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Proceedings of The Keyser Meeting (1940)

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The Seventeenth Annual Session

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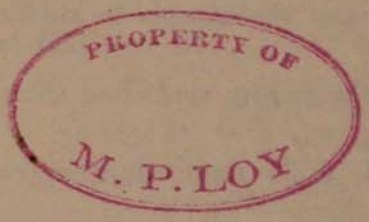

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Contents

Papers Presented to the Social Sciences Section

Papers Presented to the Symposium of West Virginia Herpetology

OFFICERS OF THE WEST VIRGINIA ACADEMY OF SCIENCE

The Officers for 1939–40

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

The Chairmen of Sections

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Chemistry	John A. Gibson, Morgantown
Geology and Mining	William A. Staab, Morgantown
Mathematics and Physics	L. H. Chambers, Keyser
Social Sciences, Group I	M. S. Cushman, Athens
Social Sciences, Group II	Frank S. White, Fairmont

The Officers for 1940–41

President	Frank S. White, Fairmont
Vice-President	Friend E. Clark, Morgantown
Secretary	J. E. Judson, Buckhannon
Treasurer	Nelle P. Ammons, Morgantown
Member of the Editorial Board	L. H. Taylor, Morgantown
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Member of the Editorial Board	J. K. Stewart, Morgantown

The Chairmen of Sections

Biology	Ivan H. Bush, Jr., Philippi
Chemistry	H. F. Rogers, Fairmont
Geology and Mining	Dana Wells, Morgantown
Mathematics and Physics	M. L. Vest, Morgantown
Social Sciences, Group I	James T. Laing, Kent, Ohio
Social Sciences, Group II	A. F. Young, Wellsburg

MEMBERS OF THE WEST VIRGINIA ACADEMY OF SCIENCE

THE LIST of members reported in Volume 13 of the *Proceedings of the West Virginia Academy of Science*, published in April, 1940, is referred to as substantially correct. New members chosen at the 1940 meeting at Keyser follow:

ACADEMY MEMBERS ELECTED IN 1940

Anson, Chas. P., prof. of social science, Roanoke College, Salem, Va.
Arnett, Henry D., Weirton; grad. student, W. V. U., Morgantown.
Boehm, E. E., chemist, Myers Clinic Hospital, Philippi.
Callendine, Wm., Bethany College, Bethany.
Cox, H. E., director, State Hygienic Laboratory, Charleston.
Elliot, John W., president, Alderson Broaddus College, Philippi.
Friedel, John E., 2020 University Ave., Morgantown; grad. student, W. V. U.
Gunnoe, Wannis, science teacher, High School, Lookout.
Hallam, Wm. A., prof. of physics and mathematics, W. Va. Wesleyan College, Buckhannon.
Hamrick, Clarence R., prof. of education, West Liberty State Teachers College, West Liberty.
Hamrick, Randall B., assoc. prof. of philosophy and economics, W. Va. Wesleyan College, Buckhannon.
Hart, E. Ross, instr. in pharmacology, W. V. U., Morgantown.
Haught, Thos. W., prof. of geology and geography, W. Va. Wesleyan College, Buckhannon.
Hinchey, Larry, student, W. Va. Wesleyan College, Buckhannon.
Kellam, Wm. P., librarian, W. V. U., Morgantown.
Lafferty, Rob't. C., Box 1375, Charleston; Libbey-Owens gas dept.
Levy, Albert G. D., instr. in modern languages, Davis and Elkins College, Elkins.
Llewellyn, Leonard M., grad. student, Virginia Polytechnic Institute, Blacksburg, Va.
Long, W. L., Central Scientific Co., Chicago, Ill.
MacLachlan, Percival L., asst. prof. of biochemistry, W. V. U., Morgantown.
Marten, Eldor A., assoc. prof. of bacteriology, W. V. U., Morgantown.
McDaniel, L. S., prof. of education and psychology, Morris Harvey College, Charleston.
McGraw, Claude, biology teacher, High School, Lookout.
Medendorp, Alfred, 5235 Ravenswood Ave., Chicago, Ill.; Denoyer-Geppert Co.
Sharp, Roland P., teacher, elementary school, Frost.
Shawkey, Morris P., business manager and prof. of history, Morris Harvey College, Charleston.
Shreve, H. I., instr. in biology, High School, Martinsburg.
Stewart, Lincoln S., prof. of geology, Potomac State School, Keyser.
Thomas, Chas. D., asst. prof. of physics, W. V. U., Morgantown.
Van den Brink, J. J., prof. of geography, Morris Harvey College, Charleston.
Vaught, Gerald G., instr. in mathematics, High School, Charleston.
Walter, John T., assoc. prof. of business administration, West Liberty State Teachers College, West Liberty.
Wilson, L. Wayne, Moorefield; grad. student, W. V. U., Morgantown.
Wiseman, Loren R., teacher of mathematics, High School, Lookout.
Woolley, Mildred T., consulting serologist, State Hygienic Laboratory, Charleston.
Worick, N. F., Chicago Apparatus Co., Chicago, Ill.

The Minutes of the Seventeenth Annual Meeting

THE SEVENTEENTH ANNUAL MEETING of the West Virginia Academy of Science was called to order by President A. M. Reese at 10:00 a.m. on May 3, 1940, in the auditorium at Potomac State School of West Virginia University, Keyser.

The president reported briefly on the activities of the Academy during the past year. He called attention to the fact that the gavel used to call the meeting to order was made from the Mingo white oak.

The secretary read the following report of the Executive Committee:

THE EXECUTIVE COMMITTEE REPORT

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

(1) Invitations have been received from West Virginia Wesleyan College, Bethany College, and Alderson-Broaddus College for the 1941 meeting to be held on their respective campuses.

(2) The Executive Committee recommends that the 1941 meeting be held at Alderson-Broaddus College on the last Friday and Saturday in April.

(3) The Executive Committee recommends that hereafter the places of meeting of the Academy follow the sequence established during the past ten years, except that, when a college that has not been host extends an invitation for the meeting, that institution may be given preference. Thereafter the sequence is to be followed.

(4) The Executive Committee recommends that:
   (a) Mr. Jack Neely be senior sponsor, Miss Myrtle Miller be junior sponsor, and Mr. Wallace Smith be continued as treasurer for the Junior Academy of Science.
   (b) That $20 be given the Junior Academy by the Senior Academy for the publication of their News Letter for next year.
   (c) That a merit certificate be awarded to each high school making a definite contribution to the annual program of the Junior Academy.
   (d) That $2 be appropriated for printing the certificates.

(5) The Executive Committee recommends that the Legislative Committee consult with Mrs. G. P. Boomsliter of Morgantown concerning legislation in regard to sterilization.

(6) The Executive Committee recommends that a committee be appointed to study the subject of awards for the most outstanding paper to be read at the Academy next year.

(7) The Executive Committee recommends that an amendment be made to Article 6, Section 2 of the Constitution.

The report was accepted.

Because of a rule made by West Virginia University authorities, it was deemed necessary to propose the following amendment to the Constitution:

Article 6, Section 2, of the Constitution be amended so as to read: A Committee on Publications consisting of the president, the secretary, and an Editorial Board composed of three or more members chosen for a period of three years by the Executive Committee.

The amendment was adopted.

The following Legislative Committee Report was read:

THE LEGISLATIVE COMMITTEE REPORT

The Legislative Committee recommends that the West Virginia Academy of Science favor, recommend, and foster the following legislation:

(1) That we continue our efforts to have the Legislature pass the "Sterilization Law" reported in the latest PROCEEDINGS of the Academy.
(2) That we recommend that a suitable building be erected to house the State Department of Public Health. The activities of this department are growing rapidly in importance. Buildings for housing this work are very inadequate.
(3) That we recommend a legislative appropriation of $750 to be used for printing scientific monographs setting forth the results of scientific research.

We further recommend that the members of this organization "sell the recommendations" adopted by this body to the candidates for legislative offices to be elected in the forthcoming election.

(signed) A. J. DADISMAN
WALLACE SMITH
J. E. JUDSON

The report was accepted.

Dr. Earl Core reported for the Activities Committee as follows:

THE REPORT OF THE ACTIVITIES COMMITTEE

Continuing the work suggested in the 1939 report of the Activities Committee, your committee during the 1939–40 period has prepared a list of speakers who have indicated their willingness to deliver addresses before Junior Academy chapters. This list has been forwarded to the editor of the Junior News Letter for publication in that periodical. It has been our purpose to have this list include speakers representing so far as possible every region of the State in order that the item of expense to the Junior Chapters may be reduced or eliminated. This purpose has not been completely realized, because the response to our questionnaire has been by no means complete. We recommend that this work be continued by the new committee and a complete list be supplied to the Junior Academies. A list of 16-mm. sound films available at the University Film Library for loan to high-school organizations is also being prepared.

A second recommendation of the 1938–39 committee was that the Academy sponsor the publication of popular scientific treatises or technical monographs of more or less general interest. This suggestion was approved by the Academy, but no action was taken concerning the release of funds for the project. In order to place a definite proposal before the Academy, your committee is submitting to the Academy the manuscript of a projected semipopular, illustrated guide to the orchids of West Virginia, prepared by Mr. Maurice Brooks, chairman of the State Biological Survey, who has been collecting information and photographs of our native orchids for many years. It is estimated that the cost of publishing

this manuscript will be approximately $250, and the management of the Southern Appalachian Botanical Club has offered to assume half the cost, the paper to be published as a number of Castanea and separately printed as Memoir No. 1 of the West Virginia Academy of Science, to be distributed free or not as the Academy determines, and the size of the issue likewise to be determined by the Academy. It is also understood that the total cost of the publication will depend upon the number of copies to be issued, the estimate being based upon 1000 copies, 500 copies for each participating agency. It is likewise understood that approval of this report does not imply approval of this project, which is being presented separately to another session of this meeting.

A great deal of discussion has been provoked throughout the past year by the unusual delay in the publication of the 1938 PROCEEDINGS, which finally appeared in January 1940, 20 months after the meeting at which the papers were presented. The general opinion has been that not only the value of the papers is greatly lessened by such delays, but the standard of articles submitted for publication will constantly become lower.

Your Activities Committee, therefore, became interested in a study of the causes for the delay in the publication of the PROCEEDINGS with a view toward eliminating them as far as possible and working out a more satisfactory schedule. The two principal causes in the delay of the past two PROCEEDINGS were found to be in the length of time required for the work of the Editorial Board and in unfortunate selection of printer. The 1938 issue did not pass the Editorial Board until about November 1938 and, in the interest of economy, was delivered in January 1939 to the printing department of the Industrial School for Boys. Exactly twelve months' time was required for the production of the volume. The 1939 volume did not pass the Editorial Board until near the end of the summer, and publication was not begun until January 1940, when the printer was stocked with work and several weeks behind schedule.

Working with Mr. Gerald Jenny, University editor and editor, therefore, of the PROCEEDINGS, your committee has worked out the following schedule, which should bring the PROCEEDINGS from the press early in the fall term:

(1) Papers should be delivered to section chairmen immediately upon presentation, turned over to the University editor, and by him passed on to the Editorial Board.
(2) The work of the Editorial Board might very reasonably be expected to be completed by June 1.
(3) The work of the University editor requires about one month and should be completed by July 1.
(4) This year competitive bidding can be expected to demand about one more month, but after a satisfactory publisher has once been selected, bidding should be eliminated and this time saved.
(5) Production of the work might reasonably be expected to be completed in about two months, provided the printer had no previous commitments to delay the work. If the same printer is given the contract each year, he might be prepared to begin operations quickly. Also, if the manuscript reached the printer during the summer, normally a slack season with printers, it might be expected to go through more quickly than at the middle of the school year.

Adherence to this schedule would result in placing the PROCEEDINGS in the hands of the members in September, at the opening of the fall term,

which is as early as most members would be able to examine them and which compares very favorably with the length of time required for an article submitted to a national scientific periodical to appear in print. This schedule, coupled with the constantly increasing breadth of dissemination of the PROCEEDINGS in exchange for similar publications, should tend to make the publication definitely of more value to the scientific world.

Respectfully submitted,

Z. R. KNOTTS
GEORGE R. HUNT
EARL L. CORE, *chairman*

The report was accepted.

Dr. P. D. Strausbaugh distributed copies of a seven-page report to each member present. A brief of this report follows:

THE 1939 ACADEMY CONFERENCE

The Academy Conference convened for its thirteenth annual session in the Wallick suite of the Deshler-Wallick Hotel in Columbus, Ohio, at 3:00 p.m., December 27, 1939. Delegates were present from 19 of the 33 affiliated academies.

The Conference program included:

(1) A report of the Sub-committee appointed to confer with the American Institute on Problems of the Junior Academy, by H. E. Enders, Indiana Academy of Science.
(2) A report on:
  (a) The usefulness of the research grants of the American Association for the Academy of Science in retrospect and prospect.
  (b) The question "On what basis should Junior A. A. A. S. membership awards be made?" by E. F. Faust, New Orleans Academy of Science.
(3) A discussion, "Can the Academy serve as a unifying agent for the various scientific organizations of the state?" by P. D. Strausbaugh, West Virginia Academy of Science.
(4) A discussion, "The organization of a state Academy of Science, by J. C. Gilman, Iowa Academy of Science.

There followed a lively discussion of the papers presented, with maximum interest in the Junior Academy and in the research grants. It is evident that the officers of the Executive Committee of the A. A. A. S. are not fully satisfied with the way in which these grants are awarded. It is also evident that a number of the state academies are very careless in reporting the results obtained by those to whom awards have been made. Although this year one hour was added, the time allotted for the program of the Conference was much too short to permit full and free discussion of the various questions introduced. By general assent, this was voted the most spirited and the most interesting of the Academy Conference meetings up to the present time. A more detailed report of this meeting has been submitted, in mimeographed form, to each member of the West Virginia Academy of Science.

Immediately following the Conference program, a dinner tendered by the A. A. A. S. was served to the official delegates of the affiliated acad-

emies and other members of the Academy Conference. The delegate from the West Virginia Academy of Science was elected vice-president of the Academy Conference.

P. D. STRAUSBAUGH,
Delegate from the West Virginia
Academy of Science.

The report was accepted.

The A. A. A. S. Grant report was then read.

THE A. A. A. S. GRANT

Part I

Your committee desires to submit the following report and recommendation:

That the award of $50 for the coming year be made to L. W. Wilson and J. E. Friedel of West Virginia University for the following program of research:

1. Collection: gathering of mammals from various parts of the state, and preparation of study skins which are to be deposited in the West Virginia University Museum.
2. Assembling and interpretation of data: under this heading are included comparative measurements, weight comparisons, and differences in pelage as to texture and color. Emphasis will be placed on altitude records and behavior notes when available. The contribution of weight comparison notes is especially desirable, since so little of this has been done.
3. Maps: preparation of maps showing distribution by counties and places of collection.

It is understood that the work on this project will be carried out under the direction of Prof. Maurice Brooks, of West Virginia University, chairman of the West Virginia Biological Survey.

Two other meritorious applications were presented for the consideration of the committee.

Part II

Your committee further offers for your consideration the following recommendations to assist in the award of future grants:

(1) The following types of research projects will receive primary consideration:
  (a) Those projects which tie-in most closely with the scientific problems of the state of West Virginia.
  (b) Those projects for which there seems to be less possibility of support from other sources or foundations.

(2) In the awarding of grants, applications from members of the Academy shall receive first consideration.

(3) It is understood that the recipient or recipients of such grants shall match the amount of the award by an equal amount from other sources such as institutional support, support from other foundations, or personal support. It is understood that time spent by individuals on a project shall not be considered as equivalent for the stipulation relating to support from other sources already mentioned in this section.

(4) It is understood that the recipient or recipients of the award shall make a complete report on the work done, first to the American Association for the Advancement of Science and second to the West Virginia Academy of Science for publication in its PROCEEDINGS. The report to the Academy

shall be made at its next annual meeting, and in case of publication elsewhere, acknowledgment of the assistance afforded by such grant shall be made in connection with such publication.

(5) All applications for grants must be in the hands of the chairman of the Committee on A. A. A. S. Grants 60 days before the annual meeting of the West Virginia Academy of Science.

(6) All awards will be made by the Academy at its annual meeting.

Respectfully submitted,
J. E. JUDSON
R. B. DUSTMAN
B. R. WEIMER, *chairman*

The report was accepted.

The Fred E. Brooks Memorial Arboretum Committee report was read:

THE REPORT OF THE F. E. BROOKS MEMORIAL ARBORETUM COMMITTEE

Since our latest report the following improvements and additions have been carried out in the arboretum.

(1) 27 single rest benches put in along the trails.
(2) 3 group benches added with seating capacity for 12 to 15.
(3) 1 permanent trail shelter near the center of the arboretum to accommodate 50 people. N. E. S. W. marker on top.
(4) 7 or more miles of foot trails completed.
(5) 500 ft. above Island Lick Run a new footbridge crossing Two Mile Run.
(6) Leading to arborteum from Seebert, 4 permanent stone-abutment concrete-slab bridges.
(7) An entrance to arboretum latrines has been built.
(8) Some new plants have been introduced by Mr. Neese.
(9) 96 trees and shrubs checked by Mr. Neese.
(10) Plantings have been made on the abutments of footbridges.
(11) Drinking water has been analyzed and found safe.
(12) 115 markers for plants have been purchased.

Proposed Improvements

(1) Permanent marking of plants in arboretum.
(2) Direction signs on the trails.
(3) Small bypaths leading to rare species.
(4) Erection of drinking fountains along trails.
(5) Introducing new species from West Virginia not at present in the arboretum.
(6) Major Shawhan suggests removing dead and unsightly plants along the trails.
(7) Build checkdams in streams to hold trout.

Other Activities Pertaining to the Arboretum

(1) During the summer of 1939 at least 2000 people visited the arboretum.
(2) 28 states were represented by tourists visiting the arboretum, as well as British Columbia, Ontario, and other Canadian provinces.
(3) There were 165 from the Charleston Garden Club.
(4) Girl Scout troops from Elkins visited.
(5) The ladies' clubs from Lewisburg were there.
(6) The American Forestry Association (130 in party).
(7) Deer, turkeys, grouse, beaver, and other animals were present.

P. D. STRAUSBAUGH
S. R. NEESE
E. MEADE MCNEILL, *chairman*

The report was adopted.

Comments were made by Dr. P. D. Strausbaugh in which he pointed out that the above committee concerned the F. E. Brooks Memorial Arboretum, not the F. E. Brooks Garden Club.

Professor Wallace Smith gave an oral report for the Junior Academy of Science. He stated facts concerning the Junior branch in order to acquaint the Senior Academy members of the work of this organization. He pointed out that four schools were applying for membership, and that one of the big jobs was to get more chapters in the State. Professor Smith called attention to the report of Mrs. Anna Sneed at the A. A. A. S. meeting at Columbus, where she reported that 17 states had Junior Academies, that Kentucky, Indiana, Missouri, Virginia, and West Virginia had perhaps the outstanding Junior Academies. It was pointed out that the State Band Festival interfered with attendance at the Junior Academy.

The report was accepted.

President Reese called attention to the Eighth Congress of Science meeting to be held in Washington, D. C., and invited Academy members to be present.

President Reese then appointed the following committees:

Nominations:	G. S. Dodds
	Wallace Smith
	Frank Cutright
Resolutions:	Frank Gilbert
	Elizabeth Stalnaker
	H. I. Shreve
Auditing:	C. N. Reynolds
	H. A. Davis
	R. C. Patterson

Dr. C. G. Brouzas, treasurer, read a list of 29 applicants for membership in the Academy. The list was approved.

President Church of Potomac State School gave the address of welcome, in which he offered all of the facilities of the school. Vice-President Frank White took charge and introduced President A. M. Reese, who gave the main address of the morning, "Predation." Eighty-five members were present.

Beginning at 1:30 p.m. the various sections held their meetings. The regular meeting of the Biological Survey Committee was held after the meeting of the biology section. The Academy papers are listed in the program included elsewhere* in these PROCEEDINGS. A Science Exposition was held in the library, which included commercial exhibits as well as those of individual Academy members and of Junior Academy members. This exhibit was open during the two days of the Academy meeting, but special demonstrations for Academy members and townspeople were given from 4:00 to 6:00 p.m. on Friday.

A Symposium of West Virginia's Herpetology was held from 3:00 to 4:30 p.m.

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* See page 18.

At 6:15 p.m. the annual banquet took place in the Men's Hall.

The principal address of the evening was delivered by S. O. Mast of Johns Hopkins University. His subject was "Color in plants and animals."

After his address, the members and guests were entertained at an informal reception in the Woman's Hall, sponsored by Potomac State School of West Virginia University.

The second business meeting was held on Saturday morning, May 4, in the auditorium. The following State Biological Survey Committee report was read:

THE REPORT OF THE WEST VIRGINIA BIOLOGICAL SURVEY COMMITTEE

Your committee on the West Virginia Biological Survey offers the following report:

At the latest (Charleston) meeting of the Academy the report of this committee was largely concerned with a project for furthering the work of the Survey by means of a grant from the Works Progress Administration. The status of this project should be cleared up at the present time.

Under the sponsorship of a committee consisting of President Reese, Dr. P. D. Strausbaugh, Dr. Leland Taylor, Dr. Earl Core, and your chairman, applications for a grant were prepared and filed with the district and the Charleston offices of the Works Progress Administration. In the early stages of progress we received considerable encouragement, but word reached us presently from Charleston that difficulties had arisen. President Reese made contact with persons in the Charleston office, and the sponsoring committee met with a representative of the state office. His statement was that there were three principal (and, he believed, insuperable) objections to the program as proposed, namely:

(1) He did not believe that enough persons who could be certified for relief could be found to do the semitechnical work of collecting and preserving specimens in the several counties.

(2) He believed that difficulties of administration were insurmountable.

(3) He saw no means for the transportation of workers within the counties, since persons other than those actually employed on a given project are forbidden transportation on W. P. A. trucks.

The sponsoring committee recognizes the validity of these objections. We were told, however, that should it be possible to set up a project to employ from ten to 25 persons at West Virginia University (or some other point in the State), consideration would be given to a new application for funds. The sponsoring committee sees no present opportunity for setting up such a project at Morgantown, because of insufficient space for such a working force, but it gladly passes on the suggestion to any of the State's other institutions which might be interested in such a project.

A major advance in the work of classifying the collections of the Survey has been made during the past year. Prof. Bayard Green, of Marshall College, has undertaken the classification and arrangement of the extensive herpetological collections which have been made by Neil Richmond and others. He tells me that he expects to have at least 3000 specimens in the collections by the end of the year and that he believes the collection, in usefulness, will compare favorably with those of other state biological surveys.

Dr. Core states that botanical specimens have continued to arrive in gratifying numbers and that practically all available space in the University herbarium is now occupied.

Application has been made at this meeting for a grant from the A. A. A. S. funds of the Academy for the benefit of the Survey. The funds (if granted) will allow two collectors, Mr. L. Wayne Wilson and Mr. John Friedel, to spend a part of the summer in trapping and preserving small mammals. The work is planned to include collections from the southwestern counties of the State and should assist in clearing up some of the puzzles of races in that region.

An interesting enterprise, involving younger persons with biological leanings, has appeared within the past year. Under the editorship of Mr. William C. Legg, of Mount Lookout, West Virginia, an attractive monthly journal of bird studies, "Field Ornithology," has been started. It appeals to boys and girls interested in bird life and it has already published a number of notes of value from West Virginia.

Your committee feels that it should call to the special attention of the Academy a recent biological discovery of extraordinary interest to West Virginians as well as to zoologists in general. Reference is made to the recent discovery and description of *Dendroica potomac*, Sutton's Warbler, a bird new to science, found by Karl Haller and J. L. Poland and described by Haller from Jefferson County, West Virginia. This is the first new bird species to be described from continental United States since 1918, and no less an authority than Dr. Frank M. Chapman had predicted that no new species would ever again be described within this country. *This new warbler is the first bird species to be described from West Virginia.*

Within the present year a splendid manual of the liverworts of West Virginia, prepared by Miss Nelle Ammons, has been published, adding greatly to our literature pertaining to this group of plants.

And so we feel that, year by year, the biological picture in West Virginia becomes clearer in some of its details, and that steady and substantial progress is being made.

Respectfully submitted,
MAURICE BROOKS, *chairman*
ROBERT C. PATTERSON, *secretary*

The report was accepted.

The treasurer, C. G. Brouzas, reported the condition of the Academy finances and added eight more applicants to the list to be voted upon. The report was accepted and the new members were voted in. The total number of members taken in was 37.

The following report of the Executive Committee was read:

THE EXECUTIVE COMMITTEE REPORT

(1) Recommends that the outgoing president expedite the publication of the PROCEEDINGS by making certain that the schedule is maintained in such a way that by the first of June or soon thereafter the manuscripts are ready

for the printer. This will save money in bids by taking advantage of most printers' slack summer season.

(2) Recommends that the Academy subsidize the proposed monograph on West Virginia orchids, to be published jointly by the West Virginia Academy of Science and *Castanea*, the Journal of the Southern Appalachian Botanical Club, which will cost $250, to be shared equally by both organizations. The manuscript will be published as an issue of *Castanea* and printed separately as an Academy monograph. The estimated cost is based on 500 copies for each participating agency. The monographs are to be sold at 25¢ a copy and the proceeds are to go to the Academy Treasury.

(3) Recommends that the secretary be empowered to send out a letter following this meeting.

(4) Recommends that $2.50 be appropriated to purchase labels for the Biological Survey.

(5) Recommends that $50 be allotted to the F. E. Brooks Memorial Arboretum Committee.

Discussion arose over the fact that the report called for an expenditure of $177.50. Dr. Davis pointed out that this Executive Committee was rapidly running the Academy finances in the red. He stated that the expenditures exceeded the income and would soon use up the reserve in the Academy treasury. Dr. Winter called attention to the fact that all money was to be expended in the Biology section.

It was moved and seconded that the two items concerning the Arboretum and *Castanea* be postponed until next year.

The motion was lost.

It was moved to adopt the original report.

The motion carried and the report was adopted.

The Auditing Committee reported:

THE AUDITING COMMITTEE REPORT

The accounts of the West Virginia Academy of Science were audited on May 4, 1940, and were found in order.

C. N. REYNOLDS
H. A. DAVIS
R. C. PATTERSON

The report was accepted.

The Resolutions Committee made the following report:

THE RESOLUTIONS COMMITTEE REPORT

Resolved: That the West Virginia Academy of Science express the deepest appreciation to the Potomac State College and the local committee for the accommodations and cordial reception received.

That we regret the absence of the Geology and Mining Section and express the hope that they will be with the Academy in the future.

F. A. GILBERT
H. I. SHREVE
ELIZABETH M. STALNAKER

The report was accepted.

The Section Chairmen reported as follows:

Biology, 50 present, W. J. Sumpstine, chairman; for 1941, Ivan C. Bush.

Chemistry, 30 present, John A. Gibson, chairman; for 1941, H. F. Rogers.

Geology (meeting held at Charleston), 8 present, Wm. A. Staab, chairman; for 1941, Dana Wells.

Mathematics and Physics, 18 present, L. H. Chambers, chairman; for 1941, M. L. Vest.

Social Sciences, Group I, 21 present, M. S. Cushman, chairman; for 1941, J. T. Laing.

Social Sciences, Group II, 20 present, Frank S. White, chairman; for 1941, A. F. Young.

Chairman G. S. Dodds reported for the Nominations Committee:

THE NOMINATIONS COMMITTEE REPORT

Your committee recommends that the following members be elected to serve as officers for the coming year:

President.....Frank S. White
Vice-President.....Friend E. Clark
Secretary.....J. E. Judson
Treasurer.....Nelle P. Ammons

The report was accepted, and the secretary was instructed to cast the ballot of the Academy for these members.

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

Legislative: Wallace Smith, H. O. VanTromp, A. C. Blackwell, A. J. Dadisman, J. E. Judson.

Junior Academy: Jack Neely, Myrtle Miller, Wallace Smith.

Membership: A. C. Blackwell, Robert Patterson, E. Meade McNeill, H. F. Rogers, Frank Gilbert, J. E. Judson.

Activities: Earl Core, Z. R. Knotts, George R. Hunt.

F. E. Brooks Memorial Arboretum: E. Meade McNeill, S. E. Neese, P. D. Strausbaugh.

A. A. A. S. Grant: B. R. Weimer, R. B. Dustman, H. A. Davis.

State Biological Survey: Maurice Brooks, chairman, R. C. Patterson, secretary, J. E. Judson, S. B. Talbot, H. D. Bond, B. R. Weimer, C. M. Roberts, E. R. Grose, E. Meade McNeill, L. M. Peairs, A. P. Handlan, A. B. Brooks, Earl Core, Ivan C. Bush, P. J. Zucchero.

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

It was moved and seconded that the Junior and the Senior Academies would meet during the last week in April, 1941.

Retiring President Reese then introduced the new president, who spoke briefly.

The meeting adjourned. Excursions were made to the following places: West Virginia Pulp and Paper Company; Celanese Corporation of America.

One hundred members were registered in attendance during the meetings.

THE GENERAL PROGRAM OF THE KEYSER MEETING

FRIDAY, MAY 3, 1940

The address of welcome by President E. E. Church of Potomac State School of West Virginia University. The reply by Academy President A. M. Reese. The presidential address by Professor Reese: "Predator Control."

THE MEETINGS BY SECTIONS

Biology

(Botany, Zoology, Medicine, Agriculture)

B. R. Weimer and W. J. Sumpstine: A mastodon from Brooke County.

E. L. Core: The shale barren flora of West Virginia (illustrated).

G. S. Dodds: A human fetus with an unusual anomaly of the cervical and thoracic vertebrae (illustrated).

Don Ritchie: Fixation images in *Russula emetica.*

Larry Hinchey: A simplified apparatus for growing anaerobes.

Mildred T. Woolley: Evaluation studies on syphilis serological procedures.

V. G. Lilly and L. H. Leonian: The influence of cocarboxylase and the moieties of thiamin on the rate of growth of some fungi.

N. B. Green: The behavior of *Pseudacris brachyphona.*

C. C. Fenton: The laboratory diagnosis of appendicitis.

F. A. Gilbert: The *Coreopsis major* complex in Cabell County (illustrated).

A. S. Margolin: The carbohydrate requirements of *Diplodia macrospora.*

Chemistry

Gordon A. Bergy: A series of vinylite dermants.

Gordon A. Bergy: Methyl cellulose in pharmaceutical procedure.

C. B. Wagner, C. L. Lazzell, and A. R. Collett: Reaction of alkyl oxides with phosgene.

A. H. VanLandingham, Charles E. Weakley, Jr., and E. N. Moore: Changes in the chemical composition of milk associated with mastitis in dairy cattle.

J. R. Anderson and Hubert Hill: Problems in the preparation of samples for students of quantitative analysis.

E. Ross Hart: Physiological effects of certain allyl compounds and their propyl analogs.

G. A. Emerson: Pharmacological effects of two new sulfhydril substituted imidazoles.

G. A. Emerson: Toxic and depressor effects of chaulmoogryl choline.

P. L. MacLachlan: Effects of arsphenamine on liver lipids of rabbits.

Earl C. H. Davies and John N. Tully: The influence of moisture on the sorption of methane gas by some West Virginia coals.

Geology and Mining

(The Geology and Mining sections met at Charleston in joint session with the Appalachian Geological Society, the Oil and Gas section of the Engineers Society of Western Pennsylvania, and the Oil and Gas Men's Club of Clarksburg.)

Mathematics and Physics

R. C. Colwell, J. K. Stewart, and H. D. Arnett: The vibration of circular plates.

H. A. Davis and Amos Black: A birational transformation belonging to the complex of secants of the twisted cubic.

A. B. Cunningham: A birational T_7 associated with the ruled cubic.

H. A. Davis and A. B. Cunningham: A birational T_9^6 associated with the twisted cubic.

M. L. Vest: A birational transformation associated with a rational space C_n.

J. S. V. Allen and William Callendine: Spectroscopic problems.

Social Sciences, Group I

(Philosophy, Philology, Economics, History, Sociology)

C. G. Brouzas: The complexion of Sappho and the meaning of ἰόπλοκος.

Albert G. D. Levy: Mare Nostrum—the political importance of the Mediterranean area.

C. C. Regier: Rural life in South Russia, 1870.

A. J. Dadisman: The Cumberland—Shenandoah Fruit Conference, an adventure in cooperative regional research.

Charles P. Anson: The United Mine Workers in West Virginia.

Social Sciences, Group II

(Education, Psychology)

Elizabeth Stalnaker: A four-year study of the academic records of the Freshman class of 1935 at West Virginia University.

Roy C. Woods: A study of the ability of college students to remember objective test items.

John E. Winter: The relation of experimental psychology to the physical and biological sciences.

Andrew Leitch: The growth of psychology in the curriculum of a liberal arts college from 1840 to 1940.

Charles A. Drake: Experimental determination of new human individual differences.

Richard E. Hyde: Current fallacies in educational investigations.

Frank S. White: Course titles in education and psychology in the curricular offerings of teachers colleges (read by title).

W. W. Trent: Qualifications of teachers in West Virginia.

Symposium of West Virginia Herpetology

M. G. Netting: *Clemmys guttata*, an addition to the turtle fauna of West Virginia.

M. G. Netting: A revised list of the amphibians and reptiles of West Virginia.

N. B. Green: The West Virginia Biological Survey collection in herpetology.

Papers Read at the Keyser Meeting

Predator Control*

ALBERT M. REESE
Department of Zoology, West Virginia University

AT THE OUTSET let me say that I am not a sportsman. With the possible exception of fishing, I have never indulged in the killing of animals for pleasure. The more I realize the mystery of life, the less inclined I feel to destroy it without purpose. Some fifteen years ago Henry Salt edited a collection of essays which he called "Killing for Sport," which I wish all sportsmen might read. In the preface to this little volume Bernard Shaw says, "The reason I have no patience with Colonel Roosevelt's tedious string of rhinoceros murders in South Africa is not that I am not interested in weapons, in marksmanship, and in killing, but because my interest in life and creation is still greater than my interest in death and destruction, and because I have sufficient fellow feeling with a rhinoceros to think it is a frightful thing that it should be killed for fun."

Few sportsmen would rationalize their love for killing to the extent of the old English verse:

> "Happy the hounds loud-baying on his track!
> Happy the huntsmen with their murderous call!
> But the spent fox, dead-beat before the pack—
> His are the sweetest, strangest joys of all."

It is the attitude of many, but by no means all, of the sportsmen and of many persons financially interested in the sale of arms and ammunition that is largely responsible for the much-discussed question of predator control, or "vermin" campaigns.

Some of my friends may think I have already spoken and written enough against "vermin" destruction, but I believe it to be a worthy cause and I can't resist this opportunity.

There are several conservation agencies that have been hammering, with more or less vigor, at the abuse of predator control. The Audubon Society and the United States Bureau of Biological Survey, both of which have received some criticism, are known to all. There are two others that deserve the support of all true conservationists for the perfectly fearless way, without political restraint, in which they go after conservation mistakes and abuses. They are: *Nature Magazine*, published monthly in Washington, D. C., and the Emergency Conservation Committee, headed by Mr. C. N. Edge, 734 Lexington Avenue, New York City.

In this paper we shall be concerned only with the conservation of animal life.

While firearms in the hands of man have been the chief cause of the diminution in our animal population, there are other causes, not so serious or so obvious, that are more important than is generally realized. Among

* The address of the Society's president.

these causes the destruction of breeding and hiding places is of great importance. The drainage of swamps, which frequently produces land of little or no value, destroys the breeding places of countless waterfowl, while the cleaning up of fence-rows and field corners leaves many small birds and mammals without breeding places. Wandering house cats destroy millions of birds, and the loss of sheep and various wild animals by dogs is often blamed on coyotes and foxes, just as the destruction of poultry by rats is laid to the credit of minks, weasels, or skunks. The grazing of extensive ranges by domestic sheep and cattle is starving the deer and elk that formerly depended upon those ranges for their food. Forest fires take their toll, and speeding automobiles kill more animals than is generally realized. Even poisonous snakes, in some regions, kill a considerable number of the higher animals. The parasites of wild animals, about which not a great deal is known, destroy some animals directly or cause them to be easy prey to their natural enemies. Floods, extremes of temperature, excessive snowfall, all are sporadic causes of death to various forms of wildlife. A surprising number of waterfowl are killed by lead-poisoning from eating lead shot. Waterfowl have been killed in large numbers by waste petroleum on the surface of water.

Wild animals, like all others, are subject to various diseases which may become epidemic and destroy their victims in large numbers. It is thought by some that some such epidemic may have been partly responsible for the extinction of the passenger pigeon.

With all these dangers to combat it is seldom that a species becomes extinct without the direct intervention of man and his efficient implements of destruction. Much of this destruction is for pecuniary gain; much is purely for sport. It is estimated that 10,000,000 hunting licenses are issued each year in the United States, with an expenditure by these hunters of $650,000,000. Of this huge sum a large portion is directly derived from the license fees, and herein lies one of the conservation difficulties, for it is largely by these fees that the conservation commissions are supported. Since the sportsmen supply the cash it is often difficult for the commissions to put into effect measures of conservation to which ignorant or selfish sportsmen and dealers in sportsmen's supplies are opposed.

Opposed to these 10,000,000 sportsmen are other millions of us who enjoy living animals. That these non-killers are financially worthy of consideration is shown by the fact that a certain county in Wisconsin, where some 3,000 deer had been killed annually, forbade all killing because the citizens considered that the deer were worth much more alive, as an attraction to tourists, who spent more money than did the sportsmen.

Besides the large numbers of small animals that are being slaughtered, there is a much smaller number of more interesting and impressive animals that may be extinguished easily if the present rate of destruction is continued. One of these is killed purely for sport, as it is seldom accused of being harmful to man in any way. It is the Alaskan Brown Bear, the largest living land carnivore in the world. This magnificent but apparently unaggressive animal may stand eight feet in height and weigh 1500 pounds. Imagine killing such an animal for sport!

One of the most impressive of all birds is the Bald Eagle, adopted as our national emblem by an Act of Congress on June 20, 1782. In spite of all that is said to the contrary the Bald Eagle does little or no harm, as it

is largely a scavenger, being especially prone to eat dead fish. Since it is thought than an eagle can lift an object of about its own weight, from eight to eleven pounds, it is obvious that reports of its carrying away boys and girls are false. It is probable that many lambs reported killed by the Golden Eagle have been killed by dogs; an eagle seen feasting on the lamb may have been finishing what the dogs began. Eagles are protected by law in five states (not in West Virginia) and by provision in 21, but in Alaska, they not only are not protected, but there is a bounty of one dollar per head. In ten years 67,778 Bald Eagles were killed there. The status of the Golden Eagle is not so certain, but it is considered by many to be more beneficial than harmful. A San Francisco paper at one time carried the advertisement of an aviator who took up sportsmen in his plane to shoot Golden Eagles from the air. Little chance of escape had the eagles! The Bald Eagle is protected in California, but an observer claimed that the five eagles he saw shot were all of the bald variety. This is another case of a protected species being killed for an unprotected one. Another group of predators where the innocent suffer for the guilty is the hawks. Although in the popular mind all hawks, especially the larger ones, are destructive to fowls and game birds, the fact is gaining more general acceptance that most of the hawks are much more beneficial than harmful. In line with this idea the sponsors of some campaigns for the destruction of "vermin" now list specific hawks for the killing of which credit will be given. This looks well on paper, but really accomplishes little or nothing since practically no sportsmen, to say nothing of the general public, know one hawk from another, especially at a distance or on the wing. To prove this contention Dr. A. J. Dadisman and the writer, on one occasion, and Dr. Dadisman alone on one or two other occasions, gave the following test to groups of high-grade sportsmen: several mounted hawks, of the commoner species, were numbered and placed in a row on a table. The sportsmen present were asked to examine the hawks and name them by number. In one case eleven sportsmen were asked to name seven hawks. Of the eleven men five failed to name a single hawk correctly; one hunter named five of the seven birds; two named three; two named two; and one named one bird. The other tests gave similar results. It is obvious that a hunter who could not recognize a "bird in the hand" would not be able to recognize it "in the bush." In some cases only the feet of hawks and owls have to be brought in, which makes identification almost impossible. The establishing of the first hawk sanctuary at Hawk Mountain in eastern Pennsylvania, by the Emergency Conservation Committee, was a master stroke of conservation.

Extensive studies of the food of many of the mammalian predators, weasels, skunks, foxes, and coyotes have shown that these animals in many if not most cases are more beneficial than harmful. Where an individual predator becomes obnoxious it should be eliminated, just as we try to eliminate human "public enemies," but if all of us who have been guilty of an occasional anti-social act were eliminated, the human population would practically be exterminated.

The popular and greatly exaggerated idea of the destruction of useful animals by the predators extends back to the early game preserves of Europe, where game protectors were employed to protect the game in the hunting estates against human poachers and against all other animals.

One protector was reported to have killed the nightingales because their singing disturbed the rest of certain game birds. In this country the destruction of predators has taken the form of "vermin" destruction campaigns; these, I am glad to say, seem to be on the decrease. In an eastern state, according to the Emergency Conservation Committee, in 1935, 514,225 animals were destroyed, including 7,270 hawks and 3,123 owls, without discrimination as to harmful and beneficial species. In another state 69,000 chipmunks were killed in one year. In 1938, 222,854 so called "predators" were killed in West Virginia. We specify the hawks that may be counted in these campaigns, which is a step in the right direction, at least. Nothing will be said here about reptiles and amphibia, but I have strong opinions concerning them, too.*

The United States Biological Survey has come in for some criticism for its rather too liberal use of poisons in killing the larger predators of the western grazing lands. The bounty system has also received, and justly, severe criticism. Besides putting a premium on the destruction of often useful animals it is frequently and easily abused. For example, animals or their scalps are brought in from other states where there is no bounty on the given species, and cases have occurred where scalps were manufactured in large numbers and used for the collection of bounties. Many years ago a "scalp act" was passed by the Pennsylvania Legislature placing a 50¢ bounty on hawks, owls, weasels, and minks. After a year or two it was estimated that the state had paid $2,105 for each dollar saved, to say nothing of the increase in losses from the increase in rodent pests; the law was soon repealed. In the April, 1940, issue of *Nature* magazine an editorial quotes from the Board of Game Commissioners of Pennsylvania as follows: "The effects of the operation of the bounty system have been analyzed in detail and it has been shown that as a predator control measure the payment of bounties has proved grossly inefficient. . . ." In 1935, 28 states paid bounties on various animals. The highest bounties paid that year were: bear, $20.00; wildcat, $20.00; adult wolf, $50.00; mountain lion, $50.00. In West Virginia, while no bounties are being paid this year, a bonus of $50.00 is paid in each county where 2,500 or more animals are killed in organized "vermin" campaigns.

According to the annual report of the West Virginia Conservation Commission, $5,776.50 was expended for "predator control" in the fiscal year 1938–39. While we may not agree with all the methods of our Conservation Commission, we must recognize the very excellent work it is doing and we should realize some of the difficulties under which it works. One of the most valuable lines of endeavor of the Commission is its Division of Education, which by lectures, school instruction in conservation, moving pictures, etc., should have far-reaching effects upon present and future generations.

One of the most active of a considerable group of scientists who are making a study of game and wild-life conditions is Dr. Paul Errington of Iowa State College. He has been studying for years the effect of predators on various kinds of game. Field experiments carried on during the years 1929 to 1934 by Errington and others in Iowa and in Wisconsin seemed

* See article by M. Graham Netting in PROCEEDINGS, W. Va. Academy of Science, vol. 13, p. 162, 1939.

to show that the carrying capacity of bob-whites for a given area depended upon the winter carrying capacity of that area. If there were too many birds at the end of the breeding season they were reduced to a fairly definite number by the end of the winter. This depended largely on the food cover and the escape cover of the area, with little apparent relationship to the number of predators. Errington says: "I do not intend any statement of mine to mean that under no circumstances could predators have any influence upon quail populations. I make no pretense of knowing all there is to know about the matter. Natural relationships are too complex to permit of any hard and fast generalities. But the data from five years of work make it apparent, nevertheless, that the influences which differences in predator numbers may have had on the survival of quail populations studied has been so slight as to be unmeasurable. Certainly the importance of preator control in the management of the northern bob-white has been grossly overestimated, while a deplorable lack of attention has been given to the manipulation of food, cover, and cover ranges. Indeed the public tendency has been to emphasize the negligible predator factor to the virtual exclusion of management measures that really count. . . . Man himself, by means of his intelligence and modern hunting equipment, is about the only predator of which I know efficient enough to reduce bob-white populations much below the normal winter carrying capacity of the land."

In other words, the unintelligent or selfish sportsmen are the real predators that are exterminating the game in many places.

Many small and large organizations of sportsmen and dealers in firearms have been formed to increase the number of game animals. Within the past year a national group known as "Ducks Unlimited" has been organized with the purpose of raising funds primarily to increase the breeding grounds of the ducks in Canada, in spite of the fact that, as the Biological Survey has pointed out, it is more breeding birds rather than more breeding areas that are needed. A writer in *Conservation* says, "It is little wonder, then, that many people look upon 'Ducks Unlimited' as a menace to the future welfare of ducks."

An aspect of "vermin" destruction that is appreciated by but few persons other than trained naturalists is the possibility of upsetting the so-called "balance of nature" or the "web of life." As Grinnell says, "The relationships which have been set up through the ages between wild birds, mammals, and plants, in fact between all forms of life, cannot be disturbed unless we are willing to accept the consequences—and these may be exceedingly serious for us."

The possible results of the introduction of new species into a given territory are more generally appreciated than the destruction of an indigenous species.

J. R. Kinghorn, in a presidential address, "Faunal Problems," published in the *Australian Zoologist*, volume V, part 3, calls attention to the problem, among others, of the well-known rabbit pest of that country. Introduced by Governor King in 1791, the rabbits are now so numerous that it has been estimated that if they could be eradicated, "New South Wales alone could carry another 10,000,000 sheep." Although they are such a pest to agriculture, there is another side to this question, as the pelts of rabbits were exported in 1926 to the value of over 4,000,000 pounds sterling, and the carcasses brought in 3,000,000 pounds; about

$35,000,000 is a considerable income to be derived from a waste product.

Those who are advocating the extermination of our interesting pelicans because of their supposed destruction of fish might note a similar case quoted from Sir Arthur Thompson in Publication No. 1, page 16, of the Federation of Ontario Naturalists.

"There is an Australian story that reads as if written for man's instruction. On certain Murray River swamps several species of cormorants used to swarm in thousands, but ruthless massacres, based on the supposition that cormorants were spoiling the fishing, reduced them to hundreds. But the fishing did not improve; it grew worse. It was then discovered that the cormorants fed largely upon crabs, eels, and some other creatures which devour the spawn and fry of the desirable fishes. Thus the ignorant massacre of the cormorants made for the impoverishment, not for the improvement of the fishing. The obvious moral is that man should get at the facts of the web of life before, not after, he has recourse to drastic measures of interference."

The attitude of trained naturalists towards wild-life destruction is seen in the following protest, issued, a few years ago, and signed by the heads of many of our greatest natural history institutions:

A PROTEST

We, the undersigned, having taken cognizance of the fact that conditions operating for the destruction of American wild life are becoming increasingly intolerable, view with the gravest concern the present wholesale and largely indiscriminate use of poison at the hands of paid and frequently irresponsible hunters, whereby it appears that the very existence of all carnivorous mammals, including those valuable species which constitute the chief check upon injurious rodents, and are a vital element of our fauna, is imminently threatened over large areas. We therefore earnestly petition that this extensive program of poisoning operations be immediately abandoned, and that no extensive and general destruction of any form of wild life, by trapping or other means, be permitted in the name of expediency, without this course having first been abundantly proved as justifiable from an economic viewpoint by having made a thorough investigation of the food habits of the species concerned, prosecuted by disinterested and properly qualified parties.

The Biology Section

The Shale Barren Flora of West Virginia*

EARL L. CORE
Department of Botany, West Virginia University

A NARROW STRIP of shale of Ordovician and Devonian age outcropping along both sides of the Virginia-West Virginia border and extending northwards across western Maryland into central Pennsylvania supports a peculiar flora, including a considerable number of remarkable endemics which constitute one of the most interesting components of the plant life of West Virginia. The present paper summarizes the literature on the subject, locates the barren areas, and lists the typical species, with distribution records.

The term "shale-barren" was first used in 1911 by Steele[1] to designate a peculiar type of plant habitat occurring locally in the mid-Appalachian region. Steele says: "This land is made up of exposures of shale in different stages of disintegration, these at the point chiefly investigated consisting of the Romney formation of the Lower Devonian.[2] In the valleys these are reduced to a heavy clay, originally covered with good forest, and when cleared susceptible of tillage. But the declivities and uplands bear at most a low and open growth of oak and pine or frequently a still lower growth of scrub oak, kalmia, and other shrubs, in either case with an admixture of herbaceous plants. The formations are so open that over large areas they can be penetrated on foot with no great difficulty. The barrenness is perhaps largely due to the constant washing away of the finer particles of soil, but in some cases it seems as if it must be chargeable to chemical composition. The plant covering, I should say, is mildly xerophytic, but there is no evidence of extreme drought. On the contrary, the vegetation here maintains itself through the season even on sunbeaten slopes as well as that on other soils similarly situated. The variety of plant life is very considerable and together with many plants well known on other substrata, these barrens possess a number of species peculiar to themselves."

Describing one of these areas, at the western end of the railroad tunnel at Millboro, Bath County, Va., Steele styles it "one of the most fascinating spots in which it has been my fortune to botanize."[3] He adds: "The geological formation is entirely of this shale. . . . The situation is sufficiently picturesque, but the fascination chiefly lies in the unique content of the plant covering. Here within an area of perhaps half a square mile, with much up and down, occur, besides an abundance of the until recently little known *Oenothera argillicola* and *Eriogonum Alleni*, at least a dozen native species thus far unknown to northern manuals, six or eight of them entirely undescribed."

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* Contribution No. 17 from the Herbarium of West Virginia University.

[1] New or Noteworthy Plants from the Eastern United States. Contr. U. S. Nat'l. Herb. *13:* 359–374. 1911.

[2] Classified by the West Virginia Geological Survey as Middle Devonian.

[3] Steele, *loc. cit.*, p. 360.

Before 1911, the date of the publication of Steele's paper applying a specific term to this type of plant habitat, several notes had appeared dealing with the peculiar flora of the barrens, and since 1911 numerous papers have treated the subject from the ecologic as well as the taxonomic standpoint. In view of the numerous requests received at the Herbarium of West Virginia University for information concerning the shale banks and their unique plants, it has seemed worth while to gather here such geologic, geographic, ecologic, and floristic notes as apply especially to such of the barrens as occur within this state, and to append an annotated list of the principal species characterizing the areas.

Wherry has been the principal student of the shale-barren flora. "These barrens," he says,[4] "are developed on shale-slopes—places where hard shaly rocks of the Romney (Middle Devonian) and Jennings (early Upper Devonian) formations outcrop on steep hillsides, the surfaces being strewn with frost-broken fragments. They are typically occupied by a sparse, scrubby growth of pine, oak, mountain-laurel, and other woody plants, with herbaceous ones scattered between, grading into normal woodland wherever conditions permit the accumulation of sufficient soil. . . . The peculiarities of the shale-slopes which lead to their being occupied by endemic plants appear to be the sparsity of soil, the way in which the loose rock-flakes creep down the slopes under the influence of the weather, and the limited amount of available moisture and nutrient elements. The rock is made up largely of quartz and clay minerals, and exhibits a neutral reaction. The accumulation of humus in the heaps of loose fragments results in the development of considerable acidity, little mineral matter capable of neutralizing the organic acids formed being present. The litter is evidently too porous to permit the accumulation of much available nitrogen, and tests have failed to show the presence of nitrates or ammonia in appreciable amount."

Studies made by the West Virginia Geological Survey would indicate, however, that Wherry's statement in regard to acidity requires a slight modification. In certain localities the shale is very calcareous, the calcareous portion being known as the Selinsgrove Limestone. At Brandywine, in Pendleton County, this consists of three beds of black limestone with shale between.[5] At other localities the shale contains numerous concretions that are of two types, one a clay-iron concretion, the other a dark-blue calcareous concretion.

Chemical analyses made by the Geological Survey indicate that, in addition to the xeric effects produced by the lack of permeability and low porosity of the soil, barrenness is accentuated through lack of plant nutrients. A typical analysis reported by State Geologist Paul H. Price for shales of the Romney horizon lists silica (SiO_2), 53 percent; ferric iron (Fe_2O_3), 7 percent; alumina (Al_2O_3), 22 percent; and loss through ignition of carbonaceous material (bitumen) of 18 percent. Chemung shales, of the Upper Devonian, differ principally in lack of carbonaceous materials.

Geologically, the barren areas in this state are chiefly outcrops of the following rocks:

Upper Devonian (Jennings Formation)	Chemung
	(Portage)
	Genesee

[4] Plants of the Appalachian Shale Barrens. Jour. Wash. Acad. Sci. *20:* 43–52. 1930.
[5] W. Va. Geol. Surv. Pendleton County Report, pp. 147–159. 1927.

Middle Devonian	{Hamilton {Marcellus

The Portage Series contains beds of sandstone and is not important as a producer of shale-barren floras. In the Massanutten Mountain region, the Martinsburg shale, of Upper Ordovician age, also bears the typical shale-barren species,[6] but the outcrop of this shale in West Virginia (Berkeley County) is not so characterized. A few of the shale-loving species have also been found in the Blue Ridge near Hickory Stand, in Rockbridge and Bedford Counties, Virginia, on the Hampton Shale, of Cambrian age.[7]

BARREN AREAS

The classic shale-barren in West Virginia is located on Kate's[8] Mountain, at White Sulphur Springs, where early investigations of this remarkable flora were made about the turn of the century and earlier, by T. F. Allen, J. K. Small, K. K. Mackenzie, N. L. Britton, and others. The vicinity of White Sulphur Springs is the type locality for at least eight of the shale-barren endemics, including *Eriogonum Alleni, Clementis albicoma, Trifolium virginicum, Oenothera argillicola, Pseudotaenidia montana, Phlox Buckleyi, P. Brittonii,* and *Senecio antennariifolius.*

In Monroe County near Sweet Springs are other barrens that have been much studied. Most of the familiar barren species occur here, and the type localities of *Allium oxyphilum* and *Convolvulus Purshianus* are located in Monroe County. The region was explored botanically by Pursh more than a century ago.

A narrow strip of shale occurs along the Virginia line in Pocahontas County to the east of Minnehaha Springs.

One of the most extensive barren areas of the state is located in Pendleton County along the South Fork River. A few of the more southerly species fail to reach this far north, but most of the endemics can be found here. The rocks here are of the Romney horizon.

Near Wardensville, in Hardy County, is another excellent example of the barrens with the characteristic flora.

At numerous places in Hampshire County, outcrops of Chemung shales support the shale-barren flora, especially near Hanging Rock, where *Antennaria virginica* was discovered.

The valley of Mill Creek and knolls along North Fork River in Grant County near Petersburg provide other illustrations of this type of vegetation.

The valley of Patterson's Creek near Burlington in Mineral County and the lower course of the Cacapon River near Largent in Morgan County likewise possess barrens with most of the endemics.

The accompanying map shows the location of the principal shale-barrens of West Virginia.

The principal species characteristic of the shale-barrens in West Virginia are here listed, with notes on their nomenclature, distribution,

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[6] Lena B. Artz. Plants of the Shale Banks of the Massanutten Mountains of Virginia. Claytonia *3:* 45–50; 10–15. 1937.

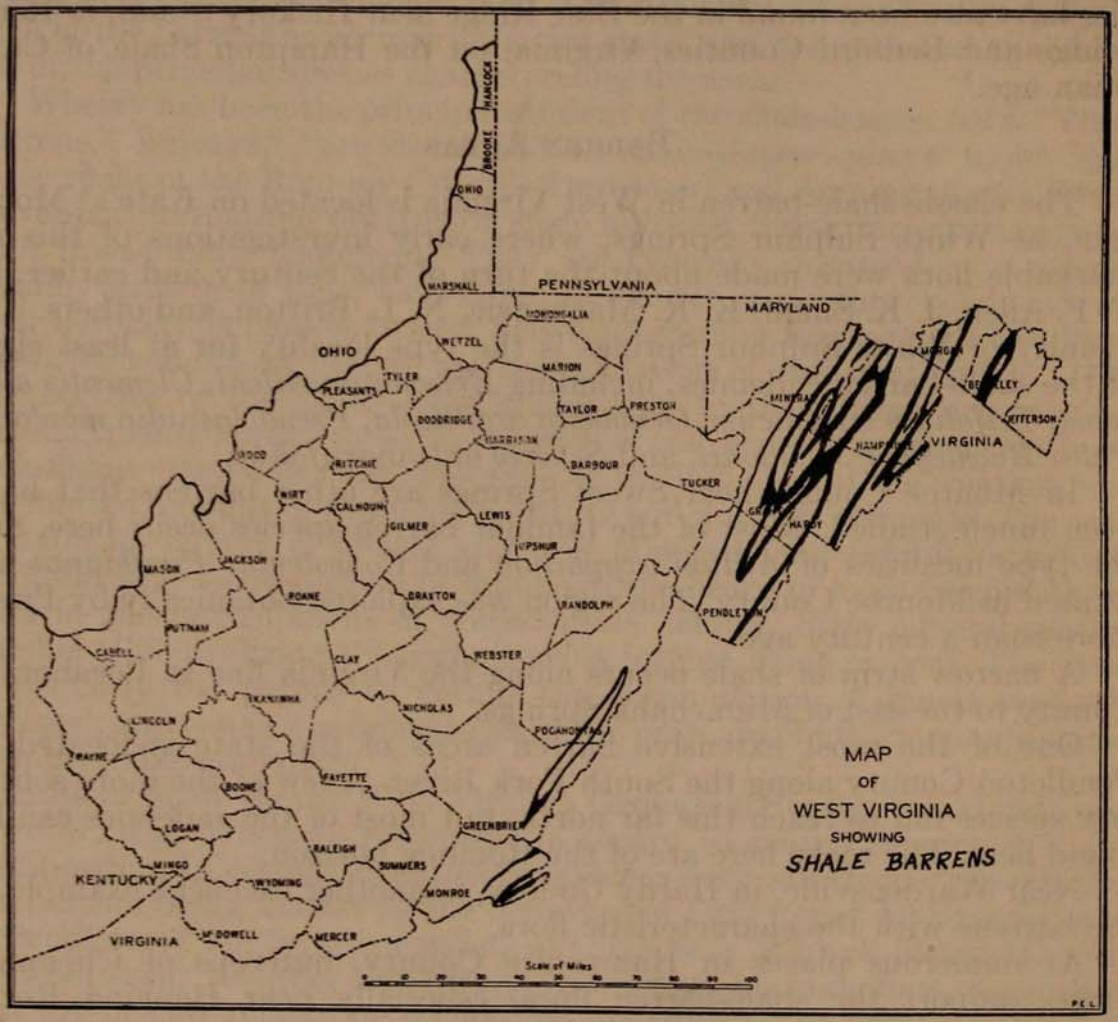
[7] Wherry, Claytonia *2:* 19. 1935.

[8] Incorrectly spelled "Cate's" in Britton & Brown, Illustrated Flora, vol. 2, p. 356, and copied in several other papers, including Steele, Contr. U. S. Nat'l. Herb., p. 364.

etc. There is no attempt to enumerate all the species that enter the barrens.

ALLIUM OXYPHILUM Wherry.
Jour. Wash. Acad. Sci. *15:* 370. 1925

This Nodding Onion is as yet known only from Monroe and Greenbrier Counties in West Virginia, and from Bath County, Virginia. The type locality is near Lillydale, Monroe County. "Locally it strays from the shale to barren sandstone



or even to limestone ledges."[9] It is "endemic in the shale-barren region, usually occurring on the more heavily wooded portions of the shale slopes, though sometimes remote from them."[10]

ERIOGONUM ALLENI Watson
In Gray's Manual, 6th ed., p. 734. 1889.

This is one of the half-dozen strict endemics of the shale-barrens. The type locality is in the vicinity of White Sulphur Springs, Greenbrier County, where it was first collected T. F. Allen. Its stout, dichotomously branched stem bears a compound cyme of yellow flowers, suggesting the common name Yellow Buckwheat. The leaves, white-woolly and velvety, in combination with the masses of yellow blossoms, make this one of the most conspicuous plants of the shale flora. The roots penetrate the cracks in the flaky rocks to great depths. Miss Artz reports a young plant 4 cm. high with one branch of its main root 110 cm. long and another more than 122 cm. long.[11]

[9] Wherry, Claytonia *2:* 20. 1935.
[10] Wherry, Jour. Wash. Acad. Sci. *20:* 45. 1930.
[11] Claytonia *3:* 47. 1937.

Eriogonum is a genus widely distributed in the Rocky Mountain region, but with only two species represented in the area of Gray's Manual. Wherry[12] suggests that the ancestors of the present species presumably crossed the continent in pre-Glacial times and were forced to migrate southward to escape the advancing ice which destroyed the geographical connection with the western relatives, leaving this single endemic in a habitat free from competition. He believes its nearest relative to be *E. Jamesii*, of the plains and Rocky Mountains, a species which lived in Canada during the Tertiary but which was exterminated there by climatic changes.

DISTRIBUTION IN WEST VIRGINIA

MONROE: Slaty Mountain, *W. V. U. Bot. Exped.;* GREENBRIER: White Sulphur Springs, *W.V.U. Bot. Exped.* It has been reported from five counties in Virginia.[13]

POLYGONUM TENUE Michx.

This widely distributed dry-soil Knotweed is abundant on the barrens, as might be expected.

GREENBRIER: Kate's Mountain, *Gilbert 505;* MONROE: Slaty Mountain, *W.V.U. Bot. Exped.;* GRANT: North Mill Creek, *W.V.U. Bot. Exped.;* HARDY: Wardensville, *Core 4378;* HAMPSHIRE: Hanging Rock, *Frye 1132.*

PARONYCHIA PUMILA (Wood) Core.

Va. Jour. Sci. *1:* 113. 1940.

Two or three species of *Paronychia* are common on shaly soils throughout the northeastern United States and may naturally be looked for on the shale barrens. The present species apparently is the most characteristic one on the barrens. This has been long regarded as identical with *Paronychia fastigiata* (Raf.) Fernald (*Anychia polygonoides* Raf.), but Steele[14] pointed out that the shale-barren form (which he called *Anychia divaricata* Raf.), is low and horizontally spreading, in contrast with the erect habit of that species; that this plant bifurcates at about the fourth or fifth node or lower, while *P. fastigiata* bifurcates at about the seventh node; that *P. pumila* commonly has shorter leaves, the outermost not exceeding 2 or 3 mm., the margin being entire and naked, instead of minutely spinulose-serrulate; that *P. pumila* has 5 stamens, *P. fastigiata*, two; and that the style of *P. pumila* is entire, with two stigmas, while that of *P. fastigiata* is divided nearly to the base.

Fernald[15] has summarized the tangled nomenclature of this form, regarding it as a variety of *P. fastigiata*. It seems certainly distinct enough in the field, at least, to justify specific ranking, even if we do not follow Small in separating it generically from its relative (as *Anychiastrum montanum*).[16]

P. L. Ricker[17] records this plant from five counties in Virginia, stating that in his study of specimens in the National Herbarium he had found most of them under *Anychia polygonoides*. Seven counties in West Virginia are represented by specimens in the University Herbarium, namely, Berkeley, Hampshire, Grant, Pendleton, Mineral, Greenbrier, and Monroe.

SILENE PENNSYLVANICA Michx.

The Wild Pink is common on rocky and gravelly places throughout the Appalachians and invades the shale barrens without substantial modification.

MONROE: Cove Creek, *W.V.U. Bot. Exped.;* GREENBRIER: Kate's Mountain, *Core 2709;* HAMPSHIRE: Okonoko, *Frye.*

CLEMATIS ALBICOMA Wherry.

Jour. Wash. Acad. Sci. *21:* 198. 1931.

(Viorna albicoma Moldenke Bull. Torr. Bot. Club *60:* 57. 1933)

Current manuals discuss the Leather-flower of the barrens under *C. ovata*, described by Pursh from the mountains of South Carolina in 1814.[18] So far as re-

[12] Jour. Wash. Acad. Sci. *20:* 45. 1930; see also Fernald, Mem. Amer. Acad. Arts & Sci. *15:* 239. 1925.
[13] Claytonia *3:* 47. 1937.
[14] Contr. U. S. Nat'l. Herb. *13:* 363. 1911.
[15] Rhodora *38:* 421. 1936.
[16] Torreya *10:* 230. 1910.
[17] Claytonia *1:* 47. 1935.
[18] Fl. Am. Sept. 736. 1814.

corded, the barrens plant was first collected by Gustav Guttenberg on Kate's Mountain, July 31, 1877. Britton[19] concluded that the Kate's Mountain plant was identical with the southern species. Wherry, however, regards the dwarf shale-barren plant as distinct from *C. ovata*, which species he relegates to varietal status under *C. ochroleuca* of the coastal plain. He accordingly renamed the shale-slope plant *C. albicoma*, in allusion to the characteristic white hair on its achenes.[20]

GREENBRIER: Kate's Mountain, *W.V.U. Bot. Exped.* It is said to reach its northern limit in Augusta County, Va.[21]

A specimen collected by Steele at Millboro, Bath County, Va., is apparently distinguished from *C. albicoma* and *C. ochroleuca* by its "slender, woody stems, short internodes, numerous branches and numerous small leaves." This was published by Steele under the name of *C. viticaulis*,[22] but this species has not been recognized in West Virginia.

DRABA RAMOSISSIMA Desv.

This little Draba, found on outcrops of many kinds of rocks throughout the southern Appalachians, enters the shale barrens essentially unchanged.

HAMPSHIRE: Okonoko, *Core 4746.*

ARABIS SEROTINA Steele.

Contr. U. S. Nat'l. Herb. *13:* 365. 1911.

The type locality of this shale-barren endemic is at the west end of the railroad tunnel near Millboro, Bath County, Va., where it was first collected by Steele on August 21, 1907. He comments: "This plant was first taken to be *Arabis laevigata Burkii* Porter,[23] which it resembles in several particulars of the description, but Doctor Rose, who kindly compared a specimen with Porter's material at the New York Botanical Garden, thinks the two are not the same. In any case it is out of the question to refer this in any way to *A. laevigata*. Even if we disregard the fact that it is in perfectly normal bloom the middle of August, while *A. laevigata* blossoms in April and May, the differences are fully of specific worth. The most striking are in the small flowers of the present plant, its narrow nonsagittate leaves, its more slender and woody stems, and its numerous spreading branches."[24] Hopkins[25] refers the shale-barren form to *A. laevigata* var. *Burkii*, but because of its branching habit and later blooming period it seems certainly distinct.

PENDLETON: Brandywine, *Core 3671.*

Miss Artz reports it from Shenandoah County, Va.[26]

SEDUM TELEPHOIDES Michx.

This plant occurs frequently on shale-barrens as well as on sandstone cliffs throughout the Appalachian counties.

TRIFOLIUM VIRGINICUM Small.

Mem. Torr. Bot. Club *4:* 112. tab. 75. 1894.

This is one of the most characteristic of the shale-barren endemics. The type locality is on Kate's Mountain, Greenbrier County, where it was discovered in 1892 by Small, who believed it by its flowers to be closely related to *T. stoloniferum* Muhl. For 30 years no other stations were known, and the plant came to be known as Kate's Mountain Clover, as many botanists went there to see it. McDermott[27] believed it to be a derivative of the Buffalo Clover, *T. reflexum* L., which grows from the Alleghenies westward, and reduced it to a variety under that species, stating, curiously, that it was "abundant throughout the Appalachian Mountains," although at that time only one locality was represented in herbaria. Wherry, however, believes *T. virginicum* to be only distantly related to *T. reflexum*, although he suggests that

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[19] Britton & Brown, Ill. Fl. *2:* 125. 1913.
[20] Jour. Wash. Acad. Sci. *21:* 198. 1931.
[21] Claytonia *2:* 20. 1935.
[22] Contr. U. S. Nat'l. Herb. *13:* 364. 1911.
[23] Bull. Torr. Bot. Club *17:* 15. 1890.
[24] Steele, Contr. U. S. Nat'l. Herb. *13:* 365. 1911.
[25] Hopkins, Arabis in Eastern and Central North America. Rhodora *39:* 163. 1937.
[26] Claytonia *2:* 10. 1935.
[27] North American Species of Trifolium, p. 273. 1908.

they may both have had the same Tertiary ancestor.[28] The second locality for the plant was discovered by Hunnewell in 1923 at Hot Springs, Virginia,[29] and by 1929 eight stations were known,[30] including one in Maryland. The extension of its range to Bedford County, Pennsylvania, was reported by Wherry in 1933.[31] Miss Artz in 1937 listed 15 counties in 4 states from which it had been reported.[32] Wherry states that "it favors the barest and most sterile situations, withstanding the instability of the surface fragments, by sending long tough roots into the crevices in the more solid rock below,"[33] and Miss Artz describes a specimen with a height of 7 cm. and a spread of about 16 cm. which had roots 60 to 90 cm. in length, each much-branched and ending in numerous rootlets.[34]

The chief morphological feature of this clover is its slender linear or oblanceolate leaves, suggesting the common name Longleaf Clover, which is proposed by Wherry. The blossoms are creamy white in color and appear in April and May.

GREENBRIER: Kate's Mt., *Strausbaugh.*
HAMPSHIRE: Romney, *Harris.*
MINERAL: Keyser, *Daisy Chapman.*
MORGAN: Largent, *Wherry.*
HARDY: Wardensville, *Core 4377.*
PENDLETON: Upper Tract, *Davey.*
MONROE: Slaty Mt., *W.V.U. Bot. Exped.*
BERKELEY: Camp Frame, *Poland.*

ASTRAGALUS DISTORTUS T. & G.

This plant, a species of the Ozark region, is found occasionally on shale-barrens, possibly as a relict of a flora that moved eastward from the southwestern arid regions during a xero-thermic period[35] following the Ice Age and then retreated upon further climatic changes. It is known from Burlington, in Mineral County, and has been reported by Hunnewell[36] from Frederick County and by Miss Artz from Shenandoah County, Virginia.[37]

VIOLA PEDATA L.

The Bird's-foot Violet is common in open sunny slopes in gravelly soil throughout the northeastern states, being represented on the shale-barrens principally by the variety *linearilobа* DC.

OPUNTIA COMPRESSA (Salisbury) MacBride.

The prickly-pear cactus so common on the shale-barrens of Mineral, Grant, Pendleton, Hardy, and Hampshire Counties was long known as *Opuntia vulgaris* Miller,[38] but as this binomial was originally proposed for a South American species, the Appalachian species is now more correctly named *O. compressa.* Wherry has described a new species, *O. calcicola,* growing on limestone and other circumneutral soils of the Appalachian region, the type locality being near Bolivar, Jefferson County.[39]

OENOTHERA ARGILLICOLA Mack.

Torreya *4:* 56. 1904.

The Large-flowered Evening Primrose is restricted apparently to the shale-barrens, although it is one of the most common and most widely distributed of the narrowly endemic species. It was discovered by Mackenzie at White Sulphur Springs, August 23, 1903. Its abundance and showy floral displays lead one to wonder why it was distinguished only so recently.[40] Evidently it had passed as a

[28] Wherry, Claytonia *2:* 20. 1935.
[29] Rhodora *25:* 168. 1923.
[30] Wherry, Torreya *29:* 105. 1929.
[31] Proc. Pa. Acad. Sci. *7:* 163, 164. 1933.
[32] Claytonia *3:* 49.
[33] Proc. Wash. Acad. Sci. *47:* 1930.
[34] Claytonia *3:* 49.
[35] Core, Plant Migrations and Vegetational History of the Southern Appalachian Region. Lilloa *3:* 24–26. 1938.
[36] Rhodora *31:* 256. 1929.
[37] Claytonia *4:* 11. 1937.
[38] Britton & Rose, The Cactaceae *1:* 127. 1919.
[39] Jour. Wash. Acad. Sci. *16:* 12. 1926.
[40] See Castanea *1:* 85. 1936.

thrifty form of *O. biennis*. The present species, however, differs in having petals 3 to 4 cm. long, whereas in typical *O. biennis* the petals do not exceed 2.5 cm. in length. Mackenzie says: "This plant with its ascending non-hirsute stems, narrow leaves, large flowers and glabrous, long-tapering capsule is one of the most distinctive species of this section."[41] Miss Artz has found a form which differs from the type specimen described by Mackenzie in having a hairy calyx instead of a glabrous one,[42] and the same form has been recognized in West Virginia.

It is known from Monroe, Greenbrier, Pocahontas, Pendleton, Grant, Mineral, Hardy, Hampshire, and Morgan Counties in West Virginia, while Miss Artz reports it from four counties in Virginia, 1 in Maryland, and three in Pennsylvania.[43]

PSEUDOTAENIDIA MONTANA Mack.

Torreya *3:* 159. 1903.

This plant, reported in Gray's Manual only from Kate's Mountain, Greenbrier County, W. Va., and from Luray Cavern, Page County, Va., represents not only an endemic species but also an endemic genus, since this is the only member. In general appearance it resembles closely *Taenidia integerrima* (L.) Drude, with which it is frequently confused, and from which it differs in having the fruit strongly flattened dorsally instead of laterally, a character not readily apparent. At the time of the publication of the 7th edition of Gray's Manual (1908), the plant had not been found in flower, due to the difficulty of distinguishing it from *Taenidia* in that condition. Numerous collections of flowers have been made since, although one of the first published records was made only recently by Walton C. Gregory and Ruskin S. Freer.[44]

The type locality is on Kate's Mountain, where it was discovered by Mackenzie, August 29, 1903. It is now known from Monroe, Greenbrier, Pendleton, Hardy, Mineral, Hampshire, and Morgan Counties.

PHLOX BUCKLEYI Wherry.

Jour. Wash. Acad. Sci. *20:* 26. 1930.

This species, termed by Wherry the Sword-leaf Phlox from the shape of its evergreen basal leaves, was originally collected by S. B. Buckley in June, 1838, at White Sulphur Springs, Greenbrier County, but remained unnamed for nearly a century. Wherry notes that, although not growing on barrens, it seems to thrive best in woods near the bases of shale-slopes.[45] Although known in West Virginia only from Greenbrier and Pocahontas Counties,[46] it has been reported from four Virginia counties.[47]

PHLOX BRITTONII Small.

Bull. Torr. Bot. Club *27:* 279. 1900.

Wherry states: "Festoons of Moss-Pink drape the ledges on many of the shale-slopes, the white or pale lavender flowers with which they are covered in spring giving them a different aspect from the related material of other habitats."[48] To this form the name *P. Brittonii* was applied by Small, the type specimen having been collected by Dr. N. L. Britton at White Sulphur Springs in May, 1898. Wherry, however, concluded that in view of the extreme variability of this group of Phloxes, the differences can not be regarded as having more than varietal significance, and proposed the combination *P. subulata* var. *Brittonii*[49] for the form with the pubescence dominantly glandular. Apparently *P. subulata* and its three varieties are distributed throughout the Allegheny counties and exist in intergrading forms.[50]

CONVOLVULUS PURSHIANUS Wherry.

Proc. Pa. Acad. Sci. *7:* 163. 1933.

One of the most characteristic plants of the shale-barrens is an erect Convol-

[41] Torreya *4:* 56, 57. 1904.
[42] Claytonia *2:* 4. 1935.
[43] Claytonia *3:* 48. 1937.
[44] Claytonia *2:* 7. 1935.
[45] Jour. Wash. Acad. Sci. *20:* 49. 1930.
[46] Castanea *1:* 15. 1936.
[47] Claytonia *2:* 21. 1935.
[48] Jour. Wash. Acad. Sci. *20:* 49. 1930.
[49] Bartonia *11:* 27. 1929.
[50] Castanea *1:* 13. 1936.

vulus which Wherry has termed the Velvet Convolvulus. It is apparently a derivative of *C. spithamaeus*, from which it differs in having extremely velvety leaves and stems, whereas in typical *C. spithamaeus* the pubescence is rather sparse. Wherry at first[51] regarded it as identical with *C. stans* Michx.,[52] the type locality of which was in Quebec, near Lake Champlain, but later concluded that the two were distinct. The southern form was first recognized by Pursh, who collected it near Sweet Springs, Monroe County, and named it *Calystegia tomentosa*.[53] Since its distinctness was first noted by Pursh, Wherry renamed the species in his honor. It is known from Monroe, Greenbrier, Pendleton, Hardy, and Hampshire Counties and is locally rather abundant, forming vast patches of more or less regularly spaced stalks, almost to the exclusion of other species.[54] Miss Artz reports it from Shenandoah County, Va.,[55] and Wherry lists three other Virginia counties.[51]

SOLIDAGO HARRISII Steele.
Contr. U. S. Natl. Herb. *13:* 369. 1911.

Steele states: "The species is doubtless akin to *S. Boottii* in its coriaceous leaves and tegules, stiff habit and recurved branches. It differs greatly from it in its more robust though typically depressed habit, much broader and more lucid leaves, more ample panicle, etc. It has the habit of a depressed and stiffened *juncea*, but is not near that species. Its closest alliance is probably with *S. arguta*, the relation being most obvious in the broadly dilated and sharply serrate leaf blades, the very distinct nervation of the petiole wings being also imperfectly anticipated in *S. arguta*. It differs from that species, however, in its lower stature and broader panicle, in its shorter and more dilated leaves with less forward-pointing teeth, and with firmer texture, brighter surface, and much more broadly winged petioles, and in its smaller heads and commonly thicker tegules."

Although reduced by Britton & Brown[56] to synonymy under *S. arguta*, this plant seems clearly distinct. It is one of our earliest-blooming goldenrods, specimens having been collected in flower as early as May 28. The type specimen was collected at Cumberland, Md., June 20, 1910, by Edmund Harris "on cliffs and hillsides of the Hamilton and Clinton shales." Other stations recorded by Steele include Sweet Springs, Monroe County, W. Va.; Millboro, Bath County, Va.; and Augusta Springs, Augusta County, Va. Specimens are in the herbarium of West Virginia University collected by Ward M. Sharp in Hampshire County and by H. A. Davis at Cabins, in Grant County, the latter in bloom on June 14. Miss Artz reports it doubtfully from Shenandoah County ,Va.[57]

ANTENNARIA VIRGINICA Stebbins.
Rhodora *37:* 229–237. 1935.

A visit by Dr. G. L. Stebbins to the shale-barrens near Hanging Rock, Hampshire County, resulted in the announcement of a new species of *Antennaria* growing chiefly but not exclusively on the barrens. Stebbins says: "*Antennaria virginica* can be distinguished from all other varieties of *A. neo-dioica* by its slender stems, shorter, narrower cauline leaves, somewhat smaller involucres, shorter corollas, and by the scarious appendages on the upper cauline leaves of the staminate and often the pistillate plants. . . . In its floral characters *A. virginica* most nearly resembles *A. plantaginifolia*, but it is otherwise totally different, being of the small-leaved group. Typically *A. virginica*, moreover, is set off from all other species of the eastern United States by two characteristics, the erose margins of the involucral bracts and the sparsely pubescent achenes. It flowers about two weeks earlier than *A. neo-dioica* and at the same time as *A. plantaginifolia*." In colonies of *A. virginica* both staminate and pistillate plants occur abundantly, whereas in *A. neo-dioica* staminate plants are rare and reproduction is chiefly parthenogenetic. Stebbins concludes that this indicates *A. virginica* to be the ancestral species. Besides the new species, a new variety was recognized, *A. virginica* var. *argillicola*, representing an approach towards *A. neo-dioica*. The variety differs from the typical phase in the breadth of its

[51] Torreya *29:* 106. 1929.
[52] Fl. Bor. Am. *1:* 136. 1803.
[53] Pursh, Fl. Am. Sept. *1:* 143. 1814.
[54] Wherry, Jour. Wash. Acad. Sci. *20:* 48. 1930; Claytonia *2:* 21. 1935.
[55] Claytonia *4:* 13. 1937.
[56] Illus. Flora. *3:* 393. 1913.
[57] Claytonia *4:* 12. 1937.

basal leaves, the absence of scarious appendages on the cauline leaves, the entire margins of the involucral bracts, and the densely pubescent achenes.

SENECIO ANTENNARIIFOLIUS Britton.

Britton & Brown, Illus. Flora, ed. 1, *3:* 478. 1898.

This species, called by Wherry the Everlasting Groundsel,[58] is one of the most characteristic plants of the shale-barrens, often forming large patches and being only rarely found in other habitats. It is, like *Eriogonum Alleni* and a few other Appalachian plants, most closely related to a Rocky Mountain species, and in the key in Gray's Manual, the range is the only criterion used to separate it from *S. canus* Hook.

The type specimen was collected May 16, 1897, by T. F. Allen and N. L. Britton, near White Sulphur Springs, although its distribution is given in Gray's Manual simply as "Blue Ridge, Va." It is known in West Virginia from Monroe, Greenbrier, Pendleton, and Hardy Counties, while Miss Artz[59] records it from seven counties in Virginia, two in Maryland, and one in Pennsylvania.

This species is easily separated from other Senecios through the hoary appearance of the thickly clustered basal leaves from which in spring arise the slender white-woolly stems capped with yellow blossoms. The basal leaves are arranged in peculiar rosettes which Miss Artz describes: "The rosettes . . . are often arranged to form circles 25–30 cm. in diameter, with an open space in the center 7–15 cm. in diameter. This center is made up of a mass of plant stems closely pressed to the ground and rooted there in such a way that seedlings cannot come up between. Shale creeps in over these stems, concealing the cause of the bare area there. The wreath thus formed, with its silvery leaves, adds an interesting bit of attraction to the shales, especially in winter."[60]

[58] Jour. Wash. Acad. Sci. *20:* 50. 1930.
[59] Claytonia *3:* 50. 1937.
[60] Claytonia *3:* 50. 1937.

A Human Fetus with an Unusual Anomaly of the Cervical and Thoracic Vertebrae (Preliminary Report)

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THE EIGHT-MONTH MALE FETUS described is No. 121 in the embryological museum of the School of Medicine of West Virginia University. It is peculiar in its very large head (hydrocephalic), its very short and thick neck, the presence of club feet, and eight fully-erupted incisor teeth. Its peculiarly interesting developmental anomaly is the complete division into right and left halves of all of the cervical vertebrae and the first six in the thorax, this division involving both the bodies and the arches. It is this feature which is responsible for the almost entire absence of the neck. The diagragm is incomplete, there being on the left side a large opening through which a large lobe of the liver, the stomach, the small intestine and the spleen have entered the thorax, crowding the heart and lungs into the right half of the thorax.

Only about 30 fetuses showing this anomaly of the vertebrae (vertebra bipartita) have been described, all of them in European literature. Probably all these cases show the same association of defective diaphragm and displaced viscera with the vertebral defect described in the present fetus.

Fixation Images in *Russula emetica* (Preliminary report)

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IT HAS BEEN SHOWN, particularly by Zirkle,[1,2] that the appearance of a cell prepared for cytological observation depends largely upon the fixing agent used. The term "fixation image" has been used to designate the special appearance of a cell after treatment with any particular fixer. It is already established in the higher plants that some cytoplasmic and nuclear structures are preserved by some substances and dissolved by others, chromosomes, for example, being preserved in acid-killing solutions but usually being destroyed by solutions of pH 4.8 and higher. Mitochondria, on the other hand, are commonly dissolved by acid fixers. In addition to the hardening or dissolution of various cell parts, different fixers cause different cell parts differentially to adsorb the mordant in iron-alum haematoxylin staining, with the result that it is possible to cause almost any cytological structure to be stained strongly by employing some special fixer.

The common agaric, *Russula emetica*, was used as a test organism to find what results would be obtained when fungus cells were treated with some of the fixers used on higher plants, the particular cells observed being the basidia, since these cells are relatively large and well filled with cytoplasm, and since it is in the basidium that many interesting events happen.

As a check fixation, Nawaschin's fluid was used. This mixture of chromic acid, acetic acid, and formaldehyde gives a fixation image that is at present popular, showing distinct chromosomes and granular cytoplasm. This fixation, however, does not give a complete picture, nor does it make possible differential staining of chromatin and plastin. These difficulties are obviated by other killing solutions.

With a mixture of formic acid and acetaldehyde, using the iron-alum haematoxylin stain, the chromatin stains heavily and the nucleoli lightly. With a mixture of chromium sulfate, formaldehyde, and copper hydroxide, the cytoplasm appears homogeneous, the vacuoles are distinctly preserved, and the nucleolus stains much more heavily than any other nuclear structure. Mitochondria are preserved by Erliki's fixer, composed of potassium dichromate, ammonium chromate, and copper sulfate. For general karyological study, chromic acid, acetic acid, and copper hydroxide is useful, showing chromatin and nucleoli clearly.

Two interesting points that have come out incidental to this study of fixation are (1) nuclear fusion in the cystidium and (2) the production of sterigmata before the second division of the zygote nucleus.

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[1] Zirkle, C. 1928a. Protoplasma *4:* 201–227.
[2] Zirkle, C. 1929a. Protoplasma *5:* 511–534.

The Periodical Cicada in West Virginia

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THE PERIODICAL CICADA, *Magicicada septendecim* (L.), is generally considered as one of the most interesting species of insect in the world. Five major broods and four minor broods occur in West Virginia with the possibility of other broods being present. The appearance of so many broods in the state makes it one of the most profitable areas in which to study this insect.

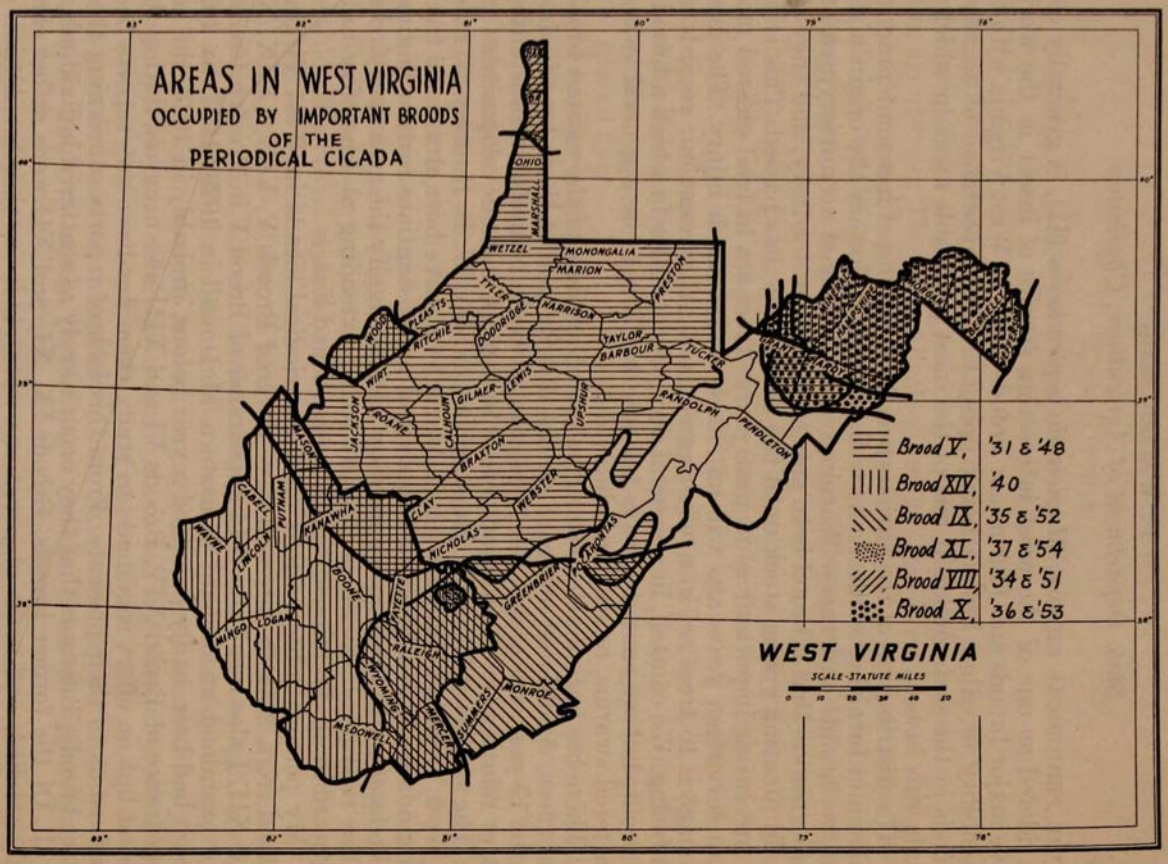
The distribution of the various broods of the insect has some practical value and furnishes evidence as well for speculation on the origin of the various broods and races. Warnings may be issued to nurserymen and fruit growers that a brood is to appear in a given territory, and they can avoid planting young stock until the adult stage has passed. This is not at present as important as in past years. Trees set in land cleared more than seventeen years ago will not likely suffer much injury. The great damage is to trees set in newly-cleared land. At present our records are confusing. We can tell, in a general way, the counties in which a brood is to occur, but we cannot always tell whether it is to be a general swarm, scattered swarms, or scattered individuals.

There has been much speculation over the origin of the various broods and races. Additional evidence on the distribution of these broods, both in the 17-year race and in the 13-year race, would be useful in substantiating or refuting the theories advanced to explain these developments.

The studies of Dr. A. D. Hopkins (*1*) and Mr. W. E. Rumsey (*3*) made in West Virginia and of Dr. C. L. Marlatt (*2*) have been drawn on freely for guidance in studying the broods and to substantiate certain findings. All references to the area occupied by a brood signify the area occupied by dense swarms. Individuals may be found extending at least five miles outward in all directions from this established line.

My personal observations on the periodical cicada in West Virginia extend from 1931 to date and have covered Broods V, VIII, IX, X, XI, and XII. I also recall the 1914 appearance of Brood V in Preston County and examined an orchard in eastern McDowell in 1926, 1927, or 1928 which had been badly damaged a year before, probably in 1923, the last appearance of Brood XIV. Broods VI and XIII also occurred during this period but no effort was made to study them nor have any reports been received as to their presence. From this lack of reports concerning these latter broods, I assume that they occur merely as scattered individuals, if at all. Of the former broods, Broods IX, XI, and XII were rather carefully studied, and some observations were made on the distribution of Brood X. The study of Broods V and VIII was confined to chance observations.

In 1931 I happened to be making frequent trips between Charleston and Lakin, Mason County. Brood V occurred in swarms that year in the portion of Mason and Kanawha Counties north of the Kanawha River.


AREAS IN WEST VIRGINIA
OCCUPIED BY IMPORTANT BROODS
OF THE
PERIODICAL CICADA
OHIO
MARSHALL
WETZEL
MONONGALIA
MARION
PRESTON
TYLER
PLEASTS
RITCHIE
DODDRIDGE
HARRISON
TAYLOR
BARBOUR
TUCKER
WIRT
JACKSON
ROANE
CALHOUN
GILMER
LEWIS
UPSHUR
RANDOLPH
PENDLETON
BRAXTON
WEBSTER
CLAY
NICHOLAS
POCAHONTAS
GREENBRIER
PUTNAM
KANAWHA
MASON
CABELL
WAYNE
LINCOLN
BOONE
LOGAN
MINGO
RALEIGH
FAYETTE
SUMMERS
MONROE
MERCER
MCDOWELL
PRENTISS
Brood V, '31 & '48
Brood XIV, '40
Brood IX, '35 & '52
Brood XI, '37 & '54
Brood VIII, '34 & '51
Brood X, '36 & '53
WEST VIRGINIA
SCALE - STATUTE MILES
0 10 20 30 40 50

An orchard, two miles north of Charleston, was protected from the adults of this brood by covering the trees with cheese cloth. No evidence was found that this brood extended south of the Kanawha River in these counties. The studies of others substantiate these observations. Anyone seeking more complete information on the distribution of this brood should consult the works of Hopkins (*1*). The extension of this brood into Mineral, Grant, and Hardy Counties is interesting.

Brood VIII occurs in West Virginia in the Northern Panhandle area. In 1934 I observed numerous dead twigs resulting from the attack of the individuals of this brood in the trees in Hancock and Brooke Counties. Older records indicate that it occurs also in Ohio County, but it must be in the eastern area only, as no dead twigs were seen along the river.

The next study was of Brood IX as it occurred in the southeastern counties in 1935. Its relative distribution is indicated in the figure. A rather careful study of the extent of this brood was made by corresponding with postmasters, county agents, and other interested parties, as well as by personal visits into the territory. As a result of this study some changes were made in the area assigned to this brood by the older investigators. This brood extended northward to a line running east and west through Marlinton in Pocahontas County and did not seem to occur in Boone County to any great extent. In the Coal River valley, the study was confined to the valley, where scattered individuals were heard as far west as Whitesville. As is known, this insect seems to prefer the hilltops and ridges; swarms may occur therefore along the ridges in the eastern ends of Boone and Logan Counties, even extending into Kanawha County.

During the studies of this year a trip was made to Cranberry Glades in Pocahontas County. On May 30, a clear, warm day, one solitary adult was heard and on the previous day, on top of Droop Mountain, not a single individual was heard. Residents at this latter point say they have never occurred. The valleys surrounding the high points were a din from great hordes of singing individuals. The swarms of this brood were the densest I have ever observed.

Brood X occurred in 1936 in the counties of the Eastern Panhandle. The studies of the distribution of this brood were to determine the western edge of the dense swarm area. Correspondence with postmasters and county agents was relied upon for the location of this line, and a few scouting trips were made through the indicated areas. Automobile trips in 1936 failed to find signs of this brood along Routes 4, 28, and 33 between Elkins and Franklin and along Route 219 between Elkins and Red House on U. S. 50. Recently the trees in Mineral and Grant Counties between Mt. Storm and Keyser were examined. As a result of this study I am inclined to believe the Alleghany Front Mountain is the western limit of this brood in West Virginia, although signs of the insect were discovered within a few miles of Mt. Storm on the top of the Alleghany plateau. These studies are, in general, in confirmation of earlier records. Unfortunately, I was unable to visit the dense swarm area during the presence of the adults and am therefore unable to compare the density of these swarms to swarms of Brood IX, which was previously discussed.

Early in 1937, I received a request from Dr. Hyslop, Director of the Insect Pest Survey, United States Department of Agriculture, to investigate the occurrence of Brood XI in Fayette County. Fortunately I

was able to be in this territory on June 19 and again on July 6. On both these occasions a small swarm of cicadas were heard raising their usual noise over a limited area east of Big Bend on U. S. 60 in Fayette County. A solitary individual was heard near Lewisburg on June 19 and another near Sewell Mountain on July 6. The appearance of this brood in West Virginia is most interesting, as the remainder of the brood occurs in New England.

The next year, 1938, a rather exhaustive survey was made of the counties in the southwestern part of the state for the presence of Brood XII. Rural mail carriers reported a few individuals present in the counties of Wayne, Cabell, Lincoln, Mason, and Putnam. Two trips were made through this territory during June, but while the weather was favorable, not a single individual was heard. I talked to some of the parties reporting they had heard the song of this insect on one or more occasions and I believe they were sufficiently well acquainted with the insect for their reports to be accepted.

This brings us up to Brood XIV, which is to appear this year, 1940. It should be looked for in all counties south of the Kanawha and New Rivers; in Wood, Jackson and Wirt Counties; and in the counties of the Eastern Panhandle. I am inclined to believe this brood will be spotty in its distribution though Hopkins (*1*) states it is referred to as being very destructive and the orchard in McDowell County, examined in 1926, '27 or '28, indicated it was very abundant there in 1923.

Reports on the local distribution of this brood will be appreciated. All records should clearly indicate whether the area is solidly covered by swarms of adults; the swarms occur only in spots; or scattered individuals only are present.

In addition to these known broods others have been reported by the other investigators. Brood I is supposed to appear in Grant, Hardy, Randolph and Pendleton Counties in 1944. Brood II, 1945, has been reported from Brooke County and is known to be near enough to Jefferson County to be watched for there. Brood VI, 1949, may be encountered anywhere in the state. It was supposed to be present in 1932, but was not reported. A doubtful record exists of Brood VII, 1950, being present in Summers County. This brood may also be found in the Northern Panhandle as it is known to exist in western Pennsylvania.

The record of Brood XIII, 1939, being present in Lincoln and Putnam Counties, can easily be some accelerated individuals from Brood XIV, 1940. No reports were made of its presence in 1939. One lone record of Brood III, 1947, has been made for Monongalia County (*1*). Scattered individuals appearing in the areas occupied by a major brood the year before or the year after the general emergency should not be counted as belonging to a separate brood. If enough individuals are retarded or accelerated, a new brood may be created.

Records of the distribution of a brood may be made during the time the adults are in existence by observing their presence or hearing their characteristic song. Throughout the immediate summer the cast skins of the pupae leave a record of its distribution. The same year the dead twigs in trees serve as a rather definite proof of the presence of this insect, especially if present in most species of trees. The next year and for many years thereafter the characteristic scars may be seen in the twigs and

records taken from them as to the extent of the dense swarm area. Usually last-year wood is used, and by counting the age of the scarred wood the year of the occurrence of the insect can be placed accurately. Several twigs may have to be counted to determine the age of the wood in which the scars appear the most frequent, and the newest wood taken for the count. It will be necessary also to examine some wood from fast-growing trees to know positively that wood large enough to receive the eggs was present in more recent years, but not used. Scars in older wood therefore must be from the insects occurring in the year the unscarred wood was produced. An occasional puncture in the current season's growth must be ruled out of the calculations.

The adults usually emerge in the latter part of May, and the first song is generally heard about June 1. In higher altitudes emergence may be retarded until in June. The adults usually disappear by July 4.

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The Growth Rate of Some Fungi in the Presence of Cocarboxylase, and the Moieties of Thiamin*

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FUNGI MAY BE CLASSIFIED as heterotrophic, partly autotrophic, and autotrophic with respect to thiamin. Organisms belonging to the first group cannot grow unless the complete thiamin molecule is supplied to them from some external source. Those classified under the second group either can synthesize one or the other of the moieties of thiamin and, if supplied with the moiety which they cannot synthesize, are able to link the two, form thiamin, and grow; or they can synthesize neither pyrimidine nor thiazole but can link the two and produce thiamin. Completely autotrophic organisms are those that can synthesize their own thiamin when grown in a mineral solution and pure sugars.

Thiamin is not merely a catalyst, for it is destroyed in life processes. Even its moieties are not safe from destruction. Leonian and Lilly (*1*) found a number of fungi capable of destroying the thiazole moiety to a greater extent than the pyrimidine moiety.

Cocarboxylase is a pyrophosphoric ester of thiamin. Thiamin, in natural sources, is frequently present in this form. The thiamin/cocarboxylase ratio varies with the source. The effect of this substance on the rate of growth when used alone or in combination with the thiamin moieties was of particular interest to the writers, in view of the possible use of fungi in vitamin B_1 assay, and experiments were outlined to determine it. The organisms used in this work varied from autotrophic to completely heterotrophic. In view of the fact that they varied in the rate of growth and length of time before autolysis began, daily weighings were made over a period of time. The first weighings were begun as soon after inoculations as the new colonies could be handled. This was continued daily until the appearance of autolysis.

The basic medium consisted of 0.5 gram each of ammonium nitrate, potassium dihydrogen phosphate, magnesium sulfate, and Robbins and Kavanagh's (1938) modification of Hoagland's A-Z mixture of rare elements, in 1000 ml. of distilled water. The amount of Bacto dextrose and amino acid mixture (*l*-aspartic acid, *d*-glutamic acid, and *d*-arginine, two parts each; glycine and *dl*-alanine, one part each) used for each fungus is given in the experimental part. The pH was adjusted to 5.5 by the addition of sodium hydroxide. Erlenmeyer flasks (250 ml.) containing 25 ml. of medium were used for all experiments except those on *Rhizopus suinus*, when 125 ml. flasks were used. The medium was sterilized by autoclaving for 15 minutes at 15 pounds pressure. All cultures were made in quintuplicate and were incubated at 25° C. Each figure given in the tables repre-

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sents the total weight in milligrams of five colonies after drying to constant weight at 100° C.

EXPERIMENTAL

Growth Rate of Rhizopus suinus. This fungus flourishes in synthetic media without the presence of extraneous auxithals. According to Schopfer (*2*, *3*) the yield is decreased markedly by the presence of thiamin in the medium. The writers tested not only the effect of thiamin but also its two moieties, pyrimidine and thiazole, separately and together, and thiamin pyrophosphoric acid ester.[1] In all cases the concentration of the auxithal was equivalent to 1 ppm. thiamin. Five grams of dextrose were added to the basic medium. The mycelium was harvested daily and weighed beginning with the third day after the inoculation and continuing through the ninth day. (Table 1.)

TABLE 1—*Daily growth rate of Rhizopus suinus in the presence of 1 ppm. thiamin, its moieties, and cocarboxylase as shown by weight of mycelium in mg.*

Time in days	Check. No auxithals	Thiamin	Thiazole	Pyrimidine	Thiazole pyrimidine	Cocarboxylase
3	61	51	48	43	67	58
4	112	93	112	102	117	125
5	136	106	133	137	142	160
6	140	141	157	153	150	156
7	146	148	159	171	162	157
8	143	153	154	169	155	156
9	138	158	153	161	150	149

The initial growth of *Rhizopus suinus* for the first few days was smaller with thiamin than without (Table 1); however, eventually the thiamin-containing cultures formed a larger yield than the controls. This work was repeated several times and always with the same result. It should be noted that neither cocarboxylase nor the moieties exerted this depressing effect upon the fungus; but, whereas all others yielded less mycelium on the 9th day than on the previous ones, thiamin-containing cultures continued to gain, even though the increase was slight and could easily come under the limits of normal fluctuation of growth.

Daily growth rate of Mucor ramannianus. Unlike any other known heterotrophic filamentous fungus, *Mucor ramannianus* grows well in the presence of thiazole alone and fails to grow without it. Therefore it was found to be a valuable organism on which to test not only thiazole but also pyrimidine, cocarboxylase, and thiamin as well as a mixture of thiazole and pyrimidine. These substances were used in concentrations equivalent to 1/20th ppm. thiamin. Dextrose was increased to 1 percent and amino acids to 0.3 percent; 0.05 percent agar was added to the basic medium. (Table 2.)

Growth was slow in getting started where cocarboxylase and thiazole were used, but eventually in all cases the yield was about the same. The slow start in case of thiazole may be explained on the basis that where

[1] Obtained through the courtesy of Merck & Co.

TABLE 2—*The effect of thiamin, cocarboxylase, thiazole, and a mixture of thiazole and pyrimidine equivalent to 1/20th ppm. thiamin upon the daily growth of Mucor ramannianus as shown by the weight of mycelium in mg.*

Time in days	Thiamin	Cocarboxylase	Thiazole	Both moieties
4	211	65	60	125
6	381	211	135	270
8	436	433	311	446
9	492	490	354	499
10	430	478	360	497
11	461	458	383	467
12	431	446	428	466

thiamin was added, the fungus did not need to synthesize pyrimidine, link it with thiazole, and produce thiamin; consequently it began to grow without interruption. Where both pyrimidine and thiazole were furnished, the need for pyrimidine synthesis was obviated, although that for the final stage in the synthesis of thiamin still remained. Consequently we found that during the early period of growth the yield was not as much when both moieties were used as with thiamin, but it was twice as much as that induced by thiazole alone.

Daily growth rate of Pythiomorpha gonapodioides. This fungus is capable of synthesizing thiazole but must be furnished with pyrimidine before it can grow. The dextrose was increased to 1 percent, and amino acids to 0.3 percent; 0.05 percent agar was added to the solution. (Table 3.)

TABLE 3—*The effect of thiamin, cocarboxylase, and the moieties equivalent to 1/20 ppm. thiamin upon the daily growth of Pythiomorpha gonapodioides as measured by the weight of mycelium in mg.*

Time in days	Thiamin	Cocarboxylase	Pyrimidine	Both moieties
3	218	248	251	206
4	517	482	435	516
5	689	615	656	684
6	664	652	706	693
7	628	631	675	679

Pythiomorpha gonapodioides is a rapidly and vigorously growing organism and seems to be capable of speedily adjusting itself to environmental changes; hence the greater uniformity of the results in Table 3. It should be noted that the largest yield occurred in the presence of pyrimidine alone. However, the differences in the foregoing table are not large enough to be significant.

Daily growth rate of Phycomyces blakesleeanus. This fungus can synthesize neither pyrimidine nor thiazole; however, it can link the two to produce thiamin. The medium used contained increased amounts of dextrose (2.5%) and amino acids (0.25%) as well as 0.05 percent agar. (Table 4.)

Despite its slow initial start in the presence of thiamin (Table 4), *Phycomyces blakesleeanus* eventually produced a larger yield than it did

TABLE 4—*The effect of thiamin, cocarboxylase, and the moieties equivalent to 1/20 ppm. thiamin upon the daily growth of Phycomyces blakesleeanus as measured by the weight of the mycelium in mg.*

Time in days	Thiamin	Both moieties	Cocarboxylase
2	45	96	108
3	380	330	344
4	554	502	472
5	543	471	511
6	524	474	542

when either both of the moieties or cocarboxylase were substituted for thiamin. However, it should be noted that on the 6th day the yield in the presence of cocarboxylase equaled the maximum yield produced in the presence of thiamin on the 4th day. The most rapid period of growth occurred after 3 days; then it gradually diminished. No actual loss in weight occurred in the presence of cocarboxylase. Probably this substance tends to delay autolysis.

Daily growth rate of Phytophthora erythroseptica. Thiazole and pyrimidine, separately or mixed, cannot induce growth in *Phytophthora erythroseptica;* the fungus must have either thiamin or its pyrophosphoric acid ester. As demonstrated by the writers (*1*), the fungus absorbs thiamin and gives off into its medium pyrimidine and smaller amounts of thiazole. Since these two substances seem to be of no value to the fungus, it was deemed advisable to determine if their presence in the medium with thiamin or with cocarboxylase would exert any influence upon the daily growth of the fungus.

The basic medium with increased dextrose (2.5%) and amino acids (0.2%) and with 0.05 percent agar was used. Thiamin was added at the rate of 1/20th ppm.; all other auxithals were equivalent to 1/20th ppm. thiamin. The mycelium was harvested on the 4th day and continued to the 12th day, inclusive. (Table 5.)

TABLE 5—*The effect of adding the moieties to thiamin and to cocarboxylase on the daily growth of Phytophthora erythroseptica as measured by the weight of mycelium in mg.*

Time in days	Thiamin	Thiamin + both moieties	Thiamin + thiazole	Thiamin + pyrimidine	Cocarboxylase	Cocarboxylase + both moieties	Cocarboxylase + thiazole	Cocarboxylase + pyrimidine
4	146	54	115	56	129	105	62	75
5	236	250	319	248	280	249	184	134
6	551	369	401	372	584	359	354	406
7	719	609	491	502	580	630	479	695
8	807	700	644	785	797	743	678	791
9	789	790	780	802	686	825	675	789
10	806	766	783	809	762	819	706	793
11	779	767	761	821	768	816	777	778
12	775	778	762	804	778	778	775	777

Table 5 shows that thiamin and cocarboxylase induced rapid acceleration in the absence of moieties, so that on the 6th day there was considerable difference in the yield. However, shortly thereafter, the others began to gain; on the last day there was remarkable uniformity of yield in all cases. The largest yield was produced in the presence of cocarboxylase and both moieties. We cannot explain why an initial inhibition should be followed by such rapid acceleration. If thiazole and pyrimidine are merely byproducts, their inhibiting action should continue; but the fact that such was not the case indicates that they have some beneficial function. It may be possible that the moieties are involved in some of the biological processes of the fungus despite the fact that *Phytophthora erythroseptica* is unable to synthesize thiamin from them.

SUMMARY

Thiamin was found to depress the rate of growth of *Rhizopus suinus* for the first five days of growth and thereafter to increase it. Cocarboxylase increased the rate of growth of this fungus and also induced the largest yields of mycelium. *Mucor ramannianus* grew more rapidly up to the 8th day in the presence of thiamin than in the presence of equivalent amounts of cocarboxylase, thiazole, or the two moieties. This fungus grew more rapidly up to the sixth day in the presence of both moieties than in the presence of thiazole or cocarboxylase. The slowest rate of growth occurred in the presence of thiazole alone. The final yields were about the same. *Pythiomorpha gonapodioides* showed no great difference in the rate of growth in the presence of thiamin, cocarboxylase, pyrimidine, or both moieties. After two days the weight of the mycelium of *Phycomyces blakesleeanus* was more than twice as much in the presence of cocarboxylase than in that of thiamin. Its growth was only slightly less in the presence of both moieties than in the presence of cocarboxylase. However, by the third day and thereafter, the rate of growth in the presence of thiamin exceeded that induced by cocarboxylase or of both moieties. The final yield was a little less for both moieties than either thiamin or cocarboxylase. *Phytophthora erythroseptica* up to the 4th day grew at a slower rate in the presence of cocarboxylase than in the presence of thiamin. Up to the 6th day, pyrimidine and thiamin or thiamin and both moieties depressed the rate of growth more than did thiazole and thiamin together. On the other hand, thiazole and pyrimidine alone in the presence of cocarboxylase depressed the rate of growth in the early stages more than did both moieties in the presence of cocarboxylase. The final yields were the same for all combinations.

Of the four heterotrophic fungi tested, cocarboxylase induced slower initial growth than the thiamin with 3 organisms and greater initial growth with one. With 3 of the heterotrophic fungi, autolysis occurred later in the presence of cocarboxylase than in the presence of thiamin; this was true whether cocarboxylase induced a more or less rapid initial rate of growth than thiamin. Under our conditions, thiamin produced only an initial depression in the rate of growth of *Rhizopus suinus*.

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The Laboratory Diagnosis of Appendicitis

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THE DIAGNOSIS OF APPENDICITIS from the clinician's point of view is very difficult. He has to differentiate it from numerous other conditions. In the female they are more numerous than in the male. French (*6*) lists 35 and Deaver (*4*) 40 conditions with which it is likely to be confused. Among them are diseases of the kidney and ureter, diseases of the gall bladder, diseases of the stomach and other portions of the intestines besides the appendix, diseases of the female genital tract, and extra-abdominal conditions such as pneumonia and pleurisy. It must even be differentiated from typhoid fever, lead colic, acute alcoholic poisoning, and reactions following vaccination for smallpox.

Certain physical signs and symptoms are present (*1*) whereby a surgeon arrives at the diagnosis. These include pain and tenderness, nausea and vomiting, increased temperature and pulse rate, constipation, rarely diarrhea, and leucocytosis. X-ray examination, following the giving of a bismuth or barium meal, is of little value in the diagnosis of acute forms of the disease but sometimes (*1*) it aids in the diagnosis of sub-acute or chronic stages of appendicitis.

The pathologist, knowing the surgeon's difficulties, appreciates the problem which he encounters in differential diagnosis. The former examines the appendices, both grossly and microscopically, after they have been removed surgically. He has an opportunity to study objectively the changes from normal that the organ had undergone which caused the patient's symptoms. Often he finds the organ seriously altered by disease, and at other times, no deviation from normal.

I am presenting the laboratory findings in a series of 1193 cases in which appendectomies alone were performed. Appendices which were removed with other organs as a prevention against a subsequent attack of appendicitis are not included. In other words, the operative procedure was undertaken only on account of symptoms referable to the appendix. The clinical histories and physical manifestations of the patients are omitted. The findings are entirely from the laboratory standpoint.

The series is divided into six groups: acute, subacute, and chronic appendicits, peri-appendiceal inflammations, neoplasms, and a group in which the findings were negative.

Types of Acute Appendicitis

	Cases	Percentage
Acute Catarrhal Appendicitis	67	5.6
Acute Diffuse Purulent Appendicitis	132	11.1
Acute Gangrenous Appendicitis	257	21.7
Acute Gangrenous with Perforation	12	1.0
Acute Hemorrhagic Appendicitis	19	1.6
	487	41.0

Acute catarrhal appendicitis is the earliest stage of acute inflammation of the organ. The inflammation in this stage is limited to the mucosa and has not involved the deeper coats. About one-half of the number of patients were operated upon in this stage in comparison with the next stage, that of acute purulent appendicitis, when the inflammation had spread diffusely through all coats of the organ. Approximately twice as many patients were operated upon in the stage of gangrene than in that of diffuse purulent inflammation. In the stage of gangrene the inflammation had advanced so far in 12 cases that the organ perforated.

The cases of acute hemorrhagic appendicitis are of interest. In these cases diffuse hemorrhages as well as infiltrations of leucocytes were observed. Hemorrhages were also observed in the gangrenous forms and to a lesser extent in the diffuse suppurative forms of the disease, but seem to dominate the picture in the cases in which the diagnosis of acute hemorrhagic appendicitis was made. In some of these cases I do not believe that the inflammation was limited to the appendix but must have been associated with a similar type of inflammation involving the intestinal tract in the region of the cecum. In fact, a few of the appendices were examined at times when an intestinal form of influenza was prevalent.

Types of Subacute Appendicitis

	Cases	Percentage
Acute Superimposed upon Chronic Appendicitis	15	1.26
Subacute Appendicitis	73	6.16
Subacute Appendicitis with Perforation	2	.02
	90	7.44

In the cases designated as acute superimposed upon chronic appendicitis, the organ had shown signs of either one or more previous attacks of inflammation which had left their mark by proliferative changes and infiltrations of lymphocytes, plasma cells, and eosinophiles. In addition a fresh acute inflammation was present.

In the cases referred to as subacute appendicitis, the inflammation had definitely passed the acute stage. The exudate, which is made up mainly of polymorphonuclear leucocytes during the acute stage, had changed to one consisting of lymphocytes, plasma cells, and eosinophiles as well as polymorphonuclear leucocytes. In two instances the organ had perforated either during the acute stage or during the subacute stage of the disease, most likely during the acute stage; and the patients had not been operated upon until the inflammation had passed into the subacute phase.

Types of Chronic Appendicitis

	Cases	Percentage
Chronic Appendicitis	26	2.1
Chronic Obliterative Appendicitis	80	6.7
Tuberculosis	1	.1
	107	8.9

The diagnosis of chronic appendicitis from the pathologist's viewpoint is exceedingly difficult. I have seen very few appendices in which the histological picture is one of chronic progressing inflammation. In some of them the microscopic appearance was that of a subsided previous acute attack, while in others the appearance was that of a progressing low-

grade inflammation. Probably in this group may be included (7) the patients with vague intra-abdominal symptoms who the surgeon believes may likely be benefited by removal of the appendix and undoubtedly some of them are afforded relief from their symptoms. A similar histological picture (3) is often seen when the organ is removed in the course of some other operative procedure.

The organ which has undergone chronic obliterative changes is not at all considered likely to produce clinical symptoms by most pathologists. The histological appearance shows the lumen represented by a core of connective tissue and the landmarks of the mucosa entirely replaced by connective tissue. Signs of chronic inflammation such as infiltrations of lymphocytes and plasma cells into this connective tissue are also seen. The deeper wall may or may not show atrophic and fibrotic changes.

There was only one case of tuberculosis involving the appendix. Tuberculosis is essentially a chronic type of inflammation. This affection of the appendix (2) will produce symptoms of appendicitis. However, in this case, it was (7) probably an extension from tuberculosis involving other portions of the intestines.

Types of Peri-appendiceal Inflammation:

	Cases	Percentage
Acute Peri-appendiceal Inflammation	10	1.00
Chronic Peri-appendiceal Inflammation	59	4.91
Tuberculous Peri-appendicitis	5	0.50
Total	74	6.41

In the group of peri-appendiceal inflammation, there was no sign of inflammation within the inner coats of the organ, but inflammatory changes were observed involving the serous coat and meso-appendix. Symptoms evidently had been referred to the region of the appendix in a more extensive involvement of the peritoneum, either locally or generally. Likewise the cases of tuberculous peri-appendicitis were local manifestations of a more generalized tuberculous peritonitis.

Types of New Growths

There is also included in this group an embryonal vestige of the organ

	Cases	Percentage
Fibroma	1	0.1
Leiomyoma	1	0.1
Carcinoid	3	0.25
Embryonal Vestige	1	0.10
Total	6	0.55

The tumors encountered were all benign. A fibroma is a (7) tumor of connective tissue origin. It is rare in the intestine and especially rare in the appendix. The leiomyoma, a benign tumor of smooth muscle, is rare (5) in the appendix as well as in other portions of the bowel. They arise from smooth muscle of the wall and may obstruct the lumen, thereby producing symptoms of appendicitis.

The carcinoid tumor is the most frequent tumor of the appendix. It is benign and is found in about 0.5 percent of all appendices (5) removed

at operation. Because of its resemblance to carcinoma it is called carcinoid. The tumors probably originate from the chromaffine (*8*) system and are in close association with the ganglia of the sympathetic nervous system, and involvement of its nerve endings may cause symptoms. They are small, yellowish nodules in the wall which grow slowly. Metastases (*5*) rarely occur.

The specimen called vestige of appendix showed nothing of the usual structure of the organ. It was only a mass of connective tissue with some lymphoid tissue present. It could not possibly have produced symptoms.

	Cases	Percentage
Normal Appendices	429	35.7

In this group the appendices showed no changes or degrees of atrophy of the muscular wall, hyperplasia of the lymphoid follicles of the submucosa, congestion, or hemorrhage into the wall or lumen or both. Hemorrhage was most likely caused by trauma at the time of removal. At any rate, the histological findings were not sufficient to account for clinical symptoms.

I have presented a series of 1193 appendices removed solely on account of symptoms referable to the appendix. It has been divided into the groups listed above. In a large number of the cases in the acute and subacute forms of the disease, fecoliths or foreign bodies were found. They caused obstruction to the lumen, which became distended with secretions added to the fecal material which was present, and caused pressure on the blood vessels and necrotic changes leading to bacterial invasion, ultimately (*3*) leading to gangrene or perforation. In 12 instances the organ had ruptured. More than one-third of the appendices removed were normal in appearance. Only 5 neoplasms were observed, none of which were malignant.

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The *Coreopsis major* Complex in Cabell County

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UNDER THE SPECIES *Coreopsis major* we have plants with leaves varying in pubescence from strict glabrosity to minute, soft, dense pubescence and in shape from ovate to narrowly lanceolate. The extremes are pronounced but intergrade completely even in the same locality.

A few plants were collected for exchange some time ago, but it was found that both the amount of pubescence and the shape of the leaflets were not consistent enough to label pubescent var. *typica* or the narrow-leaved and glabrous var. *stellata*. A few days later enough more specimens were collected to bring the total to 140, with specimens of both extremes.

If one extreme is distributed as *typica* and the other as *stellata*, should the rest of the specimens be discarded because they do not fit into the accepted slots? And should *stellata* be considered a variety? In Britton and Brown (*1*) an easy way out is taken, and no variations whatsoever are recognized. The extremes are so pronounced, however, that if this attitude were to be taken by everyone, taxonomy would languish.

In Gray (*2*), var. *stellata* is recognized as being glabrous with narrower leaflets, and Small (*3*) mentions var. *Oemleri* as being glabrous and var. *rigida* as having narrow leaflets. The glabrosity is not correlated with the narrower leaflets, and if we consider one factor in making a variety, we must disregard the other. A species is frequently divided into geographic varieties where a factor of difference is more or less correlated with a difference in geographic range, but in Cabell County all extremes are found in the same acre or so of woodland (see Table 1).

TABLE 1—Coreopsis major *showing variation*

Degree of pubescence	Total	Leaf shape		
		Lanceolate	Lanceolate-ovate	Ovate
Densely pubescent	22	3	15	4
Pubescent	74	5	60	9
Slightly pubescent	13	2	7	4
Glabrous	31	3	16	12
Total	140	13	98	29

Some taxonomists do not believe in creating varieties, to say nothing of forms. Thus if a specimen does not fit in a slot arbitrarily cut out for it, more slots, slightly different, should be made, or the one enlarged so that everything passes through without even touching the sides.

In the case of *Coreopsis major* the creation of several forms, based on

the extremes of pubescence and of leaflet shape, would seem to be more satisfactory than either of the other methods of classification.

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The Carbohydrate Requirements of *Diplodia macrospora**

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INSTANCES HAVE BEEN CITED showing that some organisms are apparently able to utilize disaccharides more readily than monosaccharides. Tamiya (*9*) reported greater growth of *Aspergillus oryzae* on polysaccharides than on monosaccharides. Wenck, Peterson, and Fred (*10*) made similar observations on *Aspergillus fischeri*. White (*13*) found that sucrose was superior to dextrose as a source of carbohydrate for excised tomato roots. Miss Kinsel (*2*), working with *Diplodia macrospora* Earle, was unable to obtain any growth on synthetic media with monosaccharides as carbon source, whereas excellent growth resulted when disaccharides or starch were used. According to Stevens and Larsh (*8*), *Diplodia macrospora* failed to grow in media containing only cerelose as a source of carbohydrate, but grew readily when cane sugar was used.

Steinberg (*6*) has suggested the desirability of a repetition of tests to determine whether the apparent greater availability of disaccharides for certain fungi is due to chemical structure or to the greater difficulty in purification of the polysaccharides. With this suggestion in mind, a preliminary test was made in which *Diplodia macrospora*, obtained from Stevens, was inoculated on agar plates containing dextrose (cerelose) and sucrose as sources of carbohydrate; one series received no auxithals, another contained thiamin, and a third both thiamin and biotin extract. No growth was observed on either dextrose or sucrose, with or without thiamin, except where biotin extract had been added; in the latter case there was excellent growth on both dextrose and sucrose.

The following experiment was made to determine whether the better growth induced by the disaccharides was due to impurities present in these sugars or to their disaccharide structure. Dextrose, sucrose, commercial cane sugar, brown sugar, and maltose were used as carbon sources at the rate of 20 gm. per liter. The sugars were treated to remove impurities by dissolving them in distilled water, boiling with Norit (activated charcoal), filtering, and recrystallizing. The basic solution consisted of 0.5 gm. each of ammonium nitrate, potassium dihydrogen phosphate, and magnesium sulfate, 1.0 gm. each of aspartic and glutamic acids, and 1000 ml. of distilled water. Ferric nitrate, manganese sulfate, and zinc sulfate in quantities furnishing one part in five million each of ferric iron and zinc, and one part in 50 million of manganese, were used to furnish the minor elements. The biotin extract used was obtained by evaporating in vacuo an alcoholic extract of the pyridine eluate of material adsorbed on

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Norit from cow manure, following the method of Kögl and Tönnis (*4*). The amount used was 0.1 gm. per liter.

The various solutions were adjusted to pH 5.5 by means of sodium hydroxide, divided into portions of 20 ml. each in Erlenmeyer flasks of 125 ml. capacity, and sterilized by autoclaving for 15 minutes at 15 lb. pressure. Five flasks were prepared for each modification of the medium. They were inoculated with discs 5 mm. in diameter, cut from a four-day-old Petri dish colony on nutrient agar. All cultures were incubated for 15 days at 25° C. The five fungus mats in each series were then removed from the flasks, combined, and dried to constant weight at 80° C. Each figure given in the following table represents the weight in milligrams of a single culture, as computed from the average of five cultures.

TABLE 1—*Growth in milligrams of Diplodia macrospora on treated and untreated sugars*

Treatment	Dextrose	C.P. sucrose	Cane sugar	Brown sugar	Maltose
Untreated sugar	11.8	12.9	14.2	132.5	36.3
Untreated sugar plus biotin extract	102.7	94.2	90.7	111.4	101.8
Sugar treated with Norit	7.6	7.4	7.3	7.0	7.8
Treated sugar plus biotin extract	83.1	88.7	85.7	95.4	59.3

There was almost no growth when untreated dextrose, sucrose, or cane sugar was used; somewhat better results were observed on untreated maltose, and an excellent crop of mycelium was obtained with brown sugar. The addition of biotin extract to untreated sugars caused increases in growth ranging from 281 to 870 percent with the exception of brown sugar, in which case there was no increase. Purification of the sugars by treatment with Norit and by recrystallization caused slight decreases in growth in all except brown sugar, where there was a significant decrease from 132.5 mg. to 7.0 mg. The addition of biotin extract to the treated sugars gave growth increases of 760 to 1360 percent.

These figures indicate that brown sugar contains some impurity which makes it capable of supporting much greater growth than dextrose, sucrose, or cane sugar; maltose contains the same, or a similar impurity, but in smaller amounts. Treatment with Norit removes this impurity and renders both maltose and brown sugar no more available than the other sugars used. This impurity is either the same as, or similar to, the active principle contained in the biotin extract, since the extract exercises the same effect on growth. Addition of the extract to untreated sugars results in large increases; in the case of brown sugar, it is assumed that an optimum amount of the necessary auxithal was already present as an impurity; hence the failure of the biotin extract to produce increased growth. The data on brown sugar illustrate the situation quite clearly; untreated, it supported excellent growth of *Diplodia macrospora*, treatment with Norit removed a substance necessary for growth, and the addition of biotin extract replaced it.

The biotin extract used in this experiment has been shown, in tests carried out by Leonian and Lilly, to be capable of supporting the growth of *Ashbya gossypii* (*Nematospora gossypii*). Kögl and Fries (*3*) found that

Ashbya gossypii required biotin; Fries (*1*) confirmed this. Robbins and Schmidt (*5*) reported the presence of biotin in liquid manure, as based on the growth of *Ashbya gossypii*. The extract used in this work contained either biotin or a closely related substance. Unfortunately the unavailability of Kögl's biotin in pure form makes it impossible, for the present, to establish definitely that the impurity present in brown sugar is biotin; however, it seems safe to predicate that the impurity is either biotin or some substance very similar to it.

The growth obtained by the addition of biotin extract to untreated sugars was consistently better than that resulting from the combination of the extract with Norit-treated sugars. One or more factors may form the basis for this behavior. The following are suggested as tentative explanations:

(A). The rather vigorous treatment of the sugars may have resulted in a change in molecular configuration from the more reactive oxide-ring formations to the more stable and less active forms. (B). The methods of purification may have caused the oxidation and destruction of some of the sugar; consequently the energy content may have been lowered, or oxidation products of toxic nature may have resulted. The behavior of the maltose series lends some support to this theory. The addition of biotin extract to recystallized maltose resulted in little more than 50 percent of the growth obtained with the untreated sugar plus the extract. Maltose is a very unstable sugar and is quite difficult to recrystallize. The lower yield suggests that something happened to the maltose during the process of purification. (C). The amount of biotin extract added to the treated sugars may have been less than the optimum, and not a sufficient quantity to replace the auxithal removed by purification. (D). In purifying the sugars, i-inositol, possibly present as an impurity, may have been removed. The biotin extract had been treated with lead acetate, which would eliminate any i-inositol in it. This substance has been reported as necessary for maximum growth of *Saccharomyces ellipsoideus* (*7*), *Ashbya gossypii* (*3*), and *Lophodermium pinastri* (*3*). The absence of i-inositol from the treated sugars might have had a similar inhibitory effect on the growth of *Diplodia macrospora*. (E). The untreated sugars may have carried with them an essential auxithal other than biotin or i-inositol, which was removed by purification, and not replaced by the biotin extract.

Discrepancies between the results on sucrose and cane sugar presented here and those obtained by Miss Kinsel (*2*) and by Stevens and Larsh (*8*) may be due to possible differences in the purity of different brands of cane sugar.

The results of this experiment demonstrate that *Diplodia macrospora* does not grow better on sucrose than on dextrose, except when biotin or a biotin-like substance is present as an impurity accompanying the disaccharide. A like situation may exist for some of those other organisms which have been reported as showing a preference for disaccharides rather than monosaccharides. That this need not necessarily be true in all instances is indicated by the observations of White (*12*) that the growth of excised tomato roots was slightly superior in the most highly purified sample of sucrose to that obtained in less pure samples. He concluded that significant impurities necessary for, or clearly beneficial to, the growth of excised tomato roots were not present. His findings showed

definitely inferior growth in dextrose solutions as compared with sucrose solutions, substantiating his earlier work (*11*). It appears to the writer that it would be exceedingly desirable to investigate this situation further; Steinberg (*6*) suggests tests with hydrolyzed polysaccharides to determine whether this effect might not be due to chemical structure, since it is evidently not the result of the presence of impurities. White (*12*) shows that the tomato roots grow well on sucrose but poorly on either dextrose or fructose. Considering the fact that any hydrolysis of the sucrose in the plant would result in a mixture of equal amounts of dextrose and fructose, the testing of excised tomato roots on such a mixture should afford some valuable information.

SUMMARY

Diplodia macrospora Earle has been reported as unable to grow on dextrose but able to grow well on sucrose. The results of this experiment indicate that this fungus grows equally well on dextrose, sucrose, and maltose if supplied with the necessary auxithal: biotin or a biotin-like substance. If this auxithal is not present, there is practically no growth on any of these sugars. The excellent growth observed on brown sugar is evidently due to the presence of the auxithal as an impurity, since treatment of the brown sugar with Norit to remove impurities resulted in a tremendous decrease in its ability to support growth, while the addition of biotin extract to Norit-treated brown sugar restored that ability.

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The Chemistry Section

William Prout (1785–1850)*

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WILLIAM PROUT was born in England, 1785. He graduated from Edinburgh, 1811, with the M.D. degree, and was an active physician in London from 1812 to his death in 1850.

Prout is best known for his hypothesis (Prout's Hypothesis), which attracted attention first through an anonymous memoir, "Relation Between the Specific Gravities of Bodies in Their Gaseous State," published by him in 1815, in which he pointed out grounds for believing that the atomic weights of all the elements are exact multiples of either the atomic weight of hydrogen or half that of hydrogen. In 1831 he suggested that hydrogen itself may be formed from "some body lower in the scale." Prout and his hypothesis had much to do with the activities of Dumas and Stas in the direction of atomic weight determinations.

While Prout's contemporaries were not agreed as to the truth of his predictions, it is of interest to note that Thomas Thomson was his supporter and that on the other hand Berzelius rejected Prout's views. It was revised again by Dumas and Stas in 1839 and 1840. The validity of the hypothesis is still undetermined; nevertheless it is serving as a powerful stimulus to exact experimental investigation of atomic weights.

Prout manifested ability in numerous ways. He delivered courses of lectures on chemistry and medicine at his London home. He pioneered in physiological chemistry, both in theory and practice. In 1823 he discovered that hydrochloric acid is normally present in the stomach. His demonstration left no uncertainty, as he distilled it from stomach contents. Of his numerous publication references along medical lines, mention should be made of "the application of chemistry to physiology, pathology and practice," published in 1831, and to a treatise on "chemistry, meteorology and function of digestion, considered with reference to natural theology," published in 1834. The Royal Society carries 34 papers to Prout's credit.

Pictures of Prout are difficult to find. Fortunately the writer learned through Assistant Secretary S. E. Carr of the Chemical Society (London) of a painting recently presented to the Society by a relative of Prout. Through the good services of a London photographic company, Messrs. Elliott and Fry, Ltd., the writer obtained a photograph of the painting.

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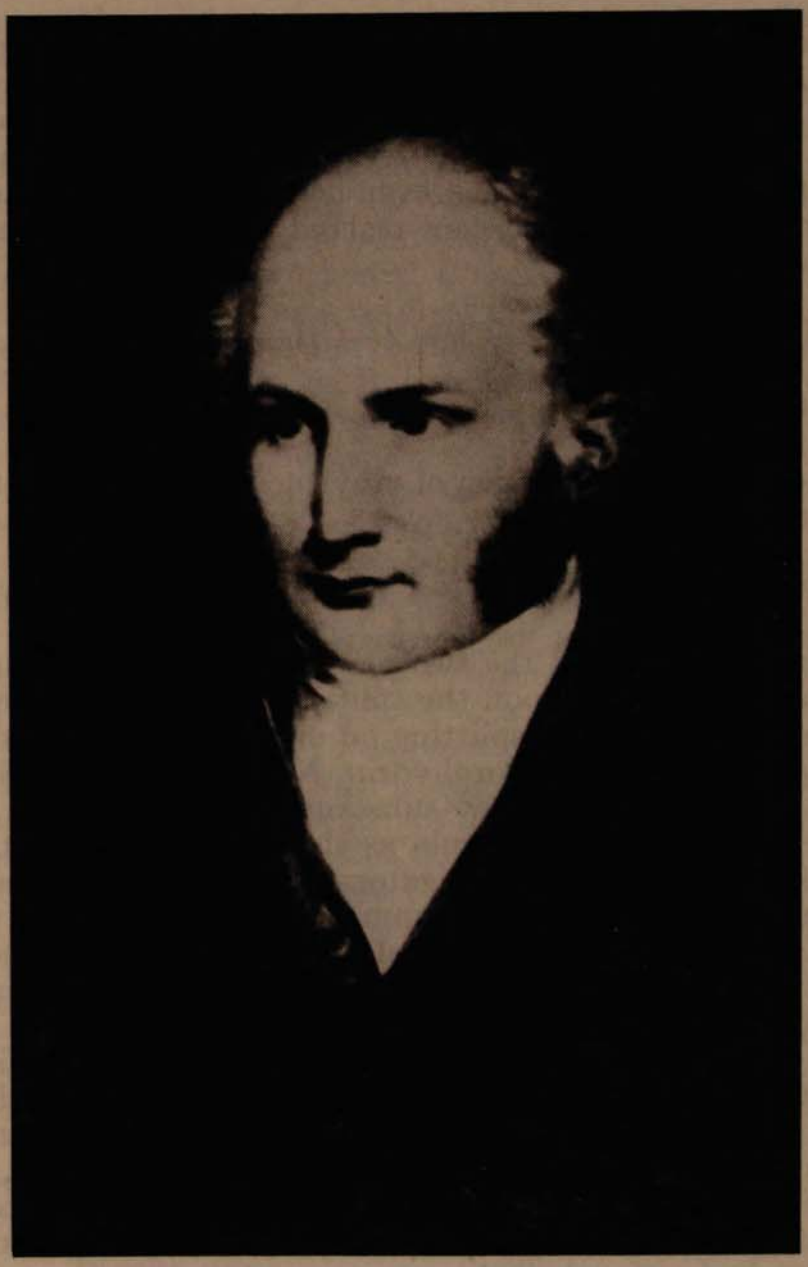
* Presented at the 1939 meeting.



WILLIAM PROUT

Reactions of Alkyl Oxides with Phosgene

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BECAUSE OF THE REACTIVITY of the alkyl oxides and of carbonyl chloride found in previous studies at West Virginia University as well as at other laboratories, it was considered possible that these two might react with each other. An exhaustive search of the literature gave no indication that this reaction has ever been attempted. It was believed that if ethylene oxide and phosgene reacted the reaction might take place in the following manner:

$$\begin{matrix} CH_2 & & \\ \diagdown & \diagup & \\ & O & \end{matrix}\!\!-CH_2+Cl-CO-Cl \rightarrow Cl-CH_2-CH_2-O-CO-Cl$$

It will be noted that the reaction of ethylene chlorohydrin with phosgene is already in the literature:

$$CH_2Cl-CH_2OH+Cl-CO-Cl \rightarrow Cl-CH_2-CH_2-O-CO-Cl+HCl$$

At first it may appear that the two reactions are very similar. However, the first reaction depends upon the splitting of a heterocyclic ring, while the latter is based upon the splitting off of a molecule of hydrogen chloride. By the method using chlorohydrin, Nemirowsky, in 1889 (J. Prakt. Chem. *31*, 173–6), found a new substance which boiled at 150° C. to 160° C. He established the formula as that of the B-Chlorethyl ester of chlorocarbonic acid. Other investigators give the boiling temperature of this compound as 152.5° C. at 752 mm. pressure.

In our laboratories the reaction of phosgene with ethylene oxide was carried out by liquefying the phosgene by passing it down through a coiled tube, around which circulated ice water, into a flask surrounded with an ice-salt mixture. Ethylene oxide was similarly liquefied and was dropped into the flask, where the two liquids were thoroughly mixed by mechanical stirring. In order to get reasonably good yields it was necessary to allow at least six hours for the reaction to take place, and even a longer time was preferable. The flask was then brought to room temperature to remove the unreacted reagents, and the liquid product was distilled. The main fraction boiled in the range 140–160° C. at atmospheric pressure. This product was then treated with ammonium hydroxide (1:1), upon which treatment a white crystalline solid precipitated. This was filtered and washed free of ammonium chloride with cold water. The supposed reaction was:

$$Cl-CH_2-CH_2-O-CO-Cl+2NH_4OH$$
$$\rightarrow Cl-CH_2-CH_2-O-CO-NH_2+2NH_4Cl+HOH$$

The yield of 54 percent was low because of partial solubility of the product

in the wash water. Later the yield was increased by dropping the chlorocarbonate into a flask filled with dry ammonia gas; immediately the white, solid urethane and ammonium chloride were formed. The flask was again filled with ammonia gas, stoppered, shaken, and allowed to stand. The urethane was then extracted with dry ether and separated by evaporation of the solvent. By this procedure the yield is nearly quantitative, but the method is considerably longer and the product no purer. The melting point of the solid urethane was found to be 75.5 to 76° C., which checks Nemirowsky's value of 76° C.

The reaction with propylene oxide was carried out first by dropping the liquefied phosgene into the propylene oxide and allowing them to stand over night. Fifteen to 30 percent of the unreacted oxide was usually recovered in the morning. A very low yield was obtained in less than five hours; there was only 7 percent conversion in the first 30 minutes and 50–60 percent in the first two hours. Boron trifluoride, which has been successfully used in the past as a catalyst in alkyl oxide reactions, apparently increased the polymerization of the propylene oxide rather than the formation of the chlorocarbonate. Bubbling the gaseous phosgene through the propylene oxide at room temperature only gave a 15 percent yield when the same amount of phosgene was used as when the liquids were mixed. Warming the propylene oxide to its boiling point (under reflux condenser) while the phosgene was bubbled through it gave even a lower yield (5%), probably as a result of decreased solubility of the phosgene gas in the oxide. An attempt was then made to react the components in the gaseous phase. This was carried out by passing the gases simultaneously through a pyrex glass tube two feet in length and $\frac{3}{4}$ inch in diameter. When the tube was warmed to a temperature just above the boiling point of the oxide there was practically no reaction; a low yield of phosgenated product, along with considerable charring, resulted when the tube was heated to a red heat. An increase of surface by filling the reaction tube with clay boiling chips did little to increase the yield. It is possible that, if a circulating system were used to pass the gases through the heated tube a number of times, an appreciable yield of phosgenated product could be obtained.

The first treatment of the product was with ammonia gas in the manner already described. This mixture was separated from the ammonium chloride by extraction with dry ether and then distilled at reduced pressure (2 cm.). There was a low-boiling liquid fraction, a solid distilling at 130° to 150° C., and a viscous high-boiling liquid. There was decomposition and charring.

Distillation of the acyl chloride before ammonia treatment was found to have the advantages of lower boiling points; all the products were liquid and there was less decomposition. At 1 cm. pressure the fractions were:

Fraction	Temperature	Distribution
1	40–55° C.	44%
2	55–70° C.	17%
3	70–100° C.	6%
4	100–117° C.	24%
5	above 117° C.	9%

Practically all of fraction 4, upon redistillation, came over in the range

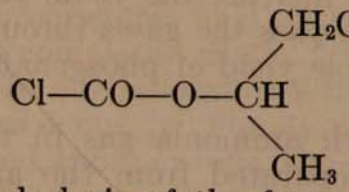
104–114° C. When this was treated with dilute ammonium hydroxide no precipitate formed and the organic layer was only slightly milky. With silver nitrate (5% solution) no precipitate of silver chloride appeared at first, but upon standing a few minutes there was some white precipitate. These tests indicated that this fraction probably contained the di-substituted carbonyl product; i.e., the di-ester of carbonic acid. This compound has the formula $C_3H_6Cl—O—CO—O—C_3H_6Cl$ and has only alkyl substituted chloride and not the acyl chloride. A chloride analysis showed that this was not polymerized propylene oxide.

Practically all of fractions 2 and 3 upon redistillation boiled in the range of fraction 1. This fraction was redistilled at 1 cm.:

Fraction	Temperature	Distribution
1a	Less than 40° C.	20%
1b	40–52° C.	30%
1c	52–58° C.	50%

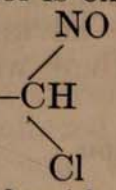
The lowest fraction yielded no urethane upon treatment with ammonia and did not give a strong test for chloride. It is believed that this fraction contained mainly polymerized propylene oxide. Both 1*b* and 1*c* yielded solid urethanes upon treatment with dilute ammonium hydroxide. The urethanes of both fractions as well as a mixture of the two melt at the same temperature and are believed to be one compound. The width of the boiling range of the acyl chloride is probably due to some polymerized propylene oxide boiling at this range. The melting point of the urethane was found to be 60–61° C. It is soluble in alcohol, ether, benzene, and the cellosolves. The percentage of chlorine was found to be 26.8.

When propylene oxide is treated with hydrogen chloride, one gets mainly the $CH_3—CHOH—CH_2Cl$ with only a small amount of $CH_3—CHCl—CH_2OH$. This is, in general, the manner in which propylene oxide reacts. Thus it is believed that, in the reaction studied, the product is:



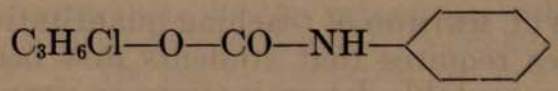
rather than: $Cl—CO—O—CH_2—CHCl—CH_3$.

Hydrolysis of the former would give $CH_3—CHOH—CH_2Cl$ and of the latter, $CH_3—CHCl—CH_2OH$. These two compounds cannot be separated readily by distillation. The boiling points are 127° C. and 134° C. Oxidation of either chlorohydrin gives a mixture of byproducts. Henry states (Chem. Zentr. II, 486 [1903]) that when the iso alcohol is oxidized with nitric acid, an intermediate compound

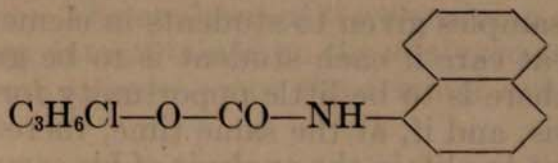


is formed which will give a yellow coloration with sodium hydroxide and a red coloration with ferric chloride. These tests were obtained in the hydrolyzed products of the chloropropyl chlorocarbonate, but this test is qualitative and does not exclude the possibility of the other isomer also being present.

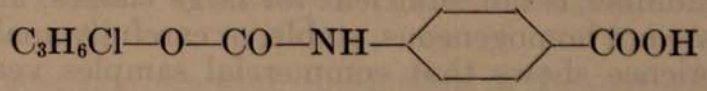
Equal molar quantities of chloropropyl chlorocarbonate and aniline (both diluted with ether) were mixed and cooled. Aniline hydrochloride precipitated immediately. The hydrochloride was removed by shaking with water. The ether layer was then evaporated and the carbanilate was distilled under reduced pressure. A yellow oil was obtained which distilled at 168–170° C. when a pressure of 4 mm. was used. It did not crystallize even when cooled with an ice-salt mixture. Its chloride content of 14.9 percent checks the theoretical for:



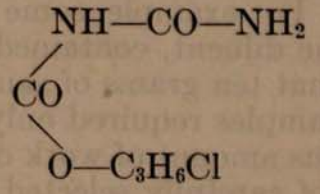
Alpha naphthyl amine treated in a similar manner gives a solid which has a pale pink color. The boiling point at 4 mm. is 210–215° C. and it melts at 49–51° C. The solid was recystallized from hot petroleum ether. The formula is:



Para amino benzoic acid gives a white solid insoluble in water but soluble in ether, alcohol, and hot petroleum ether. It melts at a temperature of 160–161.5° C. Its formula:



Warming the chloropropyl chlorocarbonate with urea for four hours yields an allophanate which crystallized from hot absolute alcohol to give fine white needles which melt at 152–153.5° C. The percentage of chlorine in this compound very closely checks the theoretical for the compound:



SUMMARY

(1) A new method for preparing chloro-substituted esters of chloro carbonic and of carbamic acids has been described.

(2) Seven new compounds not previously described in chemical literature have been prepared and their properties determined.

The Preparation of Certain Samples for Students of Elementary Quantitative Analysis

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THE MOST SUCCESSFUL METHOD of teaching quantitative chemical analysis to large classes requires that students first become proficient in making a variety of acceptable determinations on simple materials before attempting the analysis of more complex substances containing many variables. Such an approach necessitates no more supervision and personal assistance than can reasonably be given to each member of a large class.

To this end the samples given to students in elementary classes must be selected with great care if each student is to be graded fairly on his analytical work, if there is to be little opportunity for the student to go astray in the analysis, and if, at the same time, there is to be no opportunity for the student to obtain the analysis of his sample by some means other than performing the work.

Experience at West Virginia University confirms the report of Mellon and Mehlig[1] that samples obtained commercially are not often suitable because the number is not sufficient for large classes, and in some cases the samples are not homogeneous, stable, or carefully analyzed.

Our experience shows that commercial samples very often contain interfering elements which are too difficult to remove to be of use in an elementary determination. Some sets of commercial samples have too wide a range. We prefer a set with a uniform difference between successive samples of one to two percent, with the greatest difference between any two samples in a set no greater than that amount which can be determined by a single set of directions. For example, some acid samples made from solid organic acids, plus some diluent, contained such a small amount of acid, based on oxalic acid, that ten grams of sample were necessary for a determination while other samples required only one gram.

To eliminate the enormous amount of work ordinarily connected with the furnishing of hundreds of carefully selected samples year after year, a large number of sets of large stock samples have been prepared at West Virginia University from which student samples may be drawn.

Mellon and Mehlig[2] have pointed out the problems encountered in preparing such samples and have set forth the requirements that a sample must meet to be suitable for student analysis. These requirements may be summarized as follows:

1. The analysis of the sample by the method outlined for the students must be known beyond question.
2. The sample must be well mixed.
3. The sample must be of sufficiently small particle size to insure that segregation due to handling and storage has not occurred.
4. The sample must be chemically stable.

[1] Mellon, M. G., and Mehlig, J. P., Journal Chem. Educ. *11:* 664 (1934).
[2] Ibid.

In addition to these requirements the sample should, if possible, be stable as to moisture content. If the moisture content can vary enough to cause an appreciable change in the analysis, then the analysis should be made on the dried sample. For large classes too many samples of this type should ordinarily be avoided. All the samples described here meet these requirements.

MANGANESE ORE SAMPLES

Suitable for determining manganese, available oxygen, and silica.

Weighed quantities of manganese dioxide, manganous carbonate, and silicic acid to make a total of one kilogram were mixed after grinding to pass the 100-mesh sieve and drying at 120° C. The mixing was carried out in a ball mill.

It was observed that these mixtures contained an appreciable amount of sensible moisture. Therefore the samples were spread on paper and were allowed to dry to constant weight in the atmosphere. This drying required about two weeks. Analyses were made on various samples at intervals in the series. The analyses of the remaining samples in the series were calculated from data obtained on the analyzed samples. Observation and analyses of these samples since the original analyses show that the mixtures are stable.

FERRIC SULPHATE SAMPLES

Suitable for the determination of iron and sulphate.

Weighed quantities of anhydrous ferric sulphate, potassium sulphate, and potassium chloride to make one kilogram were mixed after grinding to pass the 100-mesh sieve and drying at 120° C.

Analyses of these samples were obtained as in the method outlined for manganese ores. Subsequent work shows that these samples are stable. These samples vary greatly in color, ranging from pale yellow to dark brown, so that it is necessary to have a large number of samples in this series to obviate the possibility of students comparing their samples.

Other suitable samples will be reported when their stability has been established.

Physiological Effects of Certain Allyl Compounds and Their Propyl Analogs

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AS A RESULT of a study of the health hazards of certain allylamines (*5*) it became of interest to survey the comparative activities of various allyl compounds and their propyl analogs. An experimental survey of simple allyl and propyl compounds with respect to their ability to penetrate or irritate the skin is under way and will be referred to briefly below. In connection with this some interesting comparisons between allyl and propyl compounds have been discovered in the literature. From these and a limited amount of experimental work, an attempt has been made to draw conclusions regarding the alteration in activity of a compound resulting from introduction of an allyl group.

For simplicity the list of compounds to be discussed has been divided into three groups: 1) compounds the allyl and propyl derivatives of which have been prepared and studied; 2) certain compounds the allyl derivatives of which have been studied but the propyl derivatives of which do not appear to have been studied, comparisons being deduced from other saturated analogs; and 3) certain nitrogenous compounds in which the introduction of the allyl radical markedly influences the action.

Group 1—In the Hoechst Laboratory of the I. G. Farbenindustrie in Germany a large number of acridine derivatives have been investigated in a search for useful therapeutic agents for the treatment of bacterial and trypanosomal infections (*4*). Among the 9-ethanolamino-acridines the 2-allyloxy compound proved most strongly bactericidal against Streptococci *in vitro* (the study included alkoxy compounds up to heptyl). *In vivo*, i.e. in infected animals, the ethoxy compound was found to be best. The iso-amyloxy compound appeared to be most effective against trypanosomes.

In the same laboratory a survey of tertiary acetamides was made in a search for useful sleep-producing agents (*3*). If the activity of propyl-diethyl-acetamide is taken as 1, then the allyl analog has an activity of 7. The introduction of an additional allyl group, making diallyl-ethyl-acetamide, causes a further twofold increase in the activity; and the introduction of a third allyl group, as in triallyl-acetamide, produces no further increase in potency.

In 1915 Pohl, in Germany, postulated that allyl derivatives of morphine would stimulate respiration (*10*). His prediction was based on the fact that several allyl compounds had been found to increase the respiratory energy. By combining this effect with the affinity of morphine for the central nervous system he hoped to increase the effect on the respiration. One of the compounds he prepared and studied was allyl morphine (the allyl group being attached to the phenolic hydroxyl group).

This he found to be qualitatively the same as morphine itself but quantitatively inferior in all respects. It did not possess the predicted effect on respiration. Propyl morphine has also been studied and found to be similar to the allyl compound (*2*). Both of these are slightly more active than the ethyl analog, Dionin, but are also more toxic. Because of their greater toxicity and lack of real advantage, neither allyl nor propyl morphine is used in medicine.

Lehman and Newman in a study of the toxicity of monohydric saturated alcohols (*7*) found propyl alcohol to be 2.33 times as toxic as ethyl alcohol. In 1920 Lewin (*8*) reported allyl alcohol to be 100 times as toxic as its ethyl analog; and in 1925 McCord (*9*) found that allyl alcohol was 150 times as toxic as the ethyl compound. Though these results are not strictly comparable because of differences in mode of administration and animals used, there seems no doubt that allyl alcohol is more toxic than its propyl analog.

TABLE 1—*Comparative activity of propyl and allyl compounds*

Compound	Basis of comparison	Activity of derivatives	
		R = Propyl	R = Allyl
2-R-oxy-9-ethanol-amino acridine	Bactericidal concentration (Streptococci) *in vitro*	0.0025%	0.0010%
R-diethyl acetamide	Narcotic potency	1	7
R-morphine	Narcotic potency	Slightly more than ethyl morphine (Dionin)	Almost identical with propyl morphine
R-alcohol	Toxicity	2.33 × EtOH	100–150 × EtOH
R-theobromine	Stimulation of heart and circulation	(Identity uncertain) Actions qualitatively the same but quantitative data not available	
Di-R-malonyl urea	Narcotic potency	Slightly more than diethyl malonyl urea (Barbital)	Almost identical with dipropyl malonyl urea

Both the allyl and propyl derivatives of theobromine have been studied, but, unfortunately, a quantitative comparison cannot be made on the basis of the available data. Vogt and Woodbury (*11*) at the University of Georgia have recently studied propyl theobromine (the exact position of the propyl group is uncertain) and found it to have essentially the same actions as caffeine. They did not study its potency as a diuretic. Zunz in his textbook on Pharmacology (*12*) states that allyl theobromine is 2 to 3 times as powerful as theobromine in its diuretic activity and has the same cardiac actions as caffeine, though less powerfully. Thus probably the propyl and allyl derivatives are qualitatively the same in their actions, though there may be quantitative differences.

The replacement of the two ethyl groups of diethyl-malonyl-urea, better known as barbital, by propyl groups causes some increase in activity (*2*). The dipropyl compound has been given the name "proponal," thought it is not now used as a hypnotic. Diallyl-malonyl-urea, which is on the market as "dial," has about the same activity as its propyl analog.

Group 2—In the course of a survey of unsaturated ethers as possible anesthetic agents, Leake and Chen (*6*) tested both allyl-ethyl ether and diallyl ether. They found both of these agents to be highly toxic and very irritant—too much so for clinical use. No information appears to be available concerning propyl-ethyl ether or dipropyl ether, but it seems safe to assume that the allyl analogs are the more irritant and more toxic.

Arecoline, the primary alkaloid of areca or betel nut, is chemically the methyl ester of N-methyl tetrahydronicotinic acid. It is used in veterinary medicine to stimulate intestinal peristalsis. Because its action is accompanied by undesirable side-effects such as salivation, etc., various derivatives have been prepared and studied by the I. G. Farbenindustrie (*3*). Among these are two allyl compounds: allyl N-methyl tetrahydronicotinate and methyl N-allyl tetrahydronicotinate. The allyl N-methyl compound is much weaker than the original alkaloid and the methyl N-allyl compound is said to be inactive. In this case the allyl derivatives are apparently less active than their saturated analogs.

Group 3—The substitution of a hydrogen atom on the nitrogen of an amino compound by an allyl group, in several cases, appears to result in a compound which acts oppositely to the original amine. Brauchli and Cloetta (*1*) studied several different amines, all of which cause a rise of blood pressure. They then introduced one or two allyl groups into the compound and found that the resulting compounds all caused a fall of blood pressure. The compounds studied were these given in Table 2 except monoallyl ephedrine and N-allyl norcodeine.

TABLE 2—*Comparative activity of normal and N-allyl-substituted amino compounds*

Compound	Effect of normal compound	Effect of N-allyl-substituted compound
β-tetrahydro-naphthylamine	Rise of bld. press.	(Monoallyl)—Fall of bld. press. (Diallyl) —Fall of bld. press.
β-tetrahydro-naphtho-benzylamine	Rise of bld. press.	(Diallyl) —Fall of bld. press.
Tyramine	Rise of bld. press.	(Diallyl)* —Fall of bld. press.
Phenyl-ethylamine	Rise of bld. press.	(Diallyl) —Fall of bld. press.
Ephedrine (phenylisopropanol-methyl amine)	Rise of bld. press.	(Monoallyl)—Fall of bld. press. Local anesthesia (Diallyl)* —Fall of bld. press. Local anesthesia?
n-Butylamine	Rise of bld. press.	(Diallyl) —Fall of bld. press.
iso-Amylamine	Rise of bld. press.	(Diallyl) —Fall of bld. press.
Norcodeine	Narcosis, analgesia, depression of resp.	(Monoallyl)—Inactive alone, but antagonizes morphine

* The exact position of the two allyl groups is not certain. One is almost certainly on the nitrogen, but the second may be on the nitrogen or on the hydroxyl group.

Ehrhart reports a study on monoallyl ephedrine (*3*) which gave results similar to those found by Brauchli and Cloetta with respect to blood pressure, but in addition found that the allyl-substituted ephedrine is a more powerful local anesthetic than cocaine. This study covered cinnamyl

ephedrine (the cinnamyl radical may be considered as phenyl-allyl) and found that it was essentially the same as the allyl compound. It seems likely that the diallyl ephedrine studied by Brauchli and Cloetta would have shown the local anesthetic action if their experiments had been designed to show such action.

The work of Pohl on allyl derivatives of morphine was mentioned in Group 1. In the same paper (*10*) he discussed N-allyl norcodeine. It was found that this compound was practically inactive when given to rabbits in a dose of 40 mgm. subcutaneously or 40 mgm. intravenously. However, when morphine was given to an animal which had previously been given the allyl compound, there was no effect from the morphine. It was stated that if N-allyl norcodeine is given first, doses of morphine up to 500 mgm. have no effect! Pohl's experiments were designed primarily to show effects on respiration and consequently other effects were not carefully observed.

As mentioned in the introduction, our own work has been concerned primarily with the effects of various simple allyl and propyl compounds on the intact skin. Thus far the only compounds which have been studied sufficiently to warrant mention are amines. The allyl amine appears to be slightly more irritating than its propyl analog. β-methyl allyl amine seems to be more irritating than allyl amine; diallylamine causes less irritation than any of the primary amines; and di(β-methyl-allyl)amine causes less irritation than any other compound studied so far.

Preliminary studies have been made of the effects of intravenous injections of allyl and propyl amine into dogs. The amines were injected as the hydrochlorides and the only effect measured was change in blood pressure. The two compounds both appear to cause a transient fall of blood pressure, the allyl compound being slightly more active than the propyl.

SUMMARY

From the survey given it is obviously impossible to set up any general, all-inclusive principle on which to base predictions of the activity of an allyl compound from the activity of its propyl analog. However, the introduction of an allyl radical does seem to alter the action of the compound in one of three ways. In some cases the allyl compound is more active than its propyl analog; in other cases the allyl compound is less active or even inactive; in still other cases the action may be reversed. The first of these seems to be by far the most common. The second alternative is most likely to be the case when the structure seems to be specific for the given effect, that is, when any modification of the structure results in a less active compound. The reversal of action seems to occur only in the case of amino compounds where the allyl group is substituted on the nitrogen.

Thus the allyl group seems to be in agreement with other types in that the activity of a compound containing allyl cannot be predicted with certainty from knowledge of the activity of chemical relatives.

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Certain Biochemorphic Aspects of Tri(carboxymethyl)amine*

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TRI(CARBOXYMETHYL)AMINE, $N(CH_2COOH)_3$, is of biological interest because of its chemical relationship to physiologically active tertiary amines on the one hand and to the relatively inactive amino acids on the other. It resembles mono-iodoacetic acid in that it may be considered as acetic acid in which an hydrogen atom is replaced with a group having a weight of 132, while mono-iodoacetic acid is an acetic acid with the same hydrogen atom replaced by a group with a weight of 126.9. Michaelis and Schubert (*1*) report that mono-iodoacetic acid reacts with glycine to form tri(carboxymethyl)amine under circumstances *in vitro* approaching physiological conditions.

This compound was first described by Heintz (*2*) about 75 years ago. Certain physical and chemical properties are noted by Michaelis and Schubert. It is a white crystalline solid melting at 230–235° C. The pK values of the first 2 dissociation steps overlap at about 3, and the third pK is about 10. Our preparation melted with decomposition at 235° C. (uncorr.).

First, physiologic resemblance to mono-iodoacetic acid was tested. Iodoacetic acid interferes with phosphorylation processes in living tissues, inhibiting among others the reabsorption of glucose from the glomerular filtrate in kidney tubules. This results in marked glycosuria without hyperglycemia. Tri(carboxymethyl)amine was administered subcutaneously or intraperitoneally to 2 dogs, a rabbit, and 8 rats in doses from 100–200 mg/kg. Hourly assays of urine from these animals, for 6 hours after injection, showed no significant glycosuria.

Secondly, resemblance to physiologically active amines was tested. Effects on carotid blood pressure of a neutralized solution of tri(carboxymethyl)amine were noted after intravenous injection in cats and dogs narcotized with sodium pentobarbital. In dogs, administration of 5 mg/kg. resulted in a depressor response of about 35 mm. Hg, and of 10 mg/kg. in a fall of about 80 mm. Hg. The latter effect was similar to the response to 2 mg/kg. of choline chloride in the same dogs. In cats, administration of 5 mg/kg. resulted in an insignificant fall, but a drop in pressure of 25 mm. Hg was noted after injection of 10 mg/kg. Premedication with 0.5 mg/kg. of atropine sulfate, given intravenously, did not reduce nor reverse the depressor response. In both species, the fall in blood pressure was infrequently preceded by a slight rise and was usually followed by a slight rise. Effects on pulse rate were slight and inconstant. Dyspnea often occurred. The entire depressor effect of tri(carboxymethyl)-amine was complete, with recovery, within 35 seconds after administration.

* Presented at the 1939 meeting.

The lethal dose of tri(carboxymethyl)amine lies between 100 and 200 mg/kg. when this substance is given by very slow intravenous injection to rabbits. Intraperitoneal and subcutaneous toxic doses are higher, since animals withstand 200 mg/kg. by these routes. No special susceptibility was found among rabbits, dogs, rats, cats, or pigeons.

It may be concluded that tri(carboxymethyl)amine may cause a fall in blood pressure when a fractional part of the lethal dose is injected. It has no stimulant nicotine-like action; in this it is similar to triethanolamine, according to effects of this agent reported by Renshaw and Reid Hunt (*3*). Observations on the lack of glycosuric response to tri(carboxymethyl)amine support the view of Michaelis and Schubert that it is the halogenated carbon, and not the carboxyl group, of iodoacetic acid which is effective in inhibiting phosphorylation, presumably through combination with sulfhydril or amino groups of the enzymes involved.

We are indebted to Dr. Nilkanth M. Phatak for supplying the compound used.

SUMMARY

Intravenous injections of 5–10 mg/kg. of tri(carboxymethyl)amine in dogs or cats are followed by transient depressor responses which are not inhibited nor reversed by atropine. Intraperitoneal or subcutaneous doses of 100–200 mg/kg. do not cause glycosuria in dogs, rabbits, or rats.

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Pathological Effects of Habituation to Ethanol, Morphine, and Cocaine*

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IN A RECENT pharmacological study (*1*), 4 groups of 30 mice each were given daily intraperitoneal injections of saline, ethanol, morphine sulfate, and cocaine hydrochloride for 7 weeks. When deaths occurred during habituation, necropsies were made and organs were fixed in formalin for histological examination. At the close of the period of habituation, the survivors were killed and treated similarly. Since a moderately large series of gross and histological observations was obtained, it was felt that this separate report on pathological effects of habituation was justified.

Increments in the daily dosage were made at weekly intervals. Mice receiving ethanol were injected with the equivalent of 2, 4, 6, 8, 10, and 12 ml/kg. of 95 percent ethanol daily for each of the first six weeks, respectively, and twice daily with 12 ml/kg. for the seventh week. Ethanol was administered as a 9.5 percent solution in saline. Mice treated with morphine sulfate received daily doses of 20, 40, 80, 160, 240, and 320 mg/kg. for the first 6 weeks and 320 mg/kg. twice daily for the seventh week. Mice treated with cocaine hydrochloride received 5, 10, 15, 20, 30, and 40 mg/kg. daily for the first six weeks and 40 mg/kg. twice daily for the seventh week. Concentrations of the alkaloidal solutions were so adjusted that mice received all doses in 10 ml/kg. of saline. Control mice were treated with 10 ml/kg. of saline daily for the first 5 weeks, 100 ml/kg. for the sixth, and 120 ml/kg. for the seventh week.

Gross examination of mice dying during the experiment showed that the chief cause of death was pneumonitis. This occurred most frequently in the group treated with cocaine, though all groups showed a high incidence. Mice treated with ethanol showed a high incidence of enteritis, presumably from the irritant effects of the injected solution. High incidences also appeared in the control mice and those treated with morphine, presumably from infection. Deaths attributable to acute effects of the agents were most frequent in the ethanol group (10/30) and cocaine group (7/30); only 1 mouse treated with morphine died shortly after treatment, and none of the controls.

Detailed findings from which the above conclusions were drawn may be summarized briefly. Incidence of *hemorrhage* sufficient to be observed grossly in the following organs was:

	Lungs	Gut	Peritoneal cavity	Pleural cavity
Ethanol	10	0	3	2
Morphine	8	0	0	2
Cocaine	13	1	1	1
Controls	10	2	2	0

* Presented at the 1939 meeting.

Incidence of *hyperemia* or *edema* was:

	Lungs	Liver	Gut	Spleen	Kidney
Ethanol	9	4	7	7	4
Morphine	5	4	6	5	3
Cocaine	12	1	3	4	2
Controls	8	2	5	3	3

The liver was pale in 7 mice treated with ethanol, 1 with morphine, 12 with cocaine, and in 4 control mice. It was markedly mottled in 1 treated with ethanol and 4 treated with cocaine. The adrenals were enlarged in mice treated with morphine or cocaine, in the later stages of habituation. Massive infection occurred in the lungs of 1 mouse treated with morphine and in the peritoneal cavity of 3 treated with ethanol and 1 control. Large helminthic cysts were found in the livers of 2 mice treated with morphine and 1 treated with cocaine. Minor necrotic skin lesions occurred in all groups after the second week of treatment, due to trauma from holding the mice for injection; but infected lesions serious enough to play any part in causing death occurred in less than 10 percent of the mice.

Histological examination of a number of the treated mice revealed much the same picture. All sections were stained with eosin and hematoxylin. Incidence of various diagnoses of *livers* of treated mice follows:

	Controls	Ethanol	Morphine	Cocaine
Normal	1/24	4/18	1/20	1/23
Hyperemia	12/24	8/18	13/20	13/23
Cloudy swelling	10/24	4/18	5/20	13/23
Hydropic degeneration	9/24	1/18	8/20	2/23
Hyperplasia	0/24	0/18	1/20	5/23
Focal necrosis	2/24	2/18	1/20	2/23
Diffuse necrosis	1/24	0/18	0/20	3/23
Peripheral necrosis	0/24	0/18	0/20	4/23
Subcapsular necrosis	0/24	2/18	3/20	0/23
Miliary abscesses	2/24	0/18	2/20	2/23
Acute hepatitis	1/24	0/18	0/20	0/23
Hemosiderosis	0/24	1/18	0/20	1/23
Fatty infiltration	0/24	1/18	0/20	1/23
Fibroma	1/24	0/18	0/20	0/23
Granuloma	0/24	1/18	0/20	0/23
Parasitic cysts	0/24	0/18	1/20	1/23
Chronic cholangitis	0/24	0/18	0/20	1/23

The *kidneys* of treated mice showed the following changes upon histological examination:

	Controls	Ethanol	Morphine	Cocaine
Normal	18/23	6/17	10/19	3/22
Hyperemia	5/23	10/17	5/19	19/22
Cloudy swelling	1/23	1/17	2/19	8/22
Casts	1/23	2/17	1/19	2/22
Acute tubular nephritis	0/23	1/17	1/19	0/22
Adenoma	0/23	1/17	2/19	0/22
Petechial hemorrhage	0/23	0/17	0/19	1/22
Oidiomyces infection	0/23	0/17	1/19	0/22

Incidence of pathological conditions of the *lungs* was:

	Controls	Ethanol	Morphine	Cocaine
Normal	1/22	3/17	1/20	2/22
Hyperemia	12/22	8/17	11/20	11/22
Diffuse hemorrhage	14/22	6/17	12/20	8/22

Subpleural hemorrhage	2/22	1/17	1/20	2/22
Petechial hemorrhage	2/22	0/17	0/20	0/22
Emphysema	8/22	4/17	5/20	9/22
Atelectasis	5/22	8/17	5/20	8/22
Edema	2/22	0/17	6/20	2/22
Acute hemorrhagic pneumonitis	2/22	3/17	5/20	2/22
Miliary abscesses	2/22	1/17	1/20	0/22
Pneumonia with red hepatization	0/22	0/17	1/20	0/22
Acute pneumonitis	0/22	1/17	0/20	0/22
Acute diffuse pneumonitis	0/22	1/17	0/20	0/22
Chronic interstitial pneumonia	0/22	1/17	0/20	1/22
Purulent bronchitis	2/22	2/17	0/20	0/22
Acute pleuritis	1/22	0/17	0/20	0/22
Early bronchopneumonia	0/22	0/17	0/20	1/22
Acute bronchopneumonia	0/22	0/17	0/20	1/22

Spleens of the treated animals show the following conditions:

	Controls	Ethanol	Morphine	Cocaine
Normal	18/24	12/17	12/19	8/22
Hyperemia	6/24	3/17	4/19	10/22
Follicular hyperplasia	3/24	0/17	7/19	9/22
Pigmentation	0/24	1/17	4/19	7/22
Acute splenitis	1/24	2/17	0/19	1/22
Acute suppurative splenitis	1/24	0/17	0/19	0/22
Necrosis	1/24	0/17	0/19	0/22
Acute peritonitis	1/24*	0/17	0/19	0/22
Subacute peritonitis	0/24	1/17	0/19	0/22
Giant cells:	22/24	14/17	17/19	19/22
numerous	8/24	6/17	11/19	10/22
occasional	14/24	8/17	6/19	9/22

A few *pancreases* were also studied at random. Incidence of histological changes follows:

	Controls	Ethanol	Morphine	Cocaine
Normal	5/5	1/4	5/7	0/5
Hyperemia	0/5	1/4	2/7	1/5
Cloudy swelling	0/5	0/4	1/7	3/5
Fatty infiltration	0/5	1/4	0/7	0/5
Acute suppurative pancreatitis	0/5	1/4	0/7	0/5
Subacute interstitial pancreatitis	0/5	0/4	0/7	1/5

Three of 3 *adrenals* from normal mice and 3 of 3 from mice treated with morphine show a normal cortex, while 1 of 2 from mice treated with cocaine also is normal. One adrenal from a mouse treated with ethanol shows cloudy swelling, and 1 cocaine mouse shows fatty infiltration.

DISCUSSION

The significance of the above results is not clear on casual inspection, nor should clinical application of these results be assumed without an appreciation of certain inherent limitations.

As a rule, mice are very susceptible to fatal pneumonitis, and unless special care is taken in breeding, this condition may appear whenever anything occurs which lowers their resistance, regardless of the general care they are given. Thus the high incidence of pneumonitis has no significance except to show that the mice were not benefited by daily han-

* The spleen from the control mouse with acute peritonitis shows an infiltration of leucocytes and mono-nuclear cells on the peritoneal surface.

dling or hydration, for the controls were affected as much as the treated animals.

Hyperemia and edema of viscera were in general more severe in treated mice than in controls. Results with morphine and cocaine may possibly be ascribed to effects on the autonomic nervous system. Large doses of ethanol have marked circulatory effects, and it is surprising that more definite end-results were not found in this group.

Histological examination of livers of mice habituated to ethanol did not discover the expected amount of damage, either. This may be attributed to the constant availability of a high carbohydrate diet to all mice. The more severe damage in mice treated with morphine or cocaine may be due to continued sympathetic stimulation, in which case a high carbohydrate diet would be insufficient prophylaxis against direct harmful effects of these agents. No similar explanation can be made for the controls, however. Hydration may play a part, especially in the last weeks of treatment.

The kidneys showed so little severe damage that no fair comparisons of effects of the 3 habituations can be made.

The occurrence of giant cells in spleens of the majority of treated and control mice is normal, since these are reputed to occur uniformly in spleens of several rodents. One other notable finding is the greater incidence of follicular hyperplasia and pigmentation in mice treated with morphine and cocaine.

Effects of drug habituation on the pancreas cannot be discussed properly without further studies, but results with ethanol and cocaine indicate that such studies may show definite and important detrimental action of these agents.

SUMMARY

Gross examinations and histological examinations of livers, kidneys, lungs, and spleens of 120 mice during habituation to ethanol, morphine, or cocaine, reveal no outstanding regular pathological lesions. Since all mice were maintained on a high carbohydrate diet, there may have been protection against hepatic damage which might occur with different diets. Giant cells were regularly found in most spleens, which is normal for mice. The pancreas was studied in only 21 cases, but further work is indicated by the high incidence found of pathological effects in mice treated with ethanol and cocaine.

REFERENCE

(*1*) Abreu, B. E., and G. A. Emerson. 1939. Susceptibility to ether anesthesia of mice habituated to alcohol, morphine, or cocaine. Current Researches in Anesthesia and Analgesia *18:* 294–300.

The Influence of Moisture on the Sorption of Methane Gas by Some West Virginia Coals

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MANY OF THE MOST FATAL mine explosions come in the early spring during the rains which follow cold, dry winter weather. Some of the gas, causing such explosions, is driven from the coal and from gas pockets by the flooding produced by underground streams. A change from dry to moist air in the ventilating system is also capable of releasing from the coal a surprisingly large volume of adsorbed methane.

In a previous paper* it was pointed out that preliminary measurements at 10.94°C. showed that water vapor caused a marked decrease in the sorption of methane by coal. It is now possible to report quantitative results obtained with Pittsburgh coal in contact with dry and moist methane at 12°, 17.77° (average mine temperature), and 25.1°C. and with Pocahontas No. 4 coal at 17.77°C.

Sorption experiments were carried out with a modified form of apparatus already described.† A closed manometer replaced the open type, and a tube, for the introduction of a measured amount of water, was attached through a mercury-seal stopcock to the portion of the system containing the coal.

TABLE 1—*Effect of water vapor on the sorption of methane by coal (Vapor pressure of water: at 12°C. is 10.4 mm., at 17.77°C. is 15.1 mm., at 25.1°C. is 23.7 mm.)*

Partial pressure of methane in mm. Hg	Cubic feet of dry methane per ton of coal	12°C.	Cubic feet lost per ton due to water vapor	12°C.	Loss of CH_4	Cubic feet of dry methane per ton of coal	17.77°C.	Cubic feet lost per ton due to water vapor	17.77°C.	Loss of CH_4
	Pure	Equiv. of 5%	Pure	Equiv. of 5%	%	Pure	Equiv. of 5%	Pure	Equiv. of 5%	%
	Pittsburgh Coal									
100	10.1	202	3.685	73.70	36.5	9.30	185.9	4.008	80.16	43.1
200	20.03	400.6	7.21	144.2	36.0	17.63	352.6	7.38	147.6	41.8
300	29.34	586.8	10.42	208.4	35.5	25.30	506	10.55	211	41.7
400	37.69	753.8	12.84	256.8	34.04	32.51	650.2	13.91	278.2	42.8
500	44.52	890.4	13.92	278.4	31.25	39.23	784.6	17.12	342.4	43.7
600	50.98	1019.6	15.76	315.2	30.93	45.82	916.4	20.17	403.4	44.1
700	57.0	1140	16.3	326	28.6	52.4	1048	23.05	461	44.0
800	62.8	1256	17.6	352	28.0	59.0	1180	26.3	526	44.6
	Pittsburgh Coal, 25.1°C.					Pocahontas No. 4 Coal, 17.77°C.				
100	7.37	147.4	4.97	99.4	67.4	25.69	513.8	11.27	225.4	43.9
200	14.25	285	9.77	195.4	68.6	48.02	960.4	23.95	469	49.8
300	20.5	410	14.41	288.2	70.3	68.2	1364	29.7	594	43.6
400	26.6	532	18.26	365.2	68.6	84.22	1684	37.72	754.4	44.7
500	32.06	641.2	22.14	442.8	69.0	101.0	2020	47	940	46.5
600	37.65	753	25.96	519.2	69.0	112.2	2244	51.2	1024	45.6
700	42.8	856	29.92	598.4	70.0	122.0	2440	53	1060	43.4
800	48.0	960	33.43	668.6	69.6	137.9	2758	64.1	1282	46.5

* Earl C. H. Davies and J. Barlett Sutton. 1936. Proc. W. Va. Acad. Science *10:* 103–105.
† J. Bartlett Sutton and Earl C. H. Davies. 1935. J. Am. Chem. Soc. *57:* 1785.

Results shown in Table 1 were obtained from sorption curves obtained by plotting pressures on one axis and cubic centimeters of methane (corrected to 0°C. and 760 mm. pressure), taken up by one gm. of coal, on the other axis. They are stated as cubic feet of the gas per ton of coal. Since a five percent mixture of methane with air is explosive, the table also includes the volume of the 5 percent mixture which could be obtained from the desorption of the coal under the conditions shown. For example, at mine temperature (17.77°C.) each ton of dry Pittsburgh coal in contact with dry methane at 700 mm. pressure could take up sufficient gas to give 1048 cubic feet of an explosive, 5 percent, mixture. When the air is saturated with water vapor, 461 cu. ft. of explosive gas mixture would be released from each ton of the coal. Interpolating for a pressure of 750 mm. (about average mine pressure) and at the average mine temperature, this would show that each ton of the dry Pittsburgh coal in contact with dry methane could take up sufficient gas to give about 1114 cu. ft. of explosive gas mixture, and that about 44.3 percent of this (494 cu. ft. of explosive mixture) could be released when the air is saturated with water vapor. Similar values for the Pocahontas coal are more than twice as much, namely, 2600 cu. ft. and 1710 cu. ft. In each case the higher value would represent the explosive mixture obtainable when all the gas would be displaced, as when the coal might be flooded by water entering the mine.

The Pittsburgh coal (on received basis) analyzed as follows: proximate-moisture, 0.83; volatile matter, 38.24; fixed C, 52.97; P, 0.009; ash, 7.96; ultimate—C, 75.00; H, 5.11; O, 8.22; N, 1.41; S, 2.30; ash, 7.96; B. T. U., 13890 calories. The Pocahontas No. 4 coal analyzed as follows: C, 88.7; H, 4.4; O, 2.2; N. 1.3; S, 0.5; ash, 2.9; H_2O, 0.4; density 1.3521. Analysis of the methane gave: CH_4, 97.8–98.0 percent; C_2H_6, 0.05 percent; O, 0.10 percent; N, 1.85 percent; density 0.7196. Traces of moisture were removed from the methane before it was used, by passing through a coil submerged in an ether-solid carbon dioxide mixture. Before using it the coal was passed through a jaw crusher and ground in a "coffee mill" to about 100-mesh size. Using sedimentation data and applying Stokes' equation, the range of particle size was about: 63.0 percent, 0.132 mm.; 10.0 percent, 0.045 mm.; 10.8 percent, 0.030 mm.; 10.2 percent, 0.021 mm.; 1.7 percent, 0.016 mm.; and 4.3 percent, 0.007 mm. radius. Some of the Pittsburgh coal had been stored in sacks for several months, while a check run was made with a fresh sample, only a few hours after removal from the mine. The only variance found, between the two sets of samples, was that the freshly-mined sample contained about two percent more volatile matter than did the older comparative sample. The loss on evacuation of the newer sample was also 0.1 percent higher in a total of 1.58 percent. The Pocahontas coal had been stored in a nearly airtight steel drum.

In conclusion it may be pointed out that, when mines were not so generally rock-dusted, dust explosions were especially liable to occur in very dry weather—sometimes during early winter. However, more recently, wet weather following long, dry spells has proved exceptionally dangerous. Some of the explosions have been confined to moderate-sized portions of the mine, while others have been quite general. It is believed that a study of the results summarized in the accompanying table will

show that the desorption of gassy coal, in the presence of water vapor or flooding by water, will produce ample gas for an explosive mixture. Especially would such a condition be dangerous in dead-end rooms, where thorough ventilation is difficult.

The Mathematics and Physics Section

A Birational Transformation Belonging to the Complex of Secants of the Twisted Cubic

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1. Introduction

The most general non-involutorial Cremona transformation belonging simply to the complex Γ of secants of the twisted cubic has been studied by Calderera.[1] The transformation of order 15 is determined by two projective pencils of quartic surfaces which contain the cubic C_3 as a double curve, each pair of which contains in addition a line of a regulus of bisecants to C_3. The same T_{15} is also determined by two projective pencils of cubic surfaces through C_3, each pair of which has a common variable double point on C_3. In the present paper a transformation of order 13 determined by two pencils of quadrics is discussed.

2. The Equations of the Transformation

Let $|H|$, $|H'|$, and $|a|$ be two pencils of quadrics through C_3 and a regulus of bisecants of C_3, all projectively related. Through a generic point $P(y)$ of space passes a unique H of $|H|$. The unique transversal t through P meeting C_3 and the a associated with H meets the associated H' in one residual point P', image of P in the T thus defined.
Write

$$C_3\colon\ x_1/x_2 = x_2/x_3 = x_3/x_4 = u, \qquad |a| : \begin{cases} x_1 = m^2 x_3 \\ x_2 = m^2 x_4 \end{cases}$$

$$(1)\quad |H| \equiv U - m^2 V = 0, \qquad |H'| \equiv U' - m^2 V' = 0,$$

$$U = a_1H_1 + a_2H_2 + a_3H_3, \qquad U' = a_1'H_1 + a_2'H_2 + a_3'H_3,$$

$$V = \alpha_1H_1 + \alpha_2H_2 + \alpha_3H_3, \qquad V' = \alpha_1'H_1 + \alpha_2'H_2 + \alpha_3'H_3,$$

$$H_1 = x_1x_3 - x_2^2, \qquad H_2 = x_1x_4 - x_2x_3, \qquad H_3 = x_2x_4 - x_3^2,$$

$$M = Vy_1 - Uy_3, \qquad N = Vy_2 - Uy_4.$$

In order that $P(y)$ lie on H, $m^2 = U(y)/V(y)$, and the associated a and H' are

[1] Caldarera, Grazia Macrina. 1904. "Le trasformazioni birazionali dello spazio inerenti ad una cubica sghemba." Rendiconti del Circolo Matematico di Palermo, vol. XVIII, pp. 205–212.

$$a:\begin{cases} Vx_1 - Ux_3 = 0, \\ Vx_2 - Ux_4 = 0, \end{cases} \qquad H' \equiv VU'(x) - UV'(x) = 0.$$

The transversal t of a and C_3 through P meets C_3 in

$$C(M^3, M^2N, MN^2, N^3).$$

Hence

$$(2) \qquad t:\begin{cases} \tau x_1 = J_{12}y_1 + K_4M^3, & \tau x_2 = J_{12}y_2 + K_4M^2N, \\ \tau x_3 = J_{12}y_3 + K_4MN^2, & \tau x_4 = J_{12}y_4 + K_4N^3. \end{cases}$$

For the intersection of H' by t the parameters J_{12} and K_4 are

$$(3) \qquad K_4 = UV' - U'V,$$

$$(4) \qquad \begin{aligned} J_{12} = {} & V(M^3U_1' + M^2NU_2' + MN^2U_3' + N^3U_4') \\ & - U(M^3V_1' + M^2NV_2' + MN^2V_3' + N^3V_4'), \end{aligned}$$

where the subscripts denote partial differentiation. Hence the inverse transformation T_{13}^{-1} is (2), where the J_{12} and K_4 have the values (4) and (3).

$K_4=0$ is the pointwise invariant surface, and $J_{12}=0$ is the partial image in T_{13}^{-1} of C_3.

3. Some Alternate Determinations of T

The Plucker Coordinates of a Γ-line are

$$(5) \qquad \begin{aligned} \rho p_{12} &= -M^2UH_2, & \rho p_{23} &= -MN(VH_1 + UH_3), \\ \rho p_{13} &= M(y_1N^2 - y_3M^2), & \rho p_{42} &= -N(y_2N^2 - yM_4^2), \\ \rho p_{14} &= y_1N^3 - y_4M^3, & \rho p_{34} &= -N^2VH_2. \end{aligned}$$

The complex of lines meeting a bisecant b of C_3 is

$$(6) \qquad \begin{aligned} & p_{12} - (m+n)p_{13} + mnp_{14} + (m^2 + mn + n^2)p_{23} \\ & \qquad + mn(m+n)p_{42} + m^2n^2p_{34} = 0, \end{aligned}$$

where

$$[b, C_3] = (m^3, m^2, m, 1), (n^3, n^2, n, 1).$$

The substitution of (5) and (6) gives

$$(7) \quad (M - nN)(M - nN)[(U + mnV)H_2 - (m+n)(VH_1 + UH_3)] = 0.$$

The first two factors of (7) are associated with the Γ-bundles on the points $[b, C_3]$, and the third factor with the proper Γ-congruence with directrix b.

If $n=-m$, the line b belongs to the regulus $|a|$, and (7) becomes

$$(8) \qquad (M - mN)(M + mN)(U - m^2V)H_2 = 0.$$

The first two factors of (8) are the surfaces associated with the Γ-bundles on $[a, C_3]$, the third factor is the H of (1) associated with the Γ-congruence

with directrix a, and the $H_2=0$ is a surface of parasitic lines discussed later (Section 4).

The T is determined by the pencil of cubics $|F_3| \equiv M-mN=0$, and its associated pencil $|F_3'|\,M'-mN'=0$. Through a generic point $P(y)$ of space passes a unique F_3 of $|F_3|$, for which $m=M(y)/N(y)$. The line t through P and the common double point (M^3, M^2N, MN^2, N^3) of F_3 and its associated F_3' cuts the latter surface in one residual poitn P', image in T_{13} of P.

T is also determined by any pencil $|F_4|$ of the net

$$(9) \qquad \infty^2|\ F_4| \equiv (U + mnV)H_2 - (m + n)(VH_1 + UH_3) = 0$$

and its associated pencil $|F_4'|$. Through a generic point P of space passes a single F_4 of $|F_4|$. The unique transversal through P of C_3 and the bisecant b, directrix of the Γ-congruence associated with F_4 and F_4', cuts F_4' in one residual point P', image in T_{13} of P. The locus of b as F_4 describes the pencil $|F_4|$ is a regulus $|b|$.

In particular, $n=-m$ gives a pencil of composite quartics which reduces to $H_2=0$ and (1).

4. THE P-SYSTEM

The basic curves for the various systems of defining surfaces are:

$$|\ H| : C_3 o_1, \qquad |\ F_3| : C_3 o_1 o_2 o_3, \qquad \infty^2|\ F_4| : C_3^2 o_1 o_2 o_3,$$
$$|\ H'| : C_3 o_1', \qquad |\ F_3| : C_3 o_1' o_2' o_3', \qquad \infty^2|\ F_4'| : C_3^2 o_1' o_2' o_3',$$

where the o_1, o_2, o_3, o_1', o_2', and o_3' are bisecants of C_3, and $H_2 : C_3 o_2 o_3 o_2' o_3'$.

The pencil $|F_3|$ has a common tangent plane at each point of C_3.

Through each point C of C_3 passes one line α of the regulus $|\alpha|$ associated with $|a|$ on H_2. Since this line cuts o_2, o_3, o_2', and o_3', it lies on F_C ($F_C \equiv F_3 : C^2$) and on F_C', hence is parasitic. That is, the secant regulus $|\alpha|$ of H_2 is composed of parasitic lines.

For any point C of C_3, the intersection $[F_C, F_C']$ is invariant. The locus of this curve is K_4, which may be obtained by eliminating the parameter between $|F_3|$ and $|F_3'|$, or between $|H|$ and $|H'|$.

The tangent cone K_2' of F_3' at C intersects F_3 in a curve of order 6. However, the α of $|\alpha|$ through C is part of the C_6, hence $C \sim C_5$. The elimination of the parameter between $|K_2'|$ and $|F_3|$ gives $H_2 J_{12}$ as the locus of the composite C_6.

The tangent cone K_2 of F_C at C intersects F_C in 6 lines: three bisecants h_1, h_2, h_3 of C_3, and three lines $c_{1,2}$, $c_{1,3}$, $c_{2,3}$, through C cutting o_1, o_2, o_3, in pairs. Each h_i meets F_C' in a second point C_i on C_3, hence $C_i \sim h_i$. As C generates C_3, the h's generate a surface J_x, image of C_3 residual to J_{12}.

The line $c_{2,3}$ generates H_2. Line $c_{1,2}$ lies on F_C and intersects F_C' in one point P'. As C generates C_3, the $c_{1,2}$ generates a quadric Q_1, and P' generates a curve $d_{1,2}'$. Similarly, $c_{1,3}$ generates a quadric Q_2, image in T^{-1} of $d_{1,3}'$.

The elimination of the parameter between $|K_2|$ and $|F_3|$ gives, as the locus of the 6 lines $[K_2, F_C]$, the composite surface

$$S_{14} = J_x H_2 Q_1 Q_2,$$

hence $x=8$, and, using the set-up of Section 2,

(10) $C_3 \sim J_{12}J_8 \equiv J_{12}(H_3M^2 - H_2MN + H_1N^2),$

(11) $d_{1,2}'d_{1,3}' \sim Q_1Q_2 = (a_1V - \alpha_1U)U - (a_3V - \alpha_3U)V.$

Since o_2 is a line of $|a|$, some H_a of $|H|$ and H_a' of $|H'|$ are associated with $o_2 = a$. The image of any point P on c_2 is on H_a', hence $[Q_1, H_a'] = C_3d_{1,2}'$ and $d_{1,2}'$ (also $d_{1,2}'$) is a bisecant of C_3.

The plane $\omega = (o_1', C)$ cuts F_C in a $\gamma_3 : C^2$, which is that part of the image in T^{-1} of o_1' in ω. As C generates C_3, the γ_3 generates the image L of o_1'. The elimination of the parameter between $|\omega|$ and $|F_3|$ gives the image L_4 of o_1', hence

$$o_1' \sim L_4 = (a_1'V' - \alpha_1'U')U - (a_3'V' - \alpha_3'U')V.$$

Since any H' of $|H'|$ transforms into its associated quadric H, the equations of L_4 and J_8 can be found by taking the image in T^{-1} of U'.

$$U' \sim UJ_{12}J_8L_4.$$

On each generator of the cubic cone with vertex P' on o_i $(i = 1, 2, 3)$ and standing on C_3 is one point P whose image is P'. Since one F_3 passes through P', we have for T^{-1}, $P' \sim C_4 : P'$. For $i = 1$, the locus of C_4 is a quartic L_4. For $i = 2$ or 3, the generator α of H_2 through P' is a component of C_4, leaving, after removing the factor H_2.

$$o_2'o_3' \sim S_2S_3 = (a_1'V - \alpha_1'U)U - (a_3'V - \alpha_3'U)V.$$

Since H_2 transforms into itself, the equation of S_2S_3 may be obtained from $H_2 \sim H_2J_{12}J_8S_2S_3$.

5. CONTACT

From (4) and (10), we see that, at any point C of C_3, three sheets of J_{12}, one sheet of J_8, and the $|F_3|$, have a common tangent plane. Furthermore, at each such point, one sheet of each homaloid ϕ_{13} osculates this plane. The image of C_3 for such contact is J_8.

6. ISOLATED PARASITIC LINES

The surface $F_C : h_1h_2h_3$ each of which meets C_3 again in points A_1, A_2, A_3, respectively. Likewise $F_C' : h_1, h_2\, h_3$ each of which meets C_3 again in points A_1', A_2', A_3' respectively. Should a line h (or a point A) coincide with a line h' (or a point A') the resulting line $g = h = h'$ would be parasitic.

The tangent plane of $|F_3|$ at a point A_i passes through C. Given a point A, the tangent plane of $|F_3|$ at A cuts C_3 again in a point C. On F_C' lie three lines h', which cut C_3 again in points A'. Conversely, to a point A' corresponds three points A. This (3, 3) correspondence between the points A and A' on the rational curve C_3 has six coincidences, hence there are six simple parasitic lines g, all of which lie on J_{12}, J_8, K_4, and the homoloids ϕ_{13}.

7. TABLE OF IMAGES

Under the transformation T^{-1},

$$\pi \sim \phi_{13} : C_3^{6+t}o_1^4o_2^3o_3^3d_{1,2}d_{1,3}6g,$$

$$C_3 \sim J_{12} : C_3^{5+3t}o_1^4o_2^3o_3^3d_{1,2}d_{1,3}6g$$

$$+ J_8 : C_3^{4+t} o_1^2 o_2^2 o_3^2 6g,$$

$$o_1' \sim L_4 : C_3^2 o_1 o_2 o_3 d_{1,2} d_{1,3} o_1',$$

$$o_2' \sim S_2 : C_3 o_1 d_{1,2},$$

$$o_3' \sim S_3 : C_3 o_1 d_{1,3},$$

$$d_{1,2}' \sim Q_1 : C_3 o_1 o_2 d_{1,2}',$$

$$d_{1,3}' \sim Q_2 : C_3 o_1 o_3 d_{1,3}',$$

$$K_4 : C_3^2 o_1 o_1' d_{1,2} d_{1,3} d_{1,2}' d_{1,3}' 6g,$$

where t in the multiplicity of C_3 indicates contact. The jacobian of the transformation is

$$J_{48} = J_{12} J_8^3 L_4 Q_1 Q_2 S_2 S_3.$$

A Birational T_7 Associated with the Ruled Cubic

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BY MEANS OF A PENCIL of quadrics Dye[1] has discussed some involutorial transformations associated with a rational ruled surface. If one uses two pencils of planes instead of a pencil of quadrics, one obtains some non-involutorial transformations associated with a rational ruled surface. In the present paper a particular associated surface is considered, viz., the ruled cubic.

2. Given two projective pencils of planes $|F| : g_1$, $|F'| : g_1'$ projectively related to the generators r of a ruled cubic $S : q^2$. A generic point P determines a plane F of $|F|$ and a generator r of S. The plane (Pr) is tangent to S at a point $Q(z)$ on r, hence the line $\overline{PQ}$ meets the associated F' of $|F'|$ in a point P', image (T) of P.

The locus of piercing points of the generators r and their associated planes of $|F'|$ is a fundamental curve σ_4' of order four and meeting g_1' in the three points $[g_1', S]$. Similarly, there exists a fundamental curve σ_4. At O_σ' on σ_4', the tangent plane ξ' to S meets the associated F of $|F|$ in a line $\lambda : O_\sigma \equiv [r, F]$. Then $[\lambda, F'] = O_p$, $[\xi', F'] = \mu'$ such that $O_p \sim (T)\mu' : O_p' O_\sigma' O_g'$. The point O_p describes a curve p_7.

A point O_g' on g_1' does not determine an F', but there is one determined for each generator of the tangent cone to S. Hence, $O_g' \sim (T^{-1}) g_5 : O_g' 4 O_g O_\sigma$. Considering all the points of g_1', we have

$$g_1' \sim (T^{-1}) G_6 : g_1^4 \sigma_4^{1+d} p_7 g_1'$$

where d indicates a fixed direction along σ_4.

For the two positions in which r becomes a torsal generator of S, $\lambda = \mu = s_i$, $\lambda' = \mu' = s_i'$, $O_p = O_p' = [s_i, s_i']$. Therefore,

$$\text{any point on } s_i' \sim (T^{-1})\ s_i$$
$$\text{any point on } s_i \sim (T)\ s_i'.$$

The lines s_i lie on all the P-surfaces in $\sum$ except the point-wise invariant surface K_2, eliminant of the parameter from $|F|$, $|F'|$. Similarly the lines s_i' lie on all the P-surfaces in $\sum'$ except K_2.

The table of characteristics for T^{-1} is

$$\pi \sim \phi_7 : g_1^5 \sigma_4^{1+d} p_7 s_i$$
$$K_2 \sim K_2 : g_1 \qquad p_7 \quad p_7' g_1'$$
$$g_1' \sim G_6 : g_1^4 \sigma_4^{1+d} p_7 s_i \quad g_1'$$
$$\sigma_4' \sim L_6 : g_1^5 \sigma_4 \quad p_7 s_i$$
$$p_7' \sim P_6 : g_1^5 \sigma_4^{1+d} \quad s_i p_7'$$

[1] Dye, L. A. 1936. "Involutorial space transformations associated with a rational ruled surface." Bull. Am. M. Soc. vol. XLII, no. 8, pp. 535–540.

3. If we take

$$S \equiv x_1^2 x_4 - x_2^2 x_3 = 0,$$

and

$$|F| \equiv vF_1 - uF_2 = 0; \qquad |F'| \equiv vF_1' - uF_2' = 0,$$

where

$$F_1 = (ax), \qquad F_2 = (bx), \qquad F_2' = (a'x), \qquad F_2' = (b'x),$$

then

$$(z) = (2u^2vR,\ 2uv^2R,\ u^2M,\ v^2M),$$

where

$$R = F_2y_1 - F_2y_2, \qquad M = F_2^2y_3 - F_1^2y_4.$$

The equations of T^{-1} are

$$x_j = L_6y_j - K_2z_j, \qquad = 1, 2, 3, 4$$

where

$$K_2 = F_1'F_2 - F_2'F_1$$
$$G_6 = F_2'(y)F_1'(z) - F_1'(y)F_2'(z)$$
$$L_6 = F_2(y)F_1'(z) - F_1(y)F_2'(z)$$
$$P_6 = F_2(y)F_1(z) - F_1(y)F_2(z).$$

A Birational Transformation Associated with a Rational Space C_n

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CONSIDER A RATIONAL SPACE CURVE r of order n and two pencils of planes $|\pi|$ and $|\pi'|$, the planes and the points of r being projectively related. Through a generic point $P(y)$ of space passes one π of $|\pi|$. The line t determined by $P(y)$ and the point $P(r)$ of r associated with π cuts the associated plane π' of $|\pi'|$ in a unique point $P'(x)$, the image of $P(y)$ in the T thus defined.

The points of r will in general have unique image points under T. There are, however, $n+1$ points q_i on r whose images under T are planes of $|\pi'|$; i.e., the q_i are fundamental points of the first kind under T. Similarly, r contains $n+1$ points q_i' of the first kind under T^{-1}.

Let r have as equations

$$(1) \qquad x_1 = f_1(u, v), \qquad x_2 = f_2(u, v), \qquad x_3 = f_3(u, v), \qquad x_4 = f_4(u, v),$$

where the f_i are homogeneous functions of order n, and take the pencils of planes as

$$(2) \qquad |\pi| \equiv v(ax) - u(bx) = 0$$

$$(3) \qquad |\pi'| \equiv v(a'x) - u(b'x) = 0$$

where $(ax) \equiv \sum_{i=1}^{4} a_i x_i$ and similarly for (bx), $(a'x)$ and $(b'x)$.

For a point $P(y)$ there is a plane of $|\pi|$ with parameter

$$(4) \qquad \frac{u}{v} = \frac{(ay)}{(by)}$$

and to this corresponds the point $P(r)$ having as coordinates

$$x_i = f_i(ay, by), \qquad i = 1, \cdots, 4$$

and the plane

$$(5) \qquad (a'x)(by) - (b'x)(ay) = 0$$

of $|\pi'|$. The transversal t determined by $P(y)$ and $P(r)$ intersects the plane (5) in the point whose coordinates are

$$(6) \qquad T^{-1}: \quad \tau x_i = Qy_i + Kf_i(a, b, y), \qquad i = 1, \cdots, 4$$

where $Q = (by) \sum_{i=1}^{4} a_i' f_i(a, b, y) - (ay) \sum_{i=1}^{4} b_i' f_i(a, b, y)$, (order n+1) and $K = (ay)(b'y) - (by)(a'y)$, (order 2). The surface Q consists of $n+1$ planes of $|\pi|$ which are the images of the fundamental points q_i', i.e., $q' \overset{T^{-1}}{\sim} Q$.

Equations (6) are those of the inverse transformation T^{-1} which is seen to be of order $n+2$.

Noting that $K' = -K$ the equations of T, also of order $n+2$ can be written as

$$T: \quad \tau y_i = Q' x_i - K f_i(a', b', x), \qquad i = 1, \cdots, 4 \tag{7}$$

where $Q' = (b'x)\sum_{i=1}^{4} a_i f_i(a', b', x) - (a'x)\sum_{i=1}^{4} b_i f_i(a', b', x)$, (order $n+1$). Q' consists of $n+1$ planes of $|\pi'|$ and $q \overset{T}{\sim} Q'$.

If we apply the transformation T^{-1} to a plane $(a'x)$ of $|\pi'|$ we obtain

$$(a'x) \overset{T^{-1}}{\sim} (ay)L$$

where $L = (b'y)\sum_{i=1}^{4} a_i' f_i(a, b, y) - (a'y)\sum_{i=1}^{4} b_i' f_i(a, b, y)$, a surface of order $n+1$. Here (ay) is the corresponding plane of $|\pi|$, hence

$$1' \overset{T^{-1}}{\sim} L_{n+1}$$

where $1'$ is the base of $|\pi'|$. Similarly, $(ay) \overset{T}{\sim} (a'x)L'$ and $1 \overset{T}{\sim} L'_{n+1}$.

The pointwise invariant surface of the transformation is the quadric $K=0$. We find that

$$K' \overset{T^{-1}}{\sim} KLG$$

where $G = (by)\sum_{i=1}^{4} a_i f_i(a, b, y) - (ay)\sum_{i=1}^{4} b_i f_i(a, b, y)$, a surface consisting of $n+1$ planes of $|\pi|$ which are the images under T^{-1} of $n+1$ lines g_i' and contain the fundamental points q_i. The lines g' are the intersections of corresponding planes of Q' and G. That is

$$g' \overset{T^{-1}}{\sim} G_{n+1}.$$

Similarly $K \overset{T}{\sim} KL'G'$ and $g \overset{T}{\sim} G'$; G' consisting of $n+1$ planes of $|\pi'|$ passing through q', the planes being the images of the lines g which are the intersections of corresponding planes of Q and G'.

The above statements may be expressed in the form

$$[Q_i, G_i']: g_i, \qquad i = 1, \cdots, n+1.$$
$$[Q_i', G_i]: g_i', \qquad i = 1, \cdots, n+1.$$

Furthermore

$$G' \overset{T^{-1}}{\sim} L^{n+1}Q, \qquad G \overset{T}{\sim} L'^{n+1}Q'$$

and also

$$L' \overset{T^{-1}}{\sim} QL^nG, \qquad L \overset{T}{\sim} Q'L'^nG'.$$

A generic plane $\pi' \equiv \sum_{i=1}^{4} A_i x_i = 0$ under T^{-1} gives

$$\pi' \overset{T^{-1}}{\sim} Q\sum_{i=1}^{4} A_i y_i + K\sum_{i=1}^{4} A_i f_i(a, b, y) = \phi_{n+2}$$

the homaloidal web of T^{-1}. Further

$$\phi \overset{T}{\sim} Q'L'^{n+1}G'\sum_{i=1}^{4} A_i x_i.$$

Hence the homaloidal web is

$$\infty^3 \left| \phi \right| : 1^{n+1} g.$$

The intersection of two surfaces of the web gives

$$H \equiv [\phi, \phi] : 1^{n^2+2n+1} g c_{n+2}.$$

The jacobian of T consists of $Q'^2 L' G'$.
The correspondences can now be summarized as follows:

$$1 \overset{T}{\sim} L' : 1'^n 1 g' \qquad K \overset{T}{\sim} K : 1' 1 g' g$$

$$\pi \overset{T}{\sim} \phi' : 1'^{n+1} g' \qquad g_i \overset{T}{\sim} G_i' : 1' g_i$$

$$q_i \overset{T}{\sim} Q' : 1' g_i'.$$

The intersection table follows:

$[L', K] : 1'^n 1 g'$ $\qquad$ $[K, G_i'] : 1' g_i$

$[L', \phi'] : 1'^{n^2+n} g' c_{n+1}$ $\qquad$ $[K, Q_i'] : 1' g_i'$

$[1', G_i'] : 1'^n k_1$ $\qquad$ $[\phi', Q_i'] : 1'^{n+1} g_i'$

$[L', Q_i'] : 1'^n g_i'$ $\qquad$ $[\phi', G_i'] : 1'^{n+1} c_1$

$[K, \phi'] : 1'^{n+1} g' k_2$ $\qquad$ $[G_i', Q_i'] : 1'.$

Spectroscopic Problems

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A NEW LABORATORY COURSE, Spectroscopic Analysis, has been added this year to the curriculum in physics at Bethany College. The first few weeks of the course were spent in studying the necessary theory and procedure in spectroscopic analysis. Topics considered were:

Bohr's theory of the hydrogen atom.
Types of spectra and excitation.
Spectrographs.
Gratings.
Instructions on the Hilger E-1 spectrograph.
Photographic technique.

Following these lectures, each pair of students planned a spectrographic plate, in most cases a simple plate, using samples such as aluminum, carbon, copper, iron, and zinc, but the identity of these samples was unknown to the students. The resulting spectra were analyzed by projecting on the Bardet charts and noting the correspondence between lines of the spectra and those marked on the charts.

The Hilger E-1 spectrograph and auxiliary equipment have been loaned to the physics department of Bethany College by the Follansbee Bros. Steel Co. This instrument is the largest of a series of three made by Adam Hilger, Ltd., of London, and has a dispersion of 2.4 Å per mm. at 2443 Å. This dispersion is sufficient to permit work in the complicated spectrum of steel. The possibilities of this instrument in spectroscopic research are almost unlimited.

GENERAL PROCEDURE

After the general problem has been determined, the next step is the planning of the spectrographic plate. The general plan for such a plate is the use of three adjacent horizontal exposures across the plate for the comparison of three different samples.

Pure carbon electrodes are used in making the first or upper exposure in order to determine whether there are any undesirable impurities present. By undesirable we mean those impurities in the carbon electrodes which correspond to the elements we might find in the unknown sample. The middle exposure is assigned to the unknown sample, and the third exposure to a reference spectrum of iron.

The length of exposure of the plate is determined to a large extent by the value of the current through the arc. Thus if a 1-ampere current were used, an exposure of 40 sec. might be necessary, while a current of 2 amperes might cut the exposure time to 10 sec. These currents are used for electrodes under one quarter of an inch in diameter. We have assembled a rather complete record of exposures and amperages, and by referring to this record we are able to determine accurately the correct exposure.

A contrast developer is used to develop the process plates, and the

developing tray is rocked to reduce the Eberhardt effect. When the plate has been fixed, washed, and dried it is projected upon a movable screen where the Bardet charts have been placed. The iron lines on the plate are superimposed upon those on the charts and any elements that are present can be identified by their positions. That is, if a line on the plate coincides with an aluminum line on the charts, then there is a possibility that aluminum might be present. If several lines on the plate are found to coincide with aluminum lines on the Bardet charts, then it is safe to conclude that aluminum is one of the constituents of the sample. However, if only one very faint line is discovered and none of the more intense aluminum lines is present, it is not possible to say with certainty that aluminum is present.

It might be stated that the iron line at 3100 Å is used as a starting point in the analysis because it is a very intense line and is easily located on the photographic plate and easily matched with the 3100 Å line on the Bardet chart.

The following material deals with some of the problems which have been investigated by the class in Spectroscopic Analysis during the second semester of the present school year.

The first problem of interest to be discussed concerns the contamination of foods by metals.

ALUMINUM CONTENT OF PRUNES

In this particular problem we were interested in determining whether or not aluminum was absorbed by foods cooked in aluminum utensils. Samples of prune juice, cooked prunes, and uncooked prunes were tested spectroscopically by introducing these samples directly into the carbon arc.

In the first analysis the cooked prunes and juice were allowed to stand in the aluminum pan for several days, and there was definite evidence of considerable aluminum in the juice and the cooked prunes. In the second analysis, samples were taken from the same portion as used in the first analysis but these samples were removed from the aluminum dish soon after cooking.

The results indicated that there were traces of aluminum in this second analysis and that its concentration was approximately the same in the juice, in the uncooked, and in the cooked prunes. Hence no appreciable amount of aluminum was absorbed during the cooking process. It is interesting to note that in the spectrum of the prunes, silicon was found, which probably came from the soil; and magnesium, which might explain the laxative effect of prunes, since magnesium sulphate, oxide, citrate, and carbonate have laxative properties.

TURNPLATE ANALYSIS

We have used the Hilger E-1 spectrograph in pursuing numerous problems for the Follansbee Bros. Steel Co. Recently the company asked us to analyze the coatings on three different samples of turnplate, a problem that presents great difficulty to the chemists because of their inability to obtain sufficient amounts of the samples.

For this problem the general procedure was altered. Instead of using two carbon electrodes and introducing the sample into the arc, the turn-

plate was used as the lower electrode and was moved about under the stationary upper carbon electrode while the arc was in operation, so as to pick up as much of the coating as possible and introduce it into the arc.

One of these samples was found to be plated with tin and lead, with lead predominating. A small amount of magnesium was noted but it may have come from the base material. In another sample the coating seemed to be almost entirely of cadmium. Small amounts of copper, tin, manganese, magnesium, nickel and lead were present but again these may have come from the base stock.

CHEESE CONTAMINATION FROM METAL WRAPPERS

The particular problem in this instance was to determine whether or not any of the metals from the foil wrapper penetrated cheese in contact with it. A package of cheese purchased from a local grocer showed no apparent discoloration from contact with the wrapper. The plate was planned so that we could determine (a) the constituents of the tinfoil and (b) a comparison of the foil, the cheese in contact with the foil, and the cheese from the center of the piece. There was definite evidence that small amounts of the tin from the foil penetrated the cheese.

Next an attempt was made to determine the depth of this penetration. Six slices of cheese, each 160 microns thick, were cut with a microtome, beginning at the outside of the piece of cheese. The tin penetrated the cheese with diminishing concentration throughout the six slices. Thus, even though there was no apparent discoloring of the cheese, the results indicated that the tin from the foil penetrated at least to a depth of one mm.

However, since our spectroscopic analysis was qualitative and not quantitative we were not able to determine the exact amount of this metal, but it is quite probable that the percentage is rather small. The experiment will be continued to determine the full extent of this penetration, and it is hoped that a quantitative analysis can be made later.

ANALYSIS OF BLACK AND WHITE HAIR

The comparison of the metallic constituents of white and dark hair from the same person was our next problem. We thought that possibly there might be an absence of some metal that caused hair to lose its color. Black and white hairs were taken from the same portion of the scalp and soaked in alcohol to remove all oil. Several of the black hairs were introduced into the lower electrode of the arc while it was hot; the ashes collecting there in a small cavity. The arc was again started and the exposure taken. A similar process was used in photographing the spectrum of the white hair.

An analysis of the plate showed that there was more copper in the white hair than in the black. This is just the beginning of this problem and represents only one test of a single case. We intend to continue this experiment, and after sufficient cases have been analyzed we hope to be able to give a report which may or may not have definite bearing on the graying of hair.

PROSPECTING FOR GOLD

Another interesting problem might be called scientific prospecting for

gold. Sediment from the bottom of a very small stream on the campus at Bethany was tested spectrographically for gold and other metals.

One of the men in the course had panned gold in California, so the task of obtaining the samples was assigned to him. True prospecting procedure was followed. The dirt from the stream bed was washed with a circular motion in a shallow pan, so that the lighter particles were removed. When this process of "panning" had reached the point where the sediment consisted of only heavy particles, some of the "pay dirt" was ground up to a fine powder and then pure mercury was added and mixed thoroughly in a crucible. An amalgam was formed between the mercury and those metals present which combined with mercury, gold being one of them.

Then the following spectra were photographed: pure mercury, the unknown amalgam, the sample from the stream bed, and, for comparison, the gold spectrum. Upon analysis three gold lines appeared, namely, the 2675.95, 2748.26, and 3122.78 Å lines. Traces of silver, copper, and iron were also found in the samples from the stream bed.

The amount of gold present is small, as may be gathered from the fact that half a pound of the concentrated sample yielded only enough gold to the 10 gm. of mercury in the amalgamation process to produce easily discernible but not intense gold lines. Certainly the spectroscopic evidence does not justify a gold rush to the Bethany campus.

We feel, in conclusion, that this course has great potentialities for the student. Initiative and ability are developed on the part of the student, since he chooses his own problem, obtains and prepares the samples, plans his plate, takes the exposures, develops the plate, and analyzes the results. Of course, most of the work is supervised, but on the average there is more individual interest, enthusiasm, and initiative than is found in most laboratory courses.

We wish to acknowledge the work of the following students in the Spectroscopic Analysis course for their contributions on the above problems: William Ashley, Charles Cormany, Warren Coughanour, Peter Johnson, and Goff Ramsey.

The Social Sciences Section

Mare Nostrum—The Political Importance of the Mediterranean Area

ALBERT G. D. LEVY, *Elkins*

SINCE THE OUTBREAK of the second World War, starting with Germany's invasion of Poland, the Mediterranean area has up to the present time remained one of the relatively most peaceful of all the trouble spots of the world. This fact gains momentum when we consider that only in few other places of the globe do interests clash so violently between two and more of the greater and numerous of the smaller nations, as in the *Mare Nostrum* of the Romans of old. Over two hundred million people are affected vitally by what happens in this area, and over fifteen different tongues are spoken here.

Of all Mediterranean Powers, Turkey appears to have experienced the greatest changes of territorial, ethnical, and political nature during the first part of this century. Before the outbreak of the first World War, the Sultan was suzerain over an area extending from the Gulf of Gabes to that of Alexandretta and owned also the island of Cyprus. After the war, Tripoli became Italian and Egypt an independent kingdom; the mandated territories of Palestine and Syria were attached to Britain and France respectively, and Cyprus became a British Crown Colony. While before the first World War Greece had been but one of the smaller neighbors of Turkey, and Crete and Thrace together with the region called vaguely Macedonia had been Turkish, Crete subsequently became part of Greece, and Turkey lost not only the whole of Macedonia, but also all but the eastern part of Thrace. Access to the Ionian Sea as well as to the Adriatic was also lost, and a new state, Albania, was established. Bosnia-Herzegovina, which Austria-Hungary had annexed from Turkey in 1908, was given, at the end of the war, to the newly-created Serb-Croate-Slovene State, later called Yugoslavia. Yugoslavia also received the greater part of the Adriatic east coast when the spoils of war were distributed, leaving, however, as a cause of discord with Italy the port of Fiume. The settlement of the latter question in 1924 gave this port to Italy, while the adjacent port Baross became Yugoslav. Thus the collapse of the former Ottoman Empire led to the rise, after the first World War, of states which were either new, such as Egypt, Yugoslavia, and Albania, or as Turkey and Greece, which had undergone such radical changes as to be, to all intents and purposes, new.

Turkey, which refused to recognize the validity of the Peace Treaty of Sèvres of 1920 but concluded the Lausanne Treaty of 1923 after a victory over Greece, was transformed after the war into a modern, peaceful nation. Two important events in her recent history were the ratification by the Turkish National Assembly of the Balkan Entente, on March 8, 1934, and the incident of the Sandjak Alexandretta.

After severe clashes between Arab and Turkish nationalist elements had been reported in the Sandjak, which constituted part of the French mandate of Syria, three neutral League of Nations representatives investigated the causes and, on January 26, 1937, two weeks after the opening of the investigation, Turkey and France accepted the recommendations of this commission in the League Assembly at Geneva. Under the terms, the Sandjak was to be demilitarized and given complete autonomy under the new Syrian-Lebanese Federation which France was to establish two years thence. Subsequently, under Foreign Minister Bonnet, the Sandjak caused France to suffer her greatest loss of prestige in the Near East at the time that France concluded the Turko-French Agreement of June 23, 1939, a parallel to the Anglo-Turkish Accord of March 12 of the same year. Under the terms of the accord, France ceded the Hatay Republic, once known as the Sandjak Alexandretta, to Turkey in return for a pact of mutual assistance against the Fascist Powers. For if they were to win the present war, the Allies well realized that they had to make sure that the U.S.S.R. would not supply Germany with oil. True, the Lausanne Convention of 1923 had made the Straits, the door to the Black Sea, a neutral zone; but in 1936 the Powers had agreed at Montrieux to permit Turkey to remilitarize the zone. Therefore, only with the permission of Turkey could the Allies send their warships into the Black Sea to intercept tankers carrying oil from the pipe lines at Batum and Tuapse to the Dnieper River, Odessa, the Danube and Bulgaria. Air bases, and the permission for from 200,000 to 570,000 Allied troops to pass over Turkish territory, were also needed if the strategic Russian railway route from Baku to Rostov, and thence to Germany, was to be cut.

Another diplomatic victory of the Allies finally was the signing of the 15-year alliance of France and Britain with Turkey on October 19, 1939. This pact had been hanging fire ever since the mutual assistance pledges had been exchanged in May. This constituted also an effective check to German moves in the Balkans, and served to insure continued Italian neutrality, even at the time of and after the visit of German Foreign Minister von Ribbentrop to Rome in March of this year. Thus the Allies had gained the strongest possible diplomatic position: for should Italy join in the conflict on Germany's side, Turkey, in self-defense, would join the Allies in protecting Egypt and the Suez Canal and driving Italy from the eastern Mediterranean. If the U.S.S.R., on the other hand, would push into the Balkans (although the latter had become more friendly towards the Allies since the Finnish truce, which had been negotiated with the good offices of a British diplomatic agent), Turkey would find it almost necessary to assist the Allies, although her treaty of alliance especially excepts a war with the Soviet Union. Through the alliance with Turkey, Britain had avenged herself for the Russo-German Accord, which was suddenly announced in summer 1939, even while Britain together with France was negotiating for a pact with Russia, a pact, however, which had been opposed within Britain by such men as former Ambassador to Japan and Russia, Sir Francis Lindley, and outside by Pope Pius XII. To protect her rear, Turkey also considered in February of this year to convert her non-aggression pact of July 8, 1937, with Iran, Iraq, and Afghanistan into one of mutual assistance.

Great Britain entered the Mediterranean area with her conquest of Gibraltar which British-Dutch forces under Prince George of Hesse-Darmstadt captured on July 24, 1704, after a three days' siege, while Admiral George Byng bombarded the fort. During the Crimean War, 1854–56, Britain together with France, Sardinia, and Turkey sent her warships through the Mediterranean into the Black Sea. In 1882 the British seized Cairo and entrenched themselves firmly in Egypt with the conquest of the Sudan in 1898. After the newly-built Suez Canal had been partly demilitarized and opened freely to all vessels in time of peace and war alike, under the Convention of 1888, Britain found it useful for the future of her Empire routes that Disraeli (Lord Beaconsfield) had bought Canal stocks from Egypt in 1876, when the Khedive had wished to obtain sufficient money to extricate himself from grave financial difficulties. At the turn of the century, the Mediterranean had become, in British eyes, an important longitudinal thoroughfare with naval stations such as Gibraltar, Malta, and Aden, with more to be added in following years.

During the first World War, and the ensuing years, various thorny questions arose for British Empire policy in this area. Of the four Class A Mandates in the Near East, Britain received Palestine, while France received Syria and Lebanon. The fourth, Iraq, then called Mesopotamia, was recognized by Great Britain, her original mandatory Power, as an independent state as early as 1922, when the two Powers concluded a 25-year alliance, which with a protocol of April 30, 1923, and four subsidiary agreements of March 25, 1925, defined the relations between the two countries. After the Iraqi objected to certain conditional clauses in subsequent treaties of 1926 and 1927, the British Government decided on November 4, 1929, to recommend Iraq for membership in the League of Nations in 1932.

As to the status of the Class A Mandates in general it may be mentioned that they are covered by Art. 22, par. 4, of the Covenant of the League of Nations and that they were established over territories renounced by Germany in Art. 119 of the Treaty of Versailles, while the Mediterranean Mandates were more clearly defined in Part III, Sec. 7, of the Treaty of Sèvres, August 10, 1920, which provisions were not affected by the separate Treaty of Peace with Turkey of July 24, 1923. Although the League adopted the final status of the Class A Mandates only in 1922, the allocation of these territories had been made by the "Principal Allied and Associated Powers" at the Paris Peace Conference, May 5, 1919, and at San Remo, April 25, 1920. San Remo came once more into the headlines on August 14, 1920, when France and Britain reached the Near Eastern Oil Resources Agreement. This same oil question came up also at the Lausanne Conference of 1923, where the Turks were forced to cede oil-rich Mossul to British-mandated Iraq. At the time of the Lausanne Conference, following the newspaper accounts, "the local hotels housed more representatives of oil companies than of foreign governments."

In Palestine, Britain has not yet succeeded in reconciling her two promises of first World War days: the MacMahon Pledge, given to the representative head of Arab nationalists, Emir Hussein of Hejaz, in 1915, promising the establishment of an independent Arab Palestine; the other

to the Jews in form of the Balfour Declaration of 1917, to Baron Rothschild, expressing that His Majesty's Government was viewing " . . . with favor the establishment in Palestine of a national home for the Jewish people . . . ," and the misery and strife caused are a matter of record. Even a third division of Palestine, agreeing with neither of the former two promises, was subsequently discovered in the form of the secret Sykes-Picot Agreement, concluded by the Allies in 1915. Neither High Commissioners, sent to administer the Mandate, nor Royal Commissions could find a satisfactory solution to the puzzle, a fact that came out strikingly clear at the London Conference of February 9, 1939, at which the Mandatory Power, Jews, and Arabs were represented, the latter receiving strong support from Arab nationalist elements outside of Palestine. Caught between the claims of moral rights of the Jews and those of the Arabs, who have inhabited the country for the last 2000 years, Britain has so far not changed the somewhat unjust *status quo*, because wartime expediency does not permit her to lay the Haifa head of the Mossul oil pipes open to sabotage or to capture by a foreign power. Also the thought of a sixteen million Pan-Arabia for or against her, is an important factor in making a decision. Numerous proposals have been rejected either by the Mandatory Power or the League, the last report of the League Mandates Commission showing four of the seven members opposed to the British plan of August 17, 1939.

But also in other parts, Britain watched closely events that took place in the Mediterranean area. The *Entente Cordiale* of Britain and France of 1904 was mainly intended as a common front against Germany in the Mediterranean and Africa. After lasting throughout the war, the close cooperation of the Allies almost seemed to be at a breaking point when during the years of 1921–22, during the Turko-Greek War, France favored the Turks while Britain favored the Greeks. In the end, the Turks won and Britain suffered a great loss of prestige in the Near East. To many observers at this time it seemed also as if the old Anglo-Russian rivalry in the Mediterranean would break out into the open once more. A decade later, although a possible Italo-Spanish alliance would have been a great danger to British interests during and after the Spanish Civil War of 1936, Britain connived in the defeat of the rightful Loyalist Government by a half-hearted policy of non-intervention, while permitting German and Italian war planes and other war supplies to be sent to Franco's aid unhindered. This arms traffic took place through Portugal, Britain's ally since the fourteenth century, where the Fascist Cremona-Salazar régime was, and still is, in power. Thus the names of Simon, Hoare, Baldwin, and Eden have unfortunately become representative of a tragic period in British politics, a period in which her own power decreased while the cause of the dictatorships gained momentum.

When in 1934 rearmament appeared mandatory to the British Government, a policy of rebuilding the armed forces was adopted with a budget which was to increase yearly. Isolationist sentiment forbade new alliances, but a *rapprochement* with the U.S.S.R. was achieved. During the Ethiopian War, Turkey, Greece, Yugoslavia, Rumania, and France were induced to guarantee military aid in case of an Italian attack on Britian's interests, a guarantee which terminated in 1936. King Edward VIII visited Yugoslavia, Greece, Bulgaria, and Turkey. Yet up to the time

of the Munich Four Power Agreement of 1938, there seemed to be much in the way of an effective Franco-British alliance. While not so evident during the 1921 Washington Naval Conference, Britain had watched the Franco-Italian naval rivalry in the Mediterranean at the time of the London Naval Conference of 1930 with keen interest. (This rivalry lasted even up to the London Naval Conference of 1935.) Other actions taken toward the reestablishment of security and peace of the world in general, and also of the Mediterranean area, were the American-sponsored Coolidge Geneva Conference of 1927, and the Kellogg-Briand Peace Pact of 1928. Before ratifying the latter pact, Britain made her so-called "Monroe-Doctrine" the condition of acceptance, stating that she desired to reserve her liberty of action in "certain (undefined) regions of the world, the welfare and integrity of which constitute a special and vital interest for our peace and safety." Significantly enough, besides Canada and Ireland, Turkey, Iran, and Egypt (which was to become almost independent under the terms of the Anglo-Egyptian Treaty of August 26, 1936) objected to this reservation.

Speaking of British policy in the Mediterranean area, mention must also be made of the failure of the Hoare-Laval Peace Plan, of December 9, 1935. This plan for the settlement of the Italo-Ethiopian controversy was spurned by Il Duce, which forced Sir Samuel Hoare to resign, while French Premier Pierre Laval fell shortly thereafter, January 22, 1936, to be followed by Albert Sarraut. British Prime Minister Baldwin, at the time of the framing of the peace plan, had pledged his Government to the support of the League of Nations, which had won him a sweeping victory in the British elections of November 18, 1935. After Hoare's resignation, Captain Anthony Eden became Secretary of State for Foreign Affairs, an office in which he was to become well known as an advocate of the sanctions policy and a builder of the "ideological front." Eden's resignation on February 20, 1938, opened the way for Prime Minister Chamberlain to conclude the Anglo-Italian Accord of 1938, which will be further explained in the following paragraphs.

The well-known term of the "balance of power" enters the picture if we consider the Italian and French positions in the Mediterranean. Italian foreign policy in the Mediterranean, since the close of the first World War, has been influenced by somewhat different motives than those of the other great Powers. After Italian emigration to the United States was restricted by legislation in this country and emigration to South America became increasingly difficult, new areas for possible settlement had to be found to take care of a steadily growing surplus population, as, e.g., the development of Tripoli, which was obtained from Turkey in 1912. This policy found expression, furthermore, in the eastern part of the Adriatic in the acquisition of the peninsula of Istria, with the ports of Trieste, Pola and Fiume, and of Zara and the island of Lagosta. By these acquisitions Italy obtained both complete protection for the east coast of her own peninsula (the latest move in this direction being the conquest of Albania in 1939) and possibilities of notable commercial developments.

On the whole it may be said that Italian foreign policy after 1870 pulled alternately in two directions: to build an African Empire and to secure *Italia Irredenta*, at that time a part of Austria-Hungary. In 1866

and 1882, pacts similar to the present-day Rome-Berlin Axis (with Austria included) were concluded. In 1896, while engaged in the first controversy with Ethiopia, Italy recognized the French protectorate over Tunis in return for extensive commercial concessions. In various of the following conferences, the details of which space does not permit to mention, Italy often concluded pacts with both Germany and Austria as well as with the future Allies of the first World War, which were absolutely contradictory as far as the fulfillment of their terms was concerned.

Soon after the outbreak of the first World War, Italy, in consideration of the vulnerability of her coasts, joined the Allies after the conclusion of the secret Treaty of London in 1915. At the Paris Peace Conference, however, Italy found, much to her distress, many of her claims thwarted by Wilsonian idealism, by Serbian annexationist aspirations in the Adriatic, and by French and British reluctance to permit Italy to dominate the Mediterranean.

Italy itself was able to use force only against small and weak states. The Corfu incident of August 31, 1923, with Greece and the Treaty of Tirana of November 1926, by which Albania became already a virtual Italian dependency, are vivid illustrations of this argument. If Italy, therefore, at the present time should choose to strike at Greece, with support from her new Albanian base, she could well place the supply lines of the Allies in a precarious position. Should Italy engage in a war with the Allies, Turkey would be most likely to seize this opportunity for recapturing the Dodecanese islands. Of course, the U.S.S.R. might enter the Balkans at this moment, which would force Turkey (and the Allies) into a war with the Soviet Union, an instance to which we have referred above.

To further consolidate Italy's position, Mussolini sponsored the Four Power Pact of July 15, 1933, for the promotion of peace and disarmament by consultation, with Germany, France, and Britain as participants, after the ill-fated Barthou-Litvinov "Eastern Locarno Project" had proved to be a failure. At the same time, Mussolini subsidized Chancellor Dolfuss' Austrian Heimwehr, and after Dolfuss had been murdered, crowned his actions by the conclusion of treaties with Austria and Hungary and thereby creating what he preferred to call the "Italian Bloc."

As forerunners to Italy's Ethiopian adventure, the borders of Italian Lybia had been extended at Egypt's expense in an Anglo-Italian Agreement of July 20, 1934. The following year, by the Laval-Mussolini accord of January 7, 44,500 square miles of the Tibesti desert were ceded to Lybia by France, and a strip of French Somaliland was added to Eritrea, all in final fulfillment of the London Treaty of 1915. Hitler's occupation of the Rhineland then caused London and Paris to desert Ethiopia and the League completely in the hope of bringing Mussolini back into the "Stresa Front" of 1935. In 1936, however, Mussolini could celebrate the establishment of a new Italian Empire and victory over Britain as well as the League and Ethiopia.

The Italo-German Accord of October 25, 1936, negotiated by Foreign Minister Ciano, hero of the Ethiopian war, foreshadowed an alliance of the Fascist Powers. But Italy's increased prestige in the Mediterranean offered opportunities in other directions: After M. François Poncet had

just been appointed French Ambassador to Italy, November 19, 1939, presenting his credentials addressed to the "King and Emperor of Italy," Count Ciano undertook on November 30 to express Italian territorial ambitions at the expense of France. (The return of Tunisia, Corsica, and Nice was demanded, with the probable true objective of obtaining the port of Djibuti, the gateway to Ethiopia.) Italy also denounced the Laval-Mussolini agreement of 1935 on December 9, 1938. The British route to India through Suez and the Red Sea now seemed at the mercy of Italian bombers and cruisers. The Sudan and the headwaters of the Nile lay adjacent to Italian Ethiopia. French communications with North Africa could be severed by Italian air power, and numerous intrigues against Britain and France in Palestine, Syria, and Arabia offered hope of further weakening the influence of London and Paris in the Near East. Perhaps the Mediterranean could, after all, become once more a Roman *Mare Nostrum.*

Italy's position since the outbreak of the present World War was governed by the Drummond-Ciano Mediterranean *Status Quo* Agreement of 1937, and more effectively by the Anglo-Italian Accord of April 16, 1938. Following the terms of the latter agreement, the British and Italian positions in the Mediterranean and the Red Sea would remain as they were at the signing of the Accord; Italy would seek no further claims in Spain (proof of this being the sham withdrawal of 10,000 instead of *all* Italian volunteers in the Spanish Civil War). Various clauses for the exact delimitation of the new Ethiopian possession were included, and the Egyptian Minister to Rome was present when the Accord was signed, an action intended to be a token of "good neighborship." On December 8, 1939, the Fascist Grand Council issued a rather concise, yet ambiguous, communiqué stating anew Italy's position in foreign affairs by stressing especially the status of "non-belligerency" she has chosen for herself, and minimizing the too great importance attached by the Allies to the "exchange of views which took place (before and after the outbreak of the war) at Milan, Salzburg, and Berlin" between the German and the Italian dictators, or their foreign ministers. While Britain's minister for economic warfare, Ronald Cross, demanded "plain speaking" from Italy on April 17 of this year, French Premier Reynaud stated a few days later that France was willing to settle her differences with Italy, and was even regarding the conclusion of a Mediterranean Entente of France, Italy, and Spain as basic to the reestablishment of peace in that area. Finally, Italy was reported to have coveted certain islands on the Yugoslav coast, but was kept from seizing the same by a strong Allied démarche expressing that they would regard such action as cause for a Declaration of War.

France, on the other hand, with no surplus population, has few other interests in the Mediterranean but the unhindered access to Algeria, Morocco, and Tunsia, which have been furnishing valuable regiments to the French army since 1911, and to a still greater extent since 1919. This emphasis on cross-routes (noticeable also in the case of Italy) is not only significant in itself, but something entirely modern. In the acquisition of her transoceanic possessions, France was not always guided by feelings of great international morality, however: France accomplished one of her boldest exploits under Premier Ferry in Tunisia, when on May 12, 1881, the Bey was forced to attach his signature to the Treaty of Bardo

after a French expeditionary force of 30,000 troops had descended upon his territory from Algeria under the pretext of dispersing more or less harmless cattle thieves on the border. This action by the Premier caused much criticism in the French Parliament (Clemenceau "the Tiger" leading the opposition), while Italy, stunned and made helpless by the stroke, concluded the above mentioned Triple Alliance with Germany and Austria. Tunis became formally a French protectorate in 1883, after Premier Gambetta, following Ferry, had accepted the conquest. During the ensuing decade, France had the good fortune of having perhaps one of the greatest diplomats in her history as Foreign Minister, Théophile Delcassé. He strengthened the Dual Alliance, won Italy away from Berlin and Vienna, and brought Britain back into the orbit of French designs. The *Entente Cordiale* with Britain, concluded in 1904, was supplemented by military and naval understandings in 1906, 1910, and 1912, i.e., also after Declassé had vacated the Foreign Minister's office in 1905.

After the close of the first World War, a "new era" of Franco-German relations was inaugurated under the leadership of Aristide Briand, which had its repercussions in the Mediterranean area. Briand, a close friend of the German Foreign Minister Stresemann, was the first French Minister to visit Berlin since 1870. With his aid the Locarno Pacts of October 1925 were concluded and Germany was accepted for membership in the League in 1926. The "Locarno epoch" closed with the deaths of Briand and Stresemann, and new friction developed in Central Europe over Austro-German *Anschluss*, armaments, and treaty revision during the years 1931–1932. Subsequently, Hitler's Nazis rose to political ascendency in Germany, while the failure at the London Naval Conference of 1935 of reaching a Five Power Agreement was likewise an unfavorable omen. Finally, Briand's proposal of a United States of Europe, made in May 1930, had served to align Italy, Germany, Austria, Hungary, Bulgaria, Turkey, Greece, Albania, and the U.S.S.R. against the French Bloc. The Soviet Union, however, concluded a Pact with France in 1935.

This Soviet Pact had been negotiated by Louis Barthou, who was assassinated by a Croatian terrorist, whose target was King Alexander of Yugoslavia, at Marseilles, October 9, 1934. The tragedy left France without a Foreign Minister of great ability, and it left the ally of France on the Adriatic with a boy king, Peter II. Pierre Laval, successor of Barthou, hesitated to ratify the Soviet Pact, until Germany's *démarche* in March 1936 compelled such action. Paris appeared to fall between two stools, however, when it acquiesced in German rearmament in order to help Britain to carry out the sanctions policy and "preserve peace," and on the other hand, acquiesced in Italian designs on Ethiopia and thus undermined the League system of collective security in order to placate Rome—and to "preserve peace."

For the Mediterranean area the Little as well as the Balkan Entente were, and to some extent still are, also of importance. The Little Entente, concluded February 16, 1933, was composed of Czechoslovakia, Yugoslavia, and Rumania, keystone in the present Balkans situation. The member states of the Balkan Entente, concluded at Athens February 9, 1934, constituting the result of various preceding agreements and conferences, recently sent their foreign ministers to the Entente meeting at Belgrade. Following this meeting, the *communiqué* issued February 4,

1940, stressed the intention of the conferees (representing Rumania, Greece, Turkey, and Yugoslavia) to continue to "pursue a resolute, pacific policy . . . ," to remain in close contact until the next meeting at Athens in February 1941, and to extend the life of the Entente to 1948.

Even a country as far removed from the actual Mediterranean scene as the United States of America is, not only politically, but economically vitally affected by what goes on in the Mediterranean area. After the American Civil War, Britain encouraged cotton growing in Egypt as well as in the Sudan, Mesopotamia, and Anatolia. Recently, Germany has also fostered cotton-growing in Iran, thus decreasing the need of such imports from this continent. The Open Door Policy was also stressed by our Government when American interests had been ignored by Britain at the time of the 1920 San Remo Oil Resources Agreement. As a result, in 1925, American oil interests (Rockefeller, Sinclair, and Doheny) were granted 25 percent of the shares of the Turkish Petroleum Company, which secured from Iraq an exclusive concession for the exploitation of the oil resources of the Bagdad and Mossul areas. Preferring to employ American capital, because it carried no threat to their territorial integrity, the younger Islamic states such as Iran, Iraq, and Afghanistan were quick to grant additional concessions to American companies (e.g., Standard Oil in the Bahrein Islands [1930], American Oil Co. of Delaware in northern Iran, and California-Arabian Oil Co. in Hasa Province, in Saudi Arabia).

The last World War brought not only the loss of the *Lusitania* on the Atlantic, but also that of the *Ancona* and the *Persia* in the Mediterranean, and more American lives were lost. The neutrality legislation in force at this time, therefore, is of greatest importance in the safeguarding of American ships which still ply the Mediterranean as well as of the only American airline (on the longitudinal west-east route).

We have shown to some extent how great an interest non-Mediterranean Powers such as the United States and the U.S.S.R. are taking in all that goes on in the area. Even Japan has been reported to consider the support and use of such religious forces as Islam in order to gain an easy passage to the South Atlantic. Minorities in the area, however, do not constitute a great problem at the present time, as most states having such minorities have enacted statutes recognizing minority obligations in accordance with the provisions of the 1878 Treaty of Berlin and the League system as worked out at the Paris Peace Conference. Fourteen such statutes are still being observed at this time. Foremost in the Mediterranean area, then, is the present-day naval rivalry, not so much of France any more, than of Britain on one hand, and Italy on the other.

It is merely a difference of terms if Italy claims its *Mare Nostrum* or Britain "rules the waves." Therefore, as to the Mediterranean proper, we ask: *Mare Cuius?* and will have to wait for history's answer.

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The Cumberland-Shenandoah Fruit Conference—An Adventure in Cooperative Regional Research

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PROGRESS IN EVERY FIELD is furthered by careful, painstaking research. Private organizations attack problems where they are found; the Federal government cooperates with the states in vast research undertakings; but the states have not cooperated to any extent with each other in researches common to regions extending into a number of states.

The Cumberland-Shenandoah apple-growing region extends from Southern Pennsylvania through Maryland, through West Virginia, and into Virginia, covering an area some 250 miles long and 50 miles wide. Of the 45 principal apple-producing counties in this territory four are in Pennsylvania, four in Maryland, seven in West Virginia, and 30 in Virginia.

This area was originally developed for grain and livestock farming. Commercial orcharding has developed almost entirely within the past 50 years. The area as a whole is well adapted to fruit growing, but there are many poor sites, and careful selection is essential to success in the industry.

From 1920 to 1925, crops of apples were so poor in the region that economic distress was widespread among the apple growers. Many orchardists found it difficult to meet operating expenses. As Dr. S. W. Fletcher, now dean of the School of Agriculture, and director of the Experiment Station, Pennsylvania State College, expressed it, "the apple orchards are sick and need attention." An understanding of the underlying causes of the present economic distress and future possibilities of the apple industry seemed essential.

Several officials of agricultural colleges and experiment stations in the four states observed the predicament of the apple growers and Dr. H. G. Knight suggested a conference of interested persons to see what could be done. Accordingly 24 representatives from West Virginia, Virginia, Pennsylvania, and Maryland Colleges of Agriculture and Experiment Stations met at Winchester, Virginia, July 20, 1925, and organized the "Cumberland-Shenandoah Fruit Conference." H. G. Knight, Director of West Virginia Agricultural Experiment Station, G. R. Lyman, Dean of the College of Agriculture, West Virginia University, and A. W. Drinkard, Jr., Director of the Virginia Agricultural Experiment Station, Blacksburg, Virginia, were responsible for the meeting. Representatives of the United States Department of Agriculture have participated since the first meeting.

The conference organized by electing H. G. Knight chairman and A. W. Drinkard, Jr., secretary. The chairman explained that "the purpose of the conference is to consider the feasibility of closer cooperation among agricultural experiment station workers who deal with problems of the fruit industry in the Cumberland-Shenandoah region." It was thought

that results could be obtained more quickly and the fruit growers could be served better by suitable correlation of experimental undertakings and by effective cooperation.

Need for technical research in many different fields was disclosed, and in order to arrive at definite plans of work, committees were appointed to assemble available data and to formulate cooperative research projects which seemed likely to throw light on particular problems. A committee was appointed to study each of the following phases of the subject: (1) economics of orcharding, (2) rootstock problems, (3) uniform spray service, (4) rosy-apple aphis, and (5) correlation of current research projects.

The committee on economics of orcharding was assinged the task of diagnosing the orchards in the region to ascertain just what was causing the economic distress among the apple growers. The committee felt that the first step should be to determine the extent of crop failures or low yields and the causes. This was preliminary to a study of the marketing and production problems of the growers.

Accordingly a survey was undertaken to collect data on yields per tree and per acre from 1921 to 1926 inclusive, and causes of low yields. The orchards studied included 48 varieties, 14,735 acres, and 561,680 trees, in Pennsylvania, West Virginia, and Virginia. Maryland did not participate in the studies until later. The results of this survey were published in United States Department of Agriculture, Technical Bulletin No. 54, "Factors Influencing the Yield of Apples in the Cumberland-Shenandoah Region of Pennsylvania, Virginia, and West Virginia," December, 1927.

Low yields from year to year in different orchards were attributed by the growers to many factors, the most important of which were: age and variety of trees, frost, off-year, failure of fruit to set, hail, disease, insects, drought, poor soil, and poor and indifferent management either of the trees or of the soil. Growers attributed more loss to frosts and freezes than to other causes. Frosts or freezes caused great damage to apples in parts of the region during four of the five years studied. Fluctuation in prices is caused to a large extent by fluctuation in production. When prices are high over a period of years, planting of trees is increased; when prices are low, planting is slowed up, and many orchards are neglected. The Cumberland-Shenandoah region of Pennsylvania, Virginia, and West Virginia as a whole is well adapted to fruit growing, particularly of certain varieties. It should be possible to increase materially the quantity of high-grade fruit produced.

The second phase of the task assigned to the Committee on Economics of Orcharding was the marketing of the apples produced in the region. Data on location of markets, methods of marketing, and prices received for the fruit were obtained from more than 500,000 barrels of apples sold in the three seasons—1924–25, 1925–26, and 1926–27. Detailed data were obtained from actual records from growers, dealers, and many others in Virginia, Pennsylvania, and West Virginia. Local dealers and grower-shippers opened their sales records for analysis. Quantity, variety, primary destination, methods of sale, time of sale, containers used, grade of fruit, and returns were stated in most cases. The findings of this study were published in Technical Bulletin No. 234, United States Department of Agri-

culture, "Marketing Apples Grown in the Cumberland-Shenandoah Region of Pennsylvania, Virginia, and West Virginia," March, 1931.

Marketing problems of apples produced in the Cumberland-Shenandoah region fall into two general classes: (1) problems arising from country-wide production as well as in the region, and (2) problems of merchandising the crops at hand to the best advantage. Since the region consumes only a very small portion of the apples grown, markets must be looked for in industrial and metropolitan centers and abroad. The large production of quality fruit attracts large numbers of dealers and representatives of foreign buyers. Upwards of 200 buyers are resident in the region during the picking season, and they take large quantities of fruit when prices are low. Itinerant buyers are common, and some of the largest producers ship their own fruit to distant markets. Apples from this region were sold in some 400 centers in eastern United States and Canada. In 1926, of the observed sales of the Virginia apple crop 64 percent went direct to foreign countries. Large quantities of apples are exported from Virginia and West Virginia each year, while Pennsylvania growers depend less upon foreign trade and have developed nearby markets for a much larger proportion of their production than the other states. There is a well-known, market preference for certain varieties. Some years practically all of some varieties are exported, while none of other varieties reaches these markets. Production trends are largely determined by market demands for certain varieties and grades.

The last part of the study, Orchard Farming in Pennsylvania, Virginia, and West Virginia, A Farm-Management and Cost-of-Production Study in the Cumberland-Shenandoah Region in Pennsylvania, Virginia, and West Virginia, 1929 to 1931, appeared in mimeographed form in March, 1938. To determine reasons for variations in net returns of farmers engaged in the commercial production of apples in the region, during the three-year period, farm business records were obtained each year from 40 orchardists in Pennsylvania, 44 in West Virginia, and 73 in Virginia. Detailed data on costs, returns, and methods used were obtained by the route method. The majority of the farms studied should be classified as specialized commercial apple orchards. Practically all receipts were from apples; no more than 3 percent of total farm receipts was from all other sources during either of the three years. The range in size of farms studied was from 34 to 1,048 acres. Factors contributing most to successful business on these orchard farms were size of business, yield per acre, and price received for the fruit. Profits on these farms were measured in terms of labor income, which is gross income less all costs of obtaining it, including 5 percent interest on the investment, except the value of the operator's labor. Labor incomes varied greatly on different farms and on individual farms from year to year. One farm showed a minus labor income of $5,239 one year and a plus labor income of $34,343 another year. Incomes on other farms varied almost as much. Chances of making profits on orchard operations were very poor where production was less than 25 barrels per acre and prices below $1.50 per barrel. Orchards of 160 acres had lower cost per barrel and higher receipts per acre than smaller orchards. The data presented can be used for comparative purposes or as a basis for study of costs and management practices for various sizes and types of farms of the region.

New problems have arisen, and new committees have been formed to help solve them. Some of the earlier committees no longer function. Delaware sent representatives to the Conference in 1937 for the first time. Since that date Delaware has participated in the work and has now become a regular member of the Conference. The Committee on Economics of Orcharding was discontinued for a time, but economic problems have arisen again and are being given attention. A new committee to study varieties of apples in relation to production, price, and use was appointed at the last meeting.

The Fruit Conference has been held in the region each year since 1925. The 1939 delegation met at College Park, Maryland, with representatives from West Virginia, Virginia, Pennsylvania, Maryland, Delaware, and the United States Department of Agriculture in attendance. Visitors from New York and North Carolina were present.

State lines, long a barrier to modern progress, are giving way to newer methods of attacking common problems by several groups working independently and comparing results, and not allowing state lines to interfere.

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The United Mine Workers of America in West Virginia

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ORGANIZATION OF WEST VIRGINIA COAL MINERS dates back some 68 years, when it was reported that in 1872 "branches of the Miners and Laborers' Association of the anthracite region were being formed in many of the bituminous coal-producing states including Pennsylvania, Ohio, Kentucky, West Virginia, Virginia, and Michigan."[1] In 1873, representatives of miners from West Virginia met in convention with others at Youngstown, Ohio.[2]

We can safely say that mine-union activities in West Virginia did not claim much attention through the years from 1872 down to 1890. In succession, a number of miners' unions, national and local in scope, made their appearances in the Mountain State and then passed off the stage without leaving any significant imprint. West Virginia miners at one time or another during the 1870's and 1880's became affiliated with such organizations as the Miners National Association, the Knights of Labor, the National Federation of Miners and Mine Laborers, and The National Progressive Union of Miners and Mine Laborers.

In 1890, the United Mine Workers of America was formed out of a union of the National Progressives and District Assembly 135 of the Knights of Labor. In accordance with the action of the new national organization, the miners of the state met at Wheeling, April 21, 1890, for the purpose of organizing a "State Union of the United Mine Workers to be known as District 17."[3] This historic meeitng was called to order by M. F. Moran, now state organizer (the first one) for the United Mine Workers. Eleven delegates attended. The following men were elected as the first officers of District 17: M. F. Moran, president; H. M. Smith (colored), vice-president; H. A. Foster, secretary-treasurer.[4] Moran's salary was fixed at $40 per month and Foster's at $15. This convention issued an invitation to the miners and operators of the Kanawha Valley to meet in joint conference to decide on a wage scale. However, no response was given at the time.

As a gesture toward the southern non-union fields of the state, the first annual convention was held at Charleston April 14–15, 1891. Indicative of increased membership in the new organization was the increase in delegates to 26. Geographic distribution of the union was widespread at this early date, as shown by the addresses of the delegates.[5] The young

[1] Chris Evans, History of the United Mine Workers, 2 volumes. Indianapolis, 1918, vol. 1, p. 22.
[2] *Ibid.*, p. 29.
[3] *Ibid.*, p. 40.
[4] Chris Evans, *op. cit.*, vol. 2, p. 40. Delegates beside those mentioned above were: Vincent Smith, J. H. Cable, C. Marsh, W. A. Jewell, D. W. Cadwallader, P. F. McAuly, Henry Stephenson, L. J. Hault, and F. M. Prickett.
[5] Chris Evans, *op. cit.*, vol. 2, p. 109. The above men came from: Pocahontas, Coalburg, Paint Creek, Plymouth, Dry Branch, Cedar Grove, Kelly's Creek, Central, Catawba, Handley, Coal Valley, Moundsville, Wheeling, East Branch, Raymond City, Poca, Riversville, and Winifrede.

district was having difficulty in collecting dues, according to one resolution adopted. It instructed the president and secretary-treasurer to "ignore all appeals for their services from locals which are not square on the district treasurer's books."[6]

The United Mine Workers were now launched upon their eventful career, and District 17, in particular, was facing a future full of alternate successes and failures.

During the first decade of its existence, 1890 to 1900, the United Mine Workers made slow progress in West Virginia. In the strikes of 1894 and 1897, miners in that state came out in small numbers and the pick-up in production, due to the shutdown elsewhere, gave West Virginia operators opportunities to get footholds in new coal markets.

West Virginia was indeed a "hard nut to crack" from the standpoint of union organization. The veteran Chris Evans was sent into the state to organize in 1895, but he met with poor results.[7] Later, in 1898, the new vice-president of the United Mine Workers, John Mitchell, made it his first job to organize West Virginia. However, he too failed. According to Glueck, he ran into an area where "wholesale arrests, injunctions, evictions, and deportations had broken the men."[8] Failing in direct organizing work, the United Mine Workers then tried a device which if successful might have brought the state into the union field, completely and without much delay. Mitchell, now president of the Mine Workers, attempted a boycott of West Virginia coal. Members and friends of the union were asked to cease buying coal from the state in hope that reduced sales would force operators in that non-union field to come to terms with the union. Such an effort was futile, however, and at the turn of the century, West Virginia and Eastern Pennsylvania were the two great unorganized fields. In 1899 Mitchell admitted that there were only some 365 dues-paying United Mine Workers in the state out of a total of 24,635 miners.[9]

Such is the story in brief of the United Mine Workers in West Virginia before 1900. Since then, this union has played a dominant role in the labor movement of West Virginia. To the man on the street "coal" and "West Virginia" are synonymous, and any mention of labor in that state is immediately associated with the United Mine Workers. Such impressions are justified to no small degree. This one union has probably dominated the labor movement of this state to a greater extent than has any other single union in any other state.

The growth of the United Mine Workers has not been a steady, gradual process. Rather it has been marked by extreme fluctuation in membership, as indicated below. The long and bitter struggle to organize the miners of the state can be summed up in the one word *tenacity*. For a third of a century the international union tenaciously fought to "get in" the West Virginia coal fields and, during the same period, operators were equally tenacious in their efforts to keep the union out.

The industrial strife engendered by these organizing efforts has been amply covered by various writers. In this paper the more peaceful aspects of the mine labor movement in the state are emphasized.

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[6] *Ibid.*, vol. 2, p. 113.
[7] *Ibid.*, *op. cit.*, vol. 2, p. 237.
[8] Elsie Glueck, *op. cit.*, p. 45.
[9] Glueck, *op. cit.*, p. 68.

In 1900 the United Mine Workers claimed about 1000 members.[10] At the national convention of that union in the same year, of nearly 500 delegates only 20 were from West Virginia.[11]

In view of the failure of West Virginia miners to give much support to the national strikes of 1894 and 1897, a widespread organizing campaign was begun in 1900. Vice-President Tom Lewis was placed in charge. After two years' work the union felt strong enough to call a general strike for state-wide recognition. The miners evidently over-estimated their strength, because the strike ended, leaving them strongly entrenched in only one section, namely, the Kanawha. The operators were quite successful in keeping the union out of the Pocahontas, Fairmont, and New River fields. Between 1902 and 1904, membership in district 17 ranged between 1000 and 12,000 miners.[12] That little progress was being made is indicated by the fact that very few items pertaining to West Virginia were to be found in the *United Mine Workers Journal* from 1901 to 1904. Furthermore, District 17 failed to print its quarterly report in the *Journal* although the other districts sent their reports in.

By the end of 1904, many of the operators had broken their contract relations with the union in the Kanawha field, and for the ensuing three years the union struggled continuously to hold its ground in the area.[13] An indication of the low ebb of union influence is seen in the inability of the miners to bring any West Virginia operators to the 1906 Interstate Joint Conference.[14]

A highlight in 1907 was the occasion of a visit by President John Mitchell to Charleston. In his speech to the miners, Mitchell declared, "we have come to stay. . . . West Virginia was born as a protest against injustice and I am here today to protest against injustice."[15]

In the spring of 1907, there was evidence of considerable union activity in the Kanawha area. The seventh annual convention of District 17 was held at Charleston, and at that time Tom Cairnes was elected District President.[16] According to the Argus, this convention of miners was a "harmonious one and the delegates made a most favorable impression upon our citizens by their gentlemanly conduct and strict attention to the business in hand."[17] Organization appeared to be progressing in different parts of the state. Organizers held meetings at Elkridge, Cannelton, Oakland, Raymond City, Gawley Bridge, Crown Hill, and Plymouth during June and July.[18] President John Mitchell was quoted as being "very much impressed with improved conditions in West Virginia."[19] Secretary Morris of District 17 reported 20 new locals with 1000 members for July.[20] Despite optimistic reports which appeared in the Charleston

[10] Based on estimate given in the Report of the Industrial Commission, 1901, vol. 17, p. 185. Union membership data are seldom accurate. This is particularly true in the case of the United Mine Workers. In their long struggle to organize in the state it was "good tactics" to exaggerate. Again, it is difficult to determine what a *member* is. A union leader will state that he "pulled out" 20,000 men in a strike inferring all were union men. Actually, and this was often the case, a small minority of Mine Workers would cause a shut-down of mines, thereby forcing all the workers off the job.

[11] Wheeling Intelligencer, Jan. 15, 1900.

[12] Testimony of Mr. D. C. Kennedy, Hearings of Senate Committee on Education and Labor, 1921, vol. 1, p. 464.

[13] W. E. Fisher and A. Bezanson, *op. cit.*, p. 23.

[14] Glueck, *op. cit.*, p. 182.

[15] Labor Argus, Feb. 21, 1907.

[16] Labor Argus, March 14, 1907. Mr. Cairnes is a veteran labor leader in the state. He was appointed president of the State Federation of Labor by William Green after the A. F. of L.—C. I. O. schism in 1937.

[17] Labor Argus, March 15, 1907.

[18] *Ibid.*, July 25, 1907.

[19] *Ibid.*, Aug. 22, 1907.

[20] *Ibid.*

labor paper (Labor Argus) and the United Mine Workers Journal, the membership in the union in the state in 1908 was only 7000.[21] This figure remained about the same for the state until 1910. According to the tax receipts for the district, in 1908, District 17 paid into the national treasury $7,790.23 and in 1910, $7,240.91.[22]

The Kanawha field was the centre of union strength in the state until 1912. Organizers went out from Charleston to the other parts of the state during this period and usually their efforts met with little success. Their work had to be conducted secretly. An idea of the difficulty of organizing is shown in the testimony of Benjamin Davis. After stating that the operators of the state, except those in the Kanawha field, were definitely opposed to the miners organization, Davis said,

"... people employed as guards and detectives assaulted our people in many instances. I was at Grafton, 15 or 20 guards were across from my headquarters in a hotel and whenever one of us attempted to go to the post office there would be two or three of them after us."[23]

Another organizer declared that "the New River section ... is the most dangerous locality for an organizer of any place in the United States."[24]

Under such difficult conditions the miners' union experienced a continual change in membership. Membership in the United Mine Workers not only fluctuated from year to year, but it was extremely variable from month to month. This instability was especially marked in District 17 in 1912. The number of paid and exonerated members reported to the national headquarters for District 17 from December 1911 to November 1912 follows:[25]

Month	Paid Membership	Exonerated Members	Total
December	2142	198	2340
January	939	197	1136
February	2402	92	2494
March	1482	100	1583
April	2212	1402	3614
May	1455	882	2337
June	1552	656	2208
July	1519	605	2124
August	2194	591	2785
September	1944	1107	3051
October	2323	1170	3493
November	2047	1027	3074

Such extreme changes in membership, of course, reflected the unsettled conditions which existed in that year particularly in the Kanawha area. The total number of members had dropped considerably from the 7000 reported in 1908. The Paint and Cabin Creek struggle was just getting under way.

In the northern part of the state, the United Mine Workers had made comparatively little headway. They had secured a foothold in 1904 in the Wheeling district, and by 1912 a number of wage contracts had been

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[21] From testimony of Benjamin Davis, pres. of Dist. 17, Report of Mine Investigating Committee, Charleston, 1909, p. 20.
[22] United Mine Workers Journal, Jan. 19, 1911.
[23] Report of the Mine Investigating Committee, Charleston, 1909, p. 21.
[24] Proceedings of the 23rd Convention, United Mine Workers, 1912, vol. 1, p. 922.
[25] Annual Report of International Officers, United Mine Workers of America, Indianapolis, 1913, pp. 129–131.

signed with operators. In the Fairmont area, very little union strength was in evidence before 1916.

The World War not only was a stimulant to the coal industry in West Virginia; it definitely paved the way for increased organization of the miners. As coal production increased 25 percent between 1914 and 1921, the conditions of the labor market made it possible for the miners to advance their organization work openly and effectively.

In the Kanawha field, the United Mine Workers had signed a three-year contract with the check-off but without the closed shop. In 1917, upon renewal of contract, the operators agreed to the closed shop with compulsory check-off. They had agreed to this "in view of the national emergency and to prevent any decreased production of coal."[26]

After 1914 the miners commenced to extend their organizing into the New River field, which had been generally closed to them since 1904. In 1915 most of the operators in that area negotiated agreements, and the union maintained contractual relations until 1921.[27]

By 1919, the United Mine Workers had reached their first *peak* in their struggle for "industrial status" in West Virginia. As indicated above, the miners were generally working under contract with the operators in the Kanawha and New River fields. In the Panhandle (Wheeling) district the United Mine Workers had secured the closed shop in all the mines except those of the Hitchman Coal Co. After August 1918 the union had secured a closed-shop contract, including check-off, with more than 80 per cent of the Northern (Fairmont) field.

On the other side of the ledger, the miners' organization had *no* working agreements with operators in Clay County, the Winding Gulf, Logan, Williamson, Tug River (Mingo), and Pocahontas areas. In these last-named fields "some miners were still members or were members of the United Mine Workers but the members of those districts as a whole were entirely independent of the United Mine Workers."[28]

The increase in union strength had taken place within a short period of time. Frank Keeney, president of District 17, told the State Federation Convention that between January 1, 1917, and June 4, 1918, membership in the United Mine Workers had jumped from 7,000 to 17,000.[29] By the end of 1918 the figure had jumped to 30,213, and two years later found the United Mine Workers comprising 49,027 miners or approximately 50 percent of the mine labor forces in the state.[30]

In 1920, with 50 percent of her coal miners working under union contracts and the other half working largely in the southern non-union areas, West Virginia presented the picture of a house divided against itself. For the next 13 years the United Mine Workers were to fight a bitter losing fight. This descent from the 1920 peak was not gradual. Large losses in membership were the rule after strikes were lost. War-time gains of the union had not been spread over the West Virginia coal fields. A most significant development took place while the state was increasing its output of coal 23 percent between 1914 and 1921, Logan

[26] Hearing of Senate Com. on Inter. Comm., Conditions in coal fields of Pa., W. Va. and Ohio, 1928, 2 vols., p. 1938.
[27] *Ibid.*, p. 1984.
[28] *Ibid.*, pp. 1984–1985.
[29] Proceedings of the 11th Ann. Con., W. Va. State Fed. of Labor, 1918, p. 10.
[30] Report of the United States Coal Commission, pt. 3, p. 1387. Report of West Virginia Department of Mines, 1936, p. 131.

County expanded production 95 percent. Logan County was non-union.[31]

The challenge was clear-cut. The increasing competition offered by the Logan and other non-union operators to the organized fields was an unpleasant fact, indeed, a threat to union operators and miners. The United Mine Workers had no ready answer to the charge made in the central competitive field that Logan *et al.* were "taking the market" because of wage-cutting practices. Unless the miners could bring these non-union areas under wage agreements, their very existence as an organization was jeopardized. To what extent the non-union mines in West Virginia profited marketwise from a lower wage cost is another matter. At any rate, the union was determined, in 1921, to bring all of the southern fields into the union fold. There was much truth in the fighting phrase: "If Logan falls, West Virginia is organized."[32]

What happened in this struggle is a matter of common knowledge. Logan did not "fall" and the United Mine Workers lost the great bulk of their membership and power during the twenties in West Virginia.

The trend of taxes received by the United Mine Workers from the West Virginia districts indicates the extent of union losses.[33]

Tax-paying period	Taxes received from Districts 17 and 31
February 1, 1920, to January 31, 1921	$193,106.73
February 1, 1921, to January 31, 1922	139,808.58
February 1, 1922, to January 31, 1923	72,266.99
February 1, 1923, to December 1, 1923	123,275.95
December 1, 1923, to December 1, 1924	80,258.16
July 1, 1925, to June 31, 1926	12,439.00
December 1, 1927, to July 1, 1927 (7 months)	1,193.25
July 1, 1929, to December 1, 1929 (5 months)	1,805.75

State Federation of Labor figures also tell the story of the United Mine Workers collapse in the state. For the 1926–27 fiscal year, the United Mine Workers paid into the State Federation treasury only $328.90 out of a total of $5,658.04 paid by all affiliated locals.[34]

Change in union structure in the state occurred in 1924. Effective June 1, the International organization took over supervision of District 17. This action amounted to suspension of autonomy or self rule in matters of electing officers and outlining district policy. A petition had been signed by some 22 prominent men in the district.[35]

The petitioners had stated that such action

> is necessary and that the integrity and life of the organization can be prescribed and saved only by the intervention and protection of the International Union. . . . We are of the opinion that the best interests of the organization require that the International Union shall remain in full control of affairs in West Virginia . . . until such time as the organization is fully and firmly established in all mining fields. . . ."[36]

The chief reason for this action was a financial one. The International had acquired a considerable financial stake in this coal region and the

[31] Other non-union sections also gained relative to the union West Virginia fields, but Logan's gain was outstanding. From Report of Depatment of Mines, Charleston, 1936, pp. 99–100.

[32] The Nation, May 29, 1920.

[33] Data compiled from Reports of secretary-treasurer of United Mine Workers, Dist. 31, set up in 1927. Reports by districts not given every year; consolidated after 1932.

[34] Proceedings of 20th Ann. Conv., 1927, pp. 87–89.

[35] This group included C. F. Keeney, William Blizzard, and Fred Mooney.

[36] United Mine Workers Journal, July 1, 1924.

district had developed an indebtedness of some $80,000 when its affairs were taken over. In the spring of 1924, $77,380 per month was spent for strike relief by the International Union as against a district income of only $20,000.[37]

From December 1, 1925, to July 1, 1926, out of a total of $635,114.45 spent on strike relief, $325,000 went to the Fairmont area and $140,218.45 to the Kanawha field.[38] Percy Tetlow probably does not exaggerate when he asserted in 1930 that the International had expended over $3,000,000 in assisting the miners of District 17 since 1919.[39]

Another change in union structure in the state came in 1926, " . . . due to the geographical location of the Northern West Virginia coal fields and as a result of the desire of the miners to have a district organization." District 31 was established with headquarters at Fairmont.[40] The Executive Committee retained complete control of affairs.[41]

Efforts to keep the union alive were persistently made during the 1924–1930 period. The abrogation of the Jacksonville agreement by the northern operators in 1924 "broke" the union there. The union countered by organizing District 31 with the fiery, astute Van Bittner at the head. While no large organization was achieved and no wage contracts were drawn up before 1931 in Northern and Southern fields, yet the spark of unionism was by no means extinguished.

The State Federation of Labor continually gave encouragement and organizing aid; the strike relief funds sent in from national headquarters undoubtedly helped to insure union loyalty; the union officials and their legal counsel waged an incessant fight against labor injunctions which were deemed unfair.

In spite of the chronic economic illness which affected the coal industry during the 1920's and in the face of bitter employer opposition, the United Mine Workers persistently and effectively carried on reorganization work through the 1927–1931 period. Notices of union activity appeared from time to time. For example, the Charleston *Gazette* of November 10, 1929, reported that "Tetlow and his assistants are in the field in an effort to revive the union."[42] A succession of items appeared in the *Journal* carrying a message like the following: "Organization work making progress in West Virginia."[43]

The break came in 1931. In May of that year, after the Union had pulled out some 12,000 miners in the northern field in a strike for recognition, the Consolidated Coal company signed an agreement. Thirty-nine other companies then followed suit. The following January, Bittner enthusiastically declared, "Today, 6000 United Mine Workers are working under contract and 12,000 are still on strike."[44]

While this was no small achievement, yet the union had to wait until 1933 with its N.I.R.A. before it could really "come into its own"

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[37] Proceedings of 1924 Convention, W. Va. State Fed. of Labor, 1924, p. 119.
[38] Report of secretary-treasurer of the United Mine Workers, 1926, p. 39.
[39] Proceedings of State Fed. of Labor, 1930, p. 72.
[40] United Mine Workers Journal, April 15, 1926. This district comprises the following counties: Monongalia, Marian, Harrison, Preston, Taylor, Barbour, Randolph, Upshur, Lewis, Gilmer, Braxton, and Webster. It also includes that part of Nicholas County containing coal mines along the Baltimore and Ohio Railroad.
[41] Both Districts 17 and 31 are still on a non-autonomous basis.
[42] Charleston Gazette, Nov. 10, 1929.
[43] United Mine Workers Journal, Feb. 1, 1930.
[44] United Mine Workers Journal, Jan. 1, 1932.

in West Virginia. Under the stimulus and protection of the now historic section 7A of the National Recovery Act, the United Mine Workers' organizing machinery went into high gear. Between June 1933 and December 1934, dues-paying membership in Southern West Virginia jumped from 17 to over 70,000.[45] Under the aegis of the N.I.R.A. the coal fields of Kanawha, Logan, Mingo, Pocahontas, New River, Winding Gulf, and Greenbrier were successively organized. One miner expressed his feelings regarding this change by declaring that "after the 2nd of October 1933, Logan County was recognized and admitted to the United States."[46] The "pick-up" in the miners' organization is evidenced in its representation at the conventions of the State Federation of Labor. At the Charleston meeting in 1931, 54 United Mine Workers' delegates reported; 302 attended in 1934, and 671 at the 1937 meeting.[47]

Logan County, for years the bailiwick of Don Chafin, the anti-union sheriff, presented a different picture in 1938. A clipping from the *Journal* in 1938 presents the contrast:

> Local Union Number 6711, Switzer, West Virginia, recently adopted a resolution commending Everett Workman, high sheriff of Logan county for his work as a sheriff and his friendliness to organized labor in that section. The high sheriff has served two years of his term and has been highly satisfactory.[48]

Since then the United Mine Workers have persistently claimed a membership of some 115,000 men in the state. The unsuccessful efforts of the Progressive Mine Workers to enter the state during and since 1938 and the obvious loyalty of the miners displayed during the contract negotiations of 1939 give credence to the claim of practically 100 percent membership in the spring of 1940.

What is the future of the United Mine Workers in West Virginia? No one can prophesy with any finality. The present strength of the Union in the state does suggest that as long as the organization headed nationally by John L. Lewis remains strong in the coal industry at large, it will continue to play a dominant role in the labor movement of West Virginia.

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[45] Statement by Van Bittner in the Advocate, Dec. 21, 1934.
[46] Proceedings of the 1934 Convention, United Mine Workers, vol. 2, p. 496.
[47] Proceedings of the Conventions of the State Fed. of Labor for those years.
[48] United Mine Workers Journal, May 1, 1938.

Students' Ability to Remember Objective Test Items

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IT HAS BEEN CUSTOMARY for publishers of test materials to prepare two or more forms for each test. We have been told that in cases where a group was to be retested, memory would cause a carry-over from the first which renders a second form desirable. Since many schools offered the same course in two or more sections, it was claimed that there should be more than one form for each test. This reasoning has been adopted by writers in the field of informal testing without much question. I have always doubted pupils' ability to carry away many significant items when the test was of objective nature, sufficiently difficult, and with sharp time limits. I felt the students would be able to remember the general trend of the questions, but, if the test sampled the subject matter as it was taught, that trend would already have been left with the students. Any suggestion gotten from a former student for the purpose of affecting the test scores would be only such general trends as are already known by most students in the class. In an attempt to validate this reasoning the following experiment was conducted at Marshall College in the writer's classes.

It seems reasonable to assume that, the more items in a test, the more difficult it would be for students to remember them; hence a two-answer test would be more easily adaptable to such friendly help than the multiple type. For that reason I used the true-and-false type of test and prepared tests of 100 items in the subjects of instruction, sampling fairly evenly through the assignments. These tests were given over a period of years until most of the subjective features had been eliminated. I could see no gain from using standardized material, since the results were to be used primarily in informal testing. There was no visible selection other than that found in typical registration.

The students were told nothing about the experiment in advance. They were held in class until all had finished the test and were then allowed 20 minutes or more to reproduce as nearly as possible the items they could remember. They were urged to do their utmost to remember them without access to the original test copy. These statements were then given to members of the classes and to N.Y.A. students to study along with the original test copy. They were told to study these items and the original test with the assumption that they wished to take the test and had received from some friend the suggestions on the page of remembered items. They were to evaluate them in terms of (1) exact copy; (2) approximately exact copy; (3) copy of considerable value; (4) copy of very little value; and (5) copy of no value or not even on the original test. Obviously this method has its subjective features, but so would my evaluation; but it has the advantage of being the students' estimate of the value they would have received from this help. They had been assured that it was not a trick to catch cheaters but a scientific experiment to measure students' ability to remember test items. I saw nothing that would lead me to doubt the validity of the data I obtained. The experiment was tried on two different

tests in five different classes and tabulated. Table 1 shows that, if every item remembered by every student could be made immediately available to a student wishing to cheat, from 55 to 88 percent of the test could thus be assembled into a form ranging from considerable value to exact reproductions. However, when a second tabulation was made in Table 2, showing the frequency of these items, we found that the chances of this becoming objectionable were greatly reduced. In this experiment the number of students multiplied by the number of items indicated a possible carry-over of 13,700 items. This of course counts duplications. Actually Table 2 shows that only 1,863 items had value and, with them, 705 suggestions or tips that would have led the students astray. This gave 13.6 percent good suggestions and fully a third of poor leads. This indicates carry-over to be a doubtful source of worry to teachers. We must also remember that many students would not normally attempt it for honesty's sake.

I then wondered how frequently different items had been carried away and prepared, Table 3, which shows that very few had been remembered six or more times. When each student among 137 remembered on the average five or less items, we see how fast the danger zone recedes. Test IV was more factual than Test III and indicated that the type of items in the test affected the remembrance factor. This was also shown by a study of the test items remembered most easily and least easily. A few of these statements will be appended to this paper.

Not being satisfied with this, I desired to know how much this carry-away could be translated into individual gains. The problem was then approached from this angle: The class was told at the close of a test that it would be repeated at the next class meeting, and the members were given ten minutes of the regular period just closing to make notes or converse with each other. The students were actually dared to beat the game and were given a complete range of freedom except that no original copies of the test and no notes that they had made prior to the dare were to be carried away. It was easily seen that they accepted the dare and earnestly tried to increase their scores at the next class meeting. Table 4 shows the tabulated results, and part of Table 5 represents the per-pupil analysis made by the instructor. With the total average gain of less than three points in a 100-item test, one feels justified in assuming that memory and cheating as measured in this manner and as causes for the preparation of a comparable form of the test have been greatly overrated. It seems well to notice that of the items carried away by the pupils, many would have been known anyway from actual study, and part would have been gotten on a two-answer test by chance. It must be a rare coincidence if a student needing nine or ten items—a total rarely remembered—would not be sadly lacking in other ways. Actually, if he contacted a student who remembered that many items, the cheater would still fall eventually in the lowest sections of the grading curve.

The problem was repeated by "stacking the cards" more favorably for the cheater. Students in different classes were then told at the beginning of a test that it was to be repeated and dared to beat the game on the repetition. They were bribed by offering them all the points they could gain. This gave them a chance to memorize the items they had difficulty with and probably was more a measure of their ability to memorize items

TABLE 1—*Number of items remembered with 100 possible. Exact, approximate, or of considerable value*

Course no.	Percentage of possible number remembered		Number of students
	Test III	Test IV	
430	84	88	71
420	55	52	15
332	71	78	13
331	70	76	23
232	62	77	15
			137

TABLE 2—*Value and non-value of "remembered" items on Test No. III. Possible would be N×100*

Course no.	Frequency of considerable value, approximate, or exact reproduction	Possible	Frequency of non-value or very little
430	918	7100	353
420	197	1500	115
332	247	1300	65
331	273	2300	105
232	246	1500	67
Total of all	1863	13700	705
Percentage of possible remembered		13.6	

TABLE 3—*Frequency with which each item was remembered with exact, approximate, or considerable value*

Course no.	Highest	Lowest	1–5	6–9	10 or more
			Test III		
430	37	1	177	14	15
420	5	1	55	0	0
332	9	1	66	5	0
331	9	1	70	6	0
232	8	1	59	3	0
			Test IV		
430	39	1	23	17	34
420	24	1	45	5	0
332	40	1	67	9	0
331	29	1	75	9	2
232	40	1	67	7	1

TABLE 4—*The increase of score on retest*

	First test score				Second repeated test score		
Course no.	H.	Md.	L.	No. cases	H.	Md.	L.
430	89	71.2	55	46	91	72.7	61
332	84	77.5	64	25	87	81.5	65
331	83	75.0	66	13	85	76.0	67
315	94	66.5	54	33	91	69.6	51
232	86	76.0	66	12	86	76.0	66
Total	94	73.3	54	133	91	73.3	51

TABLE 5—*Analysis of individual score on retest*

	Without knowledge	With knowledge
Number of students who raised score	88	58
Number of students who lowered score	37	33
Number of students who made no change	8	13
Number of points raised	429	311
Number of points lowered	133	127
Number of total points gained in class	296	184
Number of average points raised	4.9	5.4
Number of average points lowered	3.6	3.8
Number of total average gained in class	2.2	1.8
Number of cases	133	104

TABLE 6—*Retest with previous knowledge—showing comparison between seniors and sophomores*

	First test score				Second test score		
Course number	H.	Md.	L.	No. cases	H.	Md.	L.
430 (seniors)	76	46.6	14	58	82	47.9	10
232 (sophomores)	72	55.0	32	46	72	56.4	30

TABLE 7—*Analysis of individual gains—showing comparison between seniors and sophomores*

	Ed. 430 seniors	Ed. 232 sophomores
Number of students who raised score	37	21
Number of students who lowered score	18	15
Number of students who made no change	3	10
Number of points raised	212	99
Number of points lowered	79	48
Number of total points gained in class	133	51
Number of average points raised	3.7	2.2
Number of average points lowered	1.4	1.04
Number of total average points gained in class	2.3	1.2
Number of cases	58	46
Number of students raising score 5 or less	25	14
Number of students lowering score 5 or less	12	13
Number of students raising score 6 or more	11	7
Number of students lowering score 6 or more	6	2

than to carry them away. They would memorize items they needed and not what some other party needed.

The results this time were even less favorable to any attempt to carry away significant items. Table 6 shows but slight variations in the median score for the class. Scores were raised, but not as much as in former trials. This leads one to suspect that dividing the attention between taking a test and remembering the test would act detrimentally to the student desirous of helping a friend in another class. How much this confusion hindered the student can be seen from Table 5 where the average gain per pupil in the class was less than in former trials. Table 7 shows that the amount of gain was greater for seniors than sophomores, which probably can be ex-

plained by maturity. There follows a list of statements remembered most easily and least easily on the experimental tests.

A few items frequently remembered:

1. The terms "mean" and "average" are used synonymously in this course.
2. Standard tests will eventually replace informal-type tests.
3. Reliability is the degree to which a test measures what it claims to measure.
4. Standard tests are flexible and can be adapted to local school conditions.
5. The normal curve reaches the base line at three sigma units.

Each of these items is extremely factual, bordering on memorized definitions. They had been carefully taught in the course and most students would have expected them in the test from the emphasis placed in class discussion. Just the opposite is noticed in those items most usually found among those listed as of very little value. In some of these the subjective features are quite predominant.

1. The better school systems care for non-typical children in specialized buildings.
2. Practically all schools have been influenced by modern trends and have become transitional schools.
3. The school house-organ and school newspaper often serve the public better than the annual report of the superintendent.
4. Most pupils may be handled in a similar manner.
5. Supervision deals with dynamic types of society.

SUMMARY AND CONCLUSIONS

In practical schoolroom situations, the need for multiple forms of tests has been greatly overrated by publishers.

If a student desired to obtain help from those who had taken the test in another division, he would have to contact every pupil immediately after class to secure 55–88 percent of the items, depending upon the tests used.

Of the total possible carry-away in this experiment, only 13.6 percent of the items remembered were valuable. These were mixed with a third as many items not on test or of such nature as to lead the students astray.

Counting those remembered by everyone in the class, very few items were remembered six or more times.

The more factual items were remembered most frequently, and those with elements of subjectivity or requiring thinking instead of memory were remembered with greatest difficulty.

The class averaged a gain of less than three points when told at the *close* of the test that it would be repeated at the next class meeting two days later. When told at the *beginning* that the test would be repeated, they made less than two points gain. This probably indicates that divided attention between taking test and remembering items caused confusion in the minds of many. This retarded the memory process and actually caused a loss on the retest.

A large number made a lower score on each retest.

The Relation of Experimental Psychology to the Physical and Biological Sciences

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THERE IS A GROWING TENDENCY among universities to recognize experimental psychology as a laboratory science and to place it among the physical and biological sciences from which the student is required to choose one to satisfy the science requirement for the A.B. degree. The following article was prepared to substantiate and justify this tendency.

Experimental psychology has advanced with rapid strides in recent years. Along with this movement, however, in the direction of experiment, there have appeared other developments, such as psychoanalysis, which do not conform to strict scientific demands but which have captured the popular imagination and have done much to discredit legitimate scientific procedures.

Furthermore, there is in the minds of many a lingering tradition that modern psychology is still practically identical with philosophy, and therefore not subject to scientific experimentation. In many cases this attitude has led to a prejudice, often unconscious, regarding any claims of psychology to scientific accuracy. Incidentally, to those who may have this conviction it may be interesting to know that experimental psychology is not a recent innovation, the first psychological laboratory having been established in 1879, less than ten years after the establishment of the first chemical laboratory in an American university.

In considering the relative value of experimental psychology, therefore, it will be necessary to take a detached attitude in comparing this subject with the other laboratory sciences.

THE METHODS OF SCIENCE

Scientific method is, of course, not confined to any one group of facts or subjects. It consists in the careful observation of facts, their orderly arrangement, the development of hypotheses, the setting up of experiments when possible to test hypotheses, the objective consideration of results, and the formulation of principles or laws in conformity with the findings. Scientific method can therefore be applied to the facts of human and animal behavior as well as to physics, chemistry, and biology, and this has already been done, as the many volumes on experimental psychology in any university library clearly indicate.

A HIERARCHY OF THE SCIENCES

The criticism is sometimes offered that psychology is not as exact as the other sciences. But the point here is that the other sciences are also not equally exact, that is, their laws are not all equally reducible to mathematical statements. From the standpoint of exactness physics, chemistry, biology, and psychology may thus be considered a hierarchy, each superior to the one following in the exactness of its contribution to sci-

ence. Thus considered, there would be no equality among any of the sciences. The difference between psychology and biology may very well be no greater than that between biology and chemistry. It is of course difficult, if not impossible, to make exact comparisons in this matter, but we must bear in mind that we do not refuse to admit biology as a laboratory science on the ground that it is not as exact a science as physics or chemistry.

In spite of these differences in exactitude, therefore, the underlying questions still remain: (1) Does the course in experimental psychology meet the demand of scientific method? and (2) May not experimental psychology, whatever its relative place among the sciences, be of as much value to some students as any of the other sciences would be to others?

The tendency in curriculum building today is to meet as far as possible the individual needs of students. In the light of this principle it is obvious that, for an engineering career, physics and chemistry would be the natural choice. For a medical career chemistry and biology would be chosen with the added point, however, that medical colleges are increasingly stressing the need for more psychology in the student's preparatory work.

On the other hand other students, such, for example, as those interested in law, policital science, economics, journalism, literature, etc., who in their professions will be dealing continually with human nature, may conceivably profit relatively more by an understanding of how the human mind works under controlled conditions than by a laboratory course in physical or biological science. It must not be forgotten in this connection that the student who might choose experimental psychology as his laboratory science is still eligible to choose any of the other laboratory courses.

THE INTERRELATION OF THE SCIENCES

While the sciences assume definite names such as physics, chemistry, and biology, they are by no means entirely independent of one another. Physics involves chemistry, and chemistry involves physics, while biology involves both physics and chemistry. Yet each of the sciences, while involving the others, has gathered a mass of facts, has experimented, and has formulated laws and principles which are unique for that particular science. We do not say that biology is chemistry because it employs chemistry in its procedures, or that organic chemistry is in reality biology, because it deals with organic substances.

Similarly psychology in its experimental procedure draws upon biology, physics, chemistry, and mathematics, but its purpose in so doing is the discovery of facts and principles that are unique for psychology. A simple experiment involving chemistry and biology will illustrate this point.

HARLOW AND STAGNER'S EXPERIMENT

The problem which this experiment undertook to solve was this: Can learning take place during a passive (inactive) state of the organism? The experimenters employed a powerful drug, curare, by means of which the striped muscles were paralyzed because impulses sent over the motor nerves did not reach the muscle. The muscle could still move, however, when stimulated, and the nerve could still conduct.

It was found that the curarized animals could not be taught to re-

spond either to a flash of light or to the sound of a buzzer employed as substitutes for the original stimulus of an electric shock. On the other hand non-curarized (normal) animals were readily trained to make a specific response. What is more, the curarized animals failed to make the proper response even after the effects of the drug had worn off, although they were given the same opportunity to learn as the normal animals. Thus chemistry and biology contribute to the establishment of a fact which in the psychology of learning has far-reaching implications.

It must be kept in mind that although the physical and biological sciences are distinctly interdependent, they are independent as far as the first laboratory course of each is concerned; that is, neither physics nor chemistry is required as a prerequisite to the first laboratory course in biology, nor does physics require chemistry as a prerequisite. All these courses are open independently to freshmen. Similarly the first course in psychology, while involving other sciences, can be given without a science prerequisite, although a knowledge of the other sciences is a distinct advantage.

EXPERIMENTAL PSYCHOLOGY AND EXPERIMENTAL BIOLOGY

The above experiment illustrates the relation between experimental psychology and experimental biology. The intent was not to establish a biological fact, namely, the effect of curare upon the nerve and muscle, which is strictly a biological problem, but, given this effect, to discover the significance of this fact to the learning process. The result of the experiment gives us a definite answer to the problem propounded.

The famous experiments of Franz and Lashley on the relation of brain condition to the learning process follow the same principle. These psychologists experimented with the brains of animals in order to discover the effects of brain lesions on the animal's ability to learn.

Similarly many other experiments in psychology deal with biologica facts. However, these biological facts are but stepping stones to the solution of psychological problems such as the discovery of the laws of perception, memory, illusion, learning, inhibition, etc.

EXPERIMENTAL PSYCHOLOGY AND PHYSICS (PSYCHOPHYSICS)

Experimental psychology also employs facts and instruments taken from physics, such as air and ether (?) vibrations as they apply to sound and light, as well as weights, electrical currents and apparatus, chronoscopes, etc. The object, however, is not to discover principles of physics, but to employ well-known physical principles in the discovery of facts pertaining to perception, memory, emotion, etc.

Psychophysics dates back to the 19th century, when Weber and Fechner experimented in the measurement of the intensities of sensations in relation to their stimuli. This was followed by reaction time experiments by Cattell and others. More recently Seashore and others have performed important experiments in the psychology of music.

EXPERIMENTAL PSYCHOLOGY AND MATHEMATICS (MENTAL MEASUREMENT)

Intelligence testing, which has long since passed the conjectural stage, is a psychological experiment of tremendous scope and surprising accuracy

the success of which depends upon intricate statistical treatment of masses of data. Thus mathematics plays an important role in experimental psychology.

The following eighteen universities recognize the course in experimental psychology as a laboratory science that will satisfy the science prerequisite for the A.B. degree: Clark, College of the City of Detroit, Columbia, Indiana, Johns Hopkins, Leland Stanford, Ohio, Oregon, New Mexico, Arizona, Georgia, Idaho, Illinois, Minnesota, North Carolina, Pennsylvania, Pittsburgh, and South Carolina.

The following thirteen universities require no laboratory science whatever as a prerequisite for the A.B. degree: Brown, Duquesne, Harvard, Louisiana, Buffalo, Kentucky, Louisville, Maine, Michigan, Mississippi, Washington, Wyoming, and Yale.

Concerning the other universities from which we received replies, 44 in number, it is impossible to determine from the data obtained whether the question of recognizing the course in experimental psychology has ever been raised or, having been raised, has been disapproved.

OUTLINE OF THE COURSE IN EXPERIMENTAL PSYCHOLOGY

INTRODUCTION

I. Objectives of the course. The course in experimental psychology has the following aims:
   1. To give the student an understanding of the nature of science as it is applied in the field of psychology.
   2. To show him how the scientific method may deal with the problems of human life.
   3. To give the student opportunities to discover certain facts concerning his own nature.
   4. To have him compare facts concerning himself with facts concerning human nature in general.

II. Bases for the selection of experiments. The experiments have been selected with the following ideas in mind:
   1. Experiments which are not too difficult for students who have had only the introductory course in psychology.
   2. Experiments which call for the essential features of a scientific method.
   3. Experiments which reveal the most important facts of psychology.
   4. Experiments which give clear-cut results.
   5. Experiments whose results may be treated statistically, for the most part.

III. Methods employed.
   1. During the first half of the course, students work in pairs; one student acts as the subject of the experiment, the other as the experimenter. Then the students change places. Thus each gains experience, both with handling of material and with a personal psychological experience.
   2. During the second half of the course, the student becomes more truly an experimenter in that he assembles data obtained by experimenting on all members of the class. These data he assembles and treats statistically, draws conclusions from his results, and answers all questions concerning them to the best of his ability.
   3. Some experiments are given as "class experiments" by the instructor or by one student.
   4. A few experiments are "individual"—that is, the student performs the experiment upon himself.

IV. Records. The records of all experiments are kept in notebooks which are turned in at stated intervals for grading. The records are uniform and give:
   1. The purpose of the experiment.
   2. A description of the materials used.
   3. A description of the methods used.
   4. A record of results.

5. Answers to certain questions which have been designed to direct the student's attention to (a) the main purpose of the experiment; (b) the reason for the various stages in the method; (c) the connection of results with those for former experiments; (d) the relation of ascertained facts and theories, both psychological and physiological; (e) practical application of results.
6. A record of references used as aids in answering some of the questions.

CONTENTS OF COURSE IN EXPERIMENTAL PSYCHOLOGY

I. SENSATION
- A. Vision
  - 1. The blind spot
  - 2. Retinal induction
  - 3. Negative after-images
  - 4. Retinal color fusion (Methods of positive after-images)
  - 5. Retinal color fusion (Methods of negative after-images)
  - 6. Color zones of the retina
  - 7. Binocular inhibition and fusion
- B. Audition
  - 1. Lower threshold for sound
  - 2. Differential threshold for pitch
  - 3. Seashore's musical tests
- C. Smell
  - 1. Exhaustion and recuperation
  - 2. Selective exhaustion (qualitative)
  - 3. Selective exhaustion (quantitative)
- D. Taste
  - 1. Taste and smell fusions
- E. Touch
  - 1. Location of touch and organs
  - 2. After-image
  - 3. Exhaustion
  - 4. Adaptation
- F. Warmth
  - 1. Location of warmth and organs
  - 2. Local variations in sensitivity
- G. Cold
  - 1. Location of cold and organs
  - 2. After-image
  - 3. Inhibition of cold and warmth
- H. Pain
  - 1. Location of pain and organs
- I. Labyrinthine sense
  - 1. Sensations of bodily rotation
- J. Kinaesthetic sense
  - 1. Sensations of active and passive movement
- K. The psychophysical law (Weber's law)
  - 1. The method in vision

II. PERCEPTION
- A. Perception of Space
  - a. Localization
    - 1. Localization of sound
    - 2. Localization of touch
  - b. Two-dimensional Space
    - 1. Kinaesthetic perception of horizontal linear space
    - 2. Kinaesthetic perception of vertical linear space
    - 3. Kinaesthetic perception of size
    - 4. Tactual, kinaesthetic, and visual perception of form
    - 5. Tactual perception of distance
    - 6. Tactual and visual perception of filled and unfilled space
    - 7. Optical illusions of space perception

B. Perception of Time
   1. Estimation of the time intervals
   2. Perception of filled and unfilled time
   3. Perception of filled and unfilled time (class)
   4. Perception of subjective temporal rhythm

C. Perception of Words and Meaning
   1. Synthesis of successive perceptions
   2. Fixation of attention in word perception
   3. Influence of form
   4. Perceptual cues
   5. Determining tendency
   6. Errors of perception

III. ATTENTION

A. Strength of attention
   1. Fluctuation of attention

IV. MOTOR PROCESSES

A. Voluntary action
   1. The simple reaction

V. ASSOCIATION

A. Free chain association
   1. Detection of suppressed ideas by the association method

VI. MEMORY

A. Rote memory
   1. Memory span for digits
   2. Memory span for nonsense and sense words

B. Logical memory
   1. Comparison of rote and logical memory
   2. Reproduction of connected ideas

C. Recognition and discrimination in memory
   1. Recognition
   2. Discrimination

VII. IMAGERY

   1. Kinds of vividness of imagery
   2. Imaginal types
   3. Imagery and voluntary suppressions

VIII. AFFECTION

A. Method of impression
   1. Comparative affective value of single colors
   2. Comparative affective value of color combinations
   3. Affective value of the relative position of colors
   4. Comparative affective value of linear proportions

B. Method of expression
   1. Feeling tone and motor activity

The Growth of Psychology in the Curriculum of a Liberal Arts College from 1840 to 1940

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IN CONNECTION WITH the centennial celebration of Bethany College, Bethany, West Virginia, June, 1940, the writer had occasion to make a study of the history of philosophy and psychology in the college since 1840. This study revealed the fact that there has been, in Bethany, a progressive waning of philosophy and waxing of psychology, during the past 50 years, in the emphasis placed upon them, as judged by curricular offerings and by student election of courses, so that by the end of the century the two subjects have changed places in importance attached to them. Out of that larger study grew the present more limited study of the growth of psychology in the curriculum of the college during the hundred years of its history, 1840 to 1940. The source of information was the catalogues of the college for the various years.

Naturally, the development of the curriculum in this department reflects the trends in higher education in this country and abroad in this particular period. Until the age of Wilhelm Wundt, about 1870, psychology was always regarded as a branch of philosophy, and was treated according to the accepted methods of philosophical speculation. With the establishment of the first psychological laboratory by Wundt in Leipzig, Germany, in 1879, the beginning of a new era for psychology was marked. Since that time, it has been regarded as a natural science, one of the biological sciences, with its methodology the typical methods of scientific research. In America the influence of German psychology under Wundt made itself felt in about a decade. In 1890 William James, who occupied the chair of philosophy at Harvard and most of whose writings were in philosophy, published the monumental two-volume work in psychology entitled "Principles of Psychology." This was the first American textbook in psychology treated as a natural science closely related to but separate from philosophy. At about the same time, that is, in the decade following 1890, we find such men as Münsterberg at Harvard, Cattell at Columbia, G. Stanley Hall at Clark, and Titchener at Cornell, all trained under Wundt, establishing in this country their psychological laboratories and separate departments of psychology. A little later, in the decade following 1900, we find, along with the continued work of these men, such leaders as Angell at Chicago and Ladd and Judd at Yale doing the same sort of thing.

Thus in America the quarter-century from 1890 to 1915 marks the period when psychology became well established as a science, with its separate departments and professorships, laboratories, journals, associations, textbooks, etc. Likewise, this same period marks the beginning of the transition in American colleges and universities from a major emphasis on philosophy to a major one on psychology. By 1915, in American higher education, philosophy was rapidly being superseded by psychology in

curricular offerings, in professional and graduation requirements, in teaching personnel, and in student election of courses.

Now this development in Europe and especially in America at large was clearly reflected in the changing curriculum of Bethany College. During the first half of its history (1840–1890), its offerings in this area were almost exclusively courses in philosophy. It is rather difficult to determine exactly just when the first work in psychology was offered at Bethany. From 1867 to 1881 inclusive, a course was offered entitled "Intellectual Philosophy." Likewise, from 1882 to 1887 inclusive, "Intellectual Science" appeared. This was undoubtedly the same course. Furthermore a careful study of the course in its setting along with the other courses convinces one that it was philosophy rather than psychology, probably epistemology and metaphysics. At any rate, in 1888 what is apparently the same course appeared under the title of "Metaphysics." One of the difficulties in determining the nature of a course in this period is that the content is not indicated, only the title.

The case is somewhat different for a course entitled "Mental Science," catalogued first in 1883 and reappearing in 1884, 1885, 1889, 1894, and 1895. Is this the first course in psychology under the caption mental science? We cannot be certain in 1883 to 1885. However, by 1889 it is linked with logic and ethics in such a way as to suggest that it is really a course in psychology. Furthermore, in 1894 and in 1895, this course again appeared with the text listed as "Hill: Mental Science." In 1896, instead of mental science, we find a course listed "Psychology" with the text stated as "Hill: Mental Science." It seems quite evident, therefore, that the course listed as mental science in 1894 and 1895 was the same course labeled psychology in 1896. This makes it very probable that psychology first appeared in the curriculum of Bethany College in 1883 under the title "mental science."

The first definite use of the term psychology in describing curricular content appeared in the catalogue of 1887. The courses taught by W. H. Woolery, president of the college and professor of philosophy, were listed together as follows: "Moral Philosophy; Intellectual Science-Cognitive Powers (McCosh), History of Philosophy, Especial Attention paid to Physiological Psychology; Logic." From 1887 to 1892 inclusive, this special stress on Physiological Psychology appears regularly, but always apparently in conjunction with and as a part of the philosophy courses. Thus toward the end of the first half century of the college's history, in the eighties, psychology became a part of the curriculum for the first time, occupying, however, in the beginning, a very humble place. Throughout this period the emphasis was predominantly on philosophy—metaphysics, epistemology, logic and ethics primarily.

In the third quarter-century of Bethany's history, 1890 to 1915, the remarkable growth of psychology in American colleges and universities, noted above, was felt on this campus also. We have already referred to the course listed in the catalogues of 1894 and 1895 as "Mental Science," with "Hill: Mental Science" as the textbook, and to the reasons for regarding this as the first separate course in psychology. It is in the catalogue of 1896, however, that for the first time we find a course listed separately as "Psychology." Continuously and consistently from this date to the present we find this terminology used.

In the catalogue of 1895 the courses of the college were grouped into departments for the first time. One of these was the "Department of Mental, Moral, and Political Science." The separate courses listed in 1895 in this department were: Mental Science (Hill), Logic (Jevons), Moral Science (Robinson), and Political Science (Ely). In 1896 this department listed Psychology, Moral Science, and Logic. For ten years, 1896 to 1905, inclusive, these three subjects were the offerings of the department, so that in this decade psychology constituted one third of the curriculum of the department. It was still, however, the philosophy department, and the title of the instructor was professor of philosophy.

The catalogue of 1896 also indicates the nature of the psychology taught in this period. The write-up of the course reads: "In psychology much stress is placed upon the careful definition of words in the interest of clear thinking. An appeal is constantly made to the testimony of consciousness against plausible speculations that are not in harmony with such testimony. The testimony of consciousness to the freedom of the will is an illustration. But more than all else, the dual nature of man is emphasized and the inefficiency of modern physiological psychology to account for the phenomena of mind is shown. Text-book, Hill's Mental Science." This sounds very much as if psychology in this period is a hybrid of philosophy and psychology.

The nature of the course is indicated somewhat also by the textbooks used. In 1897, Ladd's Psychology is the text. From 1898 to 1900, James' Psychology is used along with Ladd. From 1901 to 1905, Davis' Elements of Psychology is listed along with Ladd and James. From 1906 to 1908, Stout's Psychology is added to the above three. In 1909 and 1910, general psychology was well on its way, judging from the rather imposing array of texts used, although only one course was offered. The texts were: Thorndike's Elements of Psychology, Angell's Psychology, James' Psychology, Titchener's Textbook of Psychology, and Stout's Psychology. At this time the department was still named the "Department of Mental and Moral Science."

The catalogue of 1911 marks an important milepost. For the first time the department is designated the "Department of Psychology and Philosophy." Also for the first time the curriculum is enriched by adding educational psychology and child psychology along with general psychology. An important group of textbooks is also listed. In general psychology they are: Titchener's Textbook of Psychology, 2 volumes; James' Principles of Psychology; Angell's Psychology; and Yerkes' Introduction to Psychology. In educational psychology they are: Bagley's Educative Process and Thorndike's Principles of Teaching; in child psychology, Kirkpatrick's Child Psychology.

Along with the texts just noted, the catalogue write-up of general psychology in 1911 throws light on the more scientific nature of psychology in this period as compared with that of 1896, noted previously. The objectives and nature of the course are described as follows: "The student approaches the difficulties of philosophical studies through some introduction by text of general psychology. Here the terminology is gotten and interest is awakened for further progress in this and kindred sciences. The opinions of the book in the hands of the students are supplemented by lectures as the occasion may demand, and experiments are performed in

class when possible, to impress and enforce the instruction. The experimental point of view is kept constantly before the mind of the pupils. The widest possible acquaintance with the findings of present-day psychologists is given to the students. New books, psychological journals, experiments, monographs, and popular treatises are presented for their interest and instruction."

From 1912 to 1917 the department remained much the same as in 1911. The same courses were offered and the same textbooks used, except that Stout's Manual of Psychology and Sully's Human Mind were added to the list. By the end of this third quarter in the college's history (1915), psychology was firmly established as part of the curriculum, the number of courses had increased to four, and it was no longer a philosophy but a natural science.

In the last quarter-century (1915–1940) the tendencies begun in the previous quarter continued to grow apace. More and more psychology became separated from philosophy, established itself as a science, utilizing the scientific methods of research and experimentation, and multiplied its curricular offerings. This development can be indicated best in chronological order.

In 1915 the offerings were of four courses: introduction to psychology, advanced general psychology, child psychology, and educational psychology. In 1918 experimental psychology was introduced, although at this time without the facilities of a laboratory. The psychology of adolescence and the psychology of religion were also added. In 1919 applied psychology first made its appearance. In 1920 the psychology of elementary-school subjects was introduced by the education department. In 1921 we find for the first time the psychology of personality, the psychology of learning, and psychological measurements. In this year the mental testing of freshmen at Bethany was first begun by the department.

The years 1922 to 1925 mark another very important period. In 1922 the courses in philosophy and psychology were separated, so that for the first time the department of psychology, as such, came into existence in Bethany College. At this time, however, there was as yet no major in psychology. This same year marked the beginning of systematic mental testing, as an administrative procedure, of all entering students. This program was initiated by the psychology department and has been carried on continuously to date under the supervision of the department, since 1930 in cooperation with the personnel office. By 1924 the enrollment of students in the department had so increased that two sections of general psychology were offered, each of six semester hours. This year also marked the beginning of two new courses, social psychology and abnormal psychology. Of especial interest and importance is the fact that now for the first time a full major of 24 semester hours in psychology was offered. The courses listed as constituting the major were: general psychology (6 hrs.), educational (3 hrs.), mental measurements (3 hrs.), experimental (3 hrs.), applied (3 hrs.), social (3 hrs.), abnormal (3 hrs.). The year 1925 is significant because of the founding of the psychological laboratory and and the beginning of the present policy of the department of teaching all courses as far as possible on a laboratory basis. By 1925, therefore, there was a separate department of psychology, offering a full major of 24 hours credit and possessing its own laboratory.

The period from 1925 to 1940 has been characterized chiefly by enlarging and enriching the offerings of the department, by a progressive building up of the laboratory, and by an attempt to make the instruction library and laboratory centered. The course on the psychology of personality, initiated in 1921 as pioneer work before there were texts in the field, and subsequently dropped, was reinstated permanently in 1931. In this year also, an historical course on the development of the contemporary schools of psychology was introduced. From now on the course in experimental psychology was offered yearly instead of in alternate years as previously. The same became true of the course in abnormal psychology in 1932. In 1935 a laboratory course in mental testing was begun, supplementing the theoretical course in mental measurements introduced in 1921. Three new courses were added in 1936—developmental psychology, industrial psychology and psychological literature. In 1937 an advanced course in psychological problems was started. Finally, in 1938, courses on child psychology and on psychology of adolescence, previously given in the education department but dropped in the meantime, were reinstated in the psychology department. This rounds out the departmental offerings to date.

As the psychology department stands in Bethany College in 1940 the following courses are offered: general psychology (6 hrs.), educational (3), experimental (3), applied (3), social (3), abnormal (3), personality (3), child (2), adolescence (2), mental measurements (2), mental testing (2), industrial (3), contemporary schools (1), current psychological literature (1), problems (1 or 2). This is supplemented by courses on mental hygiene and psychological statistics offered in the education department. Thus, beginning with one course in 1896, a department has evolved offering 15 courses totaling approximately 40 semester hours' credit.

In conclusion, it is interesting to notice the "firsts" in this development:

1883 Mental science. Probably first course in psychology.
1887 First use of the term "psychology." "Special attention to physiological psychology."
1896 First course named psychology.
1897 First text named psychology. Ladd's Psychology.
1911 Department first designated "Department of Psychology and Philosophy." Educational and child psychology first offered.
1918 Experimental psychology first introduced. Also psychology of adolescence and psychology of religion.
1919 Applied psychology added.
1920 Psychology of elementary-school subjects offered in the education department.
1921 Psychology of personality, psychology of learning, psychological measurements. First mental testing of freshmen.
1922 First department of psychology as such. Systematic testing of freshmen as part of the administrative program.
1924 Social psychology and abnormal psychology introduced.
Full major in psychology offered.
1925 Founding of psychological laboratory.
1931 Course on contemporary schools of psychology begun.
1935 Laboratory course in mental testing.
1936 Developmental psychology, industrial psychology, psychological literature.
1937 Advanced course in psychological problems.

This development in Bethany parallels closely the growth of psychology in other American institutions.

Experimental Determination of New Human Individual Differences

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TO SOME INDUSTRIAL PSYCHOLOGISTS and to many personnel managers it has seemed that psychology should be able to make more significant contributions to the selection and training of industrial personnel than it has made thus far. The older technique featured the application of a battery of selected tests, mostly of the pencil-and-paper variety, to a group of employees. The test results were then correlated by involved statistical procedures with some criteria of success on the job. From these operations emerged a combination of tests related, usually quite moderately, to some criterion of success.

The older technique was laborious and involved, calling for psychological and statistical training beyond that usually possessed by the persons who were doing the selecting and training work. Moreover, the procedures were round-about and indirect, highly subject to chance, and characterized by a large amount of trial-and-error.

Three years ago, during some industrial testing reported at length elsewhere (see bibliography), it became apparent to us that it should be possible to devise tests for particular jobs in industry from the time and motion study data on those jobs, from direct psychological analysis of the jobs, or even from motion pictures of the operator on the job. From these crude beginnings we have since developed the new technique that has already produced astonishing successes in selecting the right person for a particular job, with resulting increases in production and wages.

One of the outstanding results of the early use of the technique was to establish the fact that no more than 15 persons out of every hundred have the basic ability to perform visual inspection operations in factory work with the accuracy and speed considered acceptable on such jobs. It was also established that normal vision was no guarantee of such special ability.

It was clear that a test of visual perception was needed for the identification of applicants possessing the basic ability required on such jobs. The first such test was one devised by Mr. Holger Oleen (*10*) in 1937. Experimentation with this test convinced us that it was measuring a new area of human individual differences. As a result, four new tests of visual perceptual ability were devised, of four different degrees of complexity and difficulty (*5*). These are pencil-and-paper performance tests involving symmetrical and non-symmetrical figures to be checked.

On these tests time-scores and error-scores are recorded separately, since speed in perception is found to be highly important in work on the job. Form A, used alone, has been found to be a good, quick test for the elimination from further consideration for inspection jobs of the applicants lacking the basic perceptual abilities required. Further, a poor score on this test frequently indicates that the person needs a correction (glasses)

or that his present correction needs to be changed—an indication that requires checking through the usual eye-examinations for lens-fitting.

A study of the scores of 146 persons who took both this test and the Henmon-Nelson Intelligence Test was made to determine the relationships between what is measured by the two tests. Total scores on the Henmon-Nelson correlated −.01 with time-scores and −.24 with error-scores on Perception Test A. An earlier study (*5*) with a smaller group, using the Otis S-A Test, gave a zero correlation with error-scores and a .20 correlation with time-scores on Perception Test A. Non-verbal perception as measured by the latter test thus seems not to be significantly related to whatever is measured by highly verbal tests of general intelligence.

But this pencil-and-paper test should not be used alone for final selection. Our experience indicates that there should be at least one other inspection test involving materials analogous with the parts handled on the job. Thus, for recent work at the Johnson & Johnson Co., we constructed a test of 100 small boards, 60 of standard length, 40 off-standard, to be sorted by the person being tested. The results of such a test show some overlapping with the perception test, as should be expected, but also a degree of freedom that indicates very definitely that this test is measuring something different from what is measured by the perception test. Both functions measured are important in success on the job.

In the area of motor manipulation several striking results have emerged. Here it has been easily possible to design tests that embody the same characteristics that are found on the jobs. Thus a job calling for hand and foot coordination requires a test involving parallel use of the hands and use of a foot lever or treadle at its appropriate place in the operation cycle.

Hand-and-foot tests correlate only moderately with other manual tests involving hands only, as shown in Tables 1 and 2. They are measuring a special ability possessed in desirable degree for industry by only about 20 persons in 100. Persons selected by such tests have been highly successful in production and earnings on work involving foot-presses and foot-operated fixtures.

TABLE 1—*Intercorrelations of the Eagle Aptitude Tests*

	PB	90°	L-R	R-R	H-F	MR	C-T	C-E	S-T
90°	.59								
L-R	.48	.26					N = 107		
R-R	.43	.26	.59						
H-F	.58	.41	.40	.41					
MR	−.22	−.11	−.11	−.13	−.28				
C-T	.36	.33	.30	.16	.38	.10			
C-E	−.03	−.01	−.12	.04	.05	.01	−.22		
S-T	.43	.27	.28	.14	.40	−.08	.39	.02	
S-E	−.05	.07	.03	.03	.07	.04	.10	−.05	.03

Code

PB	Pin Board	MR	Motor Rhythm
90°	90 Degree Dual	C-T	Case-Inspection Time
L-R	Left-Right Dual	C-E	Case-Inspection Error
R-R	Right-Right Dual	S-T	Spiral-Inspection Time
H-F	Hand-Foot Coordination	S-E	Spiral-Inspection Error

TABLE 2—*Tests designed for Johnson & Johnson*

	Pin board	M-AS test	
M-AS	.78		
Dual hand and foot	.60	.48	N = 31

Where dual-operation is required,* still another type of test is called for, since we have found that this ability varies widely among operators and applicants. This ability seems to be highly specialized, depending upon the number and kind of elements (motions) in the cycle of operations. Some few persons have such notable lack of this ability that they are completely unsuited to any dual operation. Thus Table 4 shows that some persons can effect a saving of labor of more than 50 percent by dual operation, while others actually can do less by this method than by one hand alone. These latter may still be suited to jobs requiring one hand to hold an object or part while the other hand makes the required manipulations.

A very efficient job set-up can sometimes be effected with dual-hand and foot operation. In such a set-up a suitable test is imperative, since fewer than 10 persons among a hundred are found to have this combination of abilities at an acceptable level.

Motor rhythm is another ability that seems to be unique and relatively unrelated to other measured abilities, as shown in Table 1. The test here was a motorized turntable making 40 revolutions per minute. After suitable practice, characteristic of the procedure in all the testing, the person tested was required to attempt to drop steel balls one at a time through a slot in the rotating disc. The score was the total number of successes with 50 trials.

This test was designed to measure an ability called for in machine-feeding operations, particularly on dial-feed and other similar machines where regularity of hand motions and coordination of eyes and hands were important. The uniformly low relationships of these scores to the scores on the other tests indicate the independence of the ability measured.

It may also be noted in Table 1 that time-scores on the two inspection tests are poorly correlated with scores on the other tests, the overlapping shown being due, probably, to similarities in the manipulations of the parts. The error-scores on these tests are negligibly correlated with all other scores, supporting the inference that they reflect a special perceptual ability quite independent of motor abilities.

Tables 2 and 3 give the test intercorrelation data for the new tests designed for Johnson & Johnson, comparable with the data in Table 1. Several interesting comparisons are possible. Thus the Eagle Pin Board correlates .58 with the Eagle Hand-Foot Tests, while the Johnson & Johnson Pin Board correlates .60 with a Dual Hand and Foot Test. The Eagle Pin Board correlates .36 and .43, respectively, with the time scores on the two inspection tests, while the Johnson & Johnson Pin Board shows .32 and .55, respectively, for the time scores on the Perception A and Inspection Tests.

Another significant comparison in that between the time-scores and the error-scores on the several tests. Among the Eagle tests the time-

* Doing two things at once by simultaneous motions of the two hands.

TABLE 3—*Tests designed for Johnson & Johnson*

	Pin board	Inspection Accuracy	Inspection Time	Perception A Time	Perception A Errors
Inspection-Accuracy	−.22			N=52	
Inspection-Time	.55	−.22			
Perception-Time	.32	−.16	.37		
Perception-Errors	.44	−.17	.28	−.20	

scores on the Case-Inspection and Spiral-Inspection tests correlate with their error-scores −.22 and .03, respectively, while the Johnson & Johnson Inspection Test time-scores correlate −.22 with its corresponding error-scores, and the Perception Test A time-scores correlate −.20 with its error-scores. These uniformly low figures indicate the slight effect of the length of time used upon the accuracy of the results.

We are not concerned, in this paper, with the relations between success on the tests and success on the job. Certain data on this appear in the references, as do other data on the reliabilities of the tests, and still others will appear presently in the technical literature. Most of the tests have retest reliabilities of .8 or .9. Some of the tests have identified basic skills in applicants with such success that production and earnings have been very greatly increased and failures on the job reduced to an insignificant number.

TABLE 4.—*Potential labor-saving by dual operation over one-hand operation*

% Savings	Pin board	As measured by 90° dual test	L-R dual test
51–60			2
41–50	19		25
31–40	121	2	35
21–30	110	22	29
11–20	22	37	16
1–10	2	38	8
− 9 to 0	1	17	2
−19 to −10		2	2
−29 to −20		2	1
Totals	275	120	120

How are these tests designed by the new technique? For purposes of illustration, let us examine a very simple industrial job for which a test is to be devised. The job, of which there are many minor variants in some industries, involves picking up several small objects and placing them in a small box, using both hands. The packer has the box placed at a convenient distance in front of her, while the several kinds of items to be packed are in bins or hoppers within easy reach. For the moment we shall ignore the placing and removal of the box.

The cycle of operation has only a few elements. The packer must reach for the items, pick them up, carry them to the box, and place them inside.

In terms of the usual analysis this would be: transport empty, select, grasp, transport loaded, position, and release. The test to be designed must embody these elements, roughly in the amount of time and space they occupy in the cycle on the job. Let us assume that the transport distance of bin to box is 8 inches horizontally and 2 inches vertically. This will give us the dimensions for our test from the point where items are to be picked up to the point where they are to be placed. The items of the test must not be materially larger than the objects packed on the job, since we know that larger objects require less dexterity in manipulation. Assuming they are about ½ inch to ¾ inch in size, we shall use marbles of these, and one intermediate size, ⅝ inch, as the items in the test. By experimentation and past experience we have learned that a test of hand dexterity should have an everage time for performance of at least 120 seconds, preferably more, to make it of satisfactory reliability. So the number of cycles to be used will be determined by the degree of reliability we want. We shall assume that 35 is adequate.

We note on the job that the packers sometimes pack objects of two different sizes with each hand, both hands moving simultaneously, first from hoppers to the rear, then from hoppers nearer the packer. So we shall place two compartments for the marbles on either side of the center receptacle, which corresponds to the box. Since the items packed generally slide easily into the box, we shall make holes in the center receptacle large enough to require no more time for fitting or positioning than this element requires on the job.

We now have the gross outline of the test. The hands will pick up one marble each from opposite compartments, transport them to the center, drop them through the holes, and go back to the other two opposite compartments for two more. There will be 35 marbles in each of the four compartments. When the test is completed these marbles will all be in the center receptacle, and we shall have a score in seconds made with a stop watch covering the time between beginning the test and its completion.

But we are still concerned about getting the test ready for the next person to be tested. We can sort the marbles out again from a single receptacle in the center, but this takes time. We had better have four subdivisions, one for each hole. It will be better, too, to have them all roll back to their original positions when we lift a lever or make some other simple movement. So we embody this quick reset feature, always desirable in a test.

What if some of the marbles get mixed by getting into the wrong holes? We should impose a penalty in the scoring for each such error. Moreover, we should be able quickly and unmistakably to identify the misplaced marbles. So, we have the marbles in each compartment made a distinctive color. This latter consideration does not introduce any new factor in the performance of the test, but only facilitates the scoring.

Nothing has been included in the test thus far to cover the manipulations involved in placing and removing the box. If the empty box is placed by one hand while the other hand removes the filled box, this operation can be paralleled by a similar placement of an item at the center with the corresponding hand at the beginning of the cycle and its removal at the end of the cycle with the other hand. If placing or removal, or both, are accomplished by a foot-lever, or there is hand placing and "drop delivery" by a foot-lever, suitable modifications should be made in the design of the

test to include similar movements at their appropriate place in the cycle. If foot movements are not required, the test may be quite adequate for selection even without the one-hand-placing-and-removal feature.

We now have a simple test, relatively inexpensive in construction, quickly scored and reset, and paralleling the cycle of operations on the job or set of similar jobs. By giving it twice to each person tested, with some time interval between trials, we can measure its reliability. By comparing its scores with the piece-rate earnings or with the foreman's ratings of workers on the jobs, we can measure its validity in identifying the persons having the basic abilities required by the jobs. By giving it again to the same workers after some months on the job we can assure ourselves, by correlating the first scores with the last scores, that the test is measuring an innate ability rather than a learned skill.

The distribution of scores on such a test is normal. Its relationships with several other tests are shown in Table 2. The simplicity and economy of this new technique should commend it to every industrial psychologist and to every personnel manager. With experience and ingenuity, the technique can be extended to any job, however complex that job may seem to be.

Since our recent research on the Iota Function (*7*), we have reexamined the data from successive applications of several performance tests applied to industrial workers. Results thus far suggest that both a distribution of individual differences in growth increments and a set of curves similar to the Iota curves result from such analysis. Whether these data are related to the Iota phenomena observed in the more distinctively mental area is still an unsolved problem.

Wide individual differences are also observed in times taken to grasp the instructions given for the performance of the several tests. In some instances a tardy grasp of the instructions has indicated low mental level, an inference substantiated by subsequent applications of intelligence tests. In other instances the differences in speed of comprehension of the task have seemed to be independent of intelligence as measured, but indicative of another type of individual difference which we may designate *insight* (*8*). This matter merits further investigation.

It has also been shown that differences *between* levels on several tests have a diagnostic significance quite independent of the test scores considered separately. Thus accident-proneness has been found to be related to the amount of difference between the level of a score on a perception test and the level of a score on a motor or manual test, the levels being made comparable through percentiles, or, preferably, through standard scores (*6*).

It must be apparent to any qualified observer that we are on the threshold of some highly significant discoveries in this area. New tests and new techniques promise to give us the tools for application of scientific method in employment procedures and in educational and vocational guidance that will result in materially better selection, higher earnings, and increased human welfare.

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Current Fallacies in Educational Investigations

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SPECIAL INVESTIGATIONS in education suffer more from the folly of friends than from the attacks of enemies. Calculations are really a means to an end but occasionally seem to be a diversion. Figures are objective, but they won't do the thinking the calculator must do if the investigation is to be educationally important. Obviously, when the statistician becomes a machine without the ability or inclination to plan or reason about his work he should stop calculating, and take stock. Errors of computation may be checked by the use of instruments, but errors of planning and reasoning are not so easily detected. Statistical work should be verified for logical as well as technical accuracy. Formulae and figures do not go the entire way in statistical investigations.

One statistical measure used a great deal in educational research is the coefficient of correlation computed by the product-moment method. In textbooks on psychological and educational statistics one often finds statements to the effect, for example, that .75 is a high coefficient, and that .30 indicates little correlation; however, a coefficient devoid of context has little or no significance. If the factors investigated have seemingly negative correlation, an actual positive coefficient of .30 may be regarded as high.

Serious errors are made in interpreting coefficients when heterogeneity in the data is forgotten. For example, since both strength of grip and memory span increase with age, a substantial correlation will appear between these factors quite apart from any concomitant relation. To be a valid measure of relationship, a correlation coefficient must be freed of the extraneous influences which affect the relationship between the variables concerned. This may be done by use of partial correlation technique or by selecting the group so that the troublesome factor may be made constant.

Inflated correlation results when scores are averaged before the coefficient is computed, for a large number of factors, usually reducing correlation, cancel out under such conditions. Spurious correlation also results when the scores of several tests are averaged or added, and the composite scores are correlated against the scores of one of the single tests in the original series. However, if care is taken to obtain tests of equal length, the resulting correlations may be compared, for the factor causing error is then held constant.

Certain typical errors seem to be common in everyday life and also in educational research. One often finds correlation mistaken for causation. But it is not necessarily true that two things are related to each other because they occur together. One might be the cause or the result of the other, or both might be caused by some third influence. Similarly, it is unsafe to assume that because one event follows another it was caused by it.

Another typical error is the hasty generalization based upon too few cases, or upon unrepresentative data. One should avoid assuming that all teachers believe the same as those who volunteer to answer a question-

naire, or to assume that all children react in the same way as the group included in an experiment. It seems to be a constant temptation to state as general laws the conclusions which, as far as data are concerned, hold true only for case groups included in the study.

Other common errors are: (1) Mistaking a part for the whole truth. In this connection one recalls Tolstoy's story of the blind beggars who quarrelled with each other concerning the nature of an elephant because each had felt a different portion of the animal's body, and derived his definition from his personal experience. Occasionally researchers differ among themselves because each has discovered a part truth, and mistakes it for the entirety. Sometimes it is extremely difficult to avoid a tendency toward finality because of such limited perspective. (2) Attempting to prove a thesis by analogies although the matters at issue are really not analogous. Because two things are similar in a few particulars, it is no proof that they are similar in all, or at least more alike than they are unlike. Uncritical reasoning by analogy has been in the past one of the chief sources of superstitions and prejudices.

An example of this type of error occurs in the special issue of *Educational Method* for November, 1939, in Rockwell's discussion of intelligence testing, in which he states that the test scores do not measure important fluctuations of ability. Advancing no direct proof but reasoning by analogy, Rockwell states that there must be such fluctuations for "variation, as a great principle of biological design, seems to be ever present. . . . Nature, generally, seems to have employed the principle of variation lavishly." Since variation is so apparent in the rest of the organism, the author asks "why it should not be equally apparent within the realm of intelligence." The answer is that one can easily find good analogies supporting the opposite view, for human nature has also many constancies. Height quotients and eye-color change very little throughout life, while the configuration of finger ridges change not at all. But the main point at issue is that loose analogies prove nothing.

Another fallacy is exemplified by the tendency to ignore cases or results which disagree with preconceived notions. By thus closing one's eyes to opposing data it is possible, but not scientific by any means, to build up a feeling of utmost certainty about matters that are absolutely false. In this connection the writer quotes the following from an article in *School and Society*, January 13, 1940, pages 62–64:

> Those same tests administered to school children in St. Louis last year revealed much lower attainment than Dr. Gray found in 1916. . . . This type of comparison reduces the difference slightly but still leaves the scores made by children in 1916 higher in general than those made last year.
>
> The principal conclusion to be drawn from this investigation is that tests are designed to measure attainment in selected skills or qualities of reading rather than total efficiency. It is impossible, therefore, to draw any conclusion whatever concerning the total efficiency of reading in 1916 in comparison with the total efficiency of reading in 1938 by using the same tests. . . .

But the data submitted in the article point to this conclusion: in 1916 the children did better on the same oral and silent reading tests than the children did in 1938. The factors measured by the tests were held constant by using the same tests, so the principal conclusion is concerned with better accomplishment in whatever was measured.

Investigations at Duke University claim to have proved the existence of telepathy, or thought transference. The mathematics of the study seem to be sound, but the method is surely open to debate on several counts. Thus one finds that a person's testing was continued as long as he made a good score, but when the latter fell off, his testing was discontinued, the reason being he had lost his "telepathic receptivity." Thus good tries were retained while the poor ones were omitted. Obviously such procedure "loads" the data which should not be expected to agree with the mathematical characteristics of the curve of chance. Such data are neither impartial, representative, nor complete. Theoretical chance has no opportunity to operate under such conditions.

Any one capable of experimental work knows that, if a specific number of cases with unselected data are averaged, the average becomes constant, and further sampling does not change it. But in the Duke tests all scores which would modify the average are discarded. If some individual makes surprisingly high scores under such selective conditions, it may be of interest, but it has nothing in common with mathematical chance, which depends upon unselected, not selected, cases. Furthermore, in this study the cards used were both seen and handled by the persons tested; here is an excellent opportunity for error.

In 1917 at Stanford University Coover carried on extensive investigations concerning telepathy. The mathematical treatment was thorough and accurate. Many persons were tested in guessing cards and other objects; but in no instance were the results different from chance distribution. Coover shows many graphs of the curve of chance superimposed upon the curve of the experimental data, and the correspondence is surprisingly close. The conclusions upon card guessing were: "The results of 10,000 guesses are negative. No trace of an objective thought transference is found." These experiments were much more extensive than those at Duke.

The most exacting and reliable tests applied to so-called mental telepathy reveal no evidence whatsoever that there is such a process. While such proof is negative it is nevertheless evidence that no mind has ever yet communicated with another excep tthrough the ordinary sensory stimuli as far as present objective psychological investigation is concerned.

Physicians, psychologists, and psychiatrists have questioned at times the advantages to be attained by nursery schools. In the December 9, 1939, issue of *School and Society*, Stoddard lists some of these objectives which, he states, may now be listed as fallacies. Some are still widely entertained and defended. These fallacies are:

Fallacy 1. The nursery school situation is conducive to the spread of infection. It introduces special health and accident hazards that outweigh the protections of the teacher and nurse.

Fallacy 2. The nursery school takes over responsibilities that are strictly parental in nature. This weakens family ties.

Fallacy 3. The nursery school is just another example of mass education. It cannot compete with the quality of guidance possible when young children remain at home.

Fallacy 4. The nursery school socializes the child beyond his needs or desires. It overemphasizes sharing; it takes away some of his individuality.

Fallacy 5. The nursery school is fatiguing, distracting, and frustrating to the child. It leads to early conflicts and subsequent maladjustments.

Fallacy 6. While claiming to be an aid to the home, the nursery school is, in fact, a substitute for it. It gives the mother too much freedom. It permits her to loaf, to do work for pay outside the home. It even gives her a technical and professional vocabulary with which to rationalize her new freedom.

Fallacy 7. The nursery school is devoid of sentiment and affection. It takes children from their mothers, placing them under young things who, themselves childless, cannot show a proper regard for the emotional needs of children.

Some of these fallacies contain elements of truth which are applicable to poor nursery-school conditions and techniques. However, the fallacy that unites all these fallacies is the indictment of all nursery-school practice in terms of exceptional techniques and conditions.

In conclusion, it is well to dwell upon the affirmative side of this problem. Routine investigations may be done by clerks, but it takes a rea research worker to interpret the results and draw conclusions which wi "hold water." Research involves a considerable amount of reflective thinking which cannot be done hastily. It is obviously foolish to devote one's time to finding facts with infinite care and precision and then attempt to explain them with the utmost recklessness, paying little or no attention to the original data. The finishing stages of an investigation should be done with great care. One should be careful to get out of the data all conclusions of which they are capable; at the same time one must exert extreme care in formulating only conclusions warranted by the data. The latter evil may be avoided by following certain precepts.

(1) Verify all major premises which are not justified by attendant data. Untested assumptions, taken for granted, may turn out to be false and invalidate all work from that point on.

(2) Check for internal consistency. If all the aspects of an elaborate body of findings are consistent with each other, the chances are that they are all true.

(3) Check against external criteria which are safer tests of theoretical soundness than internal consistency. The results of reasoning need verification in the light of similar criteria. When the results of reasoning and sensory stimuli disagree, both must be checked; if necessary, reasoning must be adjusted to what the senses reveal. Quite often conclusions drawn by other investigators may be used as criteria in this checking.

(4) Get the criticism of other people. An audience is usually a wholesome and restraining influence, causing one to examine one's facts with much greater care. Presentation of findings to co-workers usually results in the discovery of any weaknesses or fallacies involved, and gives the worker an opportunity to make necessary revisions before publication.

In presenting this paper it has not been the author's purpose to belittle objective and scientific work in education, and thus to wash dirty linen in public. Educationists may easily point with pride to the work done in psychology, school administration, experimentation in methods of teaching, and curriculum research. Such procedures and studies are typical of the scientific effort in education, and of the purpose of this paper: to differentiate between truth and near-truth in its widely varying degrees.

The Symposium of West Virginia Herpetology

The Herpetological Collection of the West Virginia Biological Survey

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The West Virginia Biological Survey was organized in 1934 as a project of the State Academy of Science. The organization immediately drew up a constitution and bylaws, distributed cards for cataloguing specimens, and compiled a bibliography of biological papers pertaining to West Virginia. It has provided funds for the collection of specimens throughout the state, the most important of these being the collections made by Mr. Neil D. Richmond during the summers of 1935, 1937, and 1938.

The Herpetological collection now contains 1255 specimens representing 25 species of amphibians and 20 species of reptiles. Twelve species of amphibians known to occur in West Virginia are not represented in the collection. These are *Necturus maculosus, Ambystoma jeffersonianum, Ambystoma opacum, Ambystoma texanum, Desmognathus quadramaculatus, Plethodon nettingi, Plethodon richmondi, Hemidactylium scutatum, Gyrinophilus p. duryi, Pseudotriton m. montanus, Scaphiopus h. holbrookii,* and *Rana pipiens.* Reptiles not present in the collection include *Eumeces anthracinus, Eumeces laticeps, Lampropeltis g. getulus, Lampropeltis g. nigra, Natrix e. erythrogaster, Storeria dekayi, Haldea v. valeriae, Thamnophis s. sauritus, Crotalus h. horridus, Clemmys insculpta, Clemmys guttata, Graptemys geographica,* and *Amyda s. spinifera.*

The collection represents 240 county records. Twenty-three counties are not represented by a single specimen. These are Barbour, Brooke, Clay, Doddridge, Hancock, Harrison, Jackson, Jefferson, Marshall, McDowell, Mercer, Mingo, Monroe, Ohio, Pleasants, Raleigh, Ritchie, Roane, Tucker, Upshur, Wirt, Wood, and Wyoming. Pocahontas County is represented by 21 species, the largest number from any county in the collection.

The collection is in excellent condition but is not representative of the state's herpetofauna because of the small number of specimens, the large areas not represented by specimens, and the absence of species that are known to occur within the state.

The Spotted Turtle, *Clemmys guttata* (Schneider)

(An Addition to the Herpetofauna of West Virginia)

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WHEN I BEGAN active herpetological collecting in West Virginia in June 1931, I prepared a mimeographed list of the amphibians and reptiles whose occurrence in the State appeared probable; *Clemmys guttata* was one of the turtles listed. Since then I have pestered the obliging students of the Oglebay Nature Training School, as well as other helpful collectors, to search for this turtle in both of the panhandles of West Virginia. These efforts did not bear fruit until the summer of 1939, when Mr. J. Lloyd Poland of Martinsburg, an energetic ornithologist and a former Nature Training student, saw a "yellow-spotted turtle" in a swamp near Charles Town, Jefferson County. Mr. Poland visited this swamp again on March 19, 1940, and secured one specimen (CM 18683) of the Spotted Turtle, *Clemmys guttata* (Schneider), and two specimens (CM 18684–85) of the Eastern Painted Turtle, *Chrysemys picta picta* (Schneider). Another visit, on March 23, yielded four additional *C. guttata* (CM 18686–89) and two additional *C. p. picta* (CM 18690–91).

The swamp where the turtles were collected is situated about one mile west of Charles Town at an elevation of approximately 500 feet. It is drained by Evitt Run, which empties into the Shenandoah River at a point approximately five miles east by southeast of the swamp. Mr. Poland estimated that the swamp was roughly 40 acres in extent. He found that a considerable amount of organic debris has accumulated in some places, since it was possible for him to sink waist-deep without touching firm bottom. An extensive area is covered with cattails, but the turtles were secured in a sedge-meadow section.

The Spotted Turtles taken by Mr. Poland appear to be the first living specimens obtained by a collector in West Virginia. Strader,[1] in his *Herpetology of the Eastern Panhandle of West Virginia*, lists "*Clemmys guttata* (Schneider)?" and states that it is common, especially in the eastern portion of the panhandle. In view of the fact that Strader failed to list *Clemmys insculpta*, which is very numerous in this area, and since he informed me that he had seen dried shells only, presumably those of specimens killed by fishermen, his record was not accepted as positive proof of the occurrence of *Clemmys guttata* in eastern West Virginia. Mr. Strader, after examining a living specimen of *guttata* at the Keyser meeting, stated that the shells which he had found were conspecific, and that this turtle is frequently taken from the waters of old quarry holes by fishermen, who call it the "scorpion."

The five specimens of *guttata* are all males, which is of interest in connection with Blake's[2] statement regarding the seasonal occurrence of the sexes in Massachusetts: "Babcock has recorded the fact that the males are less in evidence in late summer and fall than the females, which ac-

[1] Strader, L. Dow. 1936. Proc. W. Va. Acad. Sci. 9: 35.
[2] Blake, S. F. 1921. Proc. U. S. Nat. Mus. 59: 468.

cords with my own observations. Most of my males were taken in March and none later than May. My earliest date of observation of the species is March 5, 1910, when a female was collected in North Easton, Massachusetts; my latest December 6, 1912, when I saw two, one of which, a female, was collected."

The specimens have the characteristic male head and neck markings and coloration except that the horny portions of the jaws vary from horn color to dusky, and the lower jaws are spotted with yellow rather than unicolor as shown by Blake (*op. cit.*, pl. 99).

The male collected on March 19 has a perfectly smooth, unstained carapace, indicating that it may have shed since emerging from hibernation. The four individuals collected on March 23 are more or less stained with red "swamp varnish"; the horny shields are in process of flaking off in small pieces, and the incompleteness of previous sheddings is attested by the presence of a narrow ridge, composed of three or four layers of fragments, along the outer edges of the first two or three, and last three or four, marginals. All the specimens have relatively smooth plastrons; apparently shedding has occurred normally in previous years but concentric growth-ring *impressions* remain visible except on the posterior portions of the humerals and on the pectorals, which appear to have been polished by abrasion.

The sizes and weights of the specimens are listed in the following table. The relatively slight variation in weight of four adult males, weighed alive after reaching the Carnegie Museum, is of interest.

TABLE 1

CM Number	Sex	Greatest length of carapace	Greatest width of carapace	Weight
		mm	*mm*	*g*
18683	♂	91	69	—
18686	♂	89	68	106.6
18687	♂	90	66	109.0
18688	♂	91	64	106.1
18689	♂	91	67	111.6

The carapacial shields of the four *Chrysemys* are broadly margined with yellow and arranged as in New Jersey specimens of *picta*. Three have immaculate plastrons; one has an extremely faint dark cross on the plastron, but this cross bears no resemblance to the plastral blotch of *marginata*. The adults are clean and appear to have shed since emergence from hibernation; the juvenile has a rusty coating of "swamp varnish." The measurements of these specimens are listed below.

TABLE 2

CM Number	Sex	Greatest length of carapace	Greatest width of carapace	Weight
		mm	*mm*	*g*
18684	♀	125	92	—
18685	juv.	70	61	—
18690	♂	125	92	237.0
18691	♂	110	85	164.0

The Amphibians and Reptiles of Mineral County, West Virginia

LEONARD M. LLEWELLYN
Keyser

FOR APPROXIMATELY THE PAST TEN YEARS an energetic study of the herpetofauna of West Virginia has taken place. This has been due largely to the interest created by Mr. M. Graham Netting of the Carnegie Museum through his work in the state and his contacts with the students and staff of the West Virginia Nature Training School, and by the work of the West Virginia Biological Survey.

In 1931 as a student in this training school I became interested in herpetology and since that time I have been actively engaged in collecting and studying in West Virginia. Thus after nine years work in the state I would like to submit a list for Mineral County.

Mineral County, with an area of 332 square miles, is situated in the eastern part of the state. The topographical features are very irregular and the elevation varies from 550 feet to 3327 feet above sea level. The drainage is to the North Branch of the Potomac.

Thirty-eight forms of amphibians and 34 forms of reptiles have been recorded from West Virginia. Of these, 24 amphibians and 21 reptiles are known to occur in Mineral County. Specimens of practically all the species listed have been deposited in the Carnegie Museum, Pittsburgh, Pennsylvania.

SALAMANDERS

1. *Triturus viridescens viridescens* Rafinesque, Red-spotted Newt
   This is the most common salamander in the warmer streams and ponds.
2. *Ambystoma jeffersonianum* (Green), Jefferson's Salamander
   This species seems to be rare in the area covered by this paper. I collected one specimen in a pond at Gerstell on March 3, 1935, and one was picked up in the road just west of Keyser on March 3, 1938. This *Ambystoma* usually comes to the breeding pools very early in the spring after an extended rain.
3. *Ambystoma maculatum* (Shaw), Spotted Salamander
   I have collected this species at Gerstell for three consecutive years (1935–1937). On March 29, 1937, I collected fifteen specimens just west of Keyser as they were moving to a breeding pool. The jelly-like masses of eggs about the size of a lemon have been found also. All records have been made after an extended rain in March.
4. *Gyrinophilus porphyriticus porphyriticus* (Green), Eastern Purple Salamander
   This species inhabits the cold springs and cooler mountain streams of the area.
5. *Pseudotriton ruber ruber* (Sonnini), Common Red Salamander
   Found in habitats similar to preceding species.
6. *Eurycea bislineata bislineata* (Green), Two-lined Salamander
   The two-lined salamander is common in Mineral County, being found in streams, under rocks, and in leafmold.
7. *Eurycea longicauda longicauda* (Green), Long-tailed Salamander
   This beautiful salamander with its long slender tail and yellow coloration is common in Mineral County.
8. *Plethodon cinereus* (Green), Red-backed Salamander
   This salamander is found in decayed wood and under stones mostly at the higher elevations in the county. In summer its masses of eggs may be found in rotten logs, the female often being found curled up around the mass.
9. *Plethodon richmondi* Netting and Mittleman, Ravine Salamander

Only one specimen of this recently described species has been collected in Mineral County, namely CM 5864, taken near Keyser in 1932, but I feel that more will be collected on the ravine slopes which are its preferred habitat.

10. *Plethodon glutinosus* (Green), Slimy Salamander

This salamander is found generally distributed throughout the county under damp rotten logs, in woods, and under rocks and leafmolds.

11. *Hemidactylium scutatum* (Schlegel), Four-toed Salamander

This beautiful tiny salamander seems to be rare in the area, as the only specimen recorded is one taken by Neil D. Richmond in June 1933 near Burlington and now in the Carnegie Museum (CM 7490).

12. *Desmognathus fuscus fuscus* (Rafinesque), Dusky Salamander

This salamander is common everywhere near wet places and in small streams.

13. *Desmognathus ochrophaeus ochrophaeus* Cope, Allegheny Salamander

This species is usually found in the higher elevations in the county, especially in the Allegheny Mountains.

14. *Desmognathus phoca* (Matthes), Seal Salamander

The preferred habitat of this salamander is the cooler mountain streams and springs.

FROGS

15. *Bufo americanus americanus* Holbrook, American Toad

This is the toad commonly found in the mountains. It breeds in the ponds in the spring, laying its eggs in long strings. Breeding date for Elk Garden, May 18.

16. *Bufo woodhousii fowleri* Hinckley, Fowler's Toad

This species is generally found in the lowlands and near the streams. Its breeding habits are quite similar to the preceding toad, but in the county, breeding usually takes place about a month later in a given region.

17. *Acris crepitans* Baird, Cricket Frog

I have collected this tiny rough-skinned frog in several places along Patterson's Creek or in ponds near that stream.

18. *Pseudacris nigrita feriarum* (Baird), Eastern Chorus Frog

This species is heard calling commonly but is usually difficult to collect.

19. *Hyla crucifer crucifer* Wied, Spring-peeper

This little frog is one of the first to be heard in the spring, when, in almost every pond or pool, it gathers in large numbers to breed.

20. *Hyla versicolor versicolor* Le Conte, Common Tree Frog

This frog, which spends most of its life on trunks or branches of trees, is fairly common in Mineral County.

21. *Rana catesbeiana* Shaw, Bullfrog

The bullfrog, our largest species, is common in ponds and larger streams.

22. *Rana clamitans* Latreille, Green Frog

This species occurs in almost every pool and watercourse in Mineral County.

23. *Rana palustris* Le Conte, Pickerel Frog

Common in the region.

24. *Rana sylvatica sylvatica* Le Conte, Wood Frog

The wood frog is one of the earliest species to breed, often migrating to the pools in March, this being the only time that they can be collected in numbers in this area. At the beginning of the breeding period the males apparently reach the breeding pools first, and as many as a dozen males may be found clasping one of the first females to reach the pools. (Breeding records for Keyser—March 20, 1937, and March 12, 1938.)

TURTLES

25. *Sternotherus odoratus* (Latreille), Musk Turtle

I have collected one specimen of this small turtle in a roadside pond just south of Fort Ashby in 1934; hence it would seem that this species is rather rare in this region.

26. *Chelydra serpentina* (L.), Snapping Turtle

Found in the larger streams and ponds and at times taken on land when the female is searching for a sandy spot to deposit her eggs.

27. *Clemmys insculpta* (Le Conte), Wood Turtle

I have collected one specimen of this semi-terrestrial turtle in Mineral County but have had reports of others being seen.

28. *Terrapene carolina carolina* (L.), Box Turtle
Common except at the higher elevations of the county.
29. *Chrysemys picta picta* (Schneider), Eastern Painted Turtle
Common in the ponds and warmer streams of the area. Mr. Netting informs me that the few Mineral County specimens which he has seen are much closer to the eastern race, *picta*, than to *marginata*, the form of the Ohio drainage streams in West Virginia.

LIZARDS

30. *Sceloporus undulatus fasciatus* (Latreille), Fence Lizard, Swift
Found commonly on dry hillsides and shale barrens.
31. *Eumeces fasciatus* (L.), Blue-tailed Skink
This species seems to be rather rare in this area, as there are but few records, including one collected by Neil D. Richmond at Burlington and one collected in a slab pile near Antioch.

SNAKES

32. *Carphophis amoena amoena* (Say), Worm Snake
I have but one record of this small secretive snake, namely, a specimen taken at Pinto under a rotten board.
33. *Diadophis punctatus edwardsii* (Merrem), Ring-necked Snake
This small snake inhabits rotten logs and is found under bark and rocks. I have taken two specimens at Gerstell in July 1938.
34. *Heterodon contortrix* (L.), Hog-nosed Snake, Spreadhead
This thick-bodied snake with a triangular head and upturned snout is found frequently in this area in gardens and cultivated fields.
35. *Opheodrys vernalis* (Harlan), Grass Snake, Smooth Green Snake
I have but one record of this bright green insectivorous species, namely, a specimen collected by Charles Chapman of Keyser, but I have had reports of its being killed in various parts of the county.
36. *Coluber constrictor constrictor* L., Black Racer
This beneficial species is found throughout the county.
37. *Elaphe obsoleta obsoleta* (Say), Pilot Black Snake
This, the largest serpent found in Mineral County, is common throughout the area.
38. *Lampropeltis triangulum triangulum* (Lacépède), House Snake, Milk Snake
The distribution of this snake in Mineral County is general but it is not found abundantly anywhere in the area.
39. *Natrix sipedon sipedon* (L.), Banded Water Snake
Common along the streams and ponds of the area.
40. *Storeria dekayi* (Holbrook), DeKay's Snake
This species appears to be scarce in the area, as I have collected but two specimens. Both were taken at Gerstell.
41. *Storeria occipitomaculata* (Storer), Red-bellied Snake
The fondness of this species for hiding under stones and bark of trees usually makes collection difficult.
42. *Haldea valeriae valeriae* (Baird and Girard), Eastern Gray Snake
Three specimens of this rare species have been collected in Mineral County. One specimen was taken at Limestone and the other two were taken by the author, one at Reese's Mill and one in Gerstell Hollow.
43. *Thamnophis sirtalis sirtalis* (L.), Common Garter Snake
Common in Mineral County.

The following two species are the only poisonous snakes that inhabit Mineral County.

44. *Agkistrodon mokasen cupreus* (Rafinesque), Northern Copperhead
Fairly common in the lowlands but because of its nocturnal habits it is not often seen.
45. *Crotalus horridus horridus* L., Banded Rattlesnake, Timber Rattlesnake
Found usually in the mountains or in rocky ledges where they may be fairly common.