here in Detroit,' Leland was saying, 'and he saw a woman trying to crank a stalled car. Stopping his own machine he got out, went over and asked if he could help".

" 'The woman thanked him and explained she did not have sufficient strength to spin the motor. He grasped the crank handle. Tried to spin it. The engine kicked back and the handle struck him in the jaw. Unthinkingly, the strange woman had not retarded the spark. My friend died—from the injuries.'

"Leland got up from his chair, walked over, and stood looking out of a window. His lips were trembling. His eyes were moist. Kettering, staring at the floor, was silent. Finally the manufacturer turned back.

" 'You know, I loved that man. I am glad you are going to work on something that will do away with hand cranking.

"Kettering returned to Dayton and through the hours on the train he thought of little else. All through the next day it was in his mind. and the next day—and the next—until days crept into months. A year later he brought what he had built to Detroit and demonstrated it to Cadillac engineers. They were skeptical.

" 'How does this device work?'

" 'It operates off the storage battery.'

"This must have sounded ridiculous to them, for they laughed.

'Don't you know that no small storage battery can furnish enough power to crank an automobile?'

"Kettering was unimpressed. 'How do you know this starter won't work until you try it?' he asked.

"That sounded reasonable as a suggestion so they made the test. The self-starter worked.

"The reason it worked was because Kettering had spent months and months experimenting and perfecting its details. He knew his device would respond to all necessary demands placed upon it. A year before, electrical engineers had told him that a small storage battery could not furnish enough power to crank an automobile, so the arguments the automobile engineers advanced were theories he had already eliminated.

"Once his experimental car slid into a ditch, breaking his leg. That same night the garage which contained the Cadillac test car on which had been installed the only other self-starter in existence, was destroyed by fire.

"If all the progress that had been made toward getting the self-starter on an automobile were not to be lost then some one had to put it in working order, so performance tests at the Cadillac company could be continued. No other person was familar enough with the mechanism, so Kettering, two days after his accident, with his broken leg in a heavy cast, traveled 200 miles on a train, from Dayton to Detroit, and then worked on his back, underneath a car, until he had his starter again in operation.

"Several months later, in June, 1911, Cadillac announced electrical starting, lighting and ignition as standard equipment for its cars. Kettering, inventor of them, is now president of the General Motors Research Laboratories and a vice president of General Motors."

The telephone, telegraph and the radio, and the aeroplane, though growing out of scientific research, have been passing through the same stages of research and invention and then further research leading to still new inventions as defects and new objectives appear.

All of the great companies of to-day recognize that further advance must come from directed organized scientific research and not only maintain adequate staffs of designing engineers, but have well organized research departments manned by the highest type of research engineers and scientists.

Man when thrown upon his own resources and told to go forth and conquer the world began by using the materials and forces near at hand —wood, stone, copper, gold and silver, then brass, iron and cement requiring more complex treatments. In a crude way he made use of animal power, the wind and the waterfall and finally steam. In the realm of mechanical movements and tools, he discovered the use of the club, the ax, the lever, the inclined plane, the wheel and axle, the pulley, etc.

These simple elements, except for new combinations, have long since been exploited and the more recent advances have come from the application and use of new hidden forces and elements which have been wrestled from nature after long and patient research. Further advance means that we must go still deeper in to the hidden recesses of nature. For centuries the inventor blazed the path of progress; in the future the research engineer and the scientist must take the lead. Now and then we may expect sporadic inventions and sporadic scientific discoveries of great importance, but there will be fewer discoveries like that of Goodyear when he accidentally discovered how to vulcanize rubber. The great advances of the future will not be the product of one man, but will come rather through organized and directed team work combining inventive genius, pure scientific and engineering research and engineering design of the highest order, backed by capital and manufacturing facilities.

DETERMINING THE ASTRONOMICAL UNIT

By
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The astronomical unit is the mean distance from the earth to the sun. The present adopted distance is 92,897,416 miles. The problem of finding this distance is one of the most important and difficult presented by astronomy. Important because this distance is the unit to which all measurements of the solar system are referred. Difficult because measurements which determine it are so delicate that any slight error of observation is enormously magnified in the result. There are several ways of determining the sun's distance and the values arrived at differ from the mean by not more than 1 in 1500. The most accurate method known at present is the measurement of the parallax of Eros. Eros is an asteroid or minor planet discovered in August 1898, photographically, by Witt of Berlin. From the numerous observations which have since been made its elements are now known with very great precision. Its sidereal period is 643.23 days, and its synodic period 845 days, the longest known. Its mean distance from the sun is 1.458 times the earth's or 135,430,000 miles. The accentricity of its orbit is so great that at aphelion it is 165,630,000 miles from the sun, while at perihelion its distance is 105,230,000 miles. The least possible distance between the earth and Eros is 13,840,000. This distance is reached when Eros come to opposition and perihelion at the same time, making it the closest planet to the earth, hence the one that can be measured most accurately. Eros was in perihelion Jan. 17-1931 but the earth did not overtake it till 13 days later where the two planets were 16,200,000 miles apart. The word parallax means the apparent displacement of a heavenly body depending upon a change in the position of the observer. In (Fig. 1) and observer at A would see a body at E in the direction AE while if he shifted his position to B he would see the body in the direction of BE. The difference in direction of AE and BE is measured by the angle E. The angle E would be the parallax of a body at the point E. To be of value the length of the line AB must be known. For bodys near the earth the equatorial radius of the earth is used. Knowing the value of the line AB in miles and the angle E in seconds of arc to find the distance to E—using the radian as the unit of measure—multiply the distance AB by 206,265 (the number of seconds in one radian) and divide by the number of seconds in the angle E. In astronomical calculations this method is permissable for the angle of parallax is always small. Even for an angle of five degrees the difference between the sine and the arc is only one unit in the fourth decimal place. Knowing the sidereal period of a planet it is possible to make a series of observations and determine its distance from the sun in terms of the earth's distance. For example the distance of Mars may be found as follows. Let S (Fig.

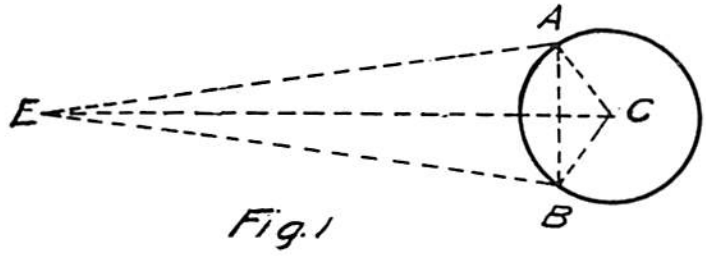

Fig. 1

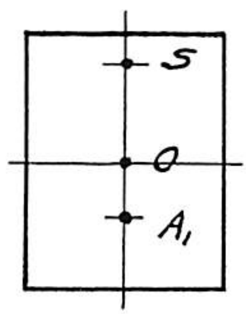

Fig. 2A

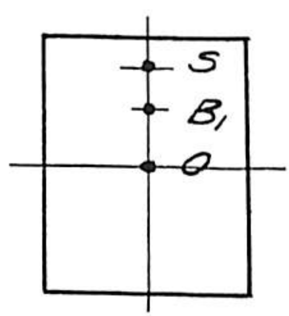

Fig. 2B

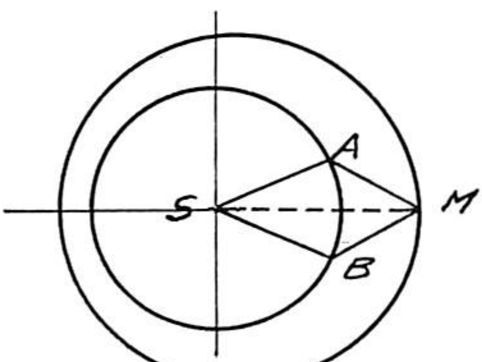

Fig. 3.

3) be the sun, A the position of the earth at any date and M the position of Mars. By means of a meridian circle measure the angle SAM, at the end of 687 days (the sidereal period of Mars) Mars will again be at M but the earth will be at B, the angle SMB will then be measured. In the quadrilateral we have measured the angles at A and B, the angle ASB will be the angle the earth passes over in 43 days, (the difference between 730 days or two revolutions of the earth and 687 days the sidereal period of Mars) and SA and SB the radius of the earth's orbit. We can now solve the quadrilateral and determine the distance SM in terms of SA. By such methods it is possible to find with great accuracy the mean distance of a planet from the sun, at any time, in terms of the earths distance, and a map of the solar system formed, but without a scale of miles. The measurement of any one planetary distance will then be sufficient to express them all in miles, hence the reason for determining the distance from the earth to Eros. The principle of finding the parallax of Eros is as follows. In Fig. 1 let the circle represent the earth whose center is at C. A and B two observers on the earths surface and E the asteroid Eros. From the elements of the orbit of Eros, its position in the sky as seen from C can be computed with great accuracy. Let this position be O Figs. 2A & 2B which represents the plates taken by the two observers, and let S be a star photographed on the plates with Eros. The exact position of the star S being known. The observer at A will photograph Eros at A1, below O, while B will photograph it at B1, above O, photographs to be taken simultaneously. By measuring on the photographic plates the angular distances SA1 and SB1 the value of A1B1 and hence the angle AEB is obtained. This is the amount Eros is displaced in the sky as seen by the two observers A & B. Knowing the dimensions of the earth, the length of AB can be determined, the triangle EAB solved and the distance EC determined. The latest information available states Eros is elongated in shape, about 20 to 25 miles long and 8 to 10 miles in diameter. The astronomers have arrived at their conclusions about the size and shape through observations of the period of variation in the range of intensity of light that comes from that planet. It revolves once on its axis in 5 hours 16 minutes 12.94 seconds and has four variations in this period. It is explained that as one side is turned toward the earth the intensity increases, then falls as one end turns toward the earth, ncreases as the other side comes into view and falls as the other end appears.

THE THEORY, PRODUCTION AND USES OF ULTRA-VIOLET RAYS

By
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Ultraviolet radiations consist of but a very small part of the solar electromagnetic wave band, the wave lengths of which vary from 5300 millimicrons to less than 292 millimicrons. Ultraviolet light is made up of waves whose lengths vary from 400 millimicrons to about 13.6 millimicrons. However, the limit of the solar spectrum in the ultraviolet is about 292 millimicrons and is due to absorbtion by ozone in the upper layers of the atmosphere, but by artificial means shorter wave lengths may be produced.

Ultraviolet light may be divided into three groups of wave lengths, the first extending from the visible spectrum to about 300 millimicrons or 3000 Å. These wave lengths are emitted by the sun in large quantities, are but slightly absorbed by the atmosphere, and the photochemical reactions they produce are almost always exotheomic. Their physiological and biological properties are similar to those of the adjacent violet and blue light, but more intense; also, they have practically no destructive action on low forms of life such as bacteria. The second group of waves extend from about 300 millimicrons to about 200 millimicrons. Only the longer of these waves are found in solar radiation. They are greatly absorbed by many substances and, therefore, produce intense chemical effects. They may be produced by the spark gap, mercury vapor lamp, or by other means, and are very effective for sterilizing purposes—the shorter the wave length the greater the bactericidal action. The third group, the extreme ultraviolet, consists of wave lengths shorter than about 200 millimicrons or 2000 Å—wave lengths that are absorbed by a few centimeters of air and, therefore, can scarcely be technically considered.

The theories of ultraviolet rays are necessarily the theories of light and, by assuming the latter to be a transverse wave motion spreading out from its source, various phenomena such as interference are easily explained. However, many effects of light are explained better by the quantum theory, according to which quanta or "bundles of energy" are emitted from the source at intervals. The quantum theory adequately explains many effects, such as photoelectric phenomena, Bohr's theory of the atom, and the relationship between the wave lengths of lines in emission spectra. The gulf between these two theories is wide, and neither appears to be able to explain all of the phenomena of light in various espects. This unsatisfactory condition is receiving extensive investigation, and we hope that a theory of light of more fitting character will result. Previous to about 1800, the old corpuscular theory that was supported by Newton was generally accepted, according to which light consists of minute particles of matter shot off by all bodies that radiate light or heat, and which produce their effects upon impact. This theory was unable to explain interference of light satisfactorily and was discarded in favor of the wave theory which was first suggested by Huygens and later contributed to by Young, Fresnel and Maxwell. Since waves must have a medium, it became necessary to postulate the existence of an "ether" having no mass but pervading all space. For about a century the ether theory was satisfactory in explaining all the phenomena of light then known.

The discovery that the visible part of the solar spectrum comprises only a small portion of the total radiant energy led to investigations of the invisible radiations—infra-red, ultraviolet and X-rays particularly, which produced results of much importance in regard to the theories of light. About the beginning of the 20th century it was observed that X-rays have the power to detach electrons from the molecules of gases through which they pass. As but a very small portion of the molecules which the rays pass are affected, it is difficult to explain this phenomenon on the basis of a wave front of uniform energy. Also, when ultraviolet light falls on metals, electrons are ejected producing the photoelectric effect. However, the energy of ejection does not depend upon the intensity of the incident light, which is difficult to explain on the basis of the wave theory, but can be explained satisfactorily in terms of the corpuscular theory. However, the old objections to a corpuscular theory remain, and in order to eliminate them as far as possible and at the same time explain the localized action of light, Thompson evolved a modification of the wave theory, sometimes called the "Ether-string" theory, according to which the ether was supposed to have a fibrous structure. Nevertheless, the facts of intereference could not be explained by this theory, and numerous other objections to it were raised from time to time until it was practically abandoned.

After considering Planck's work on black body radiation, Einstein assumed that a source of radiations could emit or absorb energy in units or quanta. The magnitude of the quantum is directly proportional to the frequency of the source, and is equal to the product of the frequency into Planck's constant. The energy with which an electron escapes in photoelectric phenomena is always equal to this product, and is not varied by the intensity of the incident light or by the nature of the emitting material. Compton confirmed the quantum theory further, and reasoned that light of a given frequency should be transformed to a lower frequency on impact with an electron. The light quantum, on striking a free or valence electron, must give up a part of its energy and recoil with a smaller amount. As the mass of a light quantum of the hardest X-ray is perhaps about 1/10 of that of an electron, it is impossible for the light quantum to give up all of its energy. However, if the light quantum collides with a bound electron nearly all of its energy is transferred due to the comparatively great mass of the atomic nucleus. This has been proved experimentally using X-rays from a molybdenum target, and the free electrons of graphite as the scattering substance. The α line of molybdenum shifted in approximate correct amount toward the longer wave lengths. Compton used the ionization chamber method, and Ross confirmed his work using the more accurate photographic plate method. Compton's work has also been confirmed by Becker, Watson, and Smythe.

Although different observers have different opinions regarding the source of the energy with which electrons are emitted, Einstein's equation has been favorably received. According to this theory the amount of radiant energy required to cause the decomposition of a gram-mole of a substance by a photochemical process is equal to the product of the number of molecules per gram-mole into Planck's constant into the frequency of the radiation used. This is known as the photochemical frequency law.

Bohr's conception of atomic structure is closely connected with the quantum theory as he assumed that the electrons revolve about a positive nucleus in orbits of different radii, and that the emission and absorption of energy quanta take place when electrons jump from one orbit to another.

Whether ultraviolet light is emitted as a transverse wave motion in the imponderable ether, or as quanta of energy is still a moot question. Regardless of the theory of light one supports, it is of considerable significance that the mass of a body is diminished by thermal radiation by an amount equal to the energy emitted divided by the square of the velocity of light. This is the law of the inertia of energy, and was worked out by Einstein.

Apart from the variable quantity of ultraviolet radiation received from the sun, the chief sources of this light are:

1. Lamps burning certain fluids, such as carbon disulfide, in oxygen. These are called chemical lamps, and are of very limited application. Wulf's carbon disulfide burner is typical.

2. High pressure disruptive electric spark discharges between metal electrodes such as iron, nickel, cobalt, copper, tugsten, zinc, magnesium, cadmium and aluminum. These form the basis of apparatus used to produce fluorescent effects. However, when observations are to be conducted over a considerable period during which the intensity of radiation must not change, the high tension disruptive spark between metallic terminals cannot be used to advantage. The "Iron Spark" appa-

ratus developed by Andrews, and the aluminum electrode apparatus developed by Ross are typical.

3. Electric arcs between solid metal electrodes such as iron, or iron and carbon, usually without exhaustion of the air. The intensity of ultraviolet radiation available through the use of arcs is greater than that from spark discharges. An arc that will emit ultraviolet radiation strongly may be constructed by employing an iron and a carbon rod, or two iron rods, for the poles. These poles are cooled by heavy brass or copper sleeves which can be moved along the rods as the latter are consumed. The upper pole which is the negative one may be an iron rod about ¼ inch in diameter. The lower pole may be an iron rod about ½ inch diameter with hollowed end. One of the poles should be adjusted vertically. In preparing the arc, a bead of molten metal is developed in the dished end of the lower electrode. The upper electrode is well cooled, and the arc is maintained very steadily between the bead of molten iron and the upper solid electrode. Such an arc may operate for as long as 30 minutes without any adjustment.

4. Mercury vapor arcs, especially those produced in vacuo. Many types of mercury arc lamps for producing ultraviolet rays have been made, the first to attract public attention being the one invented by Cooper-Hewitt. This lamp was produced in 1901 and was made with glass, but with the introduction of clear fused quartz into commerce, lamps of transparent quartz were made. For a number of years the expense attached to the production of transparent fused quartz made the cost of the lamps high. However, in 1925 Berry and others of the General Electric Co. discovered a method of producing fused quartz in larger quantities in a special electric furnace of vacuum type which enables clear quartz articles of large dimensions to be made comparatively cheap. Quartz does not transmit ultraviolet light of wave length shorter than about 1850 Å, and in the field of short wave lengths, other substances, such as calcite and fluorite which are transparent to the short waves, must be used. Much could be accomplished in the chemical field by appartus that would produce these potent short ultraviolet rays. Minerals that are transparent to these waves have been well canvassed, but it might be possible to produce glass-like synthetic solids such, for example, as those obtained by the action of formaldehyde on urea. There is a field for research in this direction. Glass is impervious to ultraviolet radiations except for the longest ones adjacent to the violet end of the spectrum of visible light; also ultraviolet light does not travel far in most materials commonly called transparent or translucent. On the other hand X-rays, which are short compared to ultraviolet rays, have such penetrating power that substances, ordinarily called opaque, are transparent to them, which fact makes them of great value in medicine and in chemical research.

It is popularly supposed that the sun provides us with beneficent ultraviolet rays, and it does emit this radiation in abundance, but when the rays enter the outer layers of the atmosphere, absorption is so great that only a very small part of the radiation penetrates to sea level. This accounts for the greater tanning of the skin at high altitudes even in winter and, also, the greater tanning in summer at low altitudes on account of the sun being more directly overhead and the rays penetrating a lesser thickness of atmosphere. Sunbaths and baths in artifically produced ultraviolet light are beneficial chiefly because the rays form vitamin D in the skin—the same vitamin that is found in cod liver oil, and the one that is especially potent in preventing rickets and tetany in children. The two most used types of lamp for the artificial production of ultraviolet light are the carbon arc lamp and the quartz mercury arc lamp. These are made in various forms for special purposes. The latest efforts have been toward producing lamps that emit light similar to sunlight. Lamps of this kind are on the market and, while they are being sold chiefly for home treatment, they are beginning to be considered as sources of general illumination. In the near future, the illuminating engineer will, no doubt, design lighting that will not only enable us to see better, but also keep us healthy. Such artificial sunlight benefits a person as much as midsummer sunlight in a clean atmosphere, and more than summer light in a smoky atmosphere, or winter sunlight everywhere in medium and high altitudes. In industries where workers spend most of the daylight hours indoors or in offices where the beneficial effects of natural light are mostly lost, artificial sunlight is of great benefit. The quartz mercury arc lamps fall into two classes; those operated on alternating current, and those taking direct current. The former require a transformer, and the latter a control rheostat; and if the lamp is to be used in the living room for general lighting purposes as well as for its beneficial effects, the transformer is placed in the base of the pedestal that supports the lamp proper, making an attractive unit. Prominent among the developers and manufacturers of quartz mercury arc lamps are the General Electric Vapor Lamp Co. of Hoboken, N. J. (formerly the Cooper-Hewitt Electric Co.) and the Hanovia Chemical and Mrg. Co. of Newark, N. J. The Gordon Ultraviolet Meter, which blocks out visible light, measures ultraviolet light quantitatively in light from any source, and is a dependable instrument for the control of dosage in the hospital, clinic, or physician's office, and replaces the crude chemical methods and the involved physical laboratory procedure that were formerly in use. The meter can be purchased from the Hanovia Chemical and Mfg. Co.

Glass is impervious to ultraviolet waves shorter than 302 millimicrons or 3020 Å and, therefore, the rays that are generally conceded to be extremely harmful are cut out by this substance, which should be worn over the eyes in the form of goggles when exposing these organs to rays of the intensities emitted from the ordinary quartz mercury lamp. The goggles should be made of glass containing titanium oxide as an essential constituent, according to the Corning Glass Works, and should absorb waves as long as 3650 Å almost completely. Good goggles can be purchased from the Hanovia Chemical and Mfg. Co. Glass mercury lamps are impervious to ultraviolet light, and can be viewed with the eyes unprotected. The radiation from this lamp is made up almost entirely of green, blue and yellow light, which brings out detail, and makes it very good for illuminating drafting rooms.

Substances that exclude the visible rays but transmit ultraviolet light are called filters or screen, and among them may be mentioned quartz coated with silver. Many striking physical changes may be obtained with an ultraviolet lamp that is well screened to prevent the passage of visible light. A great variety of fluorescent effects are easily obtained. In a darkened room irradiated only by ultraviolet light, the teeth, eyes and fingernails glow with a weird yellowish fluorescence; an effect that is very amusing to the observer who witnesses it for the first time. Artificial teeth do not fluoresce, but appear black, causing the mouth to present a very queer appearance.

At the present time ultraviolet light is being used extensively in photo-chemistry, spectrometry, polarimetry, interferometry, photomicroscopy, and in photoelectric and absorption studies. The rays are being used in the testing of paints, varnishes, lacquers, rubber, paper, textiles, dyes, inks, artificial leather, etc. They are also used for irradiating foods, and in the examination of drugs, oils, minerals, precious stones, rare paintings, manuscripts, stamps, and in crime detection.

The action of ultraviolet light in photo-chemistry seems to be that of a catalysyt. Some of the reactions thus caused to occur, may also be effected with ordinary catalysts, while in other cases it has not been found possible to carry on the reactions without the rays. Photochemical effects are now usually regarded as photoelectric effects, at least as far as the initial stages are concerned. The action of ultraviolet light on organic compounds depends largely on the wave length. Generally speaking, the shorter wave lengths split up the more complex molecules forming compounds of simpler structure, the final stage being reached with the production of carbon dioxide, methane, hydrogen and water, while the longer wave lengths freqently produce polymerization or rearrangement.

Ultraviolet light is being used extensively in man's attempt to duplicate photosynthesis or the plant's work of manufacturing starch, sugars, celluluse, etc., by combining carbon dioxide, absorbed from the air by the leaves and green twigs, with water taken up by the roots, and some progress has been made.

Regarding sterilization by ultraviolet rays, we may state that:

1. The bactericidal action is practically confined to the wave lengths between 297 millimicrons and 210 millimicrons i. e., to the middle ultraviolet light.

2. The action is a direct one upon the bodies of bacteria, and is not due to the formation of germicidal substances such as hydrogen peroxide.

3. The action is chiefly on the protein constituents of the organisms.

4. The penetration of the rays into organic matter is very feeble. They are arrested by the thinnest layer of skin. Turbidity of a liquid greatly hinders the sterilizing action, but color is of little importance.

5. Free oxygen is not necessary for the sterilization.

6. The active rays are those absorbed by the body acted upon, the effect being a function of the intensity of the radiation and of the time during which it acts.

Among the practical applications of the sterilizing action of ultraviolet light we may mention its use in the purification of water, the rendering of medicinal preparations aseptic, particularly those used for injection subcutaneously or otherwise, and the sterilizing of barrels, bacterial vaccines, milk, etc.

Eight or ten years ago treatment with ultraviolet light seemed to be the method of choice for the sterilization of water on a large scale, and several medium and large size plants were installed which have worked with entire satisfaction. Those at Henderson, Ky., and Oil Hill, Ks., are typical. The advantages of the method are very evident. The water undergoes no change, the mineral matter and air in solution, both of which give water its pleasing qualities, are retained, an overdose is impossible, the cost is not prohibitive, and the sterlization can be made as complete as desired. However, during the past few years, the method has declined in favor, not on account of any disappointment in its performance, but because of the competition of cheaper and, in some respects, simpler chemical processes, such as the chlorination of potable water, and the copper sulphate treatment for swimming pools. It is impossible to say whether or not the large scale sterilization of water by ultraviolet rays will regain its position. However, there are several fields of usefulness for the method in smaller scale operations where the chemical methods are objectionable, and especially where an overdose would be injurious. Among these, we may mention the preparation of water for surgical purposes, its sterilization for bottling or for the supply of small consumers such as residences, hotels, hospitals, ships, office buildings, public buildings, for washing butter, for the oleomargarine industry, and that to be incorporated in food.

Regarding the difficulties encountered in the sterilization of water by this method, we may mention the care that must be used to secure filtration complete enough to reduce the degree of turbidity to a very low value as particles of sediment are opaque to ultraviolet light and act as shields that protect the bacteria from its action. Proper clarification of the raw water, which is accomplished by a combination of flocking with lime and alum or lime and ferrous sulphate, sedimentation, and filtration, is sometimes a troublesome and difficult process, especially when the raw water is of high turbidity or the filtration plant is not working efficiently. Another difficulty sometimes encountered is the fouling of the lamps or their quartz casings by deposits of mineral material. Still another difficulty is the deterioration of the lamps due to long use. This is apparently due to a clouding of the quartz caused by decomposition products from the electrodes and by changes in the nature of the quartz, and produces a very noticeable loss of effectiveness after 1000 to 1500 hours of service.

In regard to the biologic effects of ultraviolet rays on living things we may say that there are two kinds of action, the first stimulative and produced by wave lengths from the limit of the visible spectrum to about 2900 Å, and corresponding closely to the ultraviolet component of solar radiation at the earth's surface; and the second effect lethal, being produced by wave lengths shorter than 2900 Å. As an example of the stimulative effect of the rays we may mention the increase in the growth of yeasts when exposed to them. A list of the conditions for the treatment of which the application of ultraviolet rays has been recommended ranges from acne to zona through tuberculosis and the major psychoses. Perhaps some of the present enthusiasm regarding the therapeutic application of ultraviolet light will be dampened by further experience, but we can be reasonably sure that some of it will be strengthened and augmented. Two types of quartz lamps are used in the treatment of diseases, the air-cooled "sun-lamp" for general application or for the treatment of large areas, and the water-cooled lamp for local applications. The former yields a relatively larger proportion of ultraviolet rays of wave lengths exceeding 300 millimicrons which are stimulative in their action. The latter gives out an intense radiation, rich in wave lengths less than 300 millimicrons which is lethal in its action. The "sum-lamp" yields a radiation that is thought, by some, to be superior to alpine sunlight in curative effect. In the treatment of skin diseases ultraviolet rays have proved to be a veritable godsend, and this field of use is expanding daily.

One of the most remarkable developments of the applications of ultraviolet light is the irradiation of a foodstuff, which will sometimes make up for a deficiency in it of vitamin A that is very necessary for the normal development of animals.

Many of the applications of ultraviolet light are of special or occasional interest only, such as the deciphering of damaged documents, or the detection of frauds in paintings, while other applications are for such constantly important work as the testing of dyes for fastness, and the artificial weathering of paints and varnishes.

A new ultraviolet microscope that magnifies up to 7000 diameters has recently been perfected by Lucas. Short waves produced by a cadmium spark are used, and the magnifications and clearness of the views are much greater than have ever been obtained before.

THE SOLUTION IN POSITIVE INTEGERS OF $2x^2+2x+1=y^2$

(Proposed by J. Rosenbaum, in the Mathematical Monthly, 1930, page 552).

By
WALLACE SMITH,
Professor of Mathematics, New River State College.

Solve in positive intergers $2x^2+2x+1=y^2$.

Proposed by J. Rosenbaum, Melford, Conn., in the Mathematical Monthly, 1930, page 552.

Solution: by Wallace Smith, New River State College, Montgomery, West Virginia.

It is seen at once that

$$2x^2+2x+1=y^2 \qquad (1)$$

may be written in the form

$$z^2-8y^2=-4, \qquad (2)$$

where $z=4x+2$. By the method in Chrystal's Algebra, Vol. II., 482, Art. 18, the solution of (2) may be made to depend on the solution of

$$z_1^2-8y_1^2=1. \qquad (3)$$

It follows at once that $z_1=3$, $y_1=1$ is a primitive solution of (3); therefore, the general solution of (3) is given by

$$z_1=(1/2)\ [(3+\sqrt{8})^n+(3-\sqrt{8})^n],$$
$$y_1=(1/2\sqrt{8})\ [(3+\sqrt{8})^n-(3-\sqrt{8})^n].$$

(See Chrystal's Algebra, Vol., II., page 480, Art. 17).

Now, it follows at once that the general solution of (2) is:

$$z=[(3+\sqrt{8})^n+(3-\sqrt{8})^n]+(\sqrt{8}/2)\ [(3+\sqrt{8})^n-(3-\sqrt{8})^n],$$
$$y=(1/\sqrt{8})[(3+\sqrt{8})^n-(3-\sqrt{8})^n]+(1/2)[(3+\sqrt{8})^n+(3-\sqrt{8})^n].$$

But since $z=4x+2$, it remains to be shown that

$$z\equiv 2(\text{mod. } 4). \qquad (4)$$

If we expand the terms in the value for z by the Binomial Theorem and collect terms we will have:

$$z=2[3^n+\frac{n(n-1)}{2!}3^{n-2}.\ 8++--]+\sqrt{8}[n.3^{n-1}.\ \sqrt{8}+\frac{n(n-1)(n-2)}{3!}.3^{n-3}.\ (\sqrt{8})^3++--],$$

or,

$$z = 2\left[3^n + \frac{n(n-1)}{2!}3^{n-2}.\ 8 + + - -\right] + \left[n.3^{n-1}.\ 8 + \frac{n(n-1)\ (n-2)}{3!}3^{n-3}\right.$$
$$\left. .8^2 + - - -\right].$$

Each term, excepting the first, in this value for z is a multiple of 8 and divisible by 4; therefore, if it can be shown that $2.3^n \equiv 2 (\text{mod. } 4)$, then (4) holds true. Since 2.3^n for $n = 0, 1, 2.----$is of the form $2(2m+1)$, and since $2(2m+1) \equiv 2(\text{mod. } 4)$, we see that $2.3^n \equiv 2(\text{mod. } 4)$ holds. Therefore, $x = (z-2)/4$ is an integer. Hence, the positive integral solution of (1) is:

$$x = (1/4)\{-2 + [(3 + \sqrt{8})^n + (3 - \sqrt{8})^n] + (\sqrt{8}/2)[(3 + \sqrt{8})^n - (3 - \sqrt{8})^n]\},$$

$$y = (1/\sqrt{8})[(3 + \sqrt{8})^n - (3 - \sqrt{8^n}] + (1/2)[(3 + \sqrt{8})^n + (3 - \sqrt{8})^n].$$

THE DEFLECTIONS OF A THIN PLATE LOADED ON THE CIRCUMFERENCE OF A CIRCLE

By

CHARLES H. VEHSE,

Assistant Professor of Mathematics, West Virginia University.

The method of finite differences has been used quite effectively by Marcus* in finding the deflections of thin plates. His methods are applied here to find the deflections of a square plate loaded on the circumference of a circle which is concentric with the plate and whose diameter equals half the length of a side of the plate. The deflections are computed when the plate is freely supported on the edges, clamped on the edge, and freely supported on the corners.

The plate is assumed to be homogenous and to have a thickness that is small compared to the other dimensions. The deflections are assumed to be small relative to the thickness.

The plate is referred to a set of axes as in the accompanying diagram, where x, y and z are the co-ordinates of a point in the plate in an unstrained position and $\zeta(x, y)$ is the deflection of the neutral surface.

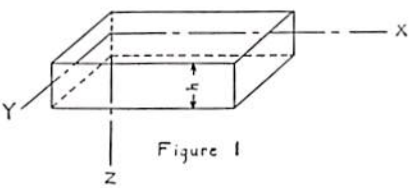


Figure 1

The deflection ζ must then satisfy the equation

$$(1) \quad \frac{\partial^4 \zeta}{\partial x^4} + 2\frac{\partial^4 \zeta}{\partial x^2 \partial y^2} + \frac{\partial^4 \zeta}{\partial y^4} = \frac{p(x, y)}{N}$$

where $p(x, y)$ = the load per unit area,

$$N = \frac{E\,h}{12(1-\sigma^2)}$$

E = Young's modulus
σ = Poisson's ratio
h = thickness of the plate

Introducing a new variable w, defined by the relation

$$(2) \quad \frac{\partial^2 \zeta}{\partial x^2} + \frac{\partial^2 \zeta}{\partial y^2} = -w$$

*Die Theorie elastischer Gewebe und ihre Anwendungen auf die Berechnung biegsamer Platten; by H. Marcus.

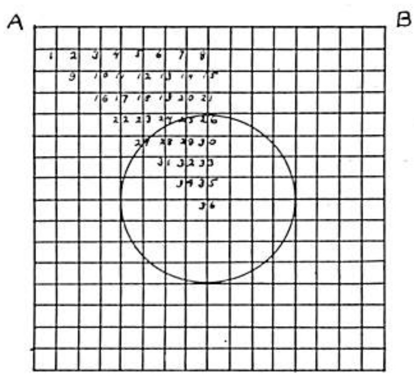
we replace (1) by the pair of equations

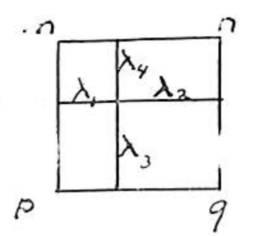
$$(3a)\qquad \frac{\partial^2\zeta}{\partial x^2}+\frac{\partial^2\zeta}{\partial y^2}=-w$$

$$(3b)\qquad \frac{\partial^2 w}{\partial x^2}+\frac{\partial^2 w}{\partial y^2}=-\frac{p}{N}$$

Assume the side of the plate to have a length 2a and that the circle of loading has a diameter a. The total load on the circle is P. Divide the circle into 16 equal arcs and suppose a load of $\frac{P}{16}$ to be concentrated at the centroid of each arc. Divide the plate into squares of side a/8 by means of a square lattice as shown. The concentrated loads are now apportioned to the vertices of the squares in which they lie by the formula

$$p_m=\frac{\lambda_2\ \lambda_3}{(\lambda_1+\lambda_2)\ \ (\lambda_3+\lambda_4)}$$





gure

Figure 2.

The values of p_m were determined as follows:

$p_{24}=.02188$ P
$p_{25}=.02012$ P
$p_{26}=.06090$ P
$p_{27}=.04104$ P
$p_{28}=.02029$ P
$p_{29}=.00982$ P
$p_{30}=.00160$ P
$p_{31}=.00225$ P

We now form the differences

$$(\Delta\zeta_m)_x = \zeta_n - \zeta_l$$
$$(\Delta\zeta_m)_y = \zeta_h - \zeta_q$$
$$(\Delta^2\zeta_m)_x = \zeta_n - 2\zeta_m + {}_1$$
$$(\Delta^2\zeta_m)_y = \zeta_h - 2\zeta_m + \zeta_q$$

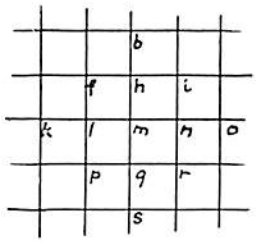


Figure 4

The derivative $\dfrac{\partial^2\zeta}{\partial x^2}$ is approximately equal to $\dfrac{(\Delta^2\zeta_m)_x}{\left(\dfrac{a}{8}\right)^2}$ at the point m, and the other derivatives can be replaced by the corresponding differences. Equations (3) then become

$$\text{(4a)} \quad (\Delta^2\zeta_m)_x + (\Delta^2\zeta_m)_y = -\left(\frac{a}{8}\right)^2 w_m$$

$$\text{(4b)} \quad (\Delta^2 w_m)_x + (\Delta^2 w_m)_y = -\frac{p_m}{N}$$

If the plate is freely supported on the edges, $(\Delta^2\zeta_m)_x = (\Delta^2\zeta_m)_y = 0$ on AB. Then the equations (4) have the boundary conditions $\zeta = w = 0$. From equation (4b) we have

$$
\begin{array}{lll}
\text{(5)} \quad 4w_1 - 2w_2 & = 0 & \\
-w_i + 4w_{i+1} - w_{i+2} - w_{i+8} & = 0 & i = 1, 2, 3, 4, 5, 6. \\
-2w_7 + 4w_8 - w_{15} & = 0 & \\
-2w_2 + 4w_9 - 2w_{10} & = 0 & \\
-w_i - w_{i+6} + 4w_{i+7} - w_{i+8} - w_{i+13} & = 0 & i = 3, 4, 5, 6, 7. \\
-w_8 - 2w_{14} + 4w_{15} - w_{21} & = 0 & \\
-2w_{10} + 4w_{16} - 2w_{17} & = 0 & \\
-w_i - w_{i+5} + 4w_{i+6} - w_{i+7} - w_{i+11} & = 0 & i = 11, 12, 13, 14. \\
-w_{15} - 2w_{20} + 4w_{21} - w_{26} & = 0 & \\
-2w_{17} + 4w_{22} - 2w_{23} & = 0 & \\
-w_{18} - w_{22} + 4w_{23} - w_{24} - w_{27} & = 0 &
\end{array}
$$

$$
\begin{aligned}
-w_{19}-w_{23}+4w_{24}-w_{25}-w_{28} &= .02188\ P/N\\
-w_{20}-w_{24}+4w_{25}-w_{26}-w_{29} &= .02012\ P/N\\
-w_{21}-2w_{25}+4w_{26}-w_{30} &= .06090\ P/N\\
-2w_{23}+4w_{27}-2w_{28} &= .04104\ P/N\\
-w_{24}-w_{27}+4w_{28}-w_{29}-w_{31} &= .02029\ P/N\\
-w_{25}-w_{28}+4w_{29}-w_{30}-w_{32} &= .00982\ P/N\\
-w_{26}-2w_{29}+4w_{30}-w_{33} &= .00160\ P/N\\
-2w_{28}+4w_{31}-2w_{32} &= .00225\ P/N\\
-w_{29}-w_{31}+4w_{32}-w_{33}-w_{34} &= 0\\
-w_{30}-2w_{32}+4w_{33}-w_{35} &= 0\\
-2w_{32}+4w_{34}-2w_{35} &= 0\\
-w_{33}-2w_{34}+4w_{35}-w_{36} &= 0\\
-4w_{35}+4w_{36} &= 0
\end{aligned}
$$

These equations can be solved by a method of successive approximations. Solving the first equation for w_1, the second for w_2, etc., and assuming any set of values as a first approximation for the w's, we find a second approximation by direct substitution into the equations. The solution of these equations is as follows:

(6)	$w_1 = .00426$ P/N	$w_{19} = .07474$ P/N
	$w_2 = .00852$ P/N	$w_{20} = .08144$ P/N
	$w_3 = .01275$ P/N	$w_{21} = .08529$ P/N
	$w_4 = .01682$ P/N	$w_{22} = .07034$ P/N
	$w_5 = .02051$ P/N	$w_{23} = .08884$ P/N
	$w_6 = .02352$ P/N	$w_{24} = .10518$ P/N
	$w_7 = .02551$ P/N	$w_{25} = .11349$ P/N
	$w_8 = .02626$ P/N	$w_{26} = .12424$ P/N
	$w_9 = .01709$ P/N	$w_{27} = .11556$ P/N
	$w_{10} = .02565$ P/N	$w_{28} = .12175$ P/N
	$w_{11} = .03401$ P/N	$w_{29} = .12299$ P/N
	$w_{12} = .04172$ P/N	$w_{30} = .12378$ P/N
	$w_{13} = .04806$ P/N	$w_{31} = .12300$ P/N
	$w_{14} = .05226$ P/N	$w_{32} = .12311$ P/N
	$w_{15} = .05401$ P/N	$w_{33} = .12330$ P/N
	$w_{16} = .03875$ P/N	$w_{34} = .12316$ P/N
	$w_{17} = .05185$ P/N	$w_{35} = .12321$ P/N
	$w_{18} = .06429$ P/N	$w_{36} = .12321$ P/N

The equations obtained from (4a) are identical with (5) in the left hand members when ζ is substituted for w. The values of w in (6) are substituted into the right hand members. The solution of this set of equations is:

(7)	$\zeta_1 = .001085\ Pa^2/N$	$\zeta_{19} = .015215\ Pa^2/N$
	$\zeta_2 = .002138\ Pa^2/N$	$\zeta_{20} = .016197\ Pa^2/N$

$\zeta_3 = .003122 \ Pa^2/N$
$\zeta_4 = .004000 \ Pa^2/N$
$\zeta_5 = .004735 \ Pa^2/N$
$\zeta_6 = .005290 \ Pa^2/N$
$\zeta_7 = .005636 \ Pa^2/N$
$\zeta_8 = .005755 \ Pa^2/N$
$\zeta_9 = .004212 \ Pa^2/N$
$\zeta_{10} = .006149 \ Pa^2/N$
$\zeta_{11} = .007881 \ Pa^2/N$
$\zeta_{12} = .009329 \ Pa^2/N$
$\zeta_{13} = .010422 \ Pa^2/N$
$\zeta_{14} = .011102 \ Pa^2/N$
$\zeta_{15} = .011336 \ Pa^2/N$
$\zeta_{16} = .008983 \ Pa^2/N$
$\zeta_{17} = .011515 \ Pa^2/N$
$\zeta_{18} = .013628 \ Pa^2/N$
$\zeta_{21} = .016540 \ Pa^2/N$
$\zeta_{22} = .014756 \ Pa^2/N$
$\zeta_{23} = .017449 \ Pa^2/N$
$\zeta_{24} = .019443 \ Pa^2/N$
$\zeta_{25} = .020661 \ Pa^2/N$
$\zeta_{26} = .021096 \ Pa^2/N$
$\zeta_{27} = .020578 \ Pa^2/N$
$\zeta_{28} = .022805 \ Pa^2/N$
$\zeta_{29} = .024133 \ Pa^2/N$
$\zeta_{30} = .024581 \ Pa^2/N$
$\zeta_{31} = .025165 \ Pa^2/N$
$\zeta_{32} = .026563 \ Pa^2/N$
$\zeta_{33} = .027029 \ Pa^2/N$
$\zeta_{34} = .028003 \ Pa^2/N$
$\zeta_{35} = .028480 \ Pa^2/N$
$\zeta_{36} = .028962 \ Pa^2/N$

In the case of a plate clamped on the edges the plate is assumed to be enlarged by adding another row of lattice points to the side of the plate. The boundary conditions are then expressed by saying that

$$\zeta_{37} = \zeta_{38} = \ldots\ldots = \zeta_{41} = 0$$

and that $\zeta_1 = \zeta_{45}, \ \zeta_2 = \zeta_{46}, \ \ldots\ldots, \ \zeta_8 = \zeta_{52}$

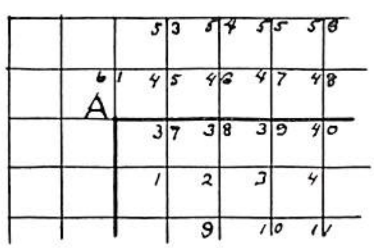


Figure 5.

Equation (1) is replaced by the difference equation

$$(\Delta^4 \zeta_m)_x + 2\,[\Delta^2 (\Delta^2 \zeta_m)_x]_y + (\Delta^4 \zeta_m)_y = \left(\frac{a}{8}\right)^2 \frac{p_m}{N}$$

where

$$(\Delta^4 \zeta_m)_x = [\Delta^2 (\Delta^2 \zeta_m)_x]_x$$
$$= [\Delta^2 (\zeta_l - 2\zeta_m + \zeta_n)]_x$$
$$= \zeta_k - 4\zeta_l + 6\zeta_m - 4\zeta_n + \zeta_o$$
$$(\Delta^4 \zeta_m)_y = \zeta_b - 4\zeta_h + 6\zeta_m - 4\zeta_q + \zeta_s$$

$$[\Delta^2(\Delta^2\zeta_m)_x]_y = [\Delta^2(\zeta_1 - 2\zeta_m + \zeta_n)]_y$$
$$= \zeta_f - 2\zeta_l + \zeta_p - 2\zeta_h + 4\zeta_m - 2\zeta_q + \zeta_1 - 2\zeta_n + \zeta_r$$

Substituting m = 1, 2, ..., 36 we obtain the 36 equations in ζ

$$22\zeta_1 - 16\zeta_2 + 2\zeta_3 + 2\zeta_9 = 0$$
$$-8\zeta_1 + 23\zeta_2 - 8\zeta_3 + \zeta_4 - 8\zeta_9 + 3\zeta_{10} = 0$$
$$\zeta_1 - 8\zeta_2 + 21\zeta_3 - 8\zeta_4 + \zeta_5 + 2\zeta_9 - 8\zeta_{10} + 2\zeta_{11} + \zeta_{16} = 0$$

. . . .

$$\zeta_{30} + 6\zeta_{32} - 8\zeta_{33} - 16\zeta_{34} + 25\zeta_{35} - 8\zeta_{36} = 0$$
$$4\zeta_{33} + 8\zeta_{34} - 32\zeta_{35} + 20\zeta_{36} = 0$$

The solution of these equations by successive approximations gives

$\zeta_1 = .00002$ Pa/N	$\zeta_{19} = .00396$ Pa/N
$\zeta_2 = .00010$ Pa/N	$\zeta_{20} = .00438$ Pa/N
$\zeta_3 = .00023$ Pa/N	$\zeta_{21} = .00454$ Pa/N
$\zeta_4 = .00038$ Pa/N	$\zeta_{22} = .00378$ Pa/N
$\zeta_5 = .00052$ Pa/N	$\zeta_{23} = .00498$ Pa/N
$\zeta_6 = .00064$ Pa/N	$\zeta_{24} = .00591$ Pa/N
$\zeta_7 = .00072$ Pa/N	$\zeta_{25} = .00649$ Pa/N
$\zeta_8 = .00074$ Pa/N	$\zeta_{26} = .00671$ Pa/N
$\zeta_9 = .00039$ Pa/N	$\zeta_{27} = .00647$ Pa/N
$\zeta_{10} = .00081$ Pa/N	$\zeta_{28} = .00755$ Pa/N
$\zeta_{11} = .00128$ Pa/N	$\zeta_{29} = .00819$ Pa/N
$\zeta_{12} = .00172$ Pa/N	$\zeta_{30} = .00841$ Pa/N
$\zeta_{13} = .00209$ Pa/N	$\zeta_{31} = .00870$ Pa/N
$\zeta_{14} = .00232$ Pa/N	$\zeta_{32} = .00938$ Pa/N
$\zeta_{15} = .00241$ Pa/N	$\zeta_{33} = .00960$ Pa/N
$\zeta_{16} = .00161$ Pa/N	$\zeta_{34} = .01008$ Pa/N
$\zeta_{17} = .00248$ Pa/N	$\zeta_{35} = .01031$ Pa/N
$\zeta_{18} = .00330$ Pa/N	$\zeta_{36} = .01054$ Pa/N

When the plate is supported on the corners, the bending moment along the edge of the plate in a direction normal to the edge vanishes. The vertical shear also vanishes along the edge. These conditions are expressed by

$$(11) \quad \frac{\partial^2\zeta}{\partial y^2} + \sigma\frac{\partial^2\zeta}{\partial x^2} = 0$$

$$(12) \quad \frac{\partial^3\zeta}{\partial y^3} + (2-\sigma)\frac{\partial^3\zeta}{\partial y\partial x^2} = 0$$

along AB.

Replacing these equations by their corresponding difference equations and assuming a value of .3 for σ we have

$$(11a)\quad (\Delta^2\zeta_m)_y + .3(\Delta^2\zeta_m)_x = 0$$

$$12a)\quad [(\Delta(\Delta^2\zeta_m)_y]_y + 1.7[\Delta(\Delta^2\zeta_m)_x]_y = 0$$

where
$$[\Delta(\Delta^2\zeta_m)_y]_y = [\Delta(\zeta_h - 2\zeta_m + \zeta_q)]_y$$
$$= \zeta_b - 2\zeta_h + 2\zeta_q - \zeta_s$$

and
$$[\Delta(\Delta^2\zeta_m)_x]_y = [\Delta(\zeta_e - 2\zeta_m + \zeta_n)]_y$$
$$= \zeta_f - 2\zeta_h + \zeta_i - \zeta_p + 2\zeta_q - \zeta_r$$

The use of equation (12a) necessitates the addition of two rows of lattice points beyond the edge of the plate. From (11a) we have $\zeta_{61} = -\zeta_{37}$. Substituting m = 1, 2, ..., 44 in (8) and m = 37, 38, ..., 44 in (11a) and (12a) we have the 60 equations necessary for the determination of the 60 variables.

The solution of this system of equations is

$\zeta_1 = .03040$ Pa/N	$\zeta_{31} = .11946$ Pa/N
$\zeta_2 = .04409$ Pa/N	$\zeta_{32} = .12234$ Pa/N
$\zeta_3 = .05674$ Pa/N	$\zeta_{33} = .12332$ Pa/N
$\zeta_4 = .06786$ Pa/N	$\zeta_{34} = .12510$ Pa/N
$\zeta_5 = .07701$ Pa/N	$\zeta_{35} = .12603$ Pa/N
$\zeta_6 = .08383$ Pa/N	$\zeta_{36} = .12694$ Pa/N
$\zeta_7 = .08803$ Pa/N	$\zeta_{37} = .01628$ Pa/N
$\zeta_8 = .08945$ Pa/N	$\zeta_{38} = .03177$ Pa/N
$\zeta_9 = .05621$ Pa/N	$\zeta_{39} = .04590$ Pa/N
$\zeta_{10} = .06759$ Pa/N	$\zeta_{40} = .05820$ Pa/N
$\zeta_{11} = .07769$ Pa/N	$\zeta_{41} = .06825$ Pa/N
$\zeta_{12} = .08606$ Pa/N	$\zeta_{42} = .07569$ Pa/N
$\zeta_{13} = .09236$ Pa/N	$\zeta_{43} = .08027$ Pa/N
$\zeta_{14} = .09622$ Pa/N	$\zeta_{44} = .08182$ Pa/N
$\zeta_{15} = .09754$ Pa/N	$\zeta_{45} = .00239$ Pa/N
$\zeta_{16} = .07789$ Pa/N	$\zeta_{46} = .01986$ Pa/N
$\zeta_{17} = .08715$ Pa/N	$\zeta_{47} = .03562$ Pa/N
$\zeta_{18} = .09488$ Pa/N	$\zeta_{48} = .04922$ Pa/N
$\zeta_{19} = .10070$ Pa/N	$\zeta_{49} = .06027$ Pa/N
$\zeta_{20} = .10431$ Pa/N	$\zeta_{50} = .06842$ Pa/N
$\zeta_{21} = .10555$ Pa/N	$\zeta_{51} = .07343$ Pa/N
$\zeta_{22} = .09573$ Pa/N	$\zeta_{52} = .07511$ Pa/N
$\zeta_{23} = .10294$ Pa/N	$\zeta_{53} = -.01067$ Pa/N
$\zeta_{24} = .10838$ Pa/N	$\zeta_{54} = .00892$ Pa/N
$\zeta_{25} = .11174$ Pa/N	$\zeta_{55} = .02639$ Pa/N
$\zeta_{26} = .11290$ Pa/N	$\zeta_{56} = .04139$ Pa/N
$\zeta_{27} = .10973$ Pa/N	$\zeta_{57} = .05352$ Pa/N
$\zeta_{28} = .11476$ Pa/N	$\zeta_{58} = .06245$ Pa/N
$\zeta_{29} = .11785$ Pa/N	$\zeta_{59} = .06792$ Pa/N
$\zeta_{30} = .11889$ Pa/N	$\zeta_{60} = .06976$ Pa/N

THE V_4^4 IN S_5 ASSOCIATED WITH A SCHLÄFFLI HEXAD

By
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(Abstract)

The paper deals with the singular lines of a V_4^4 in 5-space whose 5 fundamental flats belong to a Schläfli Hexad. The spread has 27 double lines of which 12 are tact-loci.

AN ANALYTIC DISCUSSION OF THE GENERAL CREMONA TRANSFORMATION BELONGING TO A SPECIAL LINEAR COMPLEX

By

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Introduction. The general non-involutorial cremona space transformation belonging to a special linear line complex has been studied synthetically by M. Pieri.[1] He explicitly excludes cases in which contacts occur in the defining surfaces, hence in the homaloidal webs. The author[2] has given an analytic discussion of the case in which the directrix of the complex is a tact locus for all ∞^4 surfaces associated with the linear congruences of the complex. In the present paper the Pieri transformation is discussed analytically.

1. **The Equations of the Transformation.** Let Γ be the special linear complex to which the transformation T belongs. The base of a pencil $|Q_1|$ of linear Γ-congruences is a Γ-regulus R on a quadric H. The directrices of the congruences $|Q_1|$ form the regulus R′ associated with

Line Complex, **American Journal of Mathematics,** Vol. 53 (1931), pp. 72-80.

R on H. The directrix d of Γ belongs to R′. Associated with $|Q_1|$ are the pencils $|F_n|$ and $|F'_{n'}|$[3].

Denote by $x_1 = x_2 = 0$, $x_1 x_3 - x_2 x_4 = 0$, $x^1/x_2 = x_4/x_3 = \sigma$, and $x_1/x_1 = x_2/x_3 = \varrho$, the directrix d, the quadric H, the regulus R, and the regulus R′ respectively. Then the most general $F_n{:}gd^{n-2}$, where

$g \equiv x_1 - \varrho x_4 = 0,\ x_2 - \varrho x_3 = 0$, is

$|F_n| \equiv U(x_1 - \varrho x_4) + V(x_2 - \varrho x_3) + WH = 0$, or

(1) $|F_n| \equiv x_1 M - x_2 N - \varrho L = 0$, where

$$U = \sum_{i=2}^{n} u_i\ x_1^{n-i}\ x_2^{i-2},\quad V = \sum_{i=2}^{n} v_i\ x_1^{n-i}\ x_2^{i-2},\quad W = \sum_{i=3}^{n} w_i\ x_1^{n-i}\ x_2^{i-3},$$

$$u_i = \sum_{k=1}^{4} a_{ik}\, x_k,\quad v_i = \sum_{k=1}^{4} b_{ik}\, x_k,\quad w_i = \sum_{k=1}^{4} c_{ik}\, x_k,$$

$L = x_4\, U + x_3\, V,\ M = x_3\, W + U,\ N = x_4\, W - V.$

It follows that $x_1\, M - x_2\, N = L$.

The corresponding pencil is

(2) $|F'_{n'}| \equiv x_1\, M' - x_2\, N' - \varrho\, L' = 0$, where

$$U' = \sum_{i=2}^{n'} u'_i\ x_1^{n'-i}\ x_2^{i-2},\quad u'_i = \sum_{k=1}^{4} a'_{ik}\, x_k,\quad L' = x_4\, U' + x_3\, V', \text{ etc.}$$

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[1]Sulle trasformazioni birazionali dello spazio inerenti a un complesso lineare speciale, **Circolo Matematico di Palermo,** Vol. 6 (1892), pp. 234-244.

[2]Non-Involutorial Birational Transformations Belonging to a Special Linear

[3]loc. cit.

Through a generic point $P(y)$ of space passes a single surface F_n of $|F_n|$, for which

(3) $\varrho = [y_1 M(y) - y_2 N(y)] / L(y)$.

The unique transversal t through $P(y)$ to d and g cuts these lines respectively in $D \equiv (0, 0, M, N,)$ and

$G \equiv [y_1(y_1 M - y_2 N), y_2(y_1 M - y_2 N), y_2 L, y_1 L]$.

This line t cuts the surface

(2') $F'_{n'} \equiv L[x_1 M'(x) - x_2 N'(x)] - L'(x)[y_1 M - y_2 N] = 0$

in G, $D^{n'-2}$, and in one residual point $P'(x)$, image in T of $P(y)$.

Any point of t has coordinates

$$(4) \quad \begin{aligned} \sigma x_1 &= y_1 J_1, \\ \sigma x_2 &= y_2 J_1, \\ \sigma x_3 &= y_3 J_1 + MK, \\ \sigma x_4 &= y_4 J_1 + NK. \end{aligned}$$

When these coordinates are substituted in (2'), and the factors $J_1 K^{n'-2}[J_1 H + K(y_1 M - y_2 N)]$ removed, the resulting equation, linear in J_1 and K, gives

$$J_1 = M(MV_3' + NV_4') + N(MU_3' + NU_4') - L(MW_3' + NW_4'),$$
$$K = MN' - M'N,$$

where the subscripts indicate partial differentiation. With these values of J_1 and K, (4) are the equations of T^{-1}.

The equations of T are

$$(5) \quad \begin{aligned} \sigma y_1 &= x_1 J_1', \\ \sigma y_2 &= x_2 J_1', \\ \sigma y_3 &= x_3 J_1' - M'K, \\ \sigma y_4 &= x_4 J_1' - N'K, \end{aligned}$$

$$J'_1 = M'(M'V_3 + N'V_4) + N'(M'U_3 + N'U_4) - L'(M'W_3 + N'W_4).$$

2. **Some Associated Surfaces.** It is evident that $\Gamma \equiv p_{12} = 0$, and the Plücker line coordinates of any Γ-line PP' are

$p_{12} = 0,\ p_{13} = y_1 M,\ p_{14} = y_1 N,\ p_{23} = y_2 M,\ p_{42} = -y_2 N,\ p_{34} = -L.$

The $\infty^4|Q_1|$ of Γ are the intersections of $p_{12} = 0$ with

$\alpha_{12}p_{12} + \alpha_{13}p_{13} + \alpha_{14}p_{14} + \alpha_{23}p_{23} + \alpha_{42}p_{42} + \alpha_{34}p_{34} = 0.$

Hence the associated surfaces are

(6) $\infty^4|F_n| \equiv (\alpha_{13}y_1 + \alpha_{23}y_2 - \alpha_{34}y_4)M + (\alpha_{14}y_1 - \alpha_{42}y_2 + \alpha_{34}y_3)N = 0,$

(6') $\infty^4|F'_{n'}| \equiv (\alpha_{13}y_1 + \alpha_{23}y_2 - \alpha_{34}y_4)M' + (\alpha_{14}y_1 - \alpha_{42}y_2 + \alpha_{34}y_3)N' = 0.$

The line g is

$\alpha_{13}y_1 + \alpha_{23}y_2 + \alpha_{34}y_4 = 0,\ \alpha_{14}y_1 - \alpha_{42}y_2 + \alpha_{34}y_3 = 0.$

If g belongs to Γ, $\alpha_{34} = 0$, and

$$(\alpha_{13}y_1 + \alpha_{23}y_2)(\alpha_{23}M - \alpha_{12}N) = 0.$$

Each surface of the pencil

(7) $|F_{n-1}| \equiv \alpha_{23}M - \alpha_{42}N = 0.$

is associated with the Γ-bundle on $G(0, 0, \alpha_{42}, \alpha_{23})$.

The equations (4) are readily obtained by means of this $|F_{n-1}|$ and the associated $|F'_{n'-1}|$.

3. **The T_4 in a Plane Through d.** A plane $\gamma \equiv x_1 = \sigma x_2$ cuts $|F_{n-1}|$ and the associated $|F'_{n'-1}|$ in pencils of conics,

(8) $|C_2| \equiv \alpha_{23}m - \alpha_{42}n = 0,$

(9) $|C'_2| \equiv \alpha_{23}m' - \alpha_{42}n' = 0,$ where

$m = x_3(cx) + x_2(ax),\ m' = x_3(c'x) + x_2(a'x),$

$n = x_4(cx) - x_2(bx),\ n' = x_4(c'x) - x_2(b'x),$

$l = x_4(ax) + x_3(bx),\ l' = x_4(a'x) + x_3(b'x),$

$(ax) = a_2x_2 + a_3x_3 + a_4x_4,$ etc.

The point G is now $G[0, m(y), n(y)]$.

Through a generic point $P(y)$ of γ passes one conic C_2 of $|C_2|$, for which $\alpha_{42} : \alpha_{23} = m(y) : n(y)$. This C_2 and the associated

$$C'_2 \equiv nm'(x) - mn'(x) = 0$$

pass through G. The line PG cuts C'_2 in a residual point $P'(x)$, image in T of $P(y)$. The equations of this plane T^{-1} in γ are readily obtained, being, except for an extraneous factor y_2,

$$(10)\quad \begin{aligned} \sigma x_2 &= y_2 j_1, \\ \sigma x_3 &= y_3 j_1 + mk, \\ \sigma x_4 &= y_4 j_1 + nk, \end{aligned}$$

$j_1 = n(a'_3m + a'_4n) + m(b'_3m + b'_4n) - l(c'_3m + c'^4n),$

$k = -(a'y)n - (b'y)m + (c'y)l = (ay)n' + (by)m' - (cy)l',$

$y_2k = mn' - nm'.$

It is also possible to write (10)

$$(10')\quad \begin{aligned} \sigma x_2 &= n(a'_3m + a'_4n) + m(b'_3m + b'_4n) - l(c'_3m + c'_4n), \\ \varrho x_3 &= -n(a'_2m + a'_4l) - m(b'_2m + b'_4l) + l(c'_2m - c'_4l). \\ \sigma x_4 &= -n(a'_2n - a'_3l) - m(b'_2n - b'_3l) + l(c'_2n - c'_3l). \end{aligned}$$

The base of the pencil of conics (8) is the four points $P_1\ P_2\ P_3\ O_4$, the latter being $(0, c_4, -c_3)$. The three points $P_1\ P_2\ P_3$ are common to $l = 0$, $m = 0$, and $n = 0$, hence are doubly fundamental for T_4^{-1}.

$$[j_1, k] = (P_1P_2P_3)^2P_4P_5P_6O_1O_2O_3.$$

The points $P_4P_5P_6$ are simply fundamental for T_4^{-1}, but $O_1O_2O_3$, which lie on d, are not fundamental. In fact, no point of d is fundamental for either T or T^{-1}.

The homaloidal nets of T_4 and T_4^{-1} are respectively

$\infty^2|f_4'| : (P_1'P_2'P_3')^2P_4'P_5'P_6'$ and $\infty^2|f_4| : (P_1P_2P_3)^2P_4P_5P_6.$

Under T_4^{-1},

$$(P_1'P_2'P_3') \backsim j_2:(P_1P_2P_3)^3\ (P_4P_5P_6)^2\ (P_1'P_2'P_3'),\ \text{and}$$

$$(P_4'P_5'P_6') \backsim j_3:(P_1P_2P_3)^2.$$

The j_2 is composed of three conics, each through $P_1P_2P_3$, and passing by pairs through $P_4P_5P_6$. Each passes through the point P'_1 of which it is the image.

The j_3 is composed of three straight lines joining $P_1P_2P_3$ by pairs.

As the plane γ generates the pencil on d, the T_4 generates the space $T_{n+2n'-3,\ 2n+n'-3}$ discussed by Pieri. The equations of the latter may readily be obtained from (10) by replacing l, m, n, l', m', n' and σ by U, V, W, U', V', W' and x_1/x_2 respectively.

THE PROBLEM OF LEFT-HANDEDNESS AND WHAT TO DO ABOUT IT

By
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Certain Psychologists, Scientists and Educators have stated, and continue to state, that to change a left-handed person to a right-hand writer causes speech defects such as stammering and stuttering. Some make the assertion in such a manner as to convey the idea that defective speech is always the result. Others leave the impression that such effects may result. However, I have been unable to find any treatise on changing hands that makes a distinction between the normal and the mentally or physically ill child as regards resulting speech defects.

In "The Educational Significance of the Left-Handed" Dr. Ralph Haefner makes this statement:

"The data which have been presented do not warrant the conclusion that change of the writing hand is the commonest cause of speech disorders. They do seem to justify the hypothesis that when other predisposing causes are present—such as exhaustion from illness, or anxieties —the change of hand may provide just the additional burden to the child's unstable nervous system which will bring on some form of functional speech defect."

With this conclusion, I see no reason to take exception, for, as I interpret it, the child who has had his vitality lowered by a long or severe illness or by some anxieties is not a normal child until full health and mental repose have been restored. Is this not "an exception which proves the rule?" It is, in my opinion, the duty of the school authorities (including the penmanship supervisor) to know of such cases and to act intelligently.

Why change to right-hand writing? Why not allow the left-hander to continue, teaching him the standard left-hand position and movement?

Let me answer these questions by asking others. Where are the school rooms that are lighted for the health of the left-hander? Where are the modern offices and desk arrangements to accomodate the left-hander? Who builds left-hand labor-saving machinery, left-hand office appliances, and left-arm chairs for the college classrooms?

May I state here that Mr. J. O. Cook, Superintendent of the Amherst Schools, told me only recently of a case where left-handedness kept a person from appointment to a remunerative position. The educational qualifications, the character, and the personal appearance were satisfactory but the machinery to be manipulated was not adapted to the left-handed person—one job lost as a result of this person not being able to use the right hand effectively. Doubtless, since the position in question was rather desirable, there may always be the regret of not being "changed" in school. There may be just a thought that the parents did not perform their full duty.

During my experience of ten years as director of commercial education in various Pennsylvania high schools and in my ten years of supervision of penmanship in Amherst I have had occasion to see the practical results of left-handedness, changed-handedness, and right-handedness. It has always been my belief, and still is, that it does no harm and a tremendous amount of good to the normal left-hand person to learn to write (and to do other things) with the right hand. Please note that I do not include the physically and mentally deficient, yet I fully believe that many of those who are unfortunately mentally and physically ill can be changed with good results if the change is brought about by the right method.

No scientific tests for speech defects have been made in Amherst but in so far as can be determined from listening to children talk among themselves, and to their recitation in classes, there have been absolutely no harmful results from the changes made, either in speech defects or in nervousness. Many of our high school teachers, who have no opportunity of knowing the children in the grades, have expressed much surprise when I have told them that various persons were born left-handed and learned to write with their right hands in the grades.

Perhaps I should here state the policy of the school system. All pupils in the first grade are taught to write with their right hands unless there is a specific request from the parent that the child be allowed to continue the use of the left hand. In the upper grades the same policy is followed with children who come to us from other systems except that the older boy or girl is "coaxed" (shall I say) into willingness through explanations of the numerous benefits to be derived with nothing to be lost. The child is taught from the positive rather than from the negative point of view. "Use the right hand, Mary does." or "Can you do it with this hand (referring to the right) just as Mary is doing?—taking particular care to know that "Mary" is an intimate friend or playmate of the pupil in question. "Don't use your left hand" is never uttered.

The following table shows the number of pupils in each grade, including the high school, who have changed hands for writing, and the number who have continued to use their left hand.

Grade	1	2	3	4	5	6	7	8	HS	Totals
No. students changed	4	5	12	4	7	8	11	8	21	80
No. using left hand	3	4	5	5	3	3	1	3	12	39

The following table shows the marks received, at the October, 1929, marking period by high school students who were left-handed and by those who changed hands for writing. This includes every student whether classical or commercial as well as every mark given.

Grade	A	B	C	F
Changed Group				
No. of Grades	16	37	53	19
Percentages	12.8	29.6	42.4	15.2
Left Hand Group				
No. of Grades	2	21	39	13
Percentages	2.7	28.	52.	17.3

(Grades A, B, C, Passing; F, Failure)

The changed group received the larger percentage of A's and B's while the left-hand group had the larger percentage of C's and F's. The percentage of A's of the changed group was 2.2% higher than that of the whole school; the percentage of A's of the left-hand group was far below that of the entire school; the percentage of F's in both cases was higher than that of the school, being 7.3% higher in the left-hand group.

At the close of the marking period, December, 1929, the grades of the left-hand and the changed-hand students were again tabulated and found to be as follows:

Grade	A	B	C	F
Changed Group				
No. of Grades	23	37	55	9
Percentages	18.53	29.84	44.35	7.28
Left Hand Group				
No. of Grades	3	20	39	10
Percentages	4.17	27.77	54.17	13.89

Again, it will be noticed that the changed group received the higher percentage of the desirable grades (A's and B's) and the lower percentage of the more undesirable grades (C's and F's) while the left-hand group obtained the higher percentage of the more undesirable grades (C's and F's) and the lower percentage of the better grades (A's and B's). Note particularly the A's: 18.53% to 4.17%.

"A" may be defined as: "The grade of work that is unusual. Can be attained only by a student of high mental ability who works faithfully. Written work is done neatly, promptly, and seldom needs correction. Original; not dependent on help from teacher, but able to use suggestions effectively. Always ready in recitations, thorough in mastery of facts and thoughtful and accurate in the application of principles. Near head of class on examinations and tests. Work of this grade warrants the belief that the student would pass a College Board examination with a good grade and that he or she would do good work in college in that subject."

My influence from the foregoing figures is that the changed-hand student, as a group, are doing the better work in high school; certainly, they have not been handicapped in any way for high school work by the change from left-hand to right-hand writing. Since these figures cover two consecutive marking periods it cannot be said that it just happened that way."

The following table indicates the quality of writing done by high school students who have changed to right-hand writing and by those who have continued to use their left hand. The Gettysburg Scale by Ayers was used and the scaling was done by four persons, independently of each other, and hence does not represent my personal opinion alone.

Quality Number	20	30	40	50	60	70	80	90
Changed Group								
No. of Papers	0	2	3	2	3	5	5	1
Percentages	0	9.52	14.28	9.52	14.28	23.8	23.8	4.8
Median				71				
Left Hand Group								
No. of Papers	4	2	2	1	1	0	2	0
Percentages	33.33	16.67	16.67	8.33	8.33	0	16.67	0
Median				40				

It will be observed that the changed group as a whole are the better writers. Is this because they are naturally better writers or because the right hand is better adapted to writing?

Thirty-eight and one-tenth percent (38.1%) of the entire changed group, now in high school, have been awarded Palmer Method Student's Final Certificates. If five students who entered Amherst High School from another school system and consequently never studied muscular movement writing are not counted, fifty percent (50%) of the changed group have been awarded the Palmer Method Student's Final Certificate. Of the entire left-hand group, now in high school, only one person, (8⅓%), has won the Certificate. Eleven of the twelve high school left-handers received their preparation in the Amherst schools and had the advantage of penmanship supervision.

Following is a table showing the quality of writing by the changed and non-changed groups in Grades 5, 6, 7, and 8, based on the Gettysburg Scale by Ayers.

Note that 38.23% of the changed group fall in the three highest qualities of the scale, while only 10% of the unchanged group fall in the third highest quality with none in the two highest. In quality "40" and below will be found 80% of the left-hand group as against 23.54% of the changed group.

Quality Number	20	40	50	60	70	80	90
Changed Group							
No. papers, Gr. 8	0	2	0	2	4	0	0
No. papers, Gr. 7	0	1	1	4	3	1	1
No. papers, Gr. 6	2	1	1	1	3	0	0
No. papers, Gr. 5	2	0	4	1	0	0	0
Totals	4	4	6	4	11	1	1
Percentages	11.77	11.77	17.65	20.58	32.35	2.94	2.94
Median			64.28				
Left Hand Group							
No. papers, Gr. 8	0	2	0	0	1	0	0
No. papers, Gr. 7	1	0	0	0	0	0	0
No. papers, Gr. 6	0	2	0	1	0	0	0
No. papers, Gr. 5	1	2	0	0	0	0	0
Totals	2	6	0	1	1	0	0
Median				45			

In the following table will be found the average writing speed of the changed and non-changed groups in Grades 5, 6, 7, 8, and the high school, in terms of "letters per minute."

Grade	5	6	7	8	HS
Changed Group	71.3	76.5	92.8	81.8	95.3
Left Hand Group	63.2	62.3	58.	75.8	85.7

In all grades including the high school the pupils who changed from left-hand to right-hand writing are the faster writers.

In this survey fifty-five cases in which a change of hand for writing has been made and twenty-two cases in which the left hand is used exclusively for writing have been studied. These are not "selected" students but every student in the system.

There are no cases of stammering or stuttering in either group. The writing of the changed group pupils is the better according to Ayer's Scale. The writing speed of the changed group pupils is the faster. The grades made by the changed group pupils (who are now in high school) are the better at two consecutive marking periods. These facts, to my mind, are sufficient proof that it has been wise, with these pupils, at least, to change hands for writing purposes. What is true of one representative group of normal children is true of another.

THE NEW PROFESSION OF SOCIAL WORK

By
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The New Century Dictionary devotes half a column to a definition of the word "profession". As a starting point for our discussion, we quote a part of that definition (the part which has reference to the term in the sense of which it is used in this paper): "A professed occupartion or calling; a vocation; especially one of the three vocations of theology, law, and medicine (formerly known specifically as 'the professions')—some other vocation requiring knowledge of some department of learning or science, or in which knowledge is used in the practice of an art."

If we may supplement this necessarily brief and technical **dictionary** definition of the word "profession", we perhaps should add the following descriptive statements based upon an analysis of a well-developed, recognized profession, like that of medicine. It is the writer's judgment (for reasons which we need not enter into in this paper) that, at the present time, the practice of medicine and surgery most nearly fulfills all the requirements for a **profession,** of any of our vocations, callings, or occupations. The following are descriptive statements or standards which may help us to get our perspective and that may therefore help us to discuss our subject intelligently.

1. An occupation which may properly be called a profession is based very largely upon some particular body of scientific knowledge. The profession itself is, in most cases, more of an art than a science; but, under modern conditions, a profession has a scientific basis. For example, the medical profession is based upon the sciences of chemistry, biology, anatomy, and physiology, with much dependence, also, upon physics, psychology and other sciences. Social work, in so far as it is a profession, is based upon the bodies of knowledge contained in sociology, economics, political science, history and psychology, with much dependence, also, upon biology, social geography, and other bodies of scientific knowledge.

2. Another mark of a profession is that the general public, usually by some kind of legal regulation, attempts to protect itself from those who pose as members of a certain profession but who do not have the requisite ability, training and experience to make them reasonably competent. Because of the highly technical nature of the appropriate training for professions, the general public can be much imposed upon and exploited if there are not some general safeguards in **entrance** to a profession and also in continuing to be a member of that profession.

Those who seek to become doctors, lawyers, architects, university professors, engineers, etc. must pass certain tests and examinations, or have certain specified kinds of training before they can legally engage in those professions.

Some occupations are on the borderline or they are partly **both** a **profession** and a **business.** Journalism is a notable example.

It is much easier for the general public to protect itself against the crooked business man than against the crooked professional man, for any ordinarily intelligent person can judge fairly well for himself whether he gets the worth of his money when he buys potatoes, furniture or a suit of clothes. Not so when he buys the services of a doctor, a lawyer, an architect, a university professor, or a social worker. The old saying that "a doctor buries his mistakes" is also largely applicable, in different senses, to all professional work. The lay public is, in the nature of the case, largely helpless in these matters; hence the necessity for **some** kind of guarantee, by the state, or by the profession itself, that the services rendered are reasonably up to standard, taking into account the stage of proficiency then attained by the majority of the members of that profession.

An interesting example of the growing complexity of legal regulations of professions is the law now in force in many states concerning the architect's profession. One phase of this body of laws provides that, for instance, if a registered architect designed a theater whose roof fell in, killing and injuring many people, that architect (**not** the owner of the building or the contractor) is criminally liable. On the other hand, if the owner employed a man not regularly registered as an architect, to design the building, then the owner is criminally liable in the case mentioned. Laws can not protect **totally** ignorant people. It **can,** however, say to the public, "If you desire certain services performed adequately, go to the man we have allowed to perform that service; if you do not, the risk is your own."

In spite of the growing tendency to legally standardize professions, the whole problem is far from being solved. One of our best Morgantown doctors said to me recently: "No intelligent young man will study medicine these days; the state is getting so liberal in allowing osteopaths, chiropractors, Christian Scientists, and other quacks and near-quacks to practice the healing art, that there is no longer a fair chance for the thoroughly and **expensively** trained M. D." Perhaps this man got up with a headache that morning, and would not stand by such a sweeping statement after his mind cleared up out on the golf links; but the statement was made in all seriousness.

3. In all well developed organized professions there is a high degree of mutual aid and cooperative effort, both in their daily practice and (especially) in their relations with the rest of the community. We all

know that it is exceedingly rare to hear a doctor criticize, in any **destructive** way, a fellow-practitioner. What the doctors say about each other **to** each other," the Lord only knows, and he won't tell". On the whole, this inter-professional loyalty is desirable, although it may, at times be carried too far.

4. All professions have what is usually spoken of as an ethical code. The older professions have worked their codes out in great detail, much has been written about them, they are always more or less in process of revision, but at any particular time are well understood and **reasonably** well lived up to, by the active members of these older professions. Any very serious violations of these codes lead to expulsion from the group, although this does not **always** mean actual **legal** expulsion from the right to practice. The efforts (not very successful) that have been made in recent years by the Federal Trade Commission to get leading business men in the different industries to work out a self produced and self imposed ethical code of business practices shows that the desirability and effectiveness of such codes are generally recognized. The more highly professional a group of workers becomes, the more completely they control their own professional daily activities and the less they are subject to governmental or other external control. The profession of college and university teaching is a case in point. Barring a few exceptional situations such as the unfortunate developments in the last year or two at the University of Mississippi, college and university teachers are almost entirely upon their own honor and responsibility as to **what** and **how** they teach. To be sure, the interests of the general public welfare determine and lay down broad **policies** and **conditions** of operation for **all** professions. But aside from these broad and general limitations, the doctor and the university teacher, as well as other professional men and women, are controlled by the codes and standards which have been created and are maintained by their own group.

5. Closely connected with the code of ethics of a profession is the attitude of the members of professions to the general public, and the attitude of the public to the professions. Possibly because nearly all types of professional work have more to do with human beings and their relations to one another than is the case with the work of those engaged in business and industry, the professional man, in most cases, develops a sense of **social** obligation and responsibility not so often formed in the men in business and industry. The farmer deals largely with physical nature, the manufacturer and trader deals in iron, steel, cloth and sugar. The general public senses the situation rightly when it **expects** the **professional** man (doctor, lawyer, preacher, teacher, editor), to take more than **ordinary** interest in community affairs and problems. On the whole, these expectations are realized, though there are many cases of

business men whose attitudes are well socialized, and there are some professional men who are selfish and mercenary.

6. All professions have their own organizations and authorized publications, for the maintenance and promotion of professional standards, for the give and take of professional and social intercourse and for mutual improvement. Closely related to these professional organizations which (in the larger professions) are local, state, regional, national and international in scope, we have journals, news letters, and other forms of published material for the information and stimulus of the members and for the use of such portions of the general public as are capable of understanding and enjoying them. A few groups, especially the medical profession, publish considerable material **not** designed **for** and not accessible **to** the lay public. The relative amount of this restricted information, however, is probably not very great.

7. Another characteristic of all of the larger and older professions is the rather high degree of specialization or subdivision **within** the particular profession. (This situation is also found in the business world, but not in so definite and marked a degree.) This fact is well recognized in the training schools for the various professions—thus a student in a college of law may look forward to specialization in corporation law, in criminal law, in public law, etc. A prospective M. D. may plan to specialize in surgery, in eye, ear. nose and throat, in women's or children's diseases, etc. If so, his academic course, as well as his internship or other apprenticeship is pointed in this direction, granting that he must have a good **general** foundation in the principles and technique of his profession. As the body of scientific knowledge upon which our professions are based is enlarging rather rapidly in most cases, this specialization **within** professions is increasingly desirable and necessary. We do not mean to imply, however, that there will not continue to exist a large place for the general practitioner, in law, in medicine, and perhaps in nearly all professions.

8. If a group of workers, or an established vocation, is to be correctly spoken of as a profession, a distinct majority (perhaps 75% as a minimum) of all the full-time, paid workers in that group must measure up to the minimum standards for that occupation as set by the most intelligent members of the group **and** by the government **and** by the general public opinion in so far as public opinion is vocal and effective in the particular case. These standards include (1) technical professional training of specified nature and extent, (2) the academic and technical professional training proper, (3) a successful apprenticeship in one form or another, and (4) enough of good moral character and personality to win and hold public confidence in a reasonable degree.

Just one brief illustration may be of value, in suggesting that failure to measure up to any one of these four minimum standards disqualifies a group to be spoken of correctly as professional. The Presbyterian clergy (if I understand correctly the requirements for entrance into that honorable body) may be spoken of correctly as a professional group. The Methodist clergy can probably **not** be spoken of as professional, inasmuch as about half of them, in some states, do not have even a complete high school education. Do not misunderstand me. I am not saying that the Methodist clergy are not good and useful men, possibly fully as much so as their Presbyterian brethren; but I am simply saying that we can not think of them, they can not think of **themselves** as a **professional** group, with the recognition and authority in leadership not only in their own church, but in the general community life, that naturally inheres in a more definitely trained and standardized group of workers.

We shall now proceed to analyze the status of the social workers in the United States and ascertain how nearly, if at all, they measure up to the standards of a profession. We shall also attempt to analyze present trends and make a few modest predictions as to whether or not social work is becoming **more** of a profession as time goes on.

1. In regard to the first proposition, as to the body of scientific knowledge underlying a profession, social work is handicapped by the fact that the four most closely related fields of scientific subject matter (sociology, economics, political science, and psychology) are themselves in a relatively youthful stage. The oldest of these, economics, may be said to have been born about 1776, with the publication of Adam Smith's "Wealth of Nations". For at least two generations, however, economics was much more **deductive** than **inductive.** Adam Smith, David Ricardo, John Stewart Mill in England, the Physiocrats in France, Walker and his contemporaries in America, should perhaps be spoken of as keen, broadminded social philosophers, rather than as scientists. Their observations and analyses are highly interesting and had many different kinds of values, especially as a powerful means of justifying and keeping alive (beyond their proper time of death) many erroneous notions of business and government. Especially was this true in the over-emphasis on the laissez-faire doctrine whose friends are even now, in 1931, struggling hard to keep alive. John Stuart Mill, to be sure, pointed the way toward a more objective and rational study of humanity's social and economic problems, but he had few, almost **no,** scientific tools with which to work. It was only in the late nineteenth century, under the influence of the more scientifically minded Germans and with the aid of the new science of statistics, that the social sciences began to take on vitality and dependability and to lay a solid foundation for the inductive, objective study of the phenoma of human relations. When Richard T. Ely, fresh from his studies in Germany, came to Johns Hopkins University about 1890 (and a number of other young American economists came back from Germany about the same time), economics may be said to have entered its first

stages as a social science. Alfred Marshall and his contemporaries in England came on the scene of action at this period also. It is a remarkable fact that just when economics took on a scientific aspect, the social or humanitarian approach was beginning to be emphasized. Ely in America and Marshall in England were only among the leaders who publicly announced, in their books and in their university lectures, that their main objective was to help work out a better knowledge of economic and social forces so that poverty and other social evils which they believed preventable might be done away with. It is a rather curious fact that Professor Ely, now, in 1931 thought of as a very conservative economist, was considered by many a dangerous young radical when he came back from Germany, and at one time he almost lost his university position on this account.

It is only natural that social work, or welfare work, as it was generally called at that time, has advanced rapidly from this same period (about 1980). Jane Addams founded Hull House, in Chicago, in the late eighties. This social settlement has now become probably the leading one in this country and in the world. Miss Addams, after her college life, traveled extensively in Europe, especially in England, and came into close contact with the new scientific, humanitarian movement. While in college she had also been much influenced by her study of the new social economics.

Organized charity work had begun in England about 1870, but was at first largely on a sentimental, patronizing basis. About 1900, under the influence of a more objective, scientific, democratic social outlook, organized charity activities assumed, quite rapidly in the large cities, the aspects of a real profession.

Therefore, while we must admit that accurate, classified knowledge of human inter-relations is still relatively meager (that is true, to some extent, even of the knowledge which furnished the scientific bases of the older professions), we can say with approximate accuracy that there is enough of a basis of scientifically obtained knowledge for use in the occupation of social workers to entitle men and women in that vocation to be called professional. The accumulation of further knowledge in these fields is going on rapidly. This accumulation is the result not only of the activities of research workers and statisticians, but also of the daily work and reflection of many of the more intelligent and scientifically minded social workers themselves. The analyses of the data of crime, delinquency, poverty, divorce, immigration, race relations, social institutions and activites, analyses made by careful observers and systematically recorded, are furnishing more and more adequate material for the understanding of these complicated phenomena. The social case histories from penal and correctional institutions and from criminal courts; the data of state and city health departments, the increasingly accurate and comprehensive census and other governmental reports, furnish a surprisingly large body of subject matter for use in the social sciences.

2. On the second point, of legal regulation or recognition, certain phases of social work have reached a rather definite stage of indirect regulation and recognition. This is especially true in several types of child welfare work and in the administration of poor relief. Counties, cities, states and the federal government have established and are maintaining bureaus or departments in which the essential and vital work is a particular form of social service, and the entrance to such types of work is by civil service examination or by appointment on the basis of specified standards and regulations. Notable examples are the Children's Bureau the Women's Bureau, and the Immigration Bureau, at Washington; certain classes of workers in county and city welfare departments, juvenile courts and poor relief activities, and state child welfare agencies, such as our West Virginia State Board of Children's Guardians and the Crippled Children's Council. Not all these social workers for governmental agencies are highly or thoroughly trained; some of them are. The important point is that our governmental units are recognizing and paying for the services of men and women doing various forms of social service work. The hospital or medical workers should also be mentioned in this connection, for most of these workers serve the large general hospitals which are for the most part maintained by the federal government or by city or state governments. The Cincinnati and Massachusetts General Hospitals have maintained staffs of social workers for many years.

It is interesting to note, in this connection, that the County Welfare Board of Monongalia County has, for several months, been attempting to secure a trained social worker to have general charge of poor relief and child welfare activities in this county. The difficulty encountered in attempting to secure such a worker seems to suggest that the demand for qualified workers of this type is greater than the supply.

The extent and diversity of social work maintained by the public, that is, by the taxpayers, is constantly on the increase. Our Morgantown Independent School District has employed a professionally trained recreation director for the last four years. In addition, fifteen to twenty half time playground supervisors have been employed during the summer season, and even these summer playground supervisors (with two or three exceptions) have been required to have some professional training.

In view of the fact that some of our privately supported social welfare agencies are not yet adequately organized and supported, they are not in a position to be quite so definite in requiring certain standards of training and experience for their workers. All the better agencies of this type, however, are advancing definitely **toward** these standards.

On the whole, we may say from the viewpoint of standards, required for **entrance,** the occupation of social work only **partially** qualifies as a profession.

3. As to mutual aid and cooperative effort among social workers, a rather high standard is reached. Partly due to the relatively small **number** of social workers and partly due to the human or social nature of the work itself, the men and women engaged in these activities have a well developed group consciousness and give each other much helpful mutual understanding and support. This is especially true of the social settlement workers, who usually live in groups of ten to thirty, who see each other every day, have at least their evening meals together, and practically all of whom are college graduates. There are probably 2000 professionally trained settlement workers in the United States. The esprit de corps and morale of social workers probably ranks well up toward the top among all the vocations or professions.

4. The ethical or professional code for social workers is now in process of being worked out. The American Association of Social Workers, with headquarters in New York City, has taken the lead in this process. For the past seven or eight years, an active discussion of tentative professional standards has been kept up among the chapters of this organization, as well as among the leading representatives of all organized groups or subdivisions of social workers. The principal training schools are also taking a significant part in this difficult and never ending problem of working out and maintaining a professional code.

The tentative standards that have already been accepted by social workers have considerable influence, especially in reference to the appropriate inter-relationships of the various branches of social work. Much progress has also been made in establishing minimum standards for entrance into professional social work; there has been little attempt made, yet, to secure **legal** or **compulsory** regulations in this regard. All the older and most thoroughly established social work agencies, however, of their own accord, are enforcing with a fair degree of uniformity, entrance standards and probationary apprenticeship regulations.

Therefore, we may say that the social workers have not **yet** reached a point of sufficient **definiteness** and extent of **acceptance** of codes and standards, to justify speaking of the occupation as a profession; but constant progress is being made in this direction.

5. As regards their attitude of social responsibility to the general public, it is perhaps fair to state that social workers are now measuring up to a really professional standard. Their daily work necessarily brings so many contacts with the public, that a man or woman who does not qualify as to intelligent interest in public affairs, and responsiveness to public opinion, does not long **remain** a social worker. The regular

activities which make up the occupation of social work involve contact with the mass, with business and industry, and with governmental bureaus and officials. This is true even of the social workers employed by private social welfare agencies, and naturally it is still more true in the case of men and women employed in social welfare activities maintained by city, county, state and federal governments.

In the Ohio State University Training Courses for prospective social workers, an important subdivision is made up of lecture and laboratory work in the general field of **publicity** as related to organization and promotion of all kinds of community welfare work. I am personally acquainted with Mr. C. C. Stillman who heads up this phase of the work and believe that he is competent to give a well balanced and thorough training along these lines. Formerly a successful social worker in Kansas City, where he specialized in the publicity aspects of the job. he is familar with both the theory and practice of journalism as related to community welfare. In some quarters Journalism is now being spoken of as a social science, and every prospective professional social worker should have at least six hours of work in college or university journalism courses. The **proper** use of publicity is a large factor in **all** kinds of social or community work. The **wrong** use of publicity will, if very long continued, practically destroy a social work agency and make the well-intentioned but unskillful social worker ridiculous in the eyes of the public.

An interesting local example of the relation between journalism and promotion of welfare activities has been given us in Morgantown during the past several months. The collection and distribution of the rather large amounts of money, food and clothing by the Council of Social Agencies and the special appeals for particularly needy cases, would have been practically impossible without the generous and intelligent policy of both newspapers in giving front page publicity, as well as editorial support, to these activities. In addition, both papers have recently shown a definite interest in the idea of a Community Chest for Morgantown, which is the modern way of raising and distributing money for charitable purposes.

As to the connection between politics (or government) and social work, we quote from a statement made by Edward D. Lynde, general secretary of the Cleveland Associated Charities, writing in the April, 1931 issue of The Family, which is the official organ of the family social case workers. Mr. Lynde says:

"Political science makes us aware of the necessary limitations in public service, so that we do not expect too much, and, perhaps more important, it teaches us in what ways we can bring the most gratifying rewards to those officials who are helpful to the cause of social work. The Cleveland Health Council recently put on a housing campaign which was infinitely more successful than most efforts of private social agencies because they knew every ward leader and key man and just how to enlist his interest; and they utilized nearly every public official in exactly the way in which he wished to be utilized and in which he could be most helpful, and secured for him various kinds of favorable publicity.

Even to do our everyday task properly we need to have an understanding of the content of social legislation and of the function of the various political units that touch our work. Not a day goes by but the case worker needs to make contact with some agency of the state—to consult a birth record, make a report to the health department, utilize the service of a city physician or school nurse, or take advantage of some bit of social legislation. The social settlement worker is similarly interested in the street department, the citizenship bureau, the police department, and the park department—and their functioning in his neighborhood. These contacts and responsibilities, if they are to be successful, necessitate workable knowledge of the theory and practice of government."

"Throughout Clark County, Wisconsin, there was not one public health nurse. A county conference of social work, attended by several hundred people, started a petition which later received more than a thousand signatures, and a public health nurse was engaged by the county within three months. New London, Connecticut, had been getting nowhere with a campaign for better housing. Through a carefully planned series of approaches, social workers enlisted the interest of a key politician and he put through nearly every improvement suggested.

"But is is not enough to get the state to pass legislation. Social workers have a responsibility to see that the law is wisely written, so that it is practical and can be enforced. Otherwise, it will become a dead letter. It is not enough to secure the establishment of a new bureau. We must study where it can be placed under exactly the proper auspices, or it will be handicapped. And here again, political science helps with its comparative studies of the practical workings of different administrative units; and its revelations as to the practicability of different types of legislation.

"But when we have secured provision for a new bureau under exactly the right auspices, we need still to see that the best trained people are appointed or elected to guide its administration. Even a good system falls down with untrained personnel. The successful administration of a juvenile court, for instance, requires a knowledge of social work as well as of law. It represents a move toward socialization and individualization and away from the old rule of thumb method. The solution may lie, not in mercurial changes from one type of court to another but in effectual efforts to elect capable and socialized judges. The profession of social work should be recognized as on a par with law and medicine in all those positions which call for social training."

Therefore, we can see that both because of the **essential nature** of his daily work, and because of the practical **necessities** for securing results, the social worker must be in close touch with all vital community interests. It is perhaps not going too far to say that a well trained social worker who has lived and worked in a particular neighborhood or community for a considerable period, actually knows the **people**, their individual and group characteristics and problems better than any other **one** person. The local politician and the skilled newspaper reporter who have given special attention to the neighborhood, are about the only other persons whose knowledge of the vital social situations would be equal to that of the trained social worker. We may say then that the occupation of social work ranks relatively high in the standard of social awareness and spirit of social responsibility expected of **all** professional groups.

6. In the development and maintenance of professional organizations and publications, social workers have reached the stage of **quantity** production. As to **quality** of production, naturally, there is, as in all groups which are **approaching** a professional basis, much room for improvement. Because of the wide human interest appeal of social work, it does attract a considerable number of men and women whose intentions are admirable, but whose methods and emotional base-work are more sentimental than intelligent. **Sometimes,** but with less increasing frequency as time goes on, it is a bit difficult to prevent this more sentimental group from running away with the program at a conference of social workers. In my ten years of rather close contact with West Virginia social workers, it has been an encouraging experience to note the decided trend toward more rational, intelligent and self-critical attitudes among those who make up our state and regional conferences. I hope I am not misunderstood in this brief analysis, for it is by no means true that we want emotion and sentiment ruled out of social work. It is indispensable as a vitalizing factor and always will be; we only mean to say that when it **predominates** over the aspect of intelligence it is a case of the tail wagging the dog. One of the constant objectives of all social work training and practical experience **after** training, is to maintain a suitable **balance** between **judgment** and **emotion.**

The National Conference of Social Work is made up of **all** classes and types of social workers, lay and professional, and meets once each year in cities in different geographical sections of the United States. Its sessions last about one week and cover practically every phase of social work. Subdivisions and sections have become necessary in order to provide for rapidly increasing specialization. Some sections have become so large that they are again subdivided. Attendance at the National

Conference is open to all who are willing to pay the registration fees and necessary travel expenses; but the actual control of the programs has now for several years been almost entirely in the hands of the distinctly professional element.

Several groups, especially the social settlement workers, the juvenile court probation officers, the family case workers, and the recreation group, have become so numerous that they have national associations and journals of their own, but they all retain an active interest in the all-inclusive national conference. The annual proceedings of the national conference are carefully edited and published in a comprehensive volume, about thirty of which are now in the West Virginia University library.

Of the many official journals published by and for social workers, I mention only three, as samples. The Survey, published twice a month in New York, is devoted to a broad, but critical, resume of vital and typical happenings in the social work field, including also, analyses of current problems, such as unemployment, immigration, race problems, housing reform, recent juvenile court developments, politics, and social legislation. It also helps keep the social worker up to date by the presentation of discriminating book reviews and comments on sociologically significant periodical literature.

The Family is the official organ of the Family Welfare Association of America. As its name indicates, it deals chiefly with the broader professional aspects of dependent and deliquent family problems. It is well edited and is distictly authoritative in its particular field.

The Social Service Review is a "Quarterly Devoted to the Scientific and Professional Interests of Social Work". Edited by the faculty of the University of Chicago Graduate School of Social Service Administration, it naturally is intended for the relatively limited group of social workers who desire to spend part of their time in more fundamental scientific study of their problems and conditions. Statistical and other scientific methods of approach are largely used in the presentation of the subject matter.

Besides these three rather typical journals, practically every important subdivision of social workers has its own technical journals; this is especially true of the settlement group, the recreation and playground group, the juvenile court probation officers, and the psychiatric social workers.

On the whole, the occupation of social work is approaching very nearly a professional standard in the matter of professional organizations and publications.

7. From the period of early beginnings, social and welfare workers recognized, in common with other technical occupations, the need for specialization and subdivision. Associated charities and social settlements grew up almost contemporaneously. This trend toward specialization has,

in recent years, developed rapidly. It will be treated more fully in a later section of this paper under the head "Forms of Social Work". We may fairly say that social work is quite fully meeting this test of a well organized profession.

8. When we apply the eighth (and last) test to social work activities and those who carry them on, we must admit that the professional standard is far from being reached. Probably twenty-five per cent of the approximately 25,000 social workers in the United States measure up to the technical standards of professional training and experience which have been fairly definitely laid down by the more skilled and intelligent workers in this occupation. By the term "social worker" we mean those men and women, at least 25,000 of them, who are now making their living by doing some form of full time, definitely paid for, type of social welfare work. We do **not** include the many thousands of volunteer, part time workers in this field. The very nature of social work makes it desirable and inevitable that there should be a large group of men and women who are go-betweens, so to speak, between the general public on the one hand, and the technically trained social worker on the other hand. The time will probably never come when these "volunteer" workers, so-called, will not be needed. We have a concrete example in Morgantown, West Virginia. During the past winter season, the Monongalia Council of Social Agencies has distributed most of its food, clothing, and personal service, through the medium of its case committee, made up of about a dozen loyal, intelligent, social-minded, hard working women. These women have re-made thousands of garments for needy families. They have gone directly into the homes of families who have applied for or needed relief; their investigation of the facts in the particular cases have been the solid basis for the large amount of constructive relief work which has been done since last November. The members of this case committee have made the necessary daily and weekly personal contacts, not only with needy families, but also with county and city officials, with business men and others who donated money or goods; also with the other agencies and persons concerned in the administration of probably the largest and most complicated relief program Morgantown has ever been called upon to handle. The community **should** have a thoroughly trained social worker to head up this work and organize its various phases on a more permanent basis. The chief point I am making here, however, is that even if the community had secured such a trained worker, she would, by all means, have needed the case committee to assist her in a job entirely too large and complicated for any one person to handle successfully.

In all **probability,** the **proportion** (**not** the total number) of professionally trained social workers has diminished rather than increased in the last year and a half. Since December, 1929, the whole country has been faced with perhaps the most serious and wide-spread visitation of business depression, unemployment, and consequent poverty and dependency, which it has ever had to meet. Under these conditions both the public and private charitable agencies have had to handle an unprecedented number of problems, including investigations of application for relief and the securing and distribution of money, food and clothing. Relief budgets increased enormously, and with relatively great suddenness. A few weeks ago the Chicago United Charities were dispensing relief at the rate of $100,000 a day. All the reputable charitable agencies (public and private) have endeavored to continue to carry out, as far as possible, their standards of investigation and other constructive measures, to avoid pauperization of the recipients of relief. This objective has been only partially attained, for all relief-giving agencies admit that the urgent first aid, for near starvation cases, have been so numerous that investigation and keeping of records have suffered. The agencies have, however, made an honest effort along this line, and have during the last eighteen months taken on hundreds of full time workers and thousands of volunteer workers, to help in the great task of investigation and constructive family case work. Many of these new workers have had little or no professional training, but their common sense and humanitarian inclinations have made it possible for most of the relief organizations to tide themselves over a critical period. The Cleveland Associated Charities has recently officially announced that their treasury will be completely bankrupt on May 1; and they **may** have to temporarily lay off even some of their trained workers, until additional funds are available.

Basing our conclusions then, upon the above facts (and other similar facts which could be assembled), we may state that, however **useful** an occupation social work may be, only a decided **minority** of the workers can properly be called **professional.** Barring such unusual conditions as have existed recently, however, the **proportion** of the profesional **element** in the occupation is steadily increasing.

We shall now take up a brief analysis of **some** of the more important forms (or subdivisions) of social work as we have them in the United States today.

1. Family social case work. The germ or foundation of this basic type of social work is found in the organization of the London Charity Organization society in the early 1870's. A group of educated and socially-minded men and women came to the conclusion that the age old practice of indiscriminate almsgiving was too demoralizing for the receivers and too expensive for the givers. Most of the leaders in the new movement were either public officials or clergy of the church of England. The non-conformist clergy also played a useful part, considering their relatively small number.

The organization which grew out of this agitation and discussion foreshadowed, in an elementary way, the thousands of associated charities in the world today. The sound principles of investigation, keeping of records, friendly visiting among the poor, systematic raising and distribution of relief funds, were all recognized as essential to a humane and effective poor relief plan. The old idea of giving to the poor for the primary reason of securing God's favor for the giver rather than of serving the needs of the beggar or the pauper, began to decline in the minds of the more intelligent people. Perhaps it would be too much to say, however, that this demoralizing concept of charity has even now entirely died out. Certain old traditions encouraged and handed down largely by the church leaders, both Catholic and Protestant, had been chiefly responsible for the unfortunate motivation of much charity work of medieval and early modern times.

Probably the clergy did not mean to teach that almsgiving was meritorious in the sight of God, without regard to whether the alms receiver was being helped or harmed; but there is little doubt that most of the laity so interpreted the teachings of the church concerning acts of charity.

The Organization in the 1870's and 80's in the large cities of England and America of C. O. S.'s as they were first called (Charity Organization Societies), later, known as Associated Charities and now as Family Welfare Societies, gave a tremendous impetus toward professional standards in social work. Indeed, for many years, the annual convention of social workers was called "The National Conference of Charities and Corrections". Only within the last few years has it come to be known by the more appropriate and inclusive title of the National Conference of Social Work.

2. Social settlements had their origin with Toynbee Hall in the East End of London, Hull House in the West Side Foreign Section of Chicago, and the University Settlement in the Lower East Side of New York. The movement has grown rapidly; there are now about 650 organized social settlements in the United States. The workers are both men and women, nearly all college graduates or students; and their activities are vital and varied, ranging from boys' and girls' clubs, through dramatics, music and neighborhood play to men's and women's groups for political and neighborhood improvement. For many years the men's club, fostered by Graham Taylor of Chicago Commons, was a leading factor in the maintenance of an honest and useful representation of the fourteenth ward, in the city council. When we take into account that then, as now, Chicago politics had world wide notoriety for graft and crookedness, this achievement of the men's Club (mostly Italians) at the Commons Social Settlement, was distinctly worthwhile.

The Irene Kaufman Settlement on Center Avenue, in the heart of the Jewish district of Pittsburg, is perhaps the leading social settlement in the Pennsylvania-West Virginia region.

3. Juvenile court and probation workers, with their own national organization, make up a significant division in the whole field of social work. They are nearly all full time, paid officers of courts of Domestic Relations, or Juvenile Courts or Circuit Courts, having juvenile jurisdiction. This phase of social work has also grown very rapidly since it was started in Chicago, about 1900, largely as a result of the intelligent and persistent pressure brought to bear on the county commissioners by the Chicago Federation of Women's Clubs. Probation officers, under the general direction of the courts which they serve, have responsible duties in connection with the interests of both dependent and delinquent children. The juvenile court had its origin and early development in the United States. Its fundamental principles have now been adopted by all civilized countries.

4. Medical or hospital social work was developed about fifteen years ago to care for the special needs of patients that could not be completely cared for by doctors, surgeons and nurses. Experience had taught the administrators of large charity hospitals or wards that the beneficial effects of medical, surgical and nursing work were often neutralized by the acts of the patient and members of his family during the period of convalescence. This problem and other related ones have been taken up by medical social workers, resulting in a substantial increase in the value of hospital services to the poorer elements of our population. Johns Hopkins University was among the first to organize training courses for medical and public health social workers.

5. During the last thirty years the field of play and recreation has been organized on a professional basis. Those who oppose this movement on the ground that both children and adults will play anyway and play is or should be spontaneous and not artificially stimulated, forget that we are rapidly becoming a nation of towns and cities. In our grandfather's days three-fourths of our American people lived on farms; now the situation is reversed. Three-fourths of our population live in cities and towns, one-half of them in larger towns and cities. The crowded housing conditions, the poverty of 10% of our population, the lack of work for boys and girls under sixteen, all have combined to make a real problem in the securing of adequate play and recreation facilities. The war period gave a great impetus to this movement; for it was well demonstrated then that a well organized program of athletic games, music, stunts, etc. were immensely valuable for the soldier in camp, in maintaining his morale and filling his otherwise idle moments when not drlling, eating or sleeping.

At the present time more than 1000 cities, towns and school districts have play and recreation programs organized and maintained on a tax supported basis, administered by professionally trained directors. Wheeling, Clarksburg, and Morgantown are West Virginia cities having such programs.

6. Psychiatric social work is perhaps the newest subdivision of the field to be organized on a professional basis. The world war, with its relatively new problems of shell-shocked soldiers, was probably the greatest single cause leading to the development of this, one of the most complicated and highly specialized of all the fields of social work. Sociological, psychological and medical training are indispensable for work in this field. The number of well trained psychiatric social workers is now not large; but it is growing steadily. The two chief fields of operation are in the United States veterans' hospitals, and in child welfare clinics. According to the statisticians of the United States Veterans' Bureau, the minimum number of nervous and mental cases from the World War, in hospitals, will not be reached until about 1940. There is also a growing tendency among all large welfare organizations to have at least one psychiatrist on their staff, to help in the treatment of the mental aspects of their cases.

The above six subdivisions of social work do not make a complete list, by any means; but they are among the best developed at the present time, and may serve as samples of all, so far as the manner of gradual development in response to recognized needs is concerned. They may also serve as samples in the gradual and experimental way in which technique and administrative methods have been worked out.

There are now a goodly number of recognized training schools for prospective social workers. Perhaps the leading ones are the following:

1. The New York School of Social Work, operating in close affiliation with Columbia University.

2. The University of Chicago Graduate School of Social Service Administration.

3. The Western Reserve University School of Applied Social Science, at Cleveland.

4. Johns Hopkins University Training School for Medical Social Workers Public Health Officials.

5. National Recreation Training School in New York.

The above five training schools are almost entirely on a graduate basis.

Universities which provide excellent training in social work on a combined undergraduate and graduate basis are:

1. Ohio State University.
2. University of North Carolina.
3. Carnegie Institute of Technology.
4. University of Pittsburgh.
5. University of Minnesota.

6. Smith College Training School for Psychiatric Social Workers.

All of these recognized training schools have their work organized on the principle of a combination of academic courses and field work or practical experience, following the same general principles that have secured satisfactory results in training for the medical profession.

The federal census of 1930 was the first to recognize social work as a definite occupation.

West Virginia University provides preprofessional training for prospective social workers through a curriculum emphasizing the social sciences, and through opportunity for training in practical social work at a Cleveland Social Settlement during the summer, between the junior and senior years.

In addition to the annual National Conference of Social work and the conventions of the particular groups like settlement workers, probation officers, etc., the social workers in nearly every state have, once a year, a state conference. In West Virginia our 1931 Conference will meet May 7, 8, 9, at Parkersburg. The first one of the three days is given over to an institute for the especial benefit of social workers already on the job. The other two days' program includes round table sessions, addresses, and discussions on particular aspects of the general theme of "The Child As the Center of Modern Social Work".

SOCIAL CONFLICTS OF THE ADOLESCENT

By
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In view of the changing status of family life today, the growing sophistication of youth, the decline toward the 'teen ages of the peak years in crime records, and a great many other evidences of disturbing factors in home and community, our topic becomes most timely and appropriate. If we could, in some way, smooth out the social conflicts of the adolescent years we would thereby solve many, if not most, of the problems of adult social misfits and maladjustments, for, in a large way, the root-springs of adult disturbances lay buried in the youthful years of from ten to eighteen. The challenge for such a condition is directed at us as parents, guardians, teachers, and leaders of the young folks. We have them in our care and under our guidance during the major part of their time, and, if we fail in understanding them, and in performing our tasks in directing, molding and shaping their careers, we are, to just that extent, failing in showing a fitness for our most useful and important place in society.

You will perceive at once, no doubt, that I am not planning to pass the burden of adolscent conflicts upon the adolescent. No doubt some of it belongs here, but, to my mind, a far larger share belongs with the home, the school, the church, and the community. In far too many cases all of these institutions have failed to grasp the full significance of the adolescent years, and in keeping up with youths in the new demands of the times. The home, the school, and the church have been our most conservative institutions, and, in a large way, we should be thankful for this, but, when a policy of exclusiveness, smug complacency, if not provincialism is added, it is high time we were looking into the situation with a view of eliminating the retarding factors.

Let us ask who is to blame when one discovers that a large percentage of youths must or do get their first sex knowledge from associates instead of from parents or other qualified individuals. When many of them admit of breaking the laws of the country without any thought of remorse, or of having committed a wrong. When unhappiness, parental misunderstanding, and feelings of inferiority are more or less common to the pubertal period of life. And when young people desire to run away from home because of denials, quarrels, punishments, and the lack of affection. When sometimes radical and disturbing reversals in religious concepts are made as the boy or girl advance toward adulthood. And when school or teacher fail to hold the attention and to draw out the best in the individual.

In an endeavor to reach more deeply into my subject, although in a very limited way, to be sure, I prepared and circulated a questionaire among upperclassmen in some of our courses in Sociology at Marshall College. The following eleven questions were asked so as to get a fair spread of problems touching the home and the outside interests and contacts of the boy and the girl.

Question one: At what age and over what difficulty did you have your first serious disagreement with your parents or with other members of your family?

Question two: Have you ever contemplated running away from home; if so, what were the circumstances leading to such considerations?

Question three: Have you ever been "picked on" or distressingly teased by others, and if so what have been your feelings and reactions?

Question four: At what age, under what circumstances, and by whom did you receive your first knowledge of sex?

Question five: What conflicts and disturbances of social adjustment in the home, school, or elsewhere did you experience during your pubertal period?

Question six: Have any of your brothers or sisters been especially favored, at your neglect, by your parents? If so what have been your reactions to such treatment?

Question seven: Have you ever broken any of the laws of your country, and if so, what have been your first reactions?

Question eight: Have the early teachings you received as to religion, Heaven and hell been held to, changed or discounted as you have grown older?

Question nine: What have been the chief objects and desires of your daydreams?

Question ten: What do you consider to be the most important social problems of both the boy and the girl during the adolescent years?

Question eleven: What would you suggest doing for a homesick college freshman?

I shall have to admit at the outset that the samplings for replies to these questions have been altogether too few, and that the group sampled, namely college students, and therefore a selected group, limits considerably the possibility of final and conclusive evidence. I am of the firm conviction, however, that some important trends may be observed, and that many of the disturbing social and personal factors which youths experience in the shaping of their careers have been developed by the answers. Complete replies to all questions were obtained from twenty-five girls and fifteen boys.

Under question one, relating to the first serious disagreement with parents or other members of the family, practically all replies of both the boys and the girls definitely stated one or more disagreements. The range in years at the time of the disagreement in the case of the boys was seven to twenty-two years of age, and for the girls it was seven to seventeen years of age. Most of the instances for the boys occured at thirteen to fourteen years of age, and for the girls at fourteen to fifteen years of age. The disagreements in each case were chiefly with parents and were over similar matters, with one exception, namely, the girls in many instances experienced difficulties with their parents over the question of keeping company with boys. Some of the disagreements for the boys run as follows: staying out nights; smoking; going to dances; using money; running away from home; over a parent showing favortism to a sister, and objections to going to school. The difficulties of the girls related to: boy friends; clothing; going to dances; not attending to studies, and petty arguments.

For question two concerning plans for running away from home, we find that fully two-thirds of both the boys and the girls have contemplated such an act. Some of the circumstances cited by the boys relate to being punished too severely; partiality being shown to others; unfair teachers at school, and wanderlust. The girls stated that punishments, balking of interests, unsympathetic parents, and quarrelsome parents induced them to contemplate plans for leaving home.

Under question three, which relates to being picked on and distressingly teased, we find a similar distribution of cases as given in question two, namely, about two-thirds of both the boys and the girls have had such experiences. Anger, retaliation, dislike, withdrawal from the group, and sometimes the assumption of a feeling of inferiority are reactions given by both sexes.

Answers to question four show that the majority of both the boys and the girls obtained their first instructions in sex matters from companions of the same sex. Only a small scattering of answers show that the father or the mother were the first to instruct them. The chief ages of the youths at the time of receiving such instructions were ten to twelve. In a few instances most unwholesome and harmful circumstances were related to have surrounded the individual at the time of being told of sex life. Perverted ideas and unsettled states of mind have very frequently followed the revelations under such circumstances.

In relation to the pubertal period more girls than boys stated that they experienced nervous instability, much sensitiveness, self-consciousness, a feeling of inferiority, of loneliness, and of being misunderstood in passing through the years covered by this change in life. In some instances the maladjustments formed during this period were influencing the present life of the individual. Difficulties in school and at home were named by numbers of the replies.

About one-half of the girls and one-third of the boys stated that favortism had been shown in their families. Their reactions were feel ings of unhappiness, or distrust, and sometimes of inferiority. It is almost needless to state here that young lives are sometimes badly warped and biased by the partiality of parents, or of others, either for or against an individual.

Practically all of the boys and about seventy-five per cent of the girls have been guilty of law breaking. Most of the boys did not take the matter seriously, whereas fully one-half of the girls did. Breaking the traffic laws were the most numerous of the offenses given by both of the sexes.

Most of the individuals of both sexes have experienced a considerable change of views as to religious outlook as they have grown older. Dissatisfaction with dogmatism, and decided changes in view as to Heaven and hell were frequently mentioned in the replies. A good wholesome conception of God was given in practically all cases.

The daydreams of adolescent youths tell us of many hopes and desires. In almost all cases involved in this study the dreams were of a noble and lofty character. The desire for a happy home with love in it was mentioned a number of times. Becoming a leader in business or a profession, or a great artist, or possessing much wealth were the replies of many. Daydreams, when properly directed, may lead to much constructive effort. On the other hand, they may fix upon the individual an unreal or dwadling habit of mind and lead him to seek in them a shield or cover from the stern realities of life. They need to be understood and directed that a proper course may be chosen and that the most productive results may be secured.

The best treatment for a homesick college freshman in almost all of the replies is that of providing ways and means through associates and through recreation and work of keeping his mind diverted and busy.

One of the most interesting parts of the study related to the suggestions of the young people as to the social problems of the modern boy and girl. Many of both sexes emphasized as first, a better knowledge of sex life and better opportunities for wholesome adjustments between the sexes. Other suggestions related to better recreational facilities, modern religious instruction, vocational guidance, and codes of conduct in which "Do's" and "Don'ts" are emphasized.

In this brief and partial survey of some of the common problems of the adolescent years we find many suggestions for direction and aid which all of us may well heed. Adolescent is a period of finding oneself in an increasingly complex social world. We need to marshall all of our knowledge and effort for the services of those passing through this basic period of life. All normal boys and girls of the adolescent years seek earnestly after the great truths of life; these should be given them in proper season and by properly qualified persons. Their play and recreation needs to be kept wholesome, and provided in useful abundance.

Good, sensible religious instruction is also necessary to give them the security and peace of mind needed to help meet the stresses and strains of their rapidly changing conditions of growth and development. I prefer not to speak further concerning suggestions and possible remedies for conditions developed above but instead to leave what time I have remaining on this program open for your discussion and criticism.

BACKGROUND OF CIVIL SERVICE REFORM IN THE UNITED STATES, 1789-1865

By
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In the first Congress, when the subject of removal and tenure of inferior officers was being discussed, Madison declared that the power and duty of making removals were equally vested in the President alone, with an authority on the part of the House of Representatives to impeach him if he should either allow an unworthy officer to continue in his place, or wantonly remove a meritorious one—an act of mal-administration. Fidelity and efficiency were to constitute the measure of tenure, character and capacity the test for appointments. No fixed term was specified, and apparently none was needed.[1]

Under our first six presidents only 73 subordinate officers were removed, and these, for the most part, for reasons touching their efficiency solely and not because of their political convictions.[2] Washington made only nine removals— all for cause; John Adams only nine, and none, it would seem, for political reasons; Jefferson only thirty-nine, and none of them, as he afterwards declared, on account of political opinions. About three weeks after he had been inaugurated President of the United States, the Sage of Monticello wrote (March 24, 1801) to Dr. Rush: "Of the thousands of officers ***** in the United States, a very few individuals only, probably not twenty, will be removed, and those only for doing what they ought not to have done. I know that in stopping thus short in the career of removals I shall give great offense to many of my friends. That torrent has been pressing me heavily and will require all my force to bear up against; but my maxim is **"fiat justitia, ruat coelum"**.[3]

Madison removed only five; Monroe nine; John Quincy Adams only two, and for cause. In no country in the world, in those years, were public servants so respectable or administrative so untainted. No other government had then reached so high a plane of disinterestedness, or exhibited so much regard for character and justice in dealing with those who served it. It was left for the politicians of later days to discover and to teach that it was decidedly "un-American" to select public servants for their merits and to retain them because they remained meritorious.[4]

One step taken during this period, however, was destined eventually

[1]Eaton, Term and Tenure of Office, 22-23.
[2]McAneny, Reform of the Civil Service, 3.
[3]Schurz, Civil Service Reform and Democracy, 17.
[4]Eaton, Term and Tenure of Office, 23.

to exert far-reaching influence of a baneful, unfortunate character. On May 15, 1820, a measure that had passed both houses of Congress with scarcely a protest on the part of a single Congressman became a law of the land. It provided fixed terms of four years for a large number of Federal Executive officers. It also provided that they should be "removable from office at pleasure".[5] According to the political foes of William H. Crawford, the Secretary of the Treasury, the purpose of the measure was to enable the said secretary to fill the offices of his department with influential party workers who would constitute invaluable cogs in a personal party machine which would place Mr. Crawford in the White House in the presidential election of 1824. On the other hand the loyal friends of the Georgia politician asserted with vim and vigor that the Treasury Department seriously needed a scraping off of the barnacles left by previous administrations in order that a more efficient clerical organization might be effected. Whatever the true explanation of the genesis of this bill, the fact remains that this piece of legislation emphasized the theory of rotation in office and placed the four-year tenure on a statutory basis a whole decade before President Jackson adopted and applied the principle on such a tremendous scale. The new system might well be summarized thus: No longer tenure than four years; removals at pleasure; rotation in order to supply offices to the greatest possible number of servile partisans; office and salaries the natural spoils of party welfare; all appointments and removals on purely political grounds; and the primary duty of the official to be an indefatigable worker for the interests of his party and a willing tool of its managers.[6]

This condition of affairs did not come about immediately and abruptly but evolved gradually and steadily, receiving its greatest impetus under the Jacksonian regime. Within the first year of Jackson's Administration 2,000 officers in the Federal Executive service walked the political gang-plank. As Mr. Van Buren was the dominating personality in Jackson's Cabinet, there is some reason for the oft-repeated assertion that the New York politician was largely responsible for this wholesale guillotining.[7] The Albany Regency, which had been under the leadership of Van Buren for many years, had, for a long time, been in the habit of selecting candidates for elective offices, either by the people as a whole or by the legislature, in a caucus, and then bound every member of the party to support the nominees.[8]

But this was not the first party machine in America. Aaron Burr had constructed one that ran with remarkable smoothness, precision, and effectiveness, almost a generation earlier. It had been introduced

[5]Annals of the Sixteenth Congress, First Session, 2597-8.

[6]Eaton, Term and Tenure of Office, 27.

[7]McAneny, Reform of the Civil Service, 4.

[8]Eaton, The Spoils System, 8-9.

into the realm of New York politics at the dawn of the Nineteenth Century. Out of the policies and practices of this political ring developed what has often been called the "Burrian Code", some of whose fundamental maxims on which rested political action, are, according to Parton, one of Jackson's earlies and most sympathetic biographers, as follows:

First. Politics is a game, the prize of which are offices and contracts.

Second. Fidelity to party is the sole virtue of the politician. He alone is a politician who would vote unhesitatingly for the Devil—if the Devil had been regularly nominated. There is only one unpardonable political sin—bolting.******

Third. No man must be allowed to suffer on account of fidelity to his party—no matter how odious to the people he may make himself.

Fourth. When there is a conflict between the party in the whole Union and the party in the State, or between the party in the State and the party in the country, a man must adhere to the majority group of his own local organization. That is to say, a private must obey the orders of his own immediate captain, though the captain may be in mutiny against his colonel.******

Fifth. Editors are to be used unscrupulously, but never implicitly trusted.

Sixth. The end and aim of the professional politician is to keep great men down and put little men up. Little men owing all to the wire puller will be controlled by him. Great men having ideas and convictions of their own are perilous even as tools.[9]

There was considerable more than a modicum of truth in this satirical characterization of the ethical basis of New York politics, but it seems a trifle unfair to ascribe the perfection of this system to Burr alone. The remark of President Jackson to the effect that he was not a politician but if he were to become one he wanted to become a New York politician, coupled with the high regard in which he was known to hold Van Buren, lent color to the charge that his Administration had taken over bodily **in toto** the infamous patronage policy of the Empire State. Besides these general allegations there were specific examples. For instance, two New Yorkers, Samuel Swartwout and Jesse Hoyt, were active aspirants for political plums—preferably the Collectorship of Customs at New York City. Swartwout went to Washington to press his claims while Hoyt manipulated such wires as he could advantageously pull from New York. Nor did they permit rival political ambitions to seriously interfere with their friendly relations. Shortly after Jackson's inauguration Swartwout wrote from Washington to his fellow party worker as follows: "Whether or not I shall get anything in the general scramble for plunder remains to b eproved. I think I shall, if it be only the Bergen lighthouse. I would recommend you to push like a devil if you expect

[9]Eaton. The Spoils System, 5.

anything". Swartwout proved a good prophet for his party record and his persistence won him the coveted prize—the New York Collectorship. And he was re-appointed a second time but a Congressional investigation revealed a shortage in his accounts to the amount of $1,225,705.69 —a disclosure that so shocked Mr. Swartwout's nerves that he felt impelled to travel extensively in Europe "for his health".[10]

Jesse Hoyt was very appropriately named as Swartwout's successor. Another Congressional investigation disclosed defalcations on his part to the extent of $300,000. in less than three years. Here were two New York spoilsmen of the simon pure type that believed implicitly in the old maxim, "Make hay while the sun shines!" Some of the conclusions and findings of the Congressional committee making the investigations were summed up thus: "The inspectors when absent from duty were generally engaged in electioneering and in procuring the naturalization of foreigners.**** A custom-House tax was regularly levied and paid in advance of elections*****and a refusal to pay was invariably followed by removal from office.******A system of favoritism was uniformly extended to the most violent political partisans******and finally there were evidences of official delinquency, if not of downright corruption, which have seldom if ever occurred in any civilized country on the face of the earth."[11]

Still another view of the influence of New York in the Jackson Administration from a different angle may be secured from a perusal of the spirited discussion in the United States Senate over the confirmation of Mr. Van Buren as our Minister to England. A portion of Mr. Clay's speech ran thus: "I have another objection to this nomination. I believe, upon circumstances which satisfy my mind, that to this gentleman is principally to be ascribed the introduction of the odious system of proscription for the exercise of the elective franchise in the Government of the United States. I understand that it is the system on which the party in his own State, of which he is the reputed head, constantly acts. He was among the first of the Secretaries to apply that system to the dismission of clerks in his department, known to me to be highly meritorious.******It is a detestable system, drawn from the worst periods of the Roman republic; and if it were to be perpetuated; if the officers, honors, and dignities of the people were to be put up for a scramble, to be decided by the result of every Presidental election, our Government and institutions, becoming intolerable, would finally end in a despotism as inexorable as that of Constantinople."[12]

Replying to this address of Mr. Clay, Mr. Marcy of New York declared that "men of enterprise and talent" in his home State "boldly

[10]Eaton, The Spoils System, 12-14.

[11]Ibid., 15-16.

[12]Congressional Debates, VIII, Part I, 1324.

preach what they practice. When they are contending for victory, they avow their intention of enjoying the fruits of it. If they are defeated, they expect to retire from office. If they are successful they claim, as a matter of right, the advantages of success. They see nothing wrong in the rule, that to the victor belong the spoils of the enemy".[13] This catchy phrase, "To the victor belong the spoils", speedily became the slogan and the adopted policy of our party leaders, and even at the present time is quite generally employed to stimulate the zeal of partisan workers during important political crises.

When the opponents of the Jacksonian regime organized under the name of the Whig party in 1834, they put forward the claim that they were **bona fide** representatives of the old Republican party of 1801, and took a bold stand against patronage, spoils and corruption, and executive misrule.[14] An attempt was made in 1835 to repeal the bill of 1820. During the course of the debate, Calhoun asserted that officers and people were being taught "that the most certain road to honor and fortune is servility and flattery.******I have marked its progress in a thousand instances within the last few years.******What a few years since would have shocked and aroused the whole community, is now scarcely perceived or felt.*****and*****when it is openly avowed that the public officers are the spoils of the victors, it scarcely produces a sensation".[15]

The partisan power which the four years' term system had thus suddenly and vastly increased, aided by the prestige of Jackson's Administration and the forces marshalled for Van Buren's election to the Presidency the next year, sufficed to prevent the repealing act from passing the House. The narrow partisans in the Senate managed to carry the day against its greatest statesmen. This victory of the spoilsmen increased the pressure and strength in favor of extending short terms, which the party leaders were not slow in demanding.[16] The particular step taken to extend the application of the principle of rotation in office was made in 1836 when a bill was passed "requiring that all postmasters whose compensation was one thousand dollars a year or upwards should be appointed by the President and confirmed by the Senate, and that their term of office should be but four years". They were made removable "at the pleasure of the President". Postmasters with income less than one thousand dollars were to be appointed and removed by the Postmaster-General. Thus was a great number of purely business offices deliberately brought within the range of political forces, subjected to Senatorial confirmation, given a term which both suggested and facilitated their

[13]Ibid., 1325.

[14]Tyler, Parties and Patronage, 60.

[15]Congressional Debates, 23rd. Session, 557.

[16]Eaton, Term and Tenure of Office, 30.

being made incentives and rewards of selfish activity, and a part of the spoils of partisan victory in every Presidental election.[17]

"The new theory of short terms for the inferior executive officers had come by many to be regarded as an essential part of our original institutions.******The evils they had caused or greatly exaggerated were generally regarded as the inevitable drawbacks against the blessings of our liberal institutions.******These short terms rest on the false and pernicious theory that the most salutary admonition for good official conduct in an executive subordinate is not a sense of direct responsibility to his superior, and a right and duty on the part of that superior to remove for good cause, but the certainty of going out at once when his political opponents succeed, and of going out very soon, however faithfully he may serve the people, in order to make a place for the next rotationist in the order of political favor. Every time an efficient and faithful officer left his place at the end of his term, or was sent away for political reasons, a sort of proclamation was made to the people that the well-doing of the public work was not what the Government most sought, but effective party workers and compliant tools of party managers".[18]

Though President William Henry Harrison condemned the practice of patronage and placed the blame for so many removals at the door of the Federal Whigs, "who were bent on seizing the reins of government", wholesale proscription of Federal officeholders went merrily on during his brief tenure under the direction of the heads of departments who seemed determined to satisfy the office-hunger of their Whig followers.[19]

When Tyler acceded to the Presidency he faced a difficult and complicated situation. He was a conservative Whig, while practically all the appointments and promises of appointment under Harrison had gone to the extreme Whigs. Tyler appointed some of those who had, apparently, been definitely promised places but refused point-blank to carry out the original Whig program in spite of earnest insistence and even open threats on the part of the most radical Whig leaders.[20] When a group of Maryland Whigs waited upon him and urged him to make certain appointments, "Mr. Tyler shook his head, spoke of his conscience, and determined that no more removals should be made". He issued instructions to the Postmaster-General that no editor should hold office, and during his entire incumbency refrained from appointing to office any man who was actively connected with a newspaper.[21]

In the period from 1830 to 1860, the rapt attention to, and the

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[17]Eaton, Term and Tenure of Office. 31.

[18]Eaton, Term and Tenure of Office, 32-3.

[19]Tyler, Parties and Patronage, 64-5.

[20]Niles Register, LXIII, 79.

[21]Tyler, Parties and Patronage, 68-9.

complete absorption in, the parmount question of slavery undoubtedly obscured the vision of many leaders to the growing danger lurking in the expanding "Spoils System". And yet there were indications from time to time that some of the nation's clearest-sighted statesmen keenly realized the evils of the patronage system and fully recognized the imperative necessity of employing organized resistance to its enroachments. Proof of this awareness on the part of at least a few of the members of Congress is furnished by the report of a special Congressional Committee, July 27, 1842, from which report the following excerpts are taken. "The practice of treating all the offices of this great Government as 'the spoils of victory', and with the rise and fall of contending parties the ejection of a large multitude of experienced honest, capable incumbents to make room for needy mercenaries who have entered the political conflict without any principle or love of country, but impelled wholly by a hope of plunder, is the greatest and most threatening abuse that has ever invaded our system.

"It is the degenerate and demoralizing 'spoils principle' which has contributed more than any other cause to defile our whole system, and is precipitating us rapidly upon premature decay and ruin; and we must expel it if we would save our free and glorious institutions".[22]

Under Polk's Administration the spoils system of the old Funding times, when two Speakers of the House were acknowledged speculators in their own influence and votes, was completely re-established as an essential part of our governmental organization. What change for the better could be expected of Millard Fillmore, Franklin Pierce, or James Buchanan? True, they were personally pure, able, accomplished men of incorruptible integrity, leaders of whom the nation might well be proud, but Fillmore was a finished product of the New York Anti-Masonic school, which had devised the national political convention, while Pierce and Buchanan, as original Jackson men, had endorsed the principle of rotation in office and were, therefore, bound by their own acknowledgments, and at the mercy of the spoilers who held them to their admissions.[23]

The practical application of the patronage system can best be illustrated, perhaps by an examination of the management of the New York Custom House. In the brief space of three years, 1858 to 1861, a Democratic Collector removed 389 out of 690 subordinates; and a Republican Collector, possibly to show that he was just as expert as his predecessor as a political executioner, during the next three years, removed 525 out of 702 subordinates. In a later period, Collector Smythe improved the record by getting rid of 830 out of 903; while Collector Grinnell, in sixteen months, discharged 510 out of 892—an

[22]Annual Report U. S. Civil Service Commission, XIV, 37.

[23]Tyler, Parties and Patronage, 101.

official execution for every day of his term, with thirty extras left over for Sundays. In the fifteen hundred and sixty-five days preceding the appointment of Mr. Arthur as a Collector in 1871, there were sixteen hundred and seventy-eight removals in the New York Custom House, an average of more than one a day over a period of five years. To what extent such uncertainty and instability of tenure among employees would tend to demoralize business efficiency one can easily and readily estimate.[24]

Not even the crisis precipitated by the secession of the Southern States served to quench the thirst for public office among the chronic job-hunters. So much of President Lincoln's precious time was consumed in interviewing prospective Federal officeholders that he was led, on one occasion, to complain rather bitterly, "I wish I could get time to attend to the Southern question. I think I know what is wanted, and I believe I could do something toward quieting the rising discontent, but the office seekers demand all my time. I am like a man so busy letting rooms on one end of his house that he cannot stop to put out the fire that is burning at the other".[25]

Nor did four dreary years of national bloodshed and sacrifice work any reformation in the point of view of the spoilsmen. Their appetites were still seemingly insatiable. They continued to flock to Washington and to harass the care-worn President. It is said on good authority that a few days before the fall of Richmond, Lincoln one day called the attention of a friend to the surging throng of political pie-hunters besieging his door, and somewhat sadly exclaimed: "Look at this. Now we have conquered the rebellion; but here you see something that may become more dangerous to the Republic than the rebellion itself".[26] Lincoln spoke with prophetic vision. The years that followed exemplified in manifold ways the insidious and malignant character of the constantly spreading disease. Leaving out of consideration the question of responsibility, it is sufficient to say that the very same principles that called into being the patronage system a generation earlier were destined to continue to exist and to hold high carnival during the hectic days of Southern Reconstruction.[27]

[24]Eaton, Term and Tenure of Office, 36.

[25]McAneny, Reform of the Civil Service, 4.

[26]Schurz, Civil Service Reform and Democracy, 29.

[27]Tyler Parties and Patronage, 105.

WHAT CONSTITUTES MODERN PRACTICE IN EDUCATION

(A Problem in Teacher-Training)

By
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One of the characteristic features of modern education is the emphasis that is placed on teacher training. During the last decade the practice of every state in the Union has been changed to require professional training for teachers of the high school quite as uniformly as was required of teachers of primary grades prior to and during this period. The tendency is not to stop with the high school but to extend the practice of professional training to those who teach in institutions of higher learning. The discussion and the reports of the present paper are confined to data bearing on the public schools for which the Normal Schools, Departments of Education, and Colleges of Education must train teachers.

In training teachers, these institutions must keep in mind several things: Are we training only suitable young people? Are we preparing them in the field of their greatest possibilities? Are they able to meet reasonable expectations of their employers? Is the training sufficiently detailed, properly inclusive and adequately adapted? To answer such question we must have data on which to make generalizations as to WHAT constitutes modern practice. Without this we are reaching into the dark period. For example, what it the practice in regard to promising departures from traditional procedure like the Dalton Plan? The teaching done by the Dalton Plan is sufficiently different to require special techniques. But must we assume that all teachers should know the Dalton without first knowing to what extent the schools of this area have some semblance of that plan. I say **semblance** because I know how nearly impossible it is to find a school that teaches precisely after the plan of Dalton, Massachusetts before that place discontined the procedure known as the Dalton Plan. Moreover, what is the extent of practice that requires experienced teachers? In a state that requires training and teaching to be limited to the field named in the type of certificate issued, where would teachers trained specially for high school get their two years experience if this additional requirement were to become general practice? What would a cross-section of practice show in regard to items such as these in the tri-state area, West Virginia, Ohio and Pennsylvania.

The writer in this short paper has undertaken to answer this last question by gathering data by means of a questionnaire which was sent recently to sixty superintendents of schools located at random in the three states mentioned. At the time that this report was assembled, twenty-nine (48%) of these superintendents had reported the practice in their systems of school. The distribution of these reports may be seen by reference to Table I.

The Questionnaire

(See next page)

To the person addressed: Please assist us in determining **common practice** in schools of our section by checking the following as you read it. Return to me. Indicate if you want copy of combined replies.

Cordially yours,

H. T. McKINNEY,
Professor of Education,
Bethany College.

QUESTIONNAIRE

From the literature including texts, bulletins and magazines, the following outline of subjects indicate roughly the range of items that must be included in the consideration of proper training of teachers for elementary or secondary teaching. Indicate by check if true.

ADMINISTRATION:

1. Duties of the Principal: Participates in selecting teachers......, janitors......, textbooks......, courses of study......, apparatus ......, discipline......, meets with the board of education......, has authority in matters of athletics......, expulsions......, and classifications......

2. Classification of Teachers: Only degree teachers are assigned to senior high school......, only teachers with two or more years of experience may teach in senior high school......, these rules apply to junior high......, these rules of assignment do not apply to junior high......' Degree is required but experience is not an absolute requirement for junior high......, or for senior high...... The minimum schooling required for teachers of the grades below high school is................................... Teachers are classified on the basis of their preference of grade or subject......, on the basis of the subjects named in their certificate...... Teachers are promoted with pupils to the next higher grade......, they teach the same work year after year......, there is no regulation on this matter......

3. Classification of pupils: Yearly promotions......, semiannual ......, quarterly...... Based on class-grade combined with results of a final examination........, based on ability to do the next grade above (trial)......, based on placement tests......, based on teacher's best judgment as to where in the grades the school can do the best for the pupil...... Extremely dull pupils are left in class to repeat ......, passed on with their class......, placed in special rooms

. . . . . . , given uniform course the same as normal pupils . . . . . . , or given a modified program having much handwork . . . .

4. Supervised study: Home rooms . . . . . . , all pupils not in classes are gathered in the assembly room . . . . , the same teacher for every hour of directed study . . . . . . , a different teacher for each hour . . . . The teacher merely oversees the room . . . . . . , the teacher aids the pupils with subject matter difficulties . . . . . . , the teacher notes the difficulty and reports the same to the pupil's teacher in the particular subject . . . . . . , or the pupil is directed to mark his point and take it up with his teacher . . . . Pupils are taught how to study as a part of the class-recitation . . . . . . , he is taught by teaching him a book similar to Whipple's "Effective Study" . . . . . . , he is left to find his own best way to study . . . .

5. Organization of the School: The 8-4 plan . . . . . . , the 6-3-3 . . . . . , the 6-6 . . . . . . , some other . . . . . . The single period (45 min.) . . . . . . , the double period (60 min.) . . . . . . , (90 min.) . . . . Half of period is given to study . . . . . . , less than half is for directed study . . . . Classes meet daily . . . . . . , classes meet weekly with other call sessions . . . . . . , classes meet irregularly at direction of teacher . . . . Work done by pupils on contract plan . . . .

6. Course of study: We have group singing regularly . . . . . . , Bible reading is practiced . . . . The work is all required in first six grades . . . . . . , first seven . . . . . . , first eight . . . . . . , first nine . . . . . . , all twelve . . . . We have a place in the program for extra-curricular activities . . . . This comes daily . . . . . . , weekly . . . .

7. Pupil-promotions: Entire school organized on departmental plan . . . . . . , the lowest grade in which subject-promotions are planned for is . . . . Pupils are promoted by class . . . . . . , pupils are promoted individually at irregular intervals . . . . Promotions are based on subject matter tests . . . . . . , on basis of intelligence tests . . . . . . , on a combination of these . . . . , by some other plan . . . .

8. Pupil adjustment and guidance: Thhe principal or other persons give information on guidance through lectures to the student body . . . . . . , the school has a guidance department . . . . . . , the school does not have adequate provisions for guidance . . . . . . , the school merely takes care of this matter by counseling individual students that are apparently floundering . . . . . . , the school teacher vocations . . . . . . , guidance is made a conscious part of school-work for all the grades . . . . . . , for only the senior high school . . . . We believe guidance should be emphasized more . . . . It is well cared for . . . .

METHODS OF TEACHING:

1. Assignments: Consecutive pages from the text . . . . Units or extended assignments . . . . Projects . . . . Contract plan . . . . Some combination of these . . . . Some other special plan . . . .

2. Recitation: Largely question and answer......, topical discussion of questions raised by the teacher......, of questions that originate with some pupil......, of written thought questions given by the teacher in the assignment....... The Dalton plan......, the modified Dalton....... This method is used in grades 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12. The lecture method is used not at all......, occasionally......, regularly....... The demonstration-lecture method is used......, is not used much....... The Winetka plan is used......, is not used....... The socialized recitation is used sparingly......, regularly......, not at all....... Workbooks are used in all grades......, in grades above primary......, in high school......, in certain subjects of high school......, in no grades.......

METHODS OF MEASURING RESULTS:

We use standardized tests regularly......, occasionally......, almost never....... We use as a rule the regular essay type......, the improved essay type......, the objective type...... of examinations. We report grades to parents every month......, every six weeks......, at mid-semester......, at end of semester......, not at all....... We test pupils for an advanced grade on what he has done in the present grade......, on the work of the advance grade.......

Table I, Distribution of Twenty-nine Systems Included in the Data

1927) Population	Location	State
15,061	Bellaire	Ohio
.....	Bethany	W. Va.
.....	Cadiz	Ohio
.....	Cameron	W. Va.
13,171	Chambersburg	Pa.
401,274	Cincinnati	Ohio
.....	Clarion	Pa.
27,869	Clarksburg	W. Va.
796,841	Cleveland	Ohio
.....	Claysville	Pa.
8,517	Grafton	W. Va.
4,439	Gettysburg	Pa.
67,327	Johnstown	Pa.
9,484	Latrobe	Pa.
9,849	Lewistown	Pa.
2,998	Logan	W. Va.
27,891	Marion	Ohio
12,127	Morgantown	W. Va.
11,634	Martin's Ferry	Ohio
*	New Martinsville	W. Va.
588,343	Pittsburgh	Pa.

6,957	Rochester	Pa.
5,587	Shelby	Ohio
60,840	Springfield	Ohio
15,692	Uniontown	Pa.
21,480	Washington	Pa.
9,720	Waynesburg	Pa.
56,208	Wheeling	W. Va.
29,569	Zanesville	Ohio

The data in Table I show that the three states are represented by systems typical of the largest to the smallest that employ a superintendent. Though the number of replies received at the time we had to assemble our data is more limited than was anticipated, it is probable that the particular systems included here represent the central tendency of practice in these states. These represent a total urban population of about 2,500,000 people. The census report of towns of fewer than 2,500 people are not given. The ten items which were arbitrarily chosen as a basis of inquiry are reported in terms of percent of the group reporting. These data follow.

What the Data Disclose

I.—The High School Principal is an Important Administrative Official.

He participates in the employing of teachers (83), the selection of texts (96), the making of courses of study (96), the control of athletics (96), the selection of apparatus (90), the classification of pupils (96), and occasionally in the expulsion of pupils (62) and the employment of janitors (34).

The unanimity expressed in nearly all of these replies suggest that the work of the high school principal is fast becoming standardized in this section.

II.—There is Decidedly Mixed Practice in the Requirements of Teachers.

As a rule, all teachers in the senior high school hold at least the bachelor degree (96) but the expectations for the junior high school teachers is lower (45). Slightly more than a third (37) of the reports indicated that senior high teachers are expected to have two or more years of teaching experience when employed and the same expectations were expressed (37) for junior high teachers. A degree but no experience is the practice in more senior high (50) than in junior high (36). Two thirds (68) of all high school teachers are expected to confine their work to the subjects named in the certificate. As a rule, there is no regulation as to whether or not teachers are employed for specific grades.

III.—The matter of Pupil-Promotion is in a State of Transition.

In several systems, especially large towns, two or more plans are practiced in the same system. For example, yearly promotions (73) semi-annual promotions (34) and quarterly promotions (4) might be interpreted as an incorrect report because it totals more than 100% but different systems reported that they are trying two plans. The central tendency (65) is to base promotion on some combination of class grade and final examination. Placement tests (31) are finding a place and also trial promotions (38). About half the schools (52) have no provisions for failing pupils but to repeat grades. In a few schools (13) the dull and the bright have to take the same work and promotion is on the same basis in each type of pupil. In a large number (45) of cases, however, the curricula are modified to favor dull pupils. These are usually in special rooms and emphasis is on handwork.

IV.—The Plan of Organization of School Systems is an item of Experimentation.

The types reported include almost every conceivable combination of grades. The number of schools still holding to the 8-4 plan shows that we are influenced by tradition but the remarks that sometimes attended the reports indicate that some other combination is anticipated by the superintendent concerned.

8-4 combination (48).

6-3 combination (48).

6-6 combination (20).

Some other (8).

Here too there is evidence that in the state of transition some systems have more than one type of organization.

The recitation period is either 45 minutes (45) or 60 minutes (55). Classes usually meet daily (92) and in several system the contract plan (27) is used.

(Note: The Bureau of Education Bulletin (1927)26, gives the number of segregated 4-year high schools in this area as follows: W. Va. none; Ohio, 8; and Pa. 13.)

V.—Directed Study is Common Practice in the High Schools of this Area.

Home Rooms under supervision (64) and Assembly Room under general supervision (32) are supplemented by 60-minute recitations, part of which time is devoted to study in class (92).

In case of assembly study the teacher may merely preside (32) and sometimes she helps pupils with difficulties in lessons (64). In the majority of schools (72) there is a different teacher over the study room every hour, few pupils have a handbook on how to study (32), and in one case out of every five there are no provisions for directed study (20). Rarely do we find (8) one teacher remaining in charge of a study room every hour of the school day.

VI.—Extra-curricular activities are found in nearly all schools.

In many systems (71) group singing is programmed as a regular activity and Bible reading (81) is part of the required work. As a rule all the work of the day is required of the first seven grades (61) or of the first eight grades (35). The extra-curricular where found (90) are sometimes daily (56) but are often weekly (44).

VII.—Pupil Promotions. Practice in this matter shows great variability.

In some schools essay examinations (52) are the main bases of judging fitness for promotion; in others some combination (44) of intelligence tests and other tests is the criterion. In very few systems (8) does the final examination alone determine the standing of the pupil. The new-type essay examinations 28) and the objective tests (68) supplement the older types of tests in some instances.

Reports are sent to parents every six weeks (72) or at mid semester (28). Tests for advancement through the grades are usually based on the work just covered (60) in class and rarely (16) is the pupil tested on the work of the grade that presumably he is being tested for ability to do

VIII—Adjustment and Guidance are finding places in the high school program.

In some schools (44) general lectures are given the school on guidance; in other systems (28) there is a department of guidance; and a third plan (36) is to give individual cousel as it seems to be needed. There is evident conviction (52) that provisions for guidance in the high schools are inadequate. The schools often teach **vocations** (64). But the superintendents (80) report that this work should receive more attention.

IX.—The Methods of Teaching Show a Tendency away from Question and Answer Recitations.

While some teachers (16) still adhere to the question and answer method of conducting a recitation and some schools continue to make assignments as a given number of consecutive pages (28), the tendency is topical discussion (64) based on extended assignments (70) or units. The pupils are encouraged to do the questioning (48) at the time of assignments.

The Dalton Plan as such was not reported in a single case but the modified Dalton (24) or the contract plan of assignment (28) which are part of the Dalton, was reported in about one out of every four schools. The project method (56) was reported in still a larger number of systems, and the demonstration-lecture (24) is equally popular with the modified Dalton. The Winetka Plan was not reported in any school. The socialized recitation was said to be followed sparingly in a considerable number (44) of schools.

X.—The Workbook as a Teaching Device is in General Use in High Schools.

In about one fourth (28) of the systems reporting, the workbook is more or less used in all the grades in some one or more subjects. It is more frequently used (76) in high school than in the lower grades.

Conclusions

As was suggested in this report, there is need of objective data that sets forth present practice in regard to certain items that require training of teachers so as to anticipate the techniques implied in the proper control of these matters.

The ten items about which inquiry was made were selected rather arbitrarily and should have been extended to include such items as rules against employment of married lady teachers and the like. The questionnaire was made easy by requiring no writing but the fact of so many items may explain why only 48 percent of the schools replied within the lapse of two weeks.

Considering the size and distributing systems, the conclusions set forth in the headings of the items above would be changed but little, probably, if the number of replies were twice what we have.

On the basis of these data, we are justified in saying that the teacher-training institutions are decidedly handicapped by mixed practice in the public schools for which we prepare teachers. This situation is so much a part of social evolution that little can be done to rush standardization. Studies such as this are beneficial only in the degree that they portray points of emphasis such as one may see expressed in terms of percent in parenthesis following the various items asked about in the questionnaire.

THE PRINCIPLE OF FORM IN HISTORICAL AND PSYCHOLOGICAL LINGUISTICS

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In the following pages I shall try to show the relation between historical linguistics and other kinds of language study which are now striving for recognition. I am concerned particularly with psychological linguistics and linguistic sociology. The consideration of these subjects is not new: it is older than the study of historical linguistics, which has just completed its first century; but these studies have not been fruitful, because the material for their objectivity was not available and has only become accessible through the patient and energetic labors of historical linguistics itself.

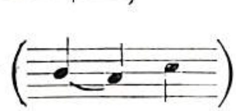
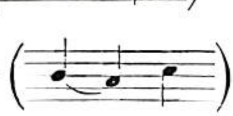
In order to establish an objective basis for their studies, the historical linguists soon discovered the principle of psycho-physical-parallelism as a working hypothesis. Language is a phenomenon that combines both fields, the physical and the psychical. On the one hand are the sounds with all their varying qualities of pitch, time, timber, intensity, etc.; on the other are the concepts, ideas, and emotions. All that lies in the realm of the physical I shall call **form;** what lies in the realm of the psychic **consciousness**[1]. **Form,** to be sure is ordinarily used in contrast to **substance;** but the substance in language, the air and anatomical machinery by which the sounds are produced, have of themselves no significance: they gain a significance only through the qualities of the sounds produced and are the physical constants, which touch the study of language no nearer than in the study of accoustics and vocal physiology. Moreover, **form** is the word that historical liguistics most commonly used to indicate the differences of language on the physical side. **Meaning** is the symbolic relation between such forms and the concomitant consciousness. **Language** includes all three: the psychic state, the physical form, and the combining symbolism of meaning. The problem

[1]I am not attempting to discuss psychological liguistics according to any particular school. Therefore I have not employed the particular terminology of such a school but tried to use common English words only. I hope my friends, the behaviorists, will take no offence at my retaining the word "consciousness" and a few others. I cannot quite reconcile myself to the aggresive elimination of words that do not exactly express our thought—I fear we should have none left. If the behaviorist prefers **stimulus, engram, ecphory** (Markey p. 122), **response,** he will indeed somewhat change the meaning (i. e. the ecphory) of short passages, but the substance of the whole article will remain the same.

And, then, I wonder too, if psychology can ultimately disregard the first teaching of modern philosophy, "Cogito, ergo sum", with the same impunity that is permitted the impersonal sciences.

of this symbolism is the problem of the philosophy of language. History, however, is an objective discipline. In order to gather the objective material that was to show the course of language through time, the history of language found itself constrained to fix its attention upon the physical forms and disregard, as far as it was able, their psychic concomitants. Thus historical linguistics has developed on an objective basis with great success and has gathered and arranged a great quantity of material, and is still gathering and arranging, on the basis of which not only its own histories could be written, but the further disciplines of psychological linguistics and linguistic sociology can be built.

Here, however, our historians of language were particularly unfortunate, because they were nursed in the schools of Sinai and Olympus. No one doubted that these sacred peoples must have had the best languages; and the all-conquering Roman, who devoured both, must have had a language as well as an army even better than theirs. About a century ago it was still seriously argued by reputable scholars that Latin was not only the best, but even the standard of languages; and still more recently, in our own vicinity, that God, coming down through these holy channels, learned finally to speak the language of Ohio. Now the misfortune of linguistic historians is that they began their studies with the dead languages and are still, for the most part, devoted to them. There is no objection, of course, to being dead, only in this case the student had to suffer, because there was no one alive to tell him what he wanted to know. All he could find out was what he could glean from documents. What a document can tell you about the form of language, however, is really only a part of it. The written language, at least in the case of the alphabetic languages, is only the symbol of the spoken language, which is itself only the symbol of the psychic state. Thus documents are one stage further removed from the meaning than the spoken language. The written language is at best only an approximation to the spoken language. It can only roughly indicate the separate sounds and their sequence, their grouping into words and their sequence of these. And even here the system of graphic representation may be more or less deficient. We know that today it is difficult, if not impossible, to find a language in which the written sign always represents the same sound and every sound has its own differentiated written sign. English is particularly rich in examples to the contrary: **bark** and **barque, sent** and **cent, get** and **gent, lawn** and **gone.** Now while the historic linguist himself will not insist that he knows just which sound each graphic sign was meant to stand for every time it occured, it is nevertheless remarkable how convincing an argument for his doctrines of pronunciation he has been able to give us, and what a beautiful system of gradually changing pronunciations he has worked out for a period of over two thousand years through more than a score of languages. Starting thus always with the written page, he has become loath to assume items or differences for which there was no graphic evidence, and thus he has discovered many marvelous things which would otherwise have remained hidden from us under the dust of forgotten time. Safer than the contemporaneous historian, because he was not biased by the opinions of the time, he has thrown light on many of the transitions in the history of civilization and opened up a whole epoch of European history of which no documents remain to tell us. All in all, he has been more historian than linguist.

Beginning, as he did, with the has-beens of language, this was inevitable. All the skillful care that he lavished upon the printed or written page could not inspire it again with life: the letters gave forth their secrets to his patience, but many secrets had never been entrusted to them. The written words are but the symbol of the spoken. Therefore the writer needs to put into them only the minimum that he thinks will be necessary to make his symbols intelligible to his reader. Much, however, his contemporaneous readers knew, that is not known to us, much that **they** even were not particularly aware of. It is impossible to speak without pitch, modulation, speed, rhythm, emphasis, resonance without making our speech significant by the very absence of one of them or more. Seldom, however, is any one of them indicated in the texts. And these are not insignificant physiological details: often the import of an expression is more readily gathered from the combined effect of such elements than from the particular sounds, which the written language symbolizes. Quite true, they are more often indications of feelings than of concepts. Still, Hubert Grimme has recently shown in the Germanisch-Romanisches Monatsheft 13 (1925), 274 & 328 f. that there may be as many as eight syntactic modulations for nouns in the same grammatical case in a North-German dialect; and we know that differences in intonation alone mark out the different significance of some words in the Scandinavian languages, e. g., in Swedish **anden**  is wild duck, but **anden**  the spirit; **brunnen**  is well, but **brunnen**  burn; **hafven**  is the sea, but **hafven**  you have.

(Poestion, **Lehrbuch der Schwedischen Sprache,** 2nd ed., p. 27.)

Chinese makes similar but more complicated distinctions throughout its vocabulary. In English we distinguish parts of speech by a change of accent: **concréte** as verb and **cóncrete** as adjective, **súrvey** and **survéy,** as well as by changed sound without change of spelling: **a house** and **to house.** To be sure, many of these things the historical linguists have discovered for the past or at least suspected, still not throughout the whole extent of a language but only in certain places where no other explanation seemed available. How do we know but that in the forgotten languages more such distinctions existed to clarify or empjhasize or shade the meaning? And how do we know how influential these unwritten qualities of speech may have been upon the changes in speech, how influential possibly upon these elements of speech that were indicated in the documents? We have, for instance, Verner's law already, according to which a change of accent was accompanied in certain places by a change of sound. And if all these things are not yet known, will it not be of some use to the historical linguist of departed languages to know how these qualities affect our speech today, that he may, as he so often has had to, assume that, no evidence to the contrary, the speech of earlier times was governed by the same principles as today?

The historians of more modern languages have, in fact, begun to examine these matters—matters of the form of speech still, but not of its graphic form. The question may be asked: what will it be worth to know these things? On the principle that we can never tell when a bit of knowledge might become valuable, it will be worth as much as any knowledge. But there is a practical value already at hand. We have noticed that these qualities of speech represent both intellectual and emotional consciousness. If now the two are confused by the hearer, he will misinterpret the speaker and thus defeat to some degree the intent of the speech. How general such misinterpretations may be and how serious their effect can only be imagined when we remember that almost everything that is done by man is done to some extent through language and that objective fact and personal emotion probably both have a part in all. This is a practical, not a historic—or, as some might choose to say, a "scientific"—value; but in the consideration of values, history must first prove its precedence.

These qualities of speech, however, still are qualities of form, accessible to the senses, amenable to physical measurement in one way or another. They are all qualities of the spoken word, of the physical symbol of thought; they are not strictly qualities of language at all: they are qualities only of that one part, sound, which, when coupled with the other part, consciousness, becomes in conjunction with the second a constituent part of language. Language is the interaction of these two: the transfer of the conscious state to the physical symbol and the retransfer of the physical symbol to the conscious state. Sound without conscious symbolization cannot be language. And, therefore, the study of sounds of language alone is no study of language at all, and a study of the forms of sound cannot be a study of language either. It may indeed be a necessary study before the study of language itself can be undertaken; it may be the longest, the most difficult, the most important part of the final total; nevertheless, in so far as its function as a symbol, its relation to the conscious state is neglected, the study of form is only a study in sound, not in language.

The total aridity of such a position has not escaped even the most metaphysical materialists. Reducing the conscious state to a physiological quiver—which for aught I know may be all that it is—they still have shrunk from including in their catalogues of language the bark of a dog or the moan of a tree. And so, while denying everything that is not physically measurable, that is not accessible to consciousness through the senses, they still allow meaning (thought and feeling) as a constituent part of language.

As the historical linguists have studied form, drawing only at times upon a kind of desultory psychology when other explanations seemed to fail; so psychology might study language making the form secondary to the state of consciousness. The objection is raised that consciousness is accesible only in its expressions, on the theory of psychophysical-parallelism[1] This may be true, yet we allow certain inductions and deductions in addition to the theory itself. The theory implies above all that there are certain psychic states and implies further that these psychic states vary with the variance of the forms. If we had all the physiological details, internal as well as external, accessible to our observation, it maybe that we could describe fully any psychic state by its physiologic parallel. But physiology has not yet been developed to this stage. We still in our daily life draw innumerable conclusions for which we have not available physiological observations. Probably most of our interpretation of the speech of others is of this kind. The speaker objectifies only what he considers necessary and allows his hearers to fill in the rest from their previous knowledge and understanding of the ways of men, i. e. introspectively. Grammarians tell us of many uses for which genitives, datives, and ablatives are used respectively, though without differentiation of form. And how shall we know in a testimony like: I saw John, old Peter Jones' son, and Frank running away with the booty, whether John is old Peter Jones' son or some one else? By the contex only or by what we already know of their family relationship. And then the grammarian says in the one case, "Peter Jones' son" is object of "saw", and in the other, it is in apposition with "John"; but there is no

[1]On a behaviorstic basis the question is: can the original stimulation for which the words are a substitute be re-discovered either through the similarity of consequent responses to it or in some other way? If not, this whole theory of substitution may have to remain a pious belief.

differentiation of form between the two. Thus frequently the grammarian must draw upon other information besides his forms and apply this to make distinctions—psychic distinctions of meaning—which his forms do not indicate. Why not, then, use oll the information he can get for his studies in linguistic history? In so far as the forms furnish him with the desired information, of course, he should not disregard them: he is fortunate: they are the simplest method of detecting differences of consciousness. But where he finds no differentiation of form, he cannot, **ipso facto,** deny a differentiation of consciousness. Since now, conscious states are the other element in language, a systematic study of these as they are connected with linguistic form, may be expected to help the historic linguist where the forms fail him, as well as reveal some things which have not been successfully described as form thus far.

Such a study, I shall call psychological. I shall not attempt to describe the methods of general psychology here, but only to point out that it is part of the business of psychology to determine on what occasions all men act alike, on what occasions groups of men act alike, and on what occasions each individual goes his own peculiar ways. For instance: must all human thought be conceived as a balance of two counter-parts: subject—predicate? Must a distinction be made in consciousness between abstract qualities and self-sufficient entities, as we are supposed to make it between adjectives and nouns. Must an action be thought of as differing from a concrete object? Can ideas be grouped together into a conscious whole without consciousness of the relations of the parts to each other? There are innumerable examples where the forms do not indicate consciousness of these and many more differences, yet grammarians have assumed **a priori** that they must be there. And may there not be other differences in consciousness accompanying linguistic expressions which grammarians have not assumed? It is manifestly impossible to get at such things by confining ourselves to the forms.

Language is the symbolization of consciousness in physical form, generally accoustic. Without either consciousness or form, it is not language. Symbolization, however, does not imply a fixed correspondence of detail. The same sound has different meaning in different languages: German **Kann'** does not mean English **can; bark** in English may be a noise, a part of a tree, or a vessel. Nor does the same group of words mean the same thing in different context: "For Brutus is an honourable man". A symbol is only a reminder of something already known; it is an incitation to recall to consciousness past situations or the abstract idea of these. It may attach itself anywhere, to any item, any relationship, any implication of the total concept, and include the rest only by implication. A **hull** may mean a **ship;** an **aunt,** a **woman; darkness, ghosts** and **hobgoblins.** If we will allow the symbol to include only the particular point of attachment and not the entire situation demanded by the context, we shall have to exclude from language all words except the most definitely defined scientific terms; and even exclude the definition of these, because it presents the single concept in its relations to the various terms of the definition. The symbol, then, that is, the form, need correspond with the concept, at but one point; and this one point, as far as we know, may be anywhere within the limits of the concept, a **sail** may mean a **ship** as well as a **hull;** the dative function is expressed in the Latin adjective, but not in the English. A form attached to a concept at one or more points may be buttressed by other forms attaching at other points to give precision or comprehension; but the possibilities can never be exhausted, because every form adds new possibilities of attachment, possibilities of inclusion and exclusion of meanings which were not intended.

This is the inherent danger of all language, the inevitable basis of misunderstanding. There is always more implied in a form than expressed; more taken for granted than is presented. Therefore, as long as we confine ourselves to the study of the forms, we confine ourselves to the smaller part of language; we dodge the real difficulties, we avoid the questions that should make our investigations fruitful to the other disciplines and instructive to the conduct of human life. I have already said that it was necessary to begin with the forms and that it continues to be necessary to regard them, and I add that we are thankful, very thankful, to those who have established their relationship to each other and are continuing to establish them out of a maze of intricate multiplicity through detailed investigation; but we must not stop here, lest all this basic work become fruitless and abortive by the isolation of its self-imposed limitation. While some of us will continue to mark out ever more clearly the history and interrelationship of forms, others must begin to widen the field of study till it may indeed include all the problems that arise from language and reach the borders of surrounding disciplines, and may unite with them to cultivate the common ground.

Among the first things, perhaps, that we should do, is to establish the disciplines of psychological linguistics and linguistic sociology. The former would investigate all those problems of the individual speaker and hearer, which historic liguistics has perforce neglected. The latter would concern itself with group activity, dealing with all the influences that language exerts upon society in its various divisions. Underlying both disciplines, as I see it, is a comparative study of existing languages, not on the basis of historic relationship, but of psychic similarity. A classification of existing vocabularies, somewhat on the basis of Roget's Thesaurus or the classification given by Bally at the end of the second volume of the Traité; and comparative tables of formal differentiations of syntactic concepts: differentiation by sound, pitch, accent, modulation, etc., graphic signs, must provide the hand-book for further investigation. Comparison of the classified vocabularies will yield all those differentiations of thought which men are traditionally making; a study of the syntactic tables will give us the traditional ways in which men are combining their concepts into new wholes. From these results a general catalog of the categories of thought in as far as they have become explicit in the languages considered, can be deduced. With this and the preceding results the available material of former languages may be compared. Thus we shall get an objective account of the traditional working of the human mind. This is but an extension of the present methods of philology and historical linguistics.

It will not be necessary for psychological linguistics and linguistic sociology to await the completion of so great a work, but it will be necessary to remain cognizant of its progress. The way forms and formulae originate in the individual and the way social groups react and are influenced by traditional language and novelties will not be determined by it. The disciplines of psychological linguistics and linguistic sociology will remain. A few words as to how these might go to work.

The psychological linguist examines the psychic concomitants of form, which with it make up language. As historic linguistics studies the forms as independently of the psychic states as it can, so psychological linguistics studies the conscious states accompanying these forms. Each tries to build up a system as far as it can without injecting into it elements of the other system. Truth is a connected whole, but science is split up into many departments and divisions separated from each other not by the nature of the material but by artificial lines of demarcation marked out for the sake of convenience of study, made necessary by the limitations of the human intellect, which prevent the comprehension of all truth within a single system or even the understanding of an appreciable part of it in unsystematic arrangement. Thus psychological and formal linguistics are two sides of the same problem, which can be united only under a higher subordination, the philosophy of language.

While formal linguistics can accomplish its task pretty successfully without psychology; psychological linguistics cannot stir without the former. This is because the objectivation of consciousness must appear in some form to be accessible to the student, while such objectivation, i. e. the forms, is already by its nature accessible. And this is the reason why a psychology of language was impossible before historical linguistics gathered and classified the formal material. The normative systems of grammatical material available before the rise of historic linguistics presented only disconnected sets of arbitrarily chosen materials, arranged according to semi-logical principles. Each grammar indicated only what the particular author deemed "correct", to be sure, often including what others, especially men of letters considered "correct"; but at any rate without any information how such forms came to be or to disappear. In other words, these grammars neglected and even tried to eliminate just those forms which marked out the individual and recorded an abberration from the temporarily static tradition of the time. They were less descriptive of what had really been than instructions of what should be. The information which they furnished was always determined by the stylistic prejudices of the author. The rise of historical linguistics brought facts uncontrolled by stylistic evaluations and has furnished us with a succession of forms acceptable to a particular linguistic group—guide-posts along the course of linguistic change. Such forms are the objectivations for psychological linguistics; with these it must begin. The fact that such forms are more fully accessible to our observation when taken from our present languages, makes the study of these languages the more valuable.

The conscious concomitants of linguistic form has two sides, the factual and the affective, or, the intellectual and the emotional.[1] To examine these and the relation between them as they appear in linguistic phenomena is the task of psychological linguistics. This furnishes three distinct studies: in vocabulary, in grammatical forms, and in syntactic formulae.

In the matter of vocabulary the task of psychological linguistics will be to classify the words according to the factual and affective content which they contain for any particular language group. E. g. in English: **nation** and **country, house** and **home, descendants** and **children.** Possibly nothing more can be done than place the words with the least affective content opposite those with most affective content, as I have just done in these three instances; possibly, however, more divisions will have to be made, if the comparative amount of affective content can be more accurately determined. Certainly, also, the kind of emotion implied can be taken into consideration[1], such as affection, anger, desire. It will not be necessary, of course, to include the whole vocabulary of a language in the first study. Individual studies can be made in the different fields of human interest: nature, politics, etiquette, science, philosophy,

[1]Words considered as substitute stimuli still are not quite the equivalent of the stimuli for which they are substitutes. We recognize them as "words" instead of the real thing, and this act of substitution we call the act of "meaning". Besides this additional substitutive stimulation, words must carry further stimulations which are not contained in the things for which they are substitutes, for the responses contain the expressions of doubt, joy, displeasure often according to the particular verbal substitute chosen. So a behaviorist might smack his lips and begin to run over at the mouth when he hears the word "science", but stimulated by the word "metaphysics", he might run over at the stomach. Expressed in these terms the task of psychological linguistics is to determine what more or less or modified stimulations are borne by the verbal stimulus than are contained in the stimulus for which it is a substitute.

[1]Havers, Die Unterscheidung von Bedingungen u. Triebkräften usw. G-R-M 16,13-30.

etc., or in special fields of activity: sights, sounds, desires, obedience, etc. Interesting comparisons can be made with such lists between the vocabularies of different languages, different dialects, social classes, groups under different geographic, economic, political, or cultural conditions. Possibly one group will look with purely intellectual eye upon certain matters which another group regards primarily emotionally, to give an extreme example, the way the historian of religion regards the names of the gods in contrast to the way of the worshipper. The affective content of words will vary with the same individual at different times of his life. As we become more skilled in comparing and thus evaluating the affective content, we will learn to evaluate the words of the earlier times, and then we may find that whole groups of words go the same way in their emotional implications; so the words for unpleasant things tend to become stronger in their connotation of unpleasantness and may become completely taboo; so some words for women have fallen in the esteem of the linguistic group: **lady, Frauenzimmer, fille; woman** itself has gone down and come up again. Thus we may find that all words have their emotional history, and we may find that they have a parallel history in some languages and a contrary history in others.

Grammatical forms, too, may not be so purely intellectual as we are at first disposed to assume. We have in German a dative with and without final **-e;** we have three imperatives: **gehe, gehen,** and **gegangen.** In all languages probably there is an affective difference between obsolescent and modern forms, between "correct" and "incorrect" speech: contractions. Probably a systematic study will reveal much more, possibly something on the distinctions of gender.

Syntactically there will apparently be more. The German fairytale begins: Es war einmal ein Mann, der hatte . . . . Why not the relative? In many languages we have a familiar and polite second person form. There are also the polite and majestic first person plural and the "editorial **we.**" Is the development of the prepositional phrase in place of the case construction due only to the mechanical loss of case-endings or an "analytic" desire for clarity? We can still say, I gave you the book, and, I gave the book to you.

Linguistic sociology studies the relation of language and social groups. By **social group** I mean any group of people that is recognized as distinct from others by the people composing it, which continues for a conscious length of time. Language is everywhere the bond that holds together social groups; it often marks the line of division between one group and another. What is the value of language to man as a social being? It is not only the medium of communication, but it is one of the important means of memory. It creates new unities and combination in the minds of men and by its exercise stimulates them to further thought. It is all but indispensable in every kind of coöperation. One of the first questions is: which are the social groups to be considered from the point of view of language and what is the social nature of their linguistic differences? Some groups will be distinguished only by language; others, perhaps, will have no linguistic differences and will not need to be considered separately. The importance of linguistic conformity in the various groups, the relations of one group to another due to minor differences (dialects) and to greater differences (different languages), are the prime problems of linguistic sociology.

The thorough study of the subject is possible only on the basis of psychological linguistics, on the basis of the affective values in the language groups considered. Some expressions will have the same factual significance to two neighboring groups, yet their affective value may differ. How great is the misunderstanding that may arise from this? Linguistic sociology includes the educational problems of native and foreign language study. It includes the problems of political or social suppression of dialects or languages; the problem of world languages. All these questions can only be finally answered after we have completed the study of psychological linguistics, in the concluding chapters of linguistic sociology; yet we are daily driven to make a practical answer to most of them.

All such studies will teach us, if they do nothing more, to respect the great power that lies in language. It is not simply a tool of communication, an idle coin of barter to take the place of more cumbersome means of exchange, which have no value but that which they can buy. It moulds our thought, it stimulates our feelings, it holds us to the traditions of our fathers, it incites us to re-creation and innovation, it accentuates our differences and forces our misunderstandings, and it punishes with cruel isolation the heart and mind that dare to seek far beyond the precincts of its established domains.

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AN IDEA OF STIMULUS-RESPONSE SUGGESTED BY GESTALT PSYCHOLOGY

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The Gestalt psychologist sees stimulus-response not as two distinct processes separated in time and having only a causal relation, but rather as two phases of a unified process. Says Ogden, ". . . . the common denominator of an object and its apprehension, or of a situation and the responses thereto, is the common form of both. Furthermore, since form is defined by context, what the mind brings to apprehension, and what the organism brings to its response by way of dispositional readiness, have their respective counterparts in the background of the object apprehended, and in the total situation to which the response is made".[1]

In support of this theory Ogden appeals to the principle of **genetic identity** which asserts that all of the diversified manifestations to which we apply the words 'mind', 'body', and 'environment' are but the products of evolution. Underlying their diversity is an identity of form. Therefore words like 'physiological', 'psychological', and 'physical' do not refer to discrete phenomena which are capable of entering into some sort of logical relation with each other, but rather to different modes of action having a common origin. The common form underlying all reality may be described as a pattern or articulation, not of substance, but of function.

If stimulus-response is a unified process then the usual sharp distinction between organism and environment is erroneous. Coming at the matter of their relation from the angle of genetic identity one is obliged to see that they are members of a unity which is larger than both. The behavior of the organism is the functional counterpart of the pattern of stimulating situation, and yet the stimulating situation is what it is because of factors contributed by the organism, as suggested by the quotation from Ogden.

The notion of the oneness of organism and environment in behavior has received almost unexpected corroboration from some recent discoveries in biology. It has been found that in the case of simple organisms which are masses of protoplasm with differentiated outer layers an incision which exposes the inner mass will result in the exposed protoplasm taking on the characteristics of the external membrane. Conversely, under certain conditions, in which a part of the membrane passes into the internal mass of protoplasm, it is assimilated to that

[1]Psychology and Education, p. 134.

mass.* These facts indicate that heredity in this case provides only a certain potentiality of becoming external or internal protoplasm, while what role a given portion of living matter will play is determined by the exigencies of environment.

If we think of a developing embryo as a group of cells striving to attain a certain structural and functional pattern each individual cell has a relation to the other cells as well as to conditions outside the organism. These relations may be spoken of as an 'internal' and an 'external' environment. Experimentation has revealed that while each cell is destined to play a certain part in the production of the mature organism its destiny is not a fixed one by any means. It can be altered by transplanting the cell and thus bringing it into a different relation with the surrounding cells. Says Jennings, "What the cells become depend on their surroundings; on what the cells about them are becoming. Their development takes such a course as to fit into the general pattern"[2]. This adjustment to internal conditions is complicated by a simultaneous adjustment to external conditions represented by such factors as alimentation, temperature, pressure, humidity, and illumination. Characteristics which are laid down in the heredity of the individual may suffer alteration under the influence of these factors. Quoting again from Jennings, "With the same set of genes* different environmental conditions may induce the production of diverse characteristics. And with the same environmental conditions different genes may induce the production of diverse characteristics. The same difference in characteristics that may be produced in some cases by diversity of genes is in the other cases produced by diversity of environment"[3] With such facts as these before us it is not hard to see that a very large part of the controversial discussion of heredity and environment is utterly beside the mark.

As may be readily inferred from the foregoing discussion the gestalist finds the mechanistic formula of S-R inadequate to indicate what actually takes place in behavior. It isolates the external world from the organism, and provides the latter with meaningless local stimuli to which it must make some sort of response. Thus it denies to the nervous system any characteristic process of its own. Professor Köhler supplies us with the formula which he says fits the facts infinitely better: **Constellation of stimuli—Organization—Reaction to the results of organization.**

The central feature of a behavior cycle is the organization because the overt reactions which complete the adjustment are more closely

*Cf. Child, C. M., "The Individual and Environment from a Physiological Viewpoint", in symposium The Child, the Clinic, and the Court; The New Republic Company, 1925.

[2]The Biological Basis of Human Nature, p. 94.

[3]Ibid., p. 134.

*The separable parts of chromosomes which are the carriers of heridity.

related to it than to the external stimulation. The gestaltist offers us the theory of **dynamical self distribution** to account for the reorganization of sensations and perceptions.

It is a commonplace in physics that many processes go forward without being guided or constrained by any mechanical arrangements. Examples are: attraction and repulsion between magnetic fields, the interaction of chemicals, the drawing apart of liquids having different surface tensions, the movements of a molecule of liquid or gas, and the balance of astronomical forces. In all such cases the distinguishing feature is interaction of stresses which, if undisturbed, will eventually move in the direction of rest, stability, or equilibrium. Applying this principle of action to the nervous system we get a new lead in psychology and suggestions for the solution of many of our problems. A good example is found in **gestalqualitäten** which can be explained only by the theory of dynamical distribution.

We look at a mural ensemble and perceive a symmetrical arrangement of items. The actual sensory data presented consists of millions of indifferent light stimuli. It is a part of our theory that these stimuli must be organized before the individual perceives the decorative items as separate forms, but for the moment we are interested in a quality which pertains to the sensory field as a whole, a larger **gestalt** in which these individualized forms are sub-wholes. The problem is: How does the perception of symmetry arise when obviously it has no actual physical counterpart among the single stimuli? Our assumption is that the dynamical processes set up in the **area striata** by transmission of retinal stimulation are distributed throughout the network of neurons until a balanced system is effected. The perception of symmetry is a property of this physiological distribution as a whole. Of course distribution is affected by more than the retinal stimulation. The Physiological conditions of the organism and the attitude of the individual would be contributing factors. These latter, however, are likely to account for the nuances of the experience, while a particular relation between the retinal stimuli account for its chief property to which we give the word 'symmetry'. There may be occasions when the subsidiary factors, cause sufficient stress to actually impair the perception, but such conditions will tend to cure themselves by introducing a discordant note in the relations of individual and environment, thus upsetting the temporary equilibrium attained. The hypothesis of dynamical distribution promises to provide us a truer picture of the physiological aspects of behavior than any machine theory provides. Considerable weight has been given to this assertion by some recent investigations by Mr. K. S. Lashley.*

Lashley tells us that he entered upon his investigation of the effects

*Cf. Brain Mechanisms and Intelligence, a Quantitative tudy of Injuries to the Brain, Univ. of Chicago Press, 1929.

of cerebral lesions in rats with certain prepossessions favorable to the reflex arc theory of neural action. He expected to be able to trace reflex arc paths through the cerebum just as they have presumably been traced through the spinal cord. And why not? If the cerebral cortex is primarily an elaborate arrangement for routing nerve impulses, analogous to a telephone switch board or a railway switch tower, then is it not theoretically possible to follow anatomically a given impulse in its course through? Would it not then be possible, pursueing our arnalogies to cut a wire or tear up a section of track and thus prevent the impulse from reaching its destination? This Mr. Lashley proposed to do by surgical operation upon the cerebral cortex. His approach to the problem was to teach his animals certain maze-running habits, operate on their brains and then test their efficiency. He used some of the animals for control purposes. The result of the work forced him to abandon the reflex arc hypothesis with its restricted conduction paths. Some of the findings that seemed to necessitate this conclusion are presented below.

It appeared that large masses of nerve tissue participated in some acts, suggesting some integrating process at work. "It is certain that the maze habit when formed is not localized in any single area of the cerebrum, and that its performance is somehow conditioned by the quality of the tissue which is intact. It is less certain, though probable, that all parts of the cortex participate equally in the performance of the habit and that lesions of equal size produce equal loss of the habit irrespective of the locus"[4].

The deterioration of habit in an operated animal could not be attributed merely to impairment of the sensory apparatus, for animals which were blind during learning suffered loss of habit after destruction of the visual cortex. "A habit involving a specific receptor is formed at normal rate after destruction of the cortical field for that receptor".[5]

The mere fact that a habit once learned was not completely lost by reason of cerebral insult has high significance for neurological theory. Lashley's statement that "the retardation of learning and the loss of the habit cannot be ascribed to defects in the motor mechanism as such, but involve disintegration at a higher level of integration"[6] is revolutionary.

We have seen that in **Gestalt** psychology stimulus-response is a total process, denying the discreteness of organism and environment; that the central feature of the process is the organization of the various elements involved by the dynamical distribution of nerve impulses, which is an integrating action.

Now we are ready to face the question, What is a stimulus to the

[4]Lashley, L. K., Brain Mechanisms and Intelligence, p. 107.
[5]Ibid., p. 115.
[6]Brain Mechanisms and Intelligence, p. 116.

gestalist? We wish to recall attention to Köhler's phrase "constellation of stimuli" and to the phrase which the writer has used in the previous discussion, 'the stimulating situation'. From these two phrases we take our point of departure. It seems legitimate to press into use the word 'configuration' as a synonym for them. Physically a configuration is an object or group of objects which can be perceived as a whole as possessing a 'belonging together' character. Neurologically a configuration is a pattern of excitation in the nerve tissue, a pattern which bears some relation to the external gestalt. Perceptually a configuration is a psychological unit of recognition of an external gestalt which includes not only the 'belonging togther' aspect but also the setting off from the ground upon which the structure is delineated.

These definitions are not only different angles for viewing the same phenomenon. Behavior is on-going, so we have to think of configurations as constantly changing. We go from situation to situation and there is no interval between them, though it is possible to mark off behavior patterns for practical purposes. However, as psychologists we need to be on our guard against the implied inference of gaps which has become fixed in the inelegant popular expression, "Life is just one darn thing after another". If we can find the direction of change in a given configuration we have found the thing which above all others may be regarded as the stimulus. Organisms do not respond to static conditions: they respond to a gradient. For confirmation of this idea we again turn to biology.

In simple forms of life we find different rates of living within a single individual represented by polarity and symmetry. These two factors seem to determine in a general way the pattern of structure of the individual. At first glance it would seem that they are hereditary, but, recalling the facts brought out earlier relative to the responsiveness of embryos to changes in the physical environment, we do well to go a little slow. Mr. M. C. Child assures us that the recent investigations point to the conclusion that such physiological gradients can be modified experimentally thus modifying the structural plan of the organism.

For example, "It is possible by means of different agents which inhibit physiological activity to decrease the rate of living of the more active relatively to the less active regions and so to produce individuals with small and imperfectly developed heads and brains: one eye in the median line instead of one on each side; or, with more extreme action, forms without any eyes, and even without heads. . . . On the other hand we can increase the relative rate of living of the more active regions and so produce individuals with large heads and brains and, in some cases, with extra eyes and with changes in position and proportion of other organs opposite in direction to those which result from inhibition. We can make bilateral animals radial and vice versa, and we can even obliterate polarity and symmetry completely, so that instead of developing into a complex individual the organism remains spherical and the only differences are those between surface and interior".[7]

These facts are cited here because of their bearing on our problem. If simple organisms respond to gradients of stimulation by gradients of living and growth with such radical results we might invoke our principle of genetic identity to suggest a physiological continuity reaching up to man himself. The nervous system doubtless had its origin in the irritability of protoplasm. It somehow became the instrument and token of this divine attribute. It would not be surprising, then, if it preserved its gradients, and isn't this just exactly what we find? Psychologically man lives fastest in his cerebral cortex. He is most aware of the direction of change which he experiences in his environment. These excite in him neurological actions which are their counterparts.

I look at the fire crackling merrily on the hearth. It looks **bright** to me, which means equally that its surroundings look less bright. The difference of brightness is a gradient. It is this which constitutes the stimulus. This fact once clearly grasped will set at rest forever the argument that the stimulus is an external thing as it will the contention that it is an internal thing. If we could examine the physiological aspect of the experience we would doubtless find that the intenser brightness of the fire is matched by a neural potential, a ratio of excitation between two brain areas. While glancing at the fire I am suddenly moved to go after fuel to renew it. The diminution of the gradient of brightness corresponding to the physical fact of the dying down of the fire is the stimulus which sets me into action. Stoking is not the only thing one does to a fire, however. He may want it to die down so that he can go away and leave it without danger. In such a case the direction of change in the brightness configuration, while itself remaining unchanged, produces a different result. Thus it would seem that the same stimulus can elicit different responses.

However, this influence has no bearing on the present illustration, for we don't have the same stimulus in the two cases mentioned. Whether the dying down of the fire leads me to seek fuel or to make my departure will depend upon my purpose. This purpose, which has its neural aspect as certainly as has the discrimination of brightness, is not something brought into the configuration from nowhere; but it is an integral part of the configuration. The direction of change in the situation, then, is not merely a diminution of brightness; but it is a diminution of brightness plus a tendency to do a certain kind of thing about it. We may generalize this as follows: **A purpose always gives a direction to any situation of which it is an integrated part.**

[7]"The Individual and Evironment from a Physiological Viewpoint," in symposium **The Child, the Clinic, and the Court;** The New Republic Company, 1925.

We would appear to have indentified purpose with stimulus. This would have the advantage of conforming with the popular common sense view that our actions, at least some of them, are the result of our intentions. It would conform equally well with the psychology of **Gestalt** provided only that purpose be interpreted as a tendency toward closure in a configuration. The question of how the right response gets connected with the stimulus pattern loses some of its difficulty when we see that the motor responses are part of the psychological pattern. They don't get connected; they are a part of the total situation, growing out of the same matrix out of which it grows. Being a part of the psychological pattern makes them part and parcel of the neurological system involved. The real mystery in psychology is not how a given motor response gets connected with a stimulus, but how a given physiological process can bear an appropriateness to a given psychological pattern.

If purpose can be used to stand for the stimulating gradient in purposive behavior, what can we say of the stimulus in behavior which is not purposive, at least on an ideational plane? Such behavior has its gradients,but it has them on a more strictly sensory basis. We turn to some experiments by Köhler for our illustration.*

Professor Köhler,* working first with hens, then with apes, and finally with a three-year-old child, trained his subjects to respond positively to one of two "stimuli"† of a certain class. Then he introduced another pair of stimuli of the same class. He found that the subjects would now react toward the stimulus which performed for the new situation the same function as was performed for thre learning situation by a given specific stimulus. With hens the stimuli used were squares of gray paper of different degrees of brightness. Positive reaction was secured by placing food upon the brighter of the two squares, and frightening the fowl away from the darker square. Between four and six hundred repetions were necessary to make the right selection reasonably certain. Changing the relative positions of the squares obviated any positional factor becoming determinant in the reaction. Presumably the fowl's response was made to the perception of a certain value of gray. However, this presumption was proved false when the darker square was replaced by one brighter than its partner. The hen rejected the paper to which it had learned to react positively in favor of the new member of the pair. Similarly a different subject shifted its response to the previously unacceptable square when this was made the brighter of the two by replacing its mate with a darker shade.

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*Cf. "Nachweis einfacher Strukturfunktionem beim Schimpansen und beim Haushuhn", Abhandlung der K. Preus, Akad. d. Wiss., Jahrgang 1918, No. 2 (separte edition), pp. 12 f.

*Lashley seems to have preceded Kohler in this type of experimentation, but the latter did not know of his work until later.

†The word is used here in its popular usage.

We are compelled to conclude that the fowls in these experiments perceived each situation in its totality as two shades of gray, or brightness, in juxtaposition, each being a member of the pattern; and that their responses were made to the central feature of the configuration, which was common to all, namely, their gradient or direction of change. Further experiments by Köhler with apes in which size and color hue discrimination were concerned lead to the same conclusion.

We leave the matter of the stimulus aspect of behavior to examine briefly the idea of response which we find in gestalt psychology. In general the writers with this orientation concur in the idea suggested by Professor Köhler's phrase "reaction to the results of organization". The phrase reminds us of Mr. Watson's "anything the animal does", and it also accords very well with the popular use of the word 'response'. We find no difficulty in bringing the gestaltist and behaviorist into practical agreement here, for the matter which irrevocably sets off their respective positions in unrelenting hostility is the explanation of the relation existing between an individual's actions and the stimuli which activate him. Sufficient has been said in the preceding pages to indicate the nature of their differences.

Responses to "the results of organization" at least have the merit of being intelligible if the observer enjoys the advantage of knowing the results of organization, either through communication or by appeal to his own experience. Deprived of the scientific right to take psychological organization into our reckoning we would be in a sorry plight when we tried to understand an individual's actions merely by observing the actions of his muscles. It is the adaptive character of an act which makes it worth interpreting psychologically; and the adaptive character of an act depends upon the faithfulness with which it reflects the perception of the situation. We have found perceptions to be patterned, so would expect overt responses to exhibit the same characteristics. Thus we are enabled to understand how familar muscular responses can be organized into new total reactions without practice. We can also understand how errors of response are committed.

SIMPLIFIED TREATMENTS FOR TWO COMMON STATISTICAL DEVICES

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I. Complex vs. Decimal Form of Stating Medians.

The following notes are the result of attempts to make clear the nature of the median to college students who are prospective teachers but who have had no course in statistical methods. These students are expected to read current educational literature; they must find ordinary statistical terms, such as the median, perfectly clear in connotation. To such students one must give a working understanding of the median in the clearest possible terms as to meaning and mode of determination. The ordinary method of computing medians, and of explaining that computation, raises too many questions, elicits too many complaints of inconsistent and questionable assumptions. These difficulties can easily be obviated by a very slight change in the form of the statement of the median. That point can be made clear by a brief review of the most elementary facts about the median and the function it serves.

Any educational situation can be described fully in verbal form, but in the interest of economy and brevity verbal descriptions may be avoided whenever statistical descriptions are feasible. The purpose of statistical descriptions is not the attainment of tremendous accuracy, but to facilitate brief, concise condensation of description. When one desires to give a statistical description of an educational situation in terms of measures of the excellence of performance, he may list his complete data if he cares to do so. A frequency table may be employed to express the same facts somewhat removed from reference to particular instances. But when one wishes to give the briefest possible statistical description of such a situation he is likely to state an average of the series of measures.

One does not attempt to describe the situation in brief compass by citing either the greatest or the least measure in the series for the reason that neither one of these measures is felt to be sufficiently and characteristically representative of the series as a whole. Largely because of the greater frequency of measures near the middle of the series one feels that the most satisfactory single measure is one at or near the middle of the series. Accordingly he selects some one of the several types of average. When he wishes to describe the situation in briefer terms than by presenting a frequency table, and yet wishes to give fuller information than is contained in an average of the series all by itself, he may announce, along with the average, some such supplementary item as the average deviation, the standard deviation, or the semi-interquartile range. But even when such a measure of variability is given, the key to the description is the average, that single measure or point on the scoring scale which is deemed most typical of the entire series.

By very virtue of its definition, the median may be regarded as a more satisfactory single representative of a series of measures than is even the arithmetic mean. Just because its definition says that the median is the middle one of a series of measures, or that it is that point on the scoring scale above which lie half, and below which lie the other half of the measures, it seems the most eminently suitable of the several average measures to be employed as the typical representative of the series. Because of this satisfactoriness, the median has attained, in statistical descriptions of educational situations, a place which should be thoroughly protected. No ambiguities should be allowed to result from any particular form of notation, employed for the sake of putative precision.

So long as the measures are not of great number no one quarrels with the first form of definition of the median, namely, that it is the middle one of a series of measures. But when the series of measures lengthens out and the frequency of appearance of particular measures becomes noticeable, then this simple definition of the median is abandoned in favor of the second form, namely, that the median is that point on the scoring scale above which lie half, and below which lie the other half of the series. And at this point the method of determination of the median changes from a counting method to a computational method.

The purpose of this change in method is clear: when measures near the middle of the series appear rather frequently so that the counting method of determining the median would merely point to one of a group of equal measures, one desires to locate the median more definitely than the counting method permits and, for the sake of this greater definiteness, one abandons the concept of a particular measure as the median, in favor of the concept of a point on the scoring scale as median. Now the desire to take advantage of the known frequency of the measure at which the median falls, and to let this advantage be expressed in the form of an exact numerical quantity, is praiseworthy in itself. The trouble is that the methods of calculation and final expression of the median involve certain assumptions that approach the absurd.

Let us assume a simple illustration. Suppose that, to a class of 38 members, there has been given a test on which any integral score from 0 to 20 may be obtained. Suppose that the frequency of score 14 is nine; suppose that 15 members of the class have scored below 14. Then four of the nine who obtained score 14 must be counted among the lower half of the class. The median is therefore 14 4/9 or 14.44. This median is interpreted as follows: the middle measure of the series was called 14, it is true, as were several other measures (number not known when decimal form is given); these several measures did not fall exactly at 14, however, although for scoring purposes we assumed that 14 meant all values from 14 up to but not including 15; the best guess was that the several measures falling between 14 and 15 really occurred at regular intervals; that is, the space between 14 and 15 had to be thought of as divided into as many parts as there were measures falling between 14 and 15; of these parts as many had to be counted off above 14 as was necessary to include all of those measures which fell into the lower half of the class when properly placed on the scoring scale; the point on the scoring scale thus determined was accepted as the median.

(1) To the casual observer it seems peculiar that each of the nine members of the class was first declared to have earned a score of 14, and yet later the nine were divided into two groups, those four who stood below 14.44 and those five who stood above 14.44. (2) Although it was the original understanding that no score between 14 and 15 could be allowed (even if it were granted that there might be intermediate performances meriting such intermediate scores), it now appears that these nine, who were said to have scored 14, did not really score 14 exactly, but scored between 14 and 15. (3) Further, it is now assumed that these nine who scored 14 actually should have been given scores distributed at regular intervals between 14 and 15 so that if a line were drawn across the scoring scale above 14, at a point 4/9 of the distance from 14 to 15, that line would leave below it four of the nine, and would itself be below the other five scores of the nine originally supposed to have been placed at 14. These contradictions and assumptions made in the interest of definiteness of location of the median seem unnecessary and ill-advised. The median would have been advantageously left in the form 14 4/9.

Let us assume another case. Suppose a spelling test of 25 words is given to a class with the understanding that a value of four is to be assigned to each word, so that the maximum possible score on the test is 100. Each pupil's score is determined on the basis of this understanding. Suppose that 30 pupils take the test; suppose that the frequency of score 76 is seven, while thirteen pupils have scores of 72 or below. Then the median by the method of computation is $76 + (2/7 \times 4)$, or 77.14. In this case the same objections hold to the form of the statement of the median that were offered in the previous illustration. In the present illustration it is rather difficult to imagine seven pupils as achieving performances that should be scored at regular intervals from 76 to 80, for the spelling of a word is traditionally asserted to be either wholly right or wholly wrong.

These two illustrations will suffice. Not the desire to take advantage of known frequency to give greater definiteness of value to the median, but the decimal form of the statement, is at fault. In the first illustration the median should simply be left in the form 14 4/9; the 4/9 should not be thought of at all as a fraction of the distance between 14 and 15 on the scoring scale, but as a statistical device for describing more adequately the median situation; 14 4/9 is a bit of symbolism which says that, of the possible measures on the scoring scale (integers from 0 to 20), the middle one of the series actually occurring was 14, but that more than one such measure was found; in fact, nine such measures were found and four of these have to be counted arbitrarily with the lower half, the other five being counted, again arbitrarily, among the upper half of the measures. This description of the middle performance of the class is fully as definite as the decimal form, 14.44. The suggested procedure provides definiteness without contradictions and gratuitous assumptions. The explanation of the method of arriving at the median is simple; students readily comprehend, and all confusion is eliminated. If the decimal form should be retained is should not be interpreted as it ordinarily is but should be read as follows: of the possible measures on the scoring scale, 14 or less was the score obtained by half of the members of the class, and 14 or more was obtained by the other half; of those who scored 14, 44% were counted arbitrarily among the lower half of the class while the other 56% were counted arbitrarily with the upper half of the class. The larger the percentage of those scoring 14 who have to be counted arbitrarily as belonging to the lower half of the class, the better the showing of the class, for if none of these were to be included in the lower half of the class the median would be barely 14, and if all of these were to be included in the lower half of the class the median would become 15. In this explanation there is no pretense that the median is placed at a point on the scoring scale whose value is 14.44. The median is 14, but the group of those receiving this score has to be split according to the decimal part of the median when stated in decimal form.

In the second illustration the median in form $76 + (2/7 \times 4)$ is perfectly clear and definite; it says that half of the class scored 76 or less, while the other half of the class scored 76 or more; that seven members of the class scored 76, and that two of these seven had to be arbitrarily counted among the lower half of the class, the other five being counted with the upper half of the class; that the step on the scoring scale was not one but four. There is here (1) no theoretical assumption that scores between 76 and 80 could be earned in a spelling test of 25 words to each of which a value of four was assigned (in other words that intermediate performances were possible) or (2) that, granting such intermediate performances, we could draw the dividing line between them, with such accuracy as is suggested by the median expressed as 77.14, or (3) that these intermediate performances tend to array themselves at uniform intervals between 76 and 80. In this second illustration it is clear that the abandonment of the complex notation of the median, $76 + (2/7 \times 4)$, in favor of the decimal form, 77.14, leads away from, instead of toward, simplicity of interpretation. Even if we try to read 77.14 after the manner previously suggested we are still at fault. Such reading would be: half of the class scored 77 or less and half scored 77 or more; of those who scored 77, 14% are to be counted with the lower half of the class and 86% with the upper half of the class. The objection to this reading is that it still involves the assumption of a possible score of 77, which is against ordinary common sense in such cases as the assumed illustration.

In view of these considerations it would appear that, in the interest, not merely of precision, but of definiteness along with clarity, simplicity, and common understanding, it would be well to express medians in complex numbers as illustrated, rather than in decimal form. The whole purpose of the median is to provide in briefest possible form the clearest possible idea of the central tendency of the measures. The customary decimal form of expression of the median is not conducive to the clearest possible understanding, and should therefore be avoided. It gives rise to confusion just at the point where it introduces the hypothesis of intermediate scores after individual scores have been determined and tabulated as falling at certain set places on the scoring scale. For the sake of nicety of calculation or placement of median certain procedures are introduced, which, to say the least, seem rather grotesque to the average teacher or student. To leave the median in the form of a complex number as here suggested still leaves us with the median in a form which has the potentiality of reduction to a form which permits exact placement of the median as a point on the scoring scale. It therefore commends itself as a minor departure from common practice which serves the purpose of considerably simplifying a troublesome situation.

II. Ratio vs. Product Moment Procedure in Obtaining Coefficient of Correlation.

The writer has never found it possible to make an intelligible explanation of the derivation of the Pearson product-moment formula to undergraduate students who have not a considerable background in mathematics. He has found it necessary to reduce work with this formula to two essential steps: (1) development of the general idea of what we mean by correlation, perfect correlation, negative correlation, etc.; (2) presentation of the Pearson formula and the routine of using it, with demonstration of its validity only to the extent of showing that it actually does produce results of +1.0, -1.0, 0.0 in situations where our general understanding of correlation lead us to anticipate such outcomes. Between these two steps there is an undesirable gap, which may be closed by development of a simple kind of formula, which formula is waived in actual practice in favor of the commonly employed Pearson product-moment technique.

By all considerations derived from the connotation of the term, we should expect a coefficient of correlation to be developed as a ratio. Some quantity should be divided by some other quantity, whereas in the commonly used Pearson formula a product is taken. Such statement does not presage an attack upon the validity of the Pearson formula. It is simply one phase of the assertion that to conceive of the coefficient of correlation as a ratio seems logical and simple, and therefore the type of introduction to the significance of the coefficient of correlation that should be employed in dealing with teachers who have had no training in advanced mathematics or statistical methods.

Possibly even the word "ratio" is sufficiently vague in the minds of many people to make it objectionable. We might improve terminology by talking about percents.

Let us take an illustration from the simple every-day situation of the relation between grades earned by a group of pupils in each of two subjects. We want to know whether a pupil's departure from the average grade in one subject is accompanied by departure of like degree from the average in the other subject. It is not just one particular pupil about whom we wish to know such fact, but pupil x, **any** pupil. We want a generalization about the tendency of deviations from the central measure in one series to be accompanied by deviation of like degrees from the central measure of another series. What could be more simple or more illuminating than to ask what percent the average deviation of one series from the average of that series is of the average deviation of the other series from the average of that series? The deviation tendency in one series is of such a magnitude; the deviation tendency of the other series is of such another magnitude. Establish a comparison by means of ratio or percent.

The situation may not be quite so simple as that sounds, but the essence of correlation measurement is expressed. We might have to take into account the different scales of measurement used in the two series, or the different types of distribution, but the correlation idea would not change. **The logical comparison of two deviation tendencies is by means of a ratio and not by means of a product.**

The most obvious objection to expressing correlations by means of ratios is the fact that correlation of A with B will be of a certain magnitude, whereas correlation of B with A will be the reciprocal of that magnitude. It would seem absurd that correlation expressed in one order should not be equal to correlation expressed in the reverse order. That is, mathematically considered, it seems absurd. In relations generally we are not conscious of any incongruity in changing the description when speaking of a situation from opposite standpoint. My nephew does not think it peculiar that he has been taught to think of me as his uncle rather than, in turn, as his nephew. If this is greater than that, then that is less than this. In other words, we are entirely accustomed to thinking of relationships as of reciprocal character when considered in reverse order.

Between any number (except unity) and the reciprocal of that number it is clear that there must be inequality, either the number or its reciprocal being less than unity. If our mathematical conception of correlation makes it impossible to admit a measure of relationship greater than unity (in other words, if perfect correlation is expressed by 1.0), then we may take the reciprocal of any computation result greater than 1.0, thus obtaining an expression of correlation less than 1.0. Or we may adhere to the conception that 1.0 expresses perfect correlation and recognize the reciprocal character of the two possible outcomes by declaring that, as any ratio less than 1.0 shows imperfect correlation, so also does any ratio greater than 1.0. In this second case, as in the first, the greater the departure from unity, the smaller the degree of correlation. There is therefore no inherent difficulty in the fact that an explanation of correlation in terms of ratios leads to either one of two reciprocal results.

Suppose that, using rectangular axes originating at a point which represents the zero of each of two measurement scales, we plot points to represent individuals on each of whom two measures have been made. This gives us a scatter diagram. Then let us shift the axes to that point as origin which represents the mean of all measures of each series, instead of the zero point of each series. We now have our scatter diagram distributed over the four quadrants of the plane. If we use x_1, x_2, x_3 ———— x_n as the horizontal distances of the several points from the new origin, these distances represent the deviations of the several measures of one series from the mean of that series. In like manner, y_1, y_2, y_3 ———— y_n represent the deviation of the several measures of the other series from the mean of that series. The coodinates of any point, representing the pair of measures for one individual, may then show any one of the four possible sign combinations: x positive, y positive; x negative, y positive; x positive, y negative; x negative, y negative. Since these two series of measures may have been on quite different scales, it will be better to reduce the coordinates to comparable units by dividing each deviation by a dispersion measure for its series—the mean deviation, or the standard deviation.*

Let us go on, understanding that $\frac{x_1}{MD_x}, \frac{y_1}{MD_y}$ are the coordinates for a certain point, representing the performances of one person on two types of tests. Then $\frac{\frac{x_1}{MD_x}}{\frac{y_1}{MD_y}}$ or $\frac{x_1}{y_1} . \frac{MD_y}{MD_x}$ is the ratio of the deviation-of-one-individual-from-the-average-in-one-trait to his deviation-from-the-average-in-the-other of the two traits that have been measured. In other words, it is the fraction, (reduced to a decimal) the percent, that one deviation is of the other. But we are not interested in this particular individual alone. We wish an expression for the deviation ratio of **any** individual. We may take the average of the series of such ratios to represent the **tendency** of deviations from the average in one trait in relation to deviations from the average in another trait. This gives us the following:

$$\frac{\frac{x_1}{y_1} . \frac{MD_y}{MD_y} + \frac{x_2}{y_2} . \frac{MD_y}{MD_x} + \frac{x_3}{y_3} . \frac{MD_y}{MD_x} \ldots\ldots \frac{x_n}{y_x} . \frac{MD_y}{MD_x}}{n}, \text{ or}$$

$$(2)\ \frac{\Sigma \frac{x}{y} . \frac{MD_y}{MD_x}}{n}, \text{ or } (3)\ \Sigma \frac{x}{y} . \frac{MD_y}{{}_nMD_x}, \text{ or simply } (4)\ \Sigma \frac{x}{y} . \frac{MD_y}{\Sigma D_x}.$$

If it seems preferable to use standard deviations instead of mean deviations, then our first ratio becomes $\frac{x_1}{y_1} . \frac{\sigma y}{\sigma x}$ instead of $\frac{x_1}{y_1} . \frac{MD_y}{MD_x}$. And our formula assumes any one of the following shapes: (5) $\frac{x_1}{y_1} . \frac{\sigma y}{\sigma x}$ -

*I am perfectly aware that in this paragraph and some others I have employed some technical terms, even while talking about an explanation which will be intelligible to students without background of technical and mathematical character. That may seem inconsistent, but it is not so in reality. The terminology here employed is elementary for the group now attending to this discussion, and there is no expression introduced which cannot be reduced to entirely non-technical language when one is talking to students who do not understand the technical terms. No mathematical concept has been introduced which is not capable of comprehension by students who have had elementary mathematics.

$\frac{x_2}{y_2} \cdot \frac{\sigma y}{\sigma x} + \ldots\ldots \frac{x_n}{y_n} \cdot \frac{\sigma y}{\sigma x}$, or (6) $\frac{\Sigma \frac{x}{y} \cdot \frac{\sigma y}{\sigma x}}{n}$ or (7) $\Sigma \frac{y}{y} \cdot \frac{\sigma y}{n\sigma x}$, or (8) - $\Sigma \frac{x}{y} \cdot \frac{\sqrt{\Sigma x^2}}{n \sqrt{\Sigma x^2}}$.

The formula in form (8) will yield a result of 1.0 (as will also the Pearson formula) if applied to the two simple series 2, 3, 4, 5, and 6, 8, 10, 12 as the scores of four individuals in two tests. If we reverse the second series, making 12, 10, 8, 6 the scores on the second test, while using 2, 3, 4, 5, for the first series, both formula (8) and the Pearson formula will yield a result of -1.0 as the measure of correlation. No claim is made that formula (8) will always yield the same result as the familar Pearson formula, however.

The formula here reported is derived by a simple process of reasoning, no step of which is obscure. Regardless of whether it is as satisfactory for professional use as is the Pearson product-moment formula, it is more satisfactory for explanatory purposes than is that formula in the respect that is depends on a ratio as the expression of relation, rather than on a product.

IS METER NECESSARY TO A TRUE DEFINITION OF POETRY

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Aristotle said not, but we no longer feel bound to agree with Aristotle, or anybody, docilely and without question. We must admit, indeed, that a poetic idea is the first prerequisite; perhaps there are others. I wish to go back and examine the growth of poetry among early civilizations less advanced than the Greek in order to see if I can deduce the nature, kinships, and functions of it.

Poetry is as old as the human race, far older than written language. Though time and place create differences of opinion as to what constitutes poetic excellence and embellishment, yet it is as universal as religion. With the invention of writing poetic utterance would seem to have lost some of the inherent and all-pervading preeminence which it easily holds in spoke language, for until the advent of writing even the history and all facts considered valuable to be remembered were chanted or sung in rhythmical, metrical language. Our American Indians had impassioned chants and recitatives with dance rhythms, which were accompanied by the beating of the tom-tom and the playing of other musical instruments. "Neophytes of the Druids, whose period of instruction and novitiate often lasted twenty years, were made to learn great quantities of verse by heart. To the present day in Arabia and Hindustan a large part of the native literature is transmitted orally, compositions being thrown into metrical form to facilitate repetition".[1] Yet the sheik will not hitch his beloved horse to a dray in spite of making so utilitarian a use of meter. The ancient Jews, the Homeric Greeks, the Teutons during the migrations and other barbaric races of which any record has been preserved since the dawn of history, lead us to see that poetry is a vital, a fundamental expression, a human need, a universal growth.

But now comes a modern question as a result of our selfstyled highly civilized state and consequent feeling of superiority and of the suspected probability of our outgrowing all our past delights and preoccupations: "Is the art of verse one that can never be superseded—or was poetry merely the extremely beautiful infancy of a type now adult"[2] This is getting back to Aristotle's idea that a poetic idea may perhaps be as well expressed in prose. Let us see. Here are the arts, according to my

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[1]Sir Jas. H. Ramsay—**Foundations of England, p. 23.**

notion, with poetry at the heart of all and akin to all as no other art is, it seems to me:

Music:
Time
Sound
Rhythm
Harmony

Drawing, Architecture, Painting
Space
Form
Color
Arrangement

POETRY

Singing and Dancing:
Time
Sound
Rhythm
Posture

Sculpture and Modeling:
Space
Form
Posture

That poetry partakes of the nature of a representative art has been often noted; Spenser speaks of "poet's wit that passeth painter farre in picturing".[3] It employs rhythm and harmony as do temporal and sonant arts, music, and singing and dancing.

Historic views concerning the function and place of meter are deserving of a brief summary here. The Greeks insisted on rhythmical prose and even developed a metrical prose called the paean, which was an alternating iamb and anapest. Cicero studied, practiced, and advocated rhythmical prose. In the Latin and Greek poetry the feet were based on quantity, whereas our poetry is scanned according to stress or accent. The poetry of the Bible is understood to have been in meter in the Hebrew original, though the principle of meter requires a new definition in each language.[1] Coming to our own literature we find Sidney denying the necessity of rhyme, as Milton and others were at great pains later to do, but not of meter. France has had vers libre at least since La Fontaine. In English Macpherson's "Ossian" and Whitman's "Leaves of Grass" have led to all sorts of prose poems, polyphonic prose and what-not. Wordsworth, Coleridge, Shelley, and Leigh Hunt have treated the question of meter in detail.

By what right does Macpherson entitle the Ossianic matter "a poem"? It is imaginative, in how far it is metrical? It employs poetic embellishments; it employs repetition and refrain: any paragraph will serve to illustrate this. It has alliteration, assonance, rhythm, the short

[1]For German opinions see Tieck, Goeth's letter of May 5, 1798 to Shiller, Jenna ed., 1905, and Hegel's Introduction to the **Aesthetik**.

phrasing which is one of the most important distinctions between poetry and prose, and does noe even avoid the use of verse for producing its effects as will appear on the next page. Whitman makes no attempt either to avoid or retain any regular verse-form in the "Leaves of Grass" and it is admittedly best in the metrical passages. In each of these writers we find wavering between poetry and prose, and often the regular rhythm of iamb.

From Fingal, p. 93, 1st column, 2nd paragraph, line 30, et seq.

The soū'nds | of crā'sh|ing ar'ms | ascen'd. (snd, snd, as, as, as)
The gr'ay | dogs hō'wl | betwē'en. (ow and ou in l)
Unequal bursts the song of battle. (b, b)
Rocking Cromla echoes round. (3 hard c's, nd)
On Lena's dusky heath they stand (nd, h)

(Woods—Poetry & prose of Rom. Movement)

Like mist that shades the hills of autumn (h)
When broken and dark it settles high, (h)
And lifts its head to heaven. (h, h)
Or the beginning of Oina-Morul:

This is Macph's Commonest Jingle

As fli'es the unco'nstant 'sun,
Over La'rmon's gra'ssy hi'll,
So p'ass the ta'les of o'ld
Alon'g my sou'l by ni'ght!
Or like Evangeline dactyls:

From Fingal, p. 95, line 46, 2nd column

They | fell like two | hind's of the | dē'sert, || by the | han'ds of the | mi'ghty | Swāran;
He sits | dim on the | clō'uds of the | North, || and en|jō'ys the | deāth of the mā'riner.

Even the punctuation coincides with end-stopped verse. The metaphor and other poetic embellishments are present, excepting only rhyme. This is underhanded verse. It is an interesting experiment but I cannot approve of it. Macpherson was too tricky to write verse outright, as Whitman was too indolent. Does the neglect of symmetrical plan and architectural beauty mark the great builder? Does a master abjure marble in the construction of his soul's dwelling-place and prefer a sprawling hut, thatched with "Leaves of Grass"? Or as Bayard Taylor said, "The difference between a prose poem and a real poem is the difference between a marble statue and a ton of marble dust".

"Why have I written in verse?" queries Wordsworth in the preface to **Lyrical Ballads.** The reason is that he wished to be remembered and a worthy thought requires beautiful expression to gain and hold attention. And thus Wordswoth says, [May] "thy memory be as a dwelling place for all sweet sounds and harmonies". It may as well be asked, when "sensations sweet [are] felt in the blood and felt along the heart": Why not write in verse? Gurney says, "Prose language is a glass through which the light passes, poetry a lens, where the thought takes fire as it passes". Hazlitt, accounting for verse, says, "As the song and dance go together, so there is no doubt that certain thoughts lead to certain tones of voice, or modulations of sound, and change the words of Mercury into the song of Apollo". This is Wordsworth's "inevitable poetry". Meter to Wordsworth is always desirable as superinducing pleasurable emotion, and for some kinds of poetic expression is a necessity.[1]

Coleridge says poetry arises out of "a more than usual state of emotion, with more than usual order". Shelley defines meter as "an observation of the regular mode of the recurrence of harmony in the language of poetical minds" and recommends it, but in emphasizing the superiority of poetic content over form, he declares that the "distinction between poets and prose writers (is) a vulgar error". Leigh Hunt says, "I do not mean to say that a poet can never show himself a poet in prose; but that being one, his desire and necessity will be to write in verse; and that if he were unable to do so, he would not and could not deserve his title".

I feel that my own opinion on this subject deserves attention too, for I have practiced writing what I called poetry since the age of eleven and lately since the charge of distortion of thought has been lodged against meter, I have practiced writing out my thought in full before putting it into meter. In no case has the recasting been laborious; the right meter has usually grown into the first draft; as the thought varies, the meter may and should vary also; and in no case has there been anything but improvement and greater satisfaction to me.

There is not a worthy thought that could not be put into some of the varying and ever-developing metrical forms. If the author is unwilling to take the trouble, if poetry hinders such a one's expression, so much the better: we shan't have to read him. As Joubert says, our great authors have been "spirits, lovers of light, who when they have an idea to put forth, brood over it first and wait patiently until it shines, as Buffon enjoined, when he defined genius to be the aptitude for patience". Poetic form requires exactly the revision, focus, and self-criticism we should desire for all high literary effort. I speak not of the rhymer and jingler, I speak of him who aspires to the task and work of a true poet, and is willing to revise, focus, and mold, to chisel and carve, until the beauty and truth stand unencumbered and clear. It is only such who will be remembered or deserve to be remembered. Press-agenting may get a thing read once but nothing except intrinsic worth will preserve it from ultimate oblivion. Barrett Wendell had a theory of natural literary aristocracy. He said that the very things we remember are the best—and do we not remember ten times as much poetry as prose?

[1]Goethe's versifying of prose passages which had seemed too painful (see letters to Schiller mentioned above) should be compared with Shakespeare's practice of dropping into prose to aggravate pain and pathos.

It ministers to our pleasure, waiting upon our moods, and lulling to sweet dreams with happy harmonies.

End-rhyme has been a much disputed metrical question. It has been denounced as an affectation and a hindrance to expression and lauded as a musical and metrical device par excellence. Supporting the latter view, Hazlitt even asks, "Since rime assists the memory, may it not also quicken the fancy?" I prefer not to enter into the dispute here except to notice the various theories of the origin of end-rhyme. Some, and I think they are right, consider it largely a spontaneous growth within a language. Courthrope traces it intricately from Arabia; Guest (I think he did too) says it originated with the Goths, was transplanted into the Latin-descended Romance languages through the Gothic incursions, that it then raged for a time as an epidemic among the Christian Celtic Welsh, and English took it because it was very contiguous (!).

But defining meter as broadly as Shelley does (cf. paragraph beginning middle of p5), are there not analogies in nature for it? True, "much prose is only crippled poetry", as Tieck says, but it is not permitted by definition ever to be more than broken music, for at the point of passing into song it ceases to be prose. The bird dancing on the spray pours out his ardent soul in a simple but oft repeated pr-r-r-it-e-e bir-r-d, for his mate seems to merit the utmost melody and embellishment of utterance within the compass of his small throat. (The man who has never felt so has never been in love.) The delight that not only savage men but animals take in rhythm is well known and is significant in this connection. A military band sets any cavalry horse and some others (I have seen horses that I knew from colthood and that had never been army horses so respond) to dancing in perfect time to the music. All must have noted rhythmic responses of elephants. Shepherds played wind instruments to keep their flocks near and to lead to new pastures. I have heard of cows that produced more milk to music. Highly intelligent dogs are sometimes sensitive to music and various moods can be noted in their responses.

I think with Omond[1] that "did verse answer to no instinct in our natures, it might well be abandoned as a thing outworn", but I feel that there is something indispensable in this interweaving of language, imagery, and music, the "fairest friend of youth through so many generations". Of course to one who enters an imposing portal supported by Corinthian columns, only to find himself in a poor, low, filthy hut where the light hardly shines at all, the relization of the incongruity will bring with it impatient disgust; it is for a like reason that flimsy versifiers are held in greater contempt than almost any other amateur practitioners in written expression. If we discover some one aping poetic form when

[1]Omond-English Metrists, p. 169.

he has not a single poetic thought to store in it, we look upon him with a peculiar disdain and an especial pity. But as the mouth is dependent on the eyes above it and the ears on either side of it for the original data for its utterances, so should expression, in a spirit of gratitude, endeavor to please the ear with harmonious sounds and cadences, and the eye with fair images for the inward eye: thus will observing be repaid, and listening be more and more worth while.

AN EXPERIMENTAL STUDY OF THE EFFECTS OF SUPERVISED STUDY AMONG COLLEGE FRESHMEN

By
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The problem in this study is two-fold: To ascertain (1) to what extent the heavy mortality among freshmen can be avoided; (2) to what extent high school grades combined with a freshmen intelligence test are a true index of the student's capacity.

An experimental group of about sixty freshmen taken from the two lowest deciles were given a course in methods of study, and were put through the actual paces of study. The semester grades of this group were compared with the grades of three control groups from the 1928, 1929 and 1930 freshmen classes, all of whom were also within the two lowest deciles of their respective classes.

The conclusions reached were as follows:

1. The course in supervised study was most effective among the students in the lowest decile or decile and a half.
2. Contrary to Pressey and others it appears from our results that the trained group on the whole showed decided superiority over the untrained group in grades. We conclude, therefore that it is eminently worthwhile to train even the lowest decile.
3. Neither intelligence tests nor high school grades are a reliable criterion of a student's scholastic capacity, at least so far as the two lowest deciles are concerned.

HOW SHOULD A COMPOSITE SCORE BE MADE FROM A BATTERY OF TESTS?

By

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In recent years many teachers have been using batteries of tests to measure the progress and achievement of students. This is true because the teachers are coming to recognize the fact that various types of abilities can be better measured by a battery of tests than by any one type of test. Many different procedures are followed in combining the scores of the various tests, for the purpose of making a composite score on which final marks are based. Among the methods practiced by teachers are: (1) The transmuting of the scores made by the pupils on each test into marks and attempting to average the marks; (2) Taking either the sum or the average of the raw scores of each pupil as the basis for determining his mark; (3) Taking the product of the raw scores made by the student on each test in the battery;[1] (4) Converting the raw scores of each test into M-Scale scores.[2]

The use of the first of these methods is evidently absurd in a school system or institution that makes use of letters to indicate the marks of the students. For example, let us take a school system that attempts to make the class achievement the basis for determining the final marks, and that also endeavors to make the distribution follow an approximation of the normal frequency curve. Let us suppose letters, A, B, C, D, and E are used with percentile values as follows: A, 95-100; B, 90-94; C, 80-90; D, 70-79; E below 70 or failure. A certain student makes on a battery of tests composed of three different types of tests marks A, B, C, we cannot say that he averages a B, because the raw scores from which his A was determined may have been in the extreme lower limits of the scores which were assigned A values. The same might have been true of the scores that were given the B and C values. On the other hand the scores on which all three of the letter values were based may have been at the upper limits of the values. Or one of the letters may have been determined from scores that represented the lowest value of that letter, the other two scores that represented the highest value. Take the definite example of a college senior who made an A on a certain test in a battery, a B on another, and a C on another. A's were given on raw scores of 71 to 84. His A was given on a score of 71. B's were rated on raw score of 56 to 69. The B was given on the score of 57

[1]This method has been suggested and practiced to some extent by the writer.

[2]For details of this process see Charles Russell, **Classroom Tests**, Chapter XIV Boston: Ginn and Company, 1926. pp. V-346.

The C's were assigned from raw score of 40-50. The C was obtained from a raw score of 40. Now those teachers who attempt to make a composite score from the letters would likely say this student's average is a B. Such is not the case. When his point scores from the three different tests are added and put in a distribution with the sum of the point scores for all members of the class, his composite point score very clearly came in the C division. Also when the scores were M-Scaled and a composite score made from them his composite score fell very definitely in the C group. Another student in this same group received marks of A, B, and C on the respective tests of the battery. His scores were all at the upper limits of the letter values. When a composite was made by either taking the sum of the raw scores for the three tests or by M-Scaling them, his composite score was in the A group.

A little observation will convince even the non-skeptical teacher that this method of combining the results of tests is extremely inaccurate. For the purpose of helping to determine which of the other three methods is the best, the writer studied the results obtained from giving many batteries of tests. The study of the results from two of the batteries will be reported in full.

The First Battery

The first battery was given recently to a class in school management, taught by the writer in Fairmont State Teachers College. There were forty-three members of the class. They were with one or two exceptions second year students pursuing the Two-Year Normal Curricula. Two tests, true-false and completion, constituted the battery. There were one hundred questions in each one. Exactly twenty minutes were allowed for each test. Both were given at the same class period by the mimeograph method. The raw scores from each test as well as the composite scores by three methods are given in Table II.

Table I. Raw scores for the True-False and Completion Tests and the composite by each of the three procedures.

Student's Numbers	True-False Test Scores	Completion Test Scores	Average of Raw Scores	Product of Scores	Average of M-Scale Scores
1.	50	14	32	700	46
2.	45	20	32.5	900	47
3.	4	30	17	120	42
4.	36	7	21.5	252	34.5
5.	49	13	31	637	48.5
6.	39	27	33	1053	47.5
7.	39	17	28	663	44.5
8.	70	50	60	3500	66
9.	45	28	36.5	1260	49.5

Student's Numbers	True-False Test Scores	Completion Test Scores	Average of Raw Scores	Product of Scores	Average of M-Ssale Scores
10.	26	8	17	208	36
11.	62	41	51.5	2542	60.5
12.	53	17	35	901	48.5
13.	49	37	43	1813	54.5
14.	69	36	52.5	2484	61.5
15.	62	30	46	1860	56.0
16.	57	17	37	969	50.0
17.	72	16	44	1152	56.5
18.	62	37	49.5	2294	59
19.	62	18	40	1364	52.5
20.	69	8	38.5	552	50
21.	76	54	65	4004	64.5
22.	59	16	37.5	944	49.5
23.	38	8	23	304	38.5
24.	55	24	38.5	1320	51.5
25.	65	24	44.5	1560	56
26.	40	22	31	880	46.5
27.	46	14	30	736	44
28.	58	14	41	812	44
29.	64	16	40	1024	51
30.	65	35	47.5	2275	58
31.	88	30	59	2640	65
32.	68	19	43.5	1292	55.5
33.	22	6	14	132	37
34.	59	14	36.5	826	48.5
35.	49	10	29.5	490	43.5
36.	54	14	34	756	46.5
37.	12	8	10	96	35
38.	58	33	41.5	2244	59.5
39.	57	7	32	399	42
40.	42	20	31	840	46.5
41.	57	32	44.5	1814	55
42.	49	23	36	1129	51
43.	66	16	41	1056	52

Table II. Letter marks that would be assigned on the basis of each of the three methods of making composite scores.

Pupil's number	Average of raw scores	Products of raw scores	M-Scale scores
1	D	D	C
2	C	C	C
3	E	E	D

Pupils number	Average of raw scores	Products of raw scores	M-Scale scores
4	D	D	E
5	D	D	C
6	C	C	D
7	D	D	D
8	A	A	A
9	C	C	C
10	D	D	D
11	B	B	B
12	C	C	C
13	B	B	B
14	B	B	B
15	B	B	B
16	C	C	C
17	B	C	B
18	B	B	B
19	C	C	C
20	C	D	C
21	A	A	A
22	C	C	C
23	D	D	D
24	C	C	C
25	C	C	B
26	C	C	C
27	D	D	D
28	C	C	C
29	C	C	C
30	B	B	B
31	A	B	A
32	B	C	B
33	E	E	D
34	C	C	C
35	D	D	D
36	C	D	C
37	E	E	E
38	B	B	B
39	D	D	D
40	D	C	C
41	B	B	B
42	C	C	C
43	C	C	C

The letter assignments were made as follows:

From mean raw scores.

A's 59-65; B's 41.5-52.5; C's 32.5-41;
D's 17-32; E's 10-17.

From products of true-false and completion scores:
A's 3400-4299; B's 1814-2640; C's 812-1560;
D's 208-756; E's 96-132.

From the mean of the M-Scale scores.
A's 64.5-66; B's 54.5-61.5; C's 45-52.5;
D's 36-44.5; E's 34.5-35.

With the exception of numbers 3, 4, 5, 20, 31, 32, and 33, each student would receive the same mark by each of three processes of combining the scores. Student three receives an E by the use of either composite score obtained from taking the mean of the raw scores, or the composite score obtained by taking the products of the raw scores, but he receives a D, which is a passing mark, from the composite score obtained by taking the mean of the M-Scale scores. Student four receives a D from both the mean and the product of the raw scores, but he receives an E from the mean of the M-Scale scores. Students 5 and 6 make the same kind of a shift with the letters C and D as is made with the letters D and E by 3 and 4. Student 20 obtains a D from the product of the raw scores, but a C from either of the other two methods. Students 31 and 32 both draw lower marks by the product method than by either of the others. 33 gets D, a passing mark, by the use of the M-Scale scores, but E, a failing mark by each of the other methods.

It will be observed that in each of the cases where there has been a change of mark from D to E, E to D or any other change by the use of the different composite scores, that the point scores from which the mark has been assigned are very close to the division line between the two letters involved in the change. Thus student 31 receives his A from the mean composite score of 59 which is the lowest point score receiving A by this process, and the B assigned from the product composite is obtained from the highest point score rated as B.

The results of the second battery which are given here were obtained by giving six diflerent tests to the members of a class of 21 students in educational measurements for high school teachers taught by the writer. The tests were: true-false, incorrect statement, traditional, completion, multiple-choice and matching test. The first three tests were given during a class period one day, the other three during the class period the following day. The time given to each test was fifteen minutes. A summary of the results of this battery is given in Table III.

Table III. Composite Scores by each of the Three Methods? Marks Actually Assigned from the Averages of the Raw Scores and the Assummed Marks for the Products of the Raw Scores and the Sum of the M-Scale Scores.

Student's Number	Average Raw Scores	Mark Assigned	Product Raw Scores*	Mark	Average M-Scale Scores	Mark
1.	27.7	B	46	C	54	B
2.	20	C	7.4	C	47	C
3.	22	C	9.5	C	48	C
4.	19.2	C	8.2	C	48	C
5.	39	A	574	A	66	A
6.	18.2	D	0	E	47	C
7.	15.7	D	3.9	D	46	C
8.	33.2	B	112.9	B	56	B
9.	32.7	B	172	B	60	B
10.	16.8	D	0	E	44	D
11.	12.5	E	.2	D	38	E
12.	22	C	15.48	C	52	C
13.	27.5	B	87.6	B	54	B
14.	13.77	D	7.24	C	44	D
15.	17	D	4	D	45	D
16.	27.7	B	91.87	B	56	B
17.	21	C	0	E	45	D
18.	18	D	0	E	44	D
19.	24.2	C	17.63	C	50	C
20.	22.7	C	8.73	C	52	C
21.	33	B	24.48	C	59	B

The letters in Table III are obtained as follows:

For the composite score made by taking the average of the raw scores, A is assigned for the score of 39; B's for scores of 27.5 to 33.2; C's, 19.7-24.2; E, for the score of 12.5.

From the product of the raw scores.

A, from the score of 574; B's, 87.6-172; C's, 7.24-17.63; D's, .2-4.

From average of M-Scale scores.

A, from the score of 66; B's, 54-60; C's, 46-52; D's, 44-45; E is given for the score of 38.

An examination of Table III reveals the fact that twelve of the twenty-one students would receive the same marks, by the use of the products of the raw scores, or by the use of the mean of the M-Scale scores to form the composite scores, as they did receive by taking the

*Each raw score was divided by 100 before multiplying, and the products taken to the nearest hundredth.

mean of the raw scores for this purpose. Of the remaining nine students, six, numbers 1, 10, 11, 14, 18 and 21, would have each received the same letter from the composite made from M-Scale score that he did receive from the average of the raw scores. Numbers 6 and 7 would have received C's by the latter method instead of D's, while number 17 would have received a D instead of a C.

The large number of E's indicated by the use of the product of the raw scores for the composite is the result of zero scores on certain tests. This is the outstanding disadvantage of the use of the products of raw scores to determine marks. No difference how high a students score may be in some of the tests, a zero score on any one test will give a zero composite score. Perhaps, the fairest practice in such cases would be to ignore the zero score and take the product of the scores of the remaining tests as the composite. It is readily noticeable from both Tables I and II that the making of composite scores by the product method magnifies individual differences in achievement. This makes the assignment of marks from the distribution of the composite scores a little easier than by either of the other methods.

In general, Table III indicates that the final marks will be about the same with any one of the methods represented in the table as with either of the others. The student who would receive different letters on different tests are students whose letters were assigned on point scores that represented values close to the border line between the letters.

The Reliability of the Composite Score

While the main problem that we are concerned with in this study centers around the marks that the students receive from their scores on a battery of tests, some light will be thrown on our problem by observing the reliability of our data. The standard deviation from the mean of the various composite scores, its reliability and coefficient of variability were calculated for both batteres of tests with the results indicated in Table IV.

Table IV. Mean, Standard Deviation, Reliability of the Mean in Terms of Standard Deviation, and Coefficient of Variability.

	FIRST BATTERY			SECOND BATTERY		
	Composite Scores Formed by Taking Mean of Raw Scores	Composite Scores Formed from Products of Raw Scores	Composite M-Scale Scores	Composite Scores Formed by Taking Mean of Raw Scores	Composite Scores Formed from Products of Raw Scores	Composite M-Scale Scores
Mean	38.1	12.26	42.72	23.04	54.9	50.29
Standard Deviation	11.81	8.94	8.30	7.57	119.95	6.46
Reliability of the mean	1.8	1.36	1.26	1.65	26.17	1.19
Coefficient of Variability	30.97	72.1	19.43	32.86	21.85	12.82

Table IV portrays a great difference between both the means and the deviations of the composite scores obtained by the various procedures. This difference is due in part to the difference in the size of the composite scores, resulting from the different treatment, but it is also due to a difference in reliability between the different processes of computing the composite scores. Principally because of the first of the preceding reasons, a direct comparison of the means or deviations for the different methods is impossible. Therefore, whatever evidence that we are able to obtain from these data in regard to the reliability and consistency of the different methods will have to come from an interpretation of the reliability of the means in terms of standard deviation, and of the coefficient of the reliability of the means.

The reliability of the mean of the composite scores obtained from the average of the raw scores of the first battery is 1.8. This is the standard deviation by which we calculate areas under the normal probability curve. Therefore, the chances are 68 in 100 that the true mean lies between (38.1-1.8 and 38.-+1.8) 36.3 and 39.9. Likewise the chances are 68 in 100 that the true mean of the composite scores for each of the other two methods (in the order appearing in the table) lies between 11 and 13.22, and 41.46 and 43.98.

For the second battery the chances are 68 in 100 that the true mean lies between (23.04-1.65 and 23.04+1.65) 21.39 and 24.69. Also, for each of the other methods (taken in the order of their appearance in the table) there are 68 chances in 100 that the true mean lies between 27.73 and 81.7 and 49.1 and 51.48.

Considerable consistency is shown by the small difference (1.8-1.65=.15) between the reliability of the means in terms of standard deviation in the two batteries by taking the mean of the raw scores for the composite score, and still more consistency is shown for the method of making the composite scores from the M-Scale scores.

As we examine the various coefficients of variability, given in the table, we observe a reasonable similarity between the coefficients of variability obtained for the two batteries by the use of the mean of the raw scores to form the composite. The respective coefficients being 30.97 and 32.86. There is less difference between the coefficients of variability of the two batteries by this method than by the use of the M-Scale scores. However it should be noted that the coefficients of variability, 19.43 for the first test and 12.82 for the second is lower for the M-Scale scores than for either of the other methods. It is very large for the composite scores formed by taking the products of the raw scores of the first battery, but about mid-way between the coefficients for the other methods of the second battery.

Since the reliability of the scores is in inverse proportion to the coefficient of variability, the composites obtained by the use of the M-Scale scores are more reliable than those obtained by either of the other methods. On the other hand, the data of Table IV implies, at least a slight superiority in consistency for the composite scores resulting from the use of the mean of the raw scores over either of the other methods.

All in all the data contained in Table IV indicates that for statistical purposes composite scores made from M-Scale scores are more reliable than composite scores obtained by either of the other two methods, but its superiority as a practical means of assigning marks over the use of the sum of the raw scores is hardly sufficient to justify the expenditure of the extra amount of time it requires.

Summary

This study has in the main centered on the results of two batteries of tests given to two groups of students in Fairmont State Teachers College. The first battery consisted of two tests given to a group of seniors in the two-year normal course. The second battery consisted of six tests given to college juniors and seniors. Four different methods of constructing composite scores have been considered. These methods are: (1) Assigning letter marks for the scores on each test and making composite scores by attempting to average the letters; (2) Taking the arithmetic mean of the raw scores; (3) Taking the product of the raw scores; (4) Taking the mean of the M-Scale scores.

The first method has been given but little consideration here, because the writer believes that its defects are so obvious that further study of it is useless. The data obtained from the two batteries of tests included in this study indicate that the majority of students will receive that same mark from one as from another of procedures two, three, and four.

The students that would receive different marks by the defferent methods are students whose scores are near the boundary line between two divisions in the marking system and there is no way of knowing for sure what is the mark deserved by the students in such cases. There is much to commend the plan of making composite scores from the product of the raw scores. It definitely discrimiates between the achievement of different individuals. On the other hand it is long and somewhat cumbersome. Furthermore, we have not yet determined the types of abilities that should be measured, and what type of test best measures a certain type of ability. When we do determine these with a reasonable degree of certainty, in all probablity the best means of making composite scores, will be the product method.

The average of the M-Scale scores is the most reliable method, but it is rather long and complicated, although with a little practice the making of M-Scale scores becomes an interesting process.

The process of taking the average of the raw scores (the same marks will be assigned by taking the sum of the raw scores of each pupil) is a simple one that can be done quickly by any teacher, and will give comparatively reliable results if the tests are well constructed and carefully scored.

Recommendations

1. For the present, the practice of making composite scores from the sum of the raw scores or from the average of the raw scores is recommended to the classroom teacher.

2. In case it is difficult to decide which of two marks a student should have, give him the benefit of the doubt and give him the higher of the two marks.

A STUDY OF THE EFFECTS OF SAMPLING FISCAL DATA IN EDUCATION

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Of recent years there has been an increasing interest, among both laymen and educators, in the fiscal aspects of education. Typical among the numerous studies in the field are the investigations of the "Educational Finance Inquiry" and the numerous School Building Surveys. The close relationship between the ability to pay and the educational opportunities in a given district warrants this increased interest. Among the various "techniques" for investigation of fiscal problems may be found the "sales technique" for computing an approximate true value for the wealth of the community. It consists in finding the ratio between the real value as shown by actual property transfers and the value as placed upon it by the tax assessor. That there are wide variations among assessors in the evaluation policy has been long known. Even in states that require by law that "property shall be assessed at its true value, having regards to its quality, location, and natural advantages, the general improvements of the vicinity and all other elements of its actual value . . . . " wide divergence exists between assessed values of properties and the sale values. The writer of this article claims no credit for the "sales technique". It has been in use for years. The purpose of this article is to study the advisability of attempting to correct data showing such fictitious considerations as "for love", or for "$1.00 and other valuable considerations"; and to study the effect of sampling the data in computing the assessment ratio. Both of them have been used by school surveys with little or no attempt to defend the action. A third question that will be studied deals with the best method of computing the assessment ratio i. e. should all transfers be summed and the ratio found from the total of the assessed values and the total of the transfer values or should an assessment ratio be computed for each property transfer and a median for all be computed?

Briefly stated the "sales technique" is a device designed to show a correction for the error of evaluating the property. In the formula it is shown as follows;-

$$\frac{\text{Assessed value}}{\text{Transfer value}} \text{ equals assessment ratio. or,}$$

$$\frac{\text{Assessed value}}{\text{Assessment ratio}} \text{ equals the approximate or estimated true value.}$$

The data may be found on the tax records. In some instances an old established firm of abstractors will have the data in a form more easily obtained in their office. The collection of the data can be done by a competent clerk.

For the years 1900, 1915, 1920, 1925 used in this study the Federal Revenue Act provided that for each $500.00 there must be a $.50 revenue stamp placed upon the deed. Is it advisable to translate the apparent fictitous consideration into some value as indicated by the stamp or ti discard all such data? Again, if such a correction is attempted should all data be so translated to insure comparability or only those which look suspicious? It seems that both offer advantages and disadvantages. Recently, under the direction of Professor E. T. Peterson of the College of Education at the University of Iowa, the writer had occasion to study a problem that involved a use of the assessment ratio. From these data has been computed the following table intended to answer the question just raised. It should be read as follows;- In the year 1915 there were 131 transfers of urban property. The assessment ratio of the transfers that appeared to have true considerations was 50.5. If all were "corrected" to the midpoint of the value of the stamp the ratio was 48.7. Of the total number of transfers there were 31 that appeared to have fictitious consideration given. Correcting these 31 cases to the midpoint as shown by stamp value and using the other valid cases the ratio was 43.2

Table I

Correcting the consideration given to a probable true figure as shown by the stamp value.

Year	Group	Number cases	Ass't ratio using only cases with apparent real consid.	Correcting all cases midpoint of stamp value	Number cases showing fictitious consid.	Correcting these cases only but using others as given
1915	Urban	131	50.5	48.7	31	43.2
1915	Rural	197	47.8	69.8	49	51.7
1920	Urban	81	38.4	38.3	91	36.9
1920	Rural	206	37.8	48.8	354	44.9
1925	Urban	34	48.5	52.2	106	59.0
1925	Rural	79	60.3	63.2	76	51.3

Sampling probably always injects some error into a study. Yet, the limitation of both money and time makes sampling a common practice in educational studies. How few cases can be used and still be within the reasonable limit of error in computing an assessment ratio for a given district? Again, after the cases are sampled and transcribed from the tax records should one use each case separately or by totals as suggested above in this article? Table II attempts to answer these questions with relation to these data. The table should be read as follows;-In the year 1875 among the urban areas within the county studied there were 135 property transfers. When the assessed values and the transfers values were totaled and an assessment ratio computed it was found to be 24.3. When each property transfer was treated individually and a median of all ratios found the assessment ratio was found to be 26.4. The average of the two methods was 25.35. This table shows eight different methods of sampling for comparative purposes.

Table II

Effect of sampling and a study of the two methods of computing the assessment ratio. (Urban transfers in County)

Sampling group	Number Cases	Ass't ratio using totals	Ass't ratio median	Average of two methods
All cases	135	24.3	26.4	25.35
Odd cases	68	26.0	32.5	29.25
Even cases	67	22.5	30.8	26.65
Every 5th	27	24.5	26.2	25.35
Every 10th	13	19.9	20.5	20.20
First 15-middle 20 and last 15 cases	50	23.8	28.8	26.30
First 50	50	24.4	25.8	25.10
First 100	100	28.6	22.8	25.70
		(Rural transfers in County)		
All cases	441	40.9	44.9	42.90
Odd cases	221	41.7	41.8	41.75
Even cases	220	40.0	46.9	43.45
Every 5th	88	36.2	44.1	40.15
Every 10th	44	36.9	45.6	41.25
First 15-middle 20 last 15	50	40.1	41.2	40.65
First 50	50	40.0	42.5	41.25
First 100	100	45.7	42.9	44.30

Similar results were obtained for the years 1880, 1900, 1920 and 1925. The data are on file in the writers study, Space, however, does not warrant publishing more than one more year. Table 3 shows same as table 2 but for the year 1925. It should be read like table 2.

Table III

Same as table II except using data for 1925. (Urban)

Sampling group	Number Cases	Ass't ratio using totals	Ass't ratio median	Average of two methods
All cases	140	51.3	43.0	47.15
Odd cases	70	48.0	43.9	45.95
Even cases	70	55.8	42.9	49.35
Every 5th	28	44.0	34.9	39.45
Every 10th	14	51.2	34.9	43.15
First 15-middle 20 last 15 cases	50	60.4	34.9	47.65
First 50	50	47.6	44.9	46.25
First 100	100	46.7	42.9	45.55
			(Rural)	
All cases	155	59.0	58.6	58.80
Odd cases	78	59.5	56.7	58.10
Even cases	77	59.7	61.3	60.50
Every 5th	31	58.2	56.4	57.20
Every 10th	15	57.1	60.5	58.80
First 15-middle 20 last 15 cases	50	64.3	60.9	62.60
First 50	50	60.0	58.9	59.45
First 100	100	59.8	57.7	58.75

The only wide variation found in the other years from the trends shown above were in cases where a badly skewed distribution was found. That is when a large number of cases sampled had an assessment ratio in excess of 100. Where the sampled distribution ran within what even a casual inspection showed to be average the results were similar to these shown. An exception like the one to follow would cause the assessment ration to vary. In 1880 in sampling the first 15, middle 20, and last 15 cases, the first 15 cases contained 6 of the 10 cases in which the assessment ratio ran over 100 and three were 550.

Again in 1900 in sampling the first 50 cases 12 cases ran over 100 and two as high as 1100 and one 2600. Such cases are obviously out of harmony with general assessment policy or indicate errors in recording which cannot be explained or corrected.

In view of the above data it seems doubtful if correcting the "consideration" to some point indicated by the stamp adds any noticeable accuracy. The difference is so small that were added accuracy known to exist the added labor would render it of doubtful value. The error introduced by discarding such transfers is probably less than is inherently to be found in the technique itself.

Further the tables show that sampling can safely be followed thus reducing the time, energy and money involved materially. It would appear from the above data, that if these data are at all in line with trends elsewhere that one would be safe in sampling fifty cases from which to compute the assessment ratio. In years in which trends are known to have been skewed towards one end of the calendar it probably would be better to use the first 15 middle 20 and last 15 cases. At other times there is probably no material advantage to be had.

No noticeable variation was to be found between the two methods of computation. Time, energy and money involved would call for the computation from the total assessed valuation and total sales valuation of the first fifty cases. In the absence of any data to prove which method is most accurate, and with a known error in recording such data on the Records, the closeness of results indicate one is safe in taking the easier of the two methods.

A final suggestion to one making use of the technique would be that a good, careful clerk can secure this data and do most of the computations.

The writer feels that with the knowledge that a ratio can be computed at greater ease more of this work will be done in states not having a tax commission which furnishes such information.