PROCEEDINGS

OF THE

# PENNSYLVANIA ACADEMY OF SCIENCE

VOLUME III

1929

HARRISBURG, PENNSYLVANIA
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# OFFICERS

1929–30

*President* ........ Robert T. Hance, Pittsburgh
*Vice-President* ........ D. S. Hartline, Bloomsburg
*Secretary* ........ T. L. Guyton, Harrisburg
*Assistant Secretary* ........ John W. Keller, Harrisburg
*Treasurer* ........ H. W. Thurston, Jr., State College
*Editor* ........ R. W. Stone, Harrisburg

The Science Press Printing Company,
Lancaster, Pa.

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# PENNSYLVANIA ACADEMY OF SCIENCE

## REPORT OF THE SECRETARY

The Pennsylvania Academy of Science held its fifth annual meeting in the Schwab Auditorium at Pennsylvania State College on the morning of March 29th, 1929. The session opened with reports of committees. Report of the Secretary follows:

The Fourth Annual Meeting of the Academy was held on April 6th and 7th, 1928, Carnegie Museum, Pittsburgh; E. A. Ziegler, President. The members were welcomed to the museum by the Director, Dr. A. Avinoff. Twenty-eight papers were presented in the meetings, covering practically all branches of science. The dinner lecture was given by Dr. E. R. Weidlein, Director of the Mellon Institute. He chose for his subject "The Present Trend in Scientific Research." After this address the Academy was entertained and instructed with three motion picture reels depicting the habits of the beaver and of certain insects. Fifty-eight persons were elected to active membership and eight resignations were accepted. The success of the session was largely due to the activity of the local committee and the thanks of the Academy was expressed to this committee by proper resolutions. The following officers were elected for the year:

*President*, F. D. Kern, State College, Pa.
*Vice-President*, Robert T. Hance, Univ. of Pittsburgh
*Secretary*, T. L. Guyton, Harrisburg
*Treasurer*, H. W. Thurston, State College
*Ass't. Sec'y.*, D. S. Chamberlin, Lehigh Univ.
*Editor*, R. W. Stone, Penna. Geological Survey, Harrisburg

The Executive Committee is composed of the elected officers and the following past presidents: O. E. Jennings, B. L. Miller, N. H. Stewart and E. A. Ziegler. The Advisory Council, Governor John S. Fisher.

The time and place of the Fifth Annual Meeting was fixed for Easter vacation, 1929, at Pennsylvania State College. The time and place of meeting for the summer meeting was to be fixed by action of the Executive Committee.

By action of this committee the summer session of the Academy was held August 10–11, 1928, at Pennsylvania State Forest School, Mt. Alto, Pa. The evening lecture was delivered by Prof. Geo. S. Perry. He chose for his subject "The Forests of the Scandinavian Peninsula." At a brief business session ten persons were elected to active membership. The field trip was through the Mt. Alto and Michaux Forests where the various forest problems were studied and explained.

During the year two members were lost by death, Dr. Edgar Fahs Smith, President Emeritus, University of Pennsylvania, died May 3, 1928; and M. W. Grissinger, Selinsgrove, Pa., died Dec. 30, 1928. The following resigned from the Academy:

Dr. Edward Hart, W. S. Taber, H. B. Kirk, Mrs. John J. Edson, Jr., Francis Knolancheek, H. D. Fish, F. G. Pond, N. E. Morse, Miss Elizabeth McWilliams, T. O. Bradley, Charles E. Roudabush, L. W. Nuttall.

The following were dropped from the rolls for non-payment of dues for two years or more:

B. H. Dimit, David Weisberger, Ellen C. Diamond, Herbert D. Smith, S. Irvine Shortess, R. B. Maxwell, A. F. McGann, Agnes Merchitis, J. Edward Hiller, John F. Kob, Helen M. Joachim, W. S. Krout, Porter R. Taylor, J. F. Penderbaugh, James B. Davis, Ray F. Deck, Mrs. Nelson F. Davis, Nelson F. Davis, Eleanor F. Karsner, Lloyd E. Howe, L. C. Krebs, Ralph E. Martin, H. C. Allaman, Ransom P. Allaman, J. H. Kunkle, C. M. Roberts, John C. Hadley, L. Lloyd Light, Helen K. Eimert, Walter S. Eisenmenger, Levi Gilbert, J. Seth Grove, Frank P. Kyle, Philip J. Herbst, E. H. Nelson, Brother Felician Peter, Frances Pinney.

At present the Academy has one honorary member, and 321 active members. Of the active members 146 are also members of the American Association for the Advancement of Science. It is the opinion of your Secretary that there should be a much larger membership among persons interested in science who are not connected with the American Association than there is at present. He has in mind the great number of persons who are teaching the sciences in the high schools.

Volume II of the "Proceedings" was published and distributed to the members. About 800 copies each of Volume I and Volume II are in storage at Harrisburg. During the year several requests have been received for exchange of publications from other Academies of science and from various educational institutions. It is hoped that some arrangement may be made by means of which exchange may be set up.

Signed:
T. L. Guyton,
*Secretary.*

The report was adopted by the Academy.



The Treasurer's report was given as follows:

*Receipts*

| | |
|---|---|
| Balance on hand | $ 380.51 |
| Dues received | 685.00 |
| A. A. A. S. rebates | 53.00 |
| Sales Proceedings | 14.00 |
| Miscellaneous | 1.20 |
| | $1,133.71 |

*Disbursements*

| | |
|---|---|
| Vol. II Proceedings | $ 511.00 |
| Stationery and printing | 35.00 |
| Secretary's account | 37.19 |
| Pittsburgh meeting | 25.75 |
| Summer meeting | 6.95 |
| Treasurer's account | 48.84 |
| Cash in bank | 468.98 |
| | $1,133.71 |

Approved:
E. Alfred Wolf,
W. A. McCubbin,
*Auditors.*

Signed:
H. W. Thurston, Jr.,
*Treasurer.*

The report was adopted after the approval of the Auditing Committee.

The president appointed the following committees:

Nominating Committee: Ziegler, Jennings and Gress.

Resolutions Committee: Hance and Reiter.

Auditing Committee: Wolf and McCubbin.

After this the following program was presented:

Bentonite in Pennsylvania, C. A. Bonine, State College, Pa.
Modern Picture of Chemical Combination, W. P. Davey, State College, Pa.
Glacial Potholes in Northeastern Pennsylvania, R. N. Davis, Scranton, Pa.
Diploid Males in Habrobracon, Anna R. Whiting, Pittsburgh, Pa.
X-Ray Mutations in Habrobracon, P. W. Whiting, Pittsburgh, Pa.
Linkage of the Semi-Lethal X-Ray Mutation, "Miniature," P. W. Whiting, Pittsburgh, Pa.
Are Habrobracon Males Diploid for the X-Ray Mutation "Short?" M. M. Torvik, Pittsburgh, Pa.
What is the X-Ray Mutation "Cream?" C. H. Bostian, Pittsburgh, Pa.
Ratios of Diploid Males in Habrobracon, D. R. Charles, Pittsburgh, Pa.

Errors in Text-books in Biology and Zoology Used in High Schools and Colleges in Pennsylvania, H. A. Surface, Selinsgrove, Pa.
Soil Fertility Problems Involved in Development and Maintenance of Fairways and Putting Greens, J. W. White, State College, Pa.
The So-called Depth of Sleep, H. M. Johnson and G. W. Weigand, Pittsburgh, Pa.
Further Notes on Plant Geography of Western Pennsylvania, O. E. Jennings, Pittsburgh, Pa.
A Sensitive Grass, O. E. Jennings, Pittsburgh, Pa.
A Survey of the Forest Soils of the Mont Alto State Forests, Prof. John T. Auten, Mont Alto, Pa.
Education and the Radio, R. T. Hance, Pittsburgh, Pa.
Survey of Algae in Ponds of Presque Isle, R. V. Morrisey, Pittsburgh, Pa.
Crystal Symmetry as Revealed by Etching Phenomena, A. P. Honess, State College, Pa.

Trips were made to a limestone quarry at Bellefonte where a thin layer of bentonite was found. This material, just lately discovered in Pennsylvania, is of volcanic origin.

A trip, also, was made to the Crystal Structure Laboratory, Pennsylvania State College. The Bellefonte trip was lead by C. A. Bonine and the work at the laboratory was under W. P. Davey. The annual supper of the Academy was at the University Club. The speakers were:

A. H. Espenshade, Some Pennsylvania Pioneers in Science.
E. L. Nixon, A Decade of Applied Botany in Pennsylvania.

A social hour followed and the Academy was entertained by the Penn State Science Club.

The meeting on Saturday, March 30th, started with the report of committees. A report was called for from the Legislative Committee, Representative to the American Association for the Advancement of Science, and the State Flower Committee. The only committee to report was the State Flower Committee: Dr. E. M. Gress, Chairman. Dr. Gress reported that he had made special effort to get an opinion from the various societies throughout the State as to the flower which would be of widest choice. This opinion centered on the tulip tree as the State tree and the flower of this tree as the State flower. Upon motion duly made and seconded the Academy in accordance with the above report unanimously adopted the following resolution:

WHEREAS: The tulip tree (*Liriodendron tulipifera*) of the Magnolia Family is a native tree of Pennsylvania and found throughout the State as a forest and cultivated shade tree and,

WHEREAS: It is an important timber tree of the State, its wood being used in cabinet work, interior finish, boat building,



wooden pumps, wooden bowls, and as a substitute for Cuban cedar in the manufacture of cigar boxes and,

WHEREAS: Its beautiful tulip-like flowers, buds, leaves and fruits are easily conventionalized for artistic use and suitable for decorative purposes and,

WHEREAS: The leaf resembles a keystone in shape and is therefore a fitting emblem and symbol for the Keystone State, the arch in the thirteen original colonies, and,

WHEREAS: It is found in full bloom the latter part of May when we wish to commemorate with floral emblems the brave deed of our soldiers of the Civil, Spanish-American, and Great World Wars, and,

WHEREAS: It has been selected by an overwhelming plurality vote of approximately forty societies in the State, that are interested in securing a flower to represent the Commonwealth of Pennsylvania;

THEREFORE: Be it recommended that the flower of the tulip tree and the tree (*Liriodendron tulipifera* L.) be adopted by choice as the State flower and State tree of Pennsylvania, and that the citizens of the State and the children of the public school be instructed to call the flower of the tulip tree the State flower and the tree the State tree of Pennsylvania, and that they shall be taught the identifying characters of the tree and flower and the correct methods of planting and caring for the same in private and public grounds and along our highways.

The Resolutions Committee reported as follows:

Owing to the increasing number of papers that are presented each year and to the difficulty of giving all an equal opportunity to deliver and to discuss the material under the present unlimited system, it is the consensus of opinion of the members of the Pennsylvania Academy of Science assembled at State College that, in fairness to all, papers listed in future programs will be limited to a maximum of fifteen minutes except at the discretion of the officers of the Academy or in accordance with the expressed desire of the members.

The members of the Pennsylvania Academy of Science desire to place on record their appreciation of the pleasant visit they have enjoyed at State College due to the hospitality and thoughtfulness of the representatives of the College and of the local members of the Academy.

ROBERT T. HANCE,
GEORGE F. REITER.

The Membership Committee presented the following names for active membership, all of whom were unanimously elected:

Roy D. Anthony, State College, Pa.
Dr. Joseph H. Barach, 401 Jenkins Bldg., Pittsburgh, Pa.

E. Raymond Binkley, 520 Cherokee St., Bethlehem, Pa.
Philip D. Brossman, 1137 Fillmore St., Frankford, Philadelphia, Pa.
Blanche Effie Brown, Wilkes-Barre Institute, Kingston, Pa.
Benjamin Brownstein, Ellwood City, Pa., Box 566.
Dr. Andrew B. Crichton, Johnstown, Pa.
D. Geo. Dery, Fifth and Pine Sts., Catasauqua, Pa.
Dr. Cadwallader Evans, Jr., 434 Wyoming Ave., Scranton, Pa.
William H. Eyster, Botanical Lab., Bucknell Univ., Lewisburg, Pa.
Lloyd W. Fisher, 207 W. Green St., Reading, Pa.
Stevenson W. Fletcher, State College, Pa.
Jacob Furth, The Henry Phipps Institute, 7th and Lombard Sts., Philadelphia, Pa.
Dr. Chas. S. Gause, 81 S. Gallatin Ave., Uniontown, Pa.
Edw. H. Graham, Carnegie Museum, Pittsburgh, Pa.
Julia Moesel Haber, Zoology Dept., Penna. State College, State College, Pa.
Prof. H. E. Hodgkiss, State College, Pa.
Chas. S. Hollander, c/o Rohm & Haas Co., Bristol, Pa.
Dr. Wilbur F. Horn, Carlisle, Pa.
John C. Johnson, State Teachers' College, West Chester, Pa.
Dr. Arthur P. Kelley, Malvern, Pa.
Max Kisliuk, Jr., 134 S. 2nd St., Philadelphia, Pa.
Dr. Edward Lodholz, Graduate School of Medicine, Univ. of Penna., Philadelphia, Pa.
William W. Long, Eighty-four, Pa.
Richard V. Morrissey, 203 Biology Hall, Univ. of Pittsburgh, Pittsburgh, Pa.
Dr. Hugh C. Muldoon, Duquesne Univ., Pittsburgh, Pa.
Francis J. Mulvihill, Dept. of Internal Affairs, Harrisburg, Pa.
William W. Murray, 218 Hawthorne St., Canonsburg, Pa.
U. H. Myers, 824 Fulton Bldg., Pittsburgh, Pa.
Dr. James A. Nelson, 605 E. Darby Rd., Llanerch, Pa.
Dr. Robert T. Paessler, 105 Coal Exchange Bldg., Wilkes-Barre, Pa.
William Alvin Parlette, Brooklyn, Pa.
Burtis L. Robertson, Dept. of Elec. Engr., Penna. State College, State College, Pa.
Herbert A. Ross, 400 Crescent Park, Warren, Pa.
Felice A. Rotondaro, 429 S. Pacific Ave., Pittsburgh, Pa.
John A. Roulton, Norris Apts., Norristown, Pa.
Leslie D. Shriver, Dunn's Station, Pa., R. D. 2.
John R. Skeen, 5810 Chew St., Philadelphia, Pa.
Dr. James C. Small, N. E. Cor. 36th and Walnut Sts., Philadelphia, Pa.
William Stanaka, Everhart Museum, Scranton, Pa.
Dr. Frank J. Steele, Oakland, Pittsburgh, Pa., Box 9.
C. Kern Stewart, 412 Fifth Ave., McKeesport, Pa.
M. C. Strauser, Dept. of Botany, Penna. State College, State College, Pa.
Thomas H. Swan, Mellon Institute, Pittsburgh, Pa.
Frank M. Swartz, 111½ W. Fairmount Ave., State College, Pa.
R. R. Tafel, 4921 Cedar Ave., Philadelphia, Pa.
Ralph N. Van Arnam, 418 N. New St., Bethlehem, Pa.
Michael P. Walle, 222 Pierce St., Kingston, Pa.
Frank M. Weida, 1016 N. New St., Bethlehem, Pa.



G. E. Weigand, Mellon Institute, Univ. of Pittsburgh, Pittsburgh, Pa.
Geo. L. Zundel, Botany Bldg., Penna. State College, State College, Pa.

Upon motion of the Secretary, Dr. W. W. Keen, of Philadelphia, was elected to honorary membership in the Academy. Dr. Keen has been referred to as the Dean of Operative Medicine in America. He has reached the advanced age of ninety-two, and is still active in his profession. The following is a brief biography of Dr. Keen taken from "Who's Who in America":

William Williams Keen:

Born January 19, 1837. Took A.M. degree in Brown University, 1859; M.D., Jefferson Medical College, 1862, Sc.D., 1912; LL.D., Brown University, 1891; Northwestern and Toronto, 1903; Ebensburg University, 1905; Yale, 1906; St. Andrews University, 1911, and University of Pennsylvania, 1911; Ph.D., University of Upsala, 1907; Sc.D., Harvard, 1920; Dr. honorus causa, University of Paris, 1923. Dr. Keen served as surgeon in the Civil War. Has practiced and lectured on pathology and anatomy in Philadelphia much of the time since 1866. Has served on various public boards and committees in both state and nation. He is the author of many papers and books on medicine and related subjects. Dr. Keen has been a leader in his profession. Is the recipient of many prizes and medals for the high character of his work and the eminent public service he has rendered.

Upon motion it was decided to hold the Sixth Annual meeting in Bloomsburg at the Easter vacation, 1930. The Nominating Committee reported as follows:

*President:* Robert T. Hance; *Vice-President:* D. S. Hartline; *Secretary:* T. L. Guyton; *Assistant Secretary:* John W. Keller; *Treasurer:* H. W. Thurston, Jr.; *Editor:* R. W. Stone.

The Secretary was instructed to cast a ballot in favor of these candidates. After this the following program was presented:

Teaching of Physical Chemistry at the Pennsylvania State College, W. P. Havey and M. J. Lisse, State College, Pa.
The Helderberg Group from Central Pennsylvania to Southeast Virginia, F. M. Swartz, State College, Pa.
*Lygodium Palmatum* in Pennsylvania, D. S. Hartline, Bloomsburg, Pa.
The Possible Biological Significance of the Increased Activity of X-Rayed Tyrosinase, R. T. Hance, Pittsburgh, Pa.
*Pimpinella Magna* in Pennsylvania, E. M. Gress, Harrisburg, Pa.
Demonstration of the Method of Ultra-violet Microradiation, E. A. Wolf, Pittsburgh, Pa.

Periodicity in Fungi, Illo Hein, State College, Pa.
Distribution of Fishes in a Typical Pennsylvania Stream, Geddes Simpson, Lewisburg, Pa.
Habits of Amphibia in Winter, Chas. Mohr, Lewisburg, Pa.
Cephenomyia, a Probable Cause of Death Among Deer, N. H. Stewart, Lewisburg, Pa.
Highway Protection and Beautification, J. W. Keller, Harrisburg, Pa. (By Title only.)
Photo-receptors in *Mya arenaria*, V. E. Light, Baltimore, Md.
Problems Involved in the Making of an Entomological Survey of a Little Known Region, S. H. Williams, Pittsburgh, Pa. (By Title only.)
The Corona, J. H. Wayman, Pittsburgh, Pa.

The new officers were inducted and the Academy adjourned.

Signed:
T. L. GUYTON,
*Secretary.*

# SOME PROBLEMS IN THE NAMING OF PLANTS[1]

PRESIDENTIAL ADDRESS

BY FRANK D. KERN
*Pennsylvania State College*

Our studies of plants, no matter how accurate and exhaustive, must be orderly and systematic to be worthwhile. We may look upon descriptions and classifications as dry-as-dust abstractions but we cannot get away from the fact that we are under great obligations to the systematists for their indispensable foundational work.

Nomenclature is as essential to classification as are conceptions of groups. Since Linnaeus introduced the binomial plan of naming plants, in 1753, a great many names have been proposed and published until now we have many more names than plants. When it is evident that we have several names, proposed at different times and in different countries, applying to a certain plant, on what basis are we going to sort them over and select one as the proper one? It becomes evident at once that application of names according to definite rules is essential and that the rules must furnish a basis both for putting in order the old names and for the formation of new ones.

The necessity of establishing rules to govern the application of names to plants has been recognized by botanists for many years. It is generally stated that the primary object of formal nomenclature is to secure stability, uniformity, and convenience. The difficulties are twofold: (1) to formulate adequate rules and (2) to secure their universal acceptance. Anything short of world-wide agreement on a system of nomenclature can lead only to confusion. It is a problem for international consideration. Several international conferences have devoted attention to the codification of rules. An international meeting in Paris in 1867 adopted what has been known as the Paris Code. A congress at Genoa, in 1892, appointed a standing committee to constitute an International Commission on Nomenclature which was to report at some future international meeting. The Madison Botanical Congress, called by American botanists in Madison, Wisconsin, in 1893, did not develop the international character which had been hoped for and did not attempt to legislate upon the question of nomenclature.

[1] Contribution from the Department of Botany, The Pennsylvania State College, No. 66.



The Vienna Congress in 1905 adopted the International Rules of Botanical Nomenclature but they were to apply only to seed plants and ferns. These rules were amended in 1910 at Brussels through the recognition that was given there to the lower plants. Several matters were reserved for a congress scheduled for London in 1915, which of course did not convene. The Ithaca Congress in 1926 did not pass any legislation but referred nomenclatorial matters to a committee on nomenclature for report at the coming congress to be held in Cambridge, England, in August, 1930.

Prior to 1905 a group of American botanists codified a set of rules known as the American Code, which was submitted to the Vienna Congress but it was not adopted there. While there are other differences between the two codes, the chief difference is that the American Code puts forward the type concept as a fundamental principle while the Vienna Code does not formally recognize it. In explanation of the type concept the following quotation from A. S. Hitchcock (Amer. Jour. Bot. **8**: 252, 1921) will be helpful. "The type species of a genus or the type specimen of a species is the species or specimen, respectively, that directs or controls the application of the generic or specific name. A generic name shall always be so applied as to include its type species; a specific name shall always be so applied as to include its type specimen. The old concept was that a genus was a group of species having a given combination of characters; a species, similarly, a group of specimens. The new or type concept is that, from a nomenclatorial standpoint, a genus is a group of species allied to the type species, a species a group of individuals similar to the type specimen." In other words, we name objects, not our conception of objects. In modified form the American Code has been known as the Type-basis Code since 1919. The International Rules and the Type-basis Code have come to be more or less contrasted and each has its supporters.

Some American botanists, although possibly not agreeing with the entire set of International Rules, are inclined to accept them because they represent the best we have in the way of international law. Other American botanists are not willing to join this "league of nations" so long as it ignores fundamental features of a basic nature which they are certain must eventually prevail.

There have been numerous recent suggestions "that the time is ripe for an attempt to secure world-wide agreement on plant nomenclature." Sprague, of the Royal Botanic Gardens, Kew, in a note in Science (Vol. 57, pp. 207–209, 1923) states "that the divergence between the Type-basis Code and the International Rules leads to dual nomenclature in one out of every nine species of Phanerogams, apart from any differences of generic concept." He points out how this state of affairs handicaps the progress of systematic botany and deplores the amount of time which must be occupied with questions of nomenclature which might otherwise be devoted to other phases of taxonomic endeavor. I have no statistics for the Fungi but I believe it safe to say that these two codes would lead to dual nomenclature in an even larger percent of cases in this group. Hitchcock has given two good discussions in which he has brought out clearly the points of difference between the two codes (Jour. Bot. **60**: 316–318. 1922; Amer. Jour. Bot. **13**: 291–300. 1926). It is the belief of Hitchcock that the code of the future will be attained by a modification of the International Rules so that they will embody certain important principles of the American Code. Other botanists see no reason why it should not be possible to combine the best features of the two systems.

There are now numerous indications of such a possibility. The type-method of applying names is not contrary to the International Rules and was recommended for future procedure by the emendations in Brussels in 1910. To make the practice retroactive is regarded as essential by many workers. An Imperial Botanical Conference in Cambridge in 1925 resolved that the type-method should be formally adopted. This conference also adopted resolutions which would change the Latin diagnosis from a requirement to a recommendation; would reject combinations which are later homonyms, and generic names which are later homonyms, unless specially conserved; would admit duplicate binomials; and call for a revision of the list of conserved names. A recognition of these suggestions would be a long step toward agreement.



The divergent views in the matter of homonyms are interesting. The International Rules state that no one is authorized to reject a name "because of the existence of an earlier homonym which is universally regarded as non-valid," and also that "when a species is moved from one genus to another, its specific epithet must be changed, if it is borne by a valid species of that genus" which means that the transferred name can stand even though there is such a previous combination provided the earlier combination is non-valid (a synonym). This leads most surely to confusion unless the worker knows or determines carefully the standing of the earlier homonym. If his knowledge is incomplete, his judgment faulty, or if there are later changes in view as to the validity of the earlier homonym an uncertain situation develops. The provision of the Type-basis Code that both generic and specific names are to be rejected, if there are earlier homonyms, is more certain and practicable.

In the foregoing paragraphs I have sketched some of the efforts of systematic botanists to attain a regular system of nomenclature. Very briefly I have referred to some of the difficulties. In spite of adverse criticisms from various quarters, I am certain that these efforts have been inspired by the highest ideals. Under the heading "General Considerations and Leading Principles" the International Rules state that the essential points are to aim at fixity of names, to reject names likely to cause error or ambiguity, to avoid useless creation of names, and to have regard for grammatical correctness, regularity or euphony, prevailing custom, and respect for person. Since the rules cannot be imposed by authority it is proposed that they must be founded on such simple, clear, and forceful conceptions that everyone will be able to comprehend them and disposed to accept them. Any rules which do not come up to such a standard will be ignored gradually and eventually abandoned. Although the past efforts have not attained their own ideals they have served a purpose and have aided in stabilization. What is needed now is an unprejudiced attitude on the part of the legislators of the future and a rationality and confidence on the part of all plant science constituency.

There is no doubt that the chief unrest with respect to nomenclature among practical plant people centers around the matter of stability or permanency of names. I have just pointed out that the botanical legislators recognize that the first essential is to aim at fixity of names. The claim of some practical plant men that changes in names are largely due to "new ideas in merely arbitrary fashions or systems of nomenclature" is not justified. It has been said that "there is no guarantee—if, indeed there is any hope—that the system which may be adopted today will be accepted by the next generation." Of course not. But the main fact to be recognized is that no rules can prevent changes in names. On the contrary a rigid application of rules is likely to bring about changes. Unrest about changing well-known names is nothing new but dates back to the earliest times when technical names were applied. Hitchcock has well called attention to the fact that Beauvois, more than a hundred years ago, found it necessary to explain his failure to conserve certain names already in use and argued that if botanists would adopt the principle of priority (use of the oldest name) beginning with the works of Linnaeus, there would be in the future neither arbitrariness nor confusion in nomenclature.

Ever since the time of Beauvois the principle of priority has been uppermost in the minds of taxonomists. The American Code proposed to apply it rigidly. Because this would force little-known or little-used earlier names in the place of more widely-used later names the International Rules propose to conserve certain generic names. Many advocates of the American Code are without doubt coming around to the view that there should be a list of *nomina conservanda,* but they do not believe that the present list is satisfactory without revision. Exceptions to the rule of priority should be few and the directing principle should be to conserve names of those genera with large numbers of species and those which include the common economic plants. There is at present no conserved list of genera of Fungi but many of us dealing with this group have accepted the principle and have already put it into practice. The difficulty in the conserving of names is to get an accurate appraisal. What may be regarded long-used names in one country or region may not be so regarded in another. Again conserving genus names will not maintain specific names for which we may have a feeling of fitness. Thus we come back to the realization that no code can prevent changes but can provide merely the uniform procedure for making them. As long as botanists continue to acquire more information, or alter their taxonomic concepts, or make incorrect identifications or misapplications, we will have to face changes in names and we may as well bow to the inevitable. Not only will we have changes in names, but from time to time will we have changes in the rules for applying them.

On this whole subject of changes of names one of the finest testimonies that I have seen is that of Dean G. W. Groff in an address read at the dedication of the Science Building, Lingnan University, Canton, China, entitled "The Botany of Kwangtung and its Relation to Agriculture." I cite the title and occasion because it helps to indicate the combined



practical and theoretical view-points of the author. I can best present his views by quoting a paragraph. "Intimately associated with these earlier and later plant classifications, and with the development of terminology, descriptions, and keys, natural and artificial, we have the tremendously interesting, to some of us fascinating and gripping subject of plant names. . . . Here, too, is a subject ever unfolding, ever involved. In botany, as in mathematics, things equal to the same thing are equal to each other. And plants, even though they be recorded under two or more different names, if they fall within the same descriptive category, should be provided with but one valid name. Nevertheless, by the marvel of creation no two plants are exactly alike, and someone must be the judge as to what is to constitute the species if mankind proposes to describe and name plants. The chief difficulty lies in the fact that plants which are discovered, described, named, and recorded today are studied, named, and recorded tomorrow, perhaps in clearer light. However, rules of priority as practiced in scientific nomenclature demand that which Mr. A sees today, if published in journals of standing, shall constitute and form the basis for any description and naming which Mr. B, working in the same field, may see tomorrow. But in a world as large as ours, with its babel of tongues and script, how can Messrs. A to Z ever be sure that they are not rediscovering, redescribing, renaming that to which some member of this large and growing group has priority? Here, too, the matter of concept of what is actually to constitute a given species is of the greatest influence. Thus we have wide and narrow limits to a species, valid names, and synonyms. A plant which is known in scientific or popular literature today, under one binomial and its authority, may be known tomorrow more correctly, under a different binomial and its authority, due to transfer or reduction. Latin names of China and Kwangtung plants are replete with this confusing situation, and one cannot use plant literature successfully without a full understanding of the situation."

In this brief and imperfect way I have tried to present some of the problems of the systematic botanist. If I have shown you that he is striving studiously to solve these problems, and to adjust himself and his work to shifting and expanding concepts of a living and growing science, I have not failed. It was not my intent to suggest solutions but to put forward a view-point from which you might give these matters friendly consideration. I should like to have you appreciate the importance of such work to other fields of human knowledge and to believe with me that the best efforts do rest on fundamental and inherently correct principles and not upon expediency and personal preference as some people would have you believe. We may as well philosophically conclude with Groff that names are a necessary means for the acquaintanceship of plants, that they cannot be ignored, that they have been used and changed, and that they will be used and changed. There are difficulties, of course, but they are not insurmountable and there is abundant evidence that we are making progress today along the right lines and that is all that we can expect.

# BENTONITE IN PENNSYLVANIA

By C. A. Bonine and A. P. Honess

*Pennsylvania State College*

## Introduction

During the summer of 1924 a bed of weathered, buff-colored clay was observed in the lower part of the Trenton limestone in a road cut near Antes Fort, Nippenose Valley, Lycoming County, Pennsylvania. The occurrence of this peculiar clay, interbedded with marine limestone, seemed so unusual and the resemblance to the Wyoming bentonite so strong that the writers collected samples for microscopic study. Samples were sent to E. T. Wherry and E. S. Larsen, both of whom expressed the opinion that the material was bentonite. A. P. Honess, of the Department of Geology and Mineralogy, Pennsylvania State College, also examined the clay and came to the conclusion that it was volcanic in origin.

During the last four years beds of similar material have been found in practically every quarry in Central Pennsylvania where marine limestones of Middle Ordovician age are exposed. Petrographic examinations by C. S. Ross,[1] of the U. S. G. S., and A. P. Honess and a chemical analysis by Professor Thomas Mason, of the Department of Chemistry, Pennsylvania State College, have established the fact that this bentonite is genetically related to that reported by Nelson, Butts and others from Kentucky, Virginia, Tennessee and Alabama.

Ross and Shannon[2] have defined bentonite as follows:—"Bentonite is a rock composed essentially of a crystalline, clay-like mineral formed by the devitrification and the accompanying chemical alteration of a glassy igneous material usually a tuff or volcanic ash; and it often contains variable proportions of accessory crystal grains that were originally phenocrysts in the volcanic glass. The characteristic clay-like mineral

[1] Clarence S. Ross, "Altered Paleozoic volcanic materials and their recognition," Bull. Amer. Assoc. Petroleum Geol., 12: 143–164 (1928).

[2] Clarence S. Ross and Earl V. Shannon, "The minerals of bentonite and related clays and their physical properties," Amer. Ceramic Soc. Jour., Vol. 9 (1926), p. 79.



has a micaceous habit and facile cleavage, high birefringence and a texture inherited from volcanic tuff or ash, and it is usually the mineral montmorillonite but less often beidellite."

Field observations show that most bentonites are sedimentary deposits formed in bodies of water which were generally saline in character. However, some small irregular deposits are undoubtedly residual clay formed *in situ* by the alteration of glassy lavas.

## Physical and Chemical Properties

Weathered outcrops of Pennsylvania bentonite do not exhibit the marked absorption and adsorption of water so characteristic of some western bentonites. When wet, the weathered clay is quite plastic and of a greenish buff color. The unweathered bentonite is blue gray to greenish in color, exhibits a waxy translucency when dry and a variable structure. Some of the clay is structureless with conchoidal fracture, although most of it has a somewhat shaley appearance. During the folding of the limestone formations movements took place extensively along the planes of the bentonite beds forming slickensided surfaces and schistose bentonite. Later thin sheets of calcite were deposited by ground waters percolating along the bedding planes of the bentonite beds.

Bentonites exhibit considerable variation in physical and chemical properties. C. W. Davis and H. C. Vacher[3] have prepared a classification of commercial bentonites based on the difference in the action of sulphuric acid on their alumina content. Bentonites containing alumina resistant to the action of sulphuric acid are called "bentonite," while those in which the alumina is mostly dissolved by sulphuric acid are called "subbentonite." According to this classification the Pennsylvania material should be classed as "bentonite." The chemical character of the unweathered bentonite from the Lemont member of the Carlim formation exposed in the Oak Hall, Pennsylvania, quarry, is shown in the following analysis:[4]

Analysis of Bentonite

| | | | |
|---|---|---|---|
| $SiO_2$ | 49.40 | $P_2O_5$ | .13 |
| $Fe_2O_3$ | .74 | $SO_3$ | .79 or S = .32% |
| $TiO_2$ | .44 | MnO | .00 |
| $Al_2O_3$ | 28.80 | Loss above 110° | 6.13% |
| CaO | .74 | Water at 110° | 3.02 |
| MgO | 3.80 | | |
| $Na_2O$ | 1.68 | | 100.65 |
| $K_2O$ | 4.98 | | |

[3] C. W. Davis and H. C. Vacher, "Bentonite, its properties, mining, preparation and utilization," Tech. Paper No. 438, U. S. Bureau of Mines.

[4] Analysis by T. W. Mason, Pennsylvania State College.

This analysis is similar to that of the bentonite from High Bridge, Kentucky, especially in the percentage of alkalis. The consistently high alkali content, particularly potash, reported from practically all the Ordovician bentonites of the Eastern United States is characteristic and serves to distinguish them from other bentonites. The alkalis probably exist partly in chemical combination in the undecomposed feldspars, partly as an essential constituent in the clay-like mineral formed by the metamorphism of the original clay mineral and partly as adsorbed salts. On the other hand there is a deficiency of silica and a distinct increase in alumina over the amounts recorded for the bentonites of Bedford County, Tennessee; High Bridge, Kentucky, and Birmingham, Alabama. However, when a comparison of these constituents is made with some of the bentonites from Crook and Natrona counties, Wyoming, a very much lower alumina and higher silica content become obvious in the Western deposit. These differences are for the most part traceable to age of beds or state of alteration. The percentage of silica, 49.40 per cent., shown in the analysis of the Oak Hall material is not in harmony with the acid character of the plagioclase found in the residue, and in view of the exceedingly fine grain of the ash from this locality, it appears there has been a decided loss of silica as result of alteration. The loss of silica, while more marked than any shown in the analyses from the southern localities just mentioned, is not surprisingly different when the textures are considered and the fact recognized that analyses reported from a single bed have been known to show considerable variation. The likenesses of the Eastern bentonites are certainly more marked than their differences, but when compared as a whole with those of the far West certain distinguishing characteristics become apparent.

## Petrography

In seeking to account for this special kind of clay two methods of approach may be utilized. The first emphasizes the original structure which alteration processes have failed to destroy completely, and which in many cases can be definitely identified beneath the petrographic microscope. The second involves a microstudy of special and characteristic minerals when these products have been concentrated either as crystals or mineral fragments in the more insoluble heavier residue obtained from crushed, flocculated, acid treated samples.

The important published accounts of Ross[5] have, without doubt, shown very clearly the igneous origin of those bentonites studied by him. The characteristic bogen structure, so common in unaltered volcanic ash deposits, has been exceptionally well preserved in many bentonites, especially those of more recent origin. The Central Pennsylvania material, however, being of much finer texture does not reveal so strikingly the evidence of special origin as some of the other deposits farther south and in the west. This fact suggested to the authors the desirability of approaching the problem of genesis by means of micro-studies of the heavier residues.

[5] *Op. cit.*



These residues[6] were prepared by crushing to a powder a suitably sized sample (50 grams) of the material taken from the bentonite bed. This was then violently agitated in a beaker of water, decanting off the finer clay substances from time to time until the solution was partially cleared. The residue was then reground, subsequently washed as before, flocculated in ammonia water and finally treated with dilute hydrochloric acid for the purpose of clearing up the residue. This treatment concentrates certain special constituents which are often obscure in thin section and affords opportunity for a more careful study of them by immersion liquids. The manner of treatment may be varied to suit the needs of the investigator, but in general the treatment is the same for all bentonites. In cases where it is desired to make a density separation bromoform has been found satisfactory.

The insoluble residues of the bentonite beds from the Trenton formation at Union Furnace, the Carlim limestone at Oak Hall, Pa., and the bentonitic shales of the Upper Black River limestone and Middle Trenton formations at Ganister, Pa., have been examined and found to show characteristics which are more or less general for the region. The advanced stages of alteration in most cases have left very little of the original material except those minerals which are usually preserved under conditions of erosion and decomposition of igneous rocks, such as zircon, acid plagioclase, quartz, apatite, etc. To these may be added biotite which, under the conditions of occurrence in Central Pennsylvania, may be called diagnostic. The character of the biotite, while generally of the same habit, differs considerably in color. The residues obtained from some of the Union Furnace, Pa., samples are much lighter in color and not as well crystallized as some observed from other localities; the residues from the bentonite beds of the Trenton formation at Ganister, Pa., especially are characterized by an abundance of dark colored biotite—often to the extent of 15 per cent. to 20 per cent. of the insoluble residue. Certain biotite flakes taken from limestone horizons quite remote strati-

[6] The authors are indebted to Mr. R. H. Smith and Mr. E. F. Williams, former students of the Geology Department, for preparation of the residues.

graphically from the bentonite beds are well crystallized and distinctly reddish. Although some of the color variations may be of primary character, leaching has undoubtedly been instrumental in decolorizing some of the biotite where alteration has been somewhat pronounced. Another characteristic, very common in the biotite flakes, is the unusual amount of interlacing rod-shaped and polygonal mineral inclusions and microlites. These are often oriented at angles of 60° and suggest by their optical behavior the minerals, apatite, zircon, and iron oxide. The zircon occurs also rather abundantly in some residues as individual crystals having definite faces and sharp edges with little if any rounding such as may result from stream transportation. The secondary products of the volcanic ash are chiefly those finely divided aggregates of clay minerals such as leverrierite, nontronite, montmorillonite and beidellite, which have as yet not been completely differentiated. Earlier petrographic work on this material suggested leverrierite as probably the most abundant species, but more recent studies by Ross and Shannon favor montmorillonite as the probable clay mineral replacing most of the less stable materials of the volcanic ash. The residues as a whole are free from material which may be called erosion residuals, a fact in keeping with the presence of fresh biotite in these bentonites and one of considerable significance when considering their origin.

It is a well known fact that biotite is widely disseminated in eruptive rocks and occurs as well crystallized hexagonal flakes in glassy extrusives. In the more crystalline phases magmatic resorption often diminishes its amount or causes it to disappear entirely. That the biotite of these bentonite beds is so abundant and well crystallized would seem to suggest acid eruptives as the probable source. Furthermore, inclusions of zircon occurring in the biotites of well crystallized plutonics are frequently bordered by pleochroic halos; however, the biotite of the bentonite beds, even though it be in many instances crowded with inclusions of crystal grains, rods and microlites, does not appear to carry zircon possessing this characteristic, a fact rather commonly recognized for extrusives.

Petrologists have long been familiar with the unstable character of biotite under conditions of rock erosion and decomposition, and its appearance in quantity as a well crystallized, unaltered species in a definite lithilogic unit of a sedimentary series, where metamorphism is not strongly emphasized, is not without suggestive significance as to the origin of the rock bearing it. This fact together with the lack of evidence supporting the suggestion of transport for the associated species points



rather conclusively to submarine burial of volcanic ash in shallow paleozoic seas without opportunity for oxidation.

## Geologic Occurrence

Six well-defined beds of bentonite, varying in thickness from one to fourteen inches, have been found in the Middle Ordovician limestones of Central Pennsylvania. Four of these occur in the basal portion of the Trenton limestone, one in the Lowville limestone near the base and one at the base of the Lemont member of the Carlim (Stones River) limestone.

The beds in the Trenton formation are more persistent than the older ones and were found in every quarry where the base of the Trenton is exposed. The following represents a typical section:

### Section at Union Furnace, Pa.

*Trenton Limestone*

| | Unit Ft. | Unit In. | Total Ft. | Total In. |
|---|---|---|---|---|
| (Top not measured) | | | | |
| Limestone, shaly | 2 | 0 | 694 | 9 |
| Bentonite, weathered, pure (Trinucleus concentricus) | | 5 | 692 | 9 |
| Limestone, massive, very little shale at top and bottom | 110 | 6 | 692 | 4 |
| Bentonite: Limestone, shaley; Bentonite (iron stained), calcite (4 in.) at top 11 in.; Bentonite, iron stained in bands, considerable shearing (calcite ½ in.) 5 in.; Shale, calcareous, brown, soft 1 in. | 1 | 5 | 581 | 10 |
| Limestone, massive, very fossiliferous, typical Trenton species | 30 | | 580 | 5 |
| Shale, calcareous, with brown layer similar to above | | 3 | 550 | 5 |
| Limestone, Trenton, massive | 13 | | 550 | 2 |
| Bentonite, banded, crushed | 1 | 1 | 537 | 2 |
| Limestone, Trenton, massive | 12 | | 536 | 1 |
| Shale, brown | | 3 | 524 | 1 |
| Limestone | | 8 | 523 | 10 |
| Shale, calcareous | | 4 | 523 | 2 |
| Limestone, bottom shaly | 6 | | 522 | 10 |
| Limestone | 2 | | 516 | 10 |
| Shale, calcareous, black | | 3 | 514 | 10 |
| Limestone | | 5 | 514 | 7 |
| Shale, calcareous, black | | 2 | 514 | 2 |
| Limestone, massive | 1 | 2 | 514 | |
| Limestone | 1 | 4 | 512 | 10 |
| Bentonitic shale | | 2 | 511 | 6 |
| Bentonite, weathered | | 7 | 511 | 4 |
| Chert, containing Trenton fossils | | ¼ | ...... | ..... |
| Limestone, Trenton, shaly | 15 | 6 | 510 | 9 |

(Top of Rodman limestone)

The following condensed sections show that the interval between the Trenton beds is fairly uniform:

| *Williamsburg, Penna.* | Ft. | In. | *Union Furnace, Penna.* | Ft. | In. | *Bellefonte, Penna.* | Ft. | In. |
|---|---|---|---|---|---|---|---|---|
| | | | Limestone | | 00 | | | |
| Surface | | | Bentonite A | | 5 | | | |
| Limestone weathered | 6 | 00 | Limestone | 110 | 00 | | | |
| Bentonite B | | 6 | Bentonite B | 1 | 5 | Surface | | |
| Limestone | 48 | 00 | Limestone | 43 | 00 | Limestone | 15 | 00 |
| Bentonite C | | 10 | Bentonite C | 1 | 1 | Bentonite C | | 5 |
| Limestone | 20 | 00 | Limestone | 24 | 00 | Limestone | 20 | 00 |
| Bentonite D | | 6 | Bentonite D | | 7 | Bentonite D | | 4 |
| Limestone | 10 | 00 | Limestone | 15 | 00 | Limestone | 21 | 00 |
| Top Rodman limestone | | | Top Rodman limestone | | | Top Rodman limestone | | |

The Rodman, Lowville and Carlim limestones vary considerably in thickness from place to place in Central Pennsylvania and the bentonite beds occurring in them are not very persistent. These formations are composed for the most part of massive bedded limestone which has been extensively folded by the mountain making movements of the Appalachian revolution. This folding has squeezed out the soft bentonite in many places, making it difficult to find. In the Bellefonte region the bentonite bed near the base of the Lowville is well exposed owing to the fact that this horizon is used as the foot wall of the quarries. The bentonite in the Lemont member of the Carlim is the oldest known bed in the eastern United States. According to Butts[7] the Lemont and Lowville of Pennsylvania are equivalent to the Lenoir and Bays formations of the Tennessee section. Seventy-five hundred feet of marine sediments, including the Holston, Athens, Tellico and Sevier formations, lie between the Lenoir and the Bays formations. This thick series is missing in Pennsylvania, the time interval being represented by a disconformity. Several million years must have elapsed between the deposition of the bentonite in the Lemont and that in the Lowville. A petrographic study of the heavy residues of the Lowville and Rodman formations is now being made by E. F. Williams and A. P. Honess, of the Pennsylvania State College, Department of Geology and Mineralogy. The presence of characteristic biotite in some of these residues shows that there is bentonite material scattered through the formations, indicating minor volcanic outbursts at frequent intervals throughout the period of deposition.

[7] Chas. Butts, "Variations in Appalachian Stratigraphy," Jour. Wash. Acad. of Sci., Vol. 18, No. 13, July, 1928.



### Conclusions

The Pennsylvania bentonite is, without doubt, genetically related to that occurring in the Southern Appalachian States. The mineralogical character, established chiefly through residue studies, is very similar to that reported for the bentonite from the Southern Appalachian district, fresh euhedral biotite being the most diagnostic accessory species. The grain size of the clay particles and accessory minerals is much smaller, indicating deposition farther from the volcanic source—a conclusion further strengthened by the thinness of the beds as compared to those several feet thick in Virginia and Kentucky. The texture of the bentonite is much finer and the characteristic ash structure, although not as well marked, is similar to that of the Southern bentonites. The geologic age of the limestone formations in which the bentonite occurs, as shown by paleontologic studies, is the same in both localities. A consideration, also, of the chemical composition of the bentonite from the two regions shows a marked similarity in chemical character, especially in alkali content. This further suggests a genetic relationship.

Owing to the nature of their origin, bentonite deposits usually occur as persistent beds over wide areas. Being deposited in such a short period of time they form very accurate chronological datum planes for the use of the stratigrapher and field geologist. The Pennsylvania bentonite beds should prove valuable for stratigraphic correlation purposes, but detailed paleontologic and petrographic studies will be required before criteria may be established for the recognition of the individual beds of considerable areal extent.

## MODERN PICTURE OF CHEMICAL COMBINATION

By W. P. Davey
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(Abstract not submitted.)

# GLACIAL POTHOLES OF NORTHEASTERN PENNSYLVANIA

By R. N. Davis
*Scranton, Pa.*

(Abstract.)

Potholes are found in solid rock where they have been formed by falling water. They are common where streams flow over a rocky bed. They are more frequently seen in glaciated areas than elsewhere because the streams have been diverted from their pre-glacial position and have not had time to reduce the course to a uniform grade. The higher ground where no streams flow at present occasionally have potholes, but these are usually covered by till so that they are seldom noticed.

An enormous pothole of this character was discovered in the Lackawanna Valley near Scranton nearly half a century ago. This pothole was revealed in a curious manner. A coal miner fired a blast and was terrified when he found a great quantity of water flowing into his "chamber." This flow soon ceased, but sand and silt mixed with gravel was in the "face" of the chamber instead of coal. The mine superintendent directed him to load this material into the mine cars and it was removed from the mine—nearly a thousand tons of it. This revealed a clearly defined pothole about forty-five feet deep. Prof. Branner, of the State Geological Survey, was appealed to for an explanation. He suggested that it was formed near the close of the Glacial Epoch when the great ice sheet was reduced locally to a valley glacier. A ridge extends across the valley here and this caused the glacier to break into crevasses, down one of which the surface water flowed with such power as to bore out the great pothole.

Some years later the writer with some of his students discovered some well-defined potholes of smaller size at the highest point of this ridge across the valley and four hundred feet above the level of the Lackawanna River, less than a mile away. One of the most remarkable of these was on the under side of a boulder. An examination of this boulder showed that it must have been "plucked" from a ledge less than a hundred feet away and turned over as it was shoved along by the glacier. This observation seems a confirmation of Prof. Branner's theory.



# X-RAYS AND HEREDITY OF WASPS AT THE UNIVERSITY OF PITTSBURGH

## An Introduction to the Five Following Papers

A series of experiments is being conducted at the Department of Zoology of the University of Pittsburgh concerned with the effects of X-rays on a parasitic wasp known as Habrobracon. This wasp, which is less than a quarter of an inch in length, is found wherever stored cereals are infested with caterpillars of the Mediterranean flour-moth, which they parasitize. The wasps have been reared for some years in order to study heredity, sex-determination, etc. Like the honey-bee they produce males from unfertilized eggs, parthenogenetically, but unlike the honey-bee, they are readily reared under controlled conditions in the laboratory. Caterpillars are fed on Pettijohn's breakfast food and then fed to the wasps. The latter pass through a whole generation in ten days and produce large numbers of progeny, so that they are convenient for studies in heredity. Dr. Anna R. Whiting, of Pennsylvania College for Women, tells how some males are produced from fertilized eggs and how this type of male can be identified; also how certain eye colors (black, orange, ivory) and various types of wings, which originated by mutation, are inherited.

Dr. P. W. Whiting, of the University of Pittsburgh, tells of the production of new types, or mutations, by treatment with X-rays and how one of the mutations produced in this way is inherited. This mutant which is called miniature is of small size and is very likely to die before maturing.

Miss M. M. Torvik has been working with another mutant with short wings. It is still a question whether the males from fertilized eggs can inherit this trait from their father. Miss Torvik has been making measurements to determine this.

Mr. C. H. Bostian is working with a pale eye color which gives very irregular results in heredity. Since this mutation which is called cream was produced by X-rays it seems likely that the rays have in some way upset the normal mechanism of heredity in addition to producing the new eye color.

Mr. Donald R. Charles has been studying the influence of X-rays on the ratios of males from fertilized eggs. He will tell something of the causes influencing these ratios.

Very little is known about the real method of sex-determination in Hymenoptera, the group of insects to which the bees, wasps, and ants belong. It was for this reason that these insects were chosen for study, but these studies are also of interest since they should tell us how we may expect characteristics to be inherited in the honey-bee, and how X-rays may produce new hereditary traits.

## DIPLOID MALES IN HABROBRACON

ANNA R. WHITING
*Pennsylvania College for Women*

Work on *Habrobracon juglandis* (Ashmead) was first done with wild black-eyed stock. It was observed that virgin females produce only males while mated females produce both males and females. The conclusion was drawn that all males come from unfertilized eggs. New data accumulated after the discovery of a recessive mutation, orange eye color, proved the above conclusion to be incorrect. From the cross of recessive orange females by related type males there appeared orange azygous males, black heterozygous females, and a few black males which must have received their eye color from the male parent.

Since it was believed that males in Hymenoptera must be haploid it was postulated that either the sperm nucleus alone had undergone cleavage in the egg cytoplasm and formed the entire embryo or that sperm and egg nuclei had developed independently, resulting in the formation of a haploid mosaic.

Study of several new recessive mutations has thrown additional light upon the subject. A series of quadruple allelomorphs affecting eye color, black, light ocelli, orange, and ivory, and three pairs of simple allelomorphs affecting wing character, defective venation, wrinkled wing and reduced wing, have been found. These four loci segregate independently.

In any type of cross between related stocks where the female is homozygous for one or more dominant and one or more recessive factors and the male carries the allelomorphs there are produced some anomalous males. Two types of such matings will be discussed in detail.

An ivory-eyed normal winged female ($o^io^iRR$) when crossed to a male with light ocelli and reduced wings ($o^lr$) gives ivory sons ($o^iR$), daughters with light ocelli ($o^io^lRr$), and a few sons with light ocelli ($o^io^lRr$?), all with normal wings. These males have, without any question, received a head character from their father and a thorax character from their mother and so cannot have been derived from the sperm nucleus alone but are biparental. An additional point of interest is brought out by this cross. Light females, heterozygous for orange or ivory, have ocelli



with less pigment than do males and females of light stock. The biparental males in the above cross likewise have lighter ocelli than ordinary haploid light males. This fact suggests that they are diploid like their sisters.

When homozygous defective, reduced females (ddWWrr) are crossed to wrinkled males (DwR) there are produced defective reduced matroclinous sons (dWr), type daughters (DdWwRr), and a few type sons (DdWwRr?). It is difficult to conceive of any relationship of chromosomes other than diploidy which will explain this for factors affecting one structure and derived from each parent appear in the males resembling their sisters.

Over 75 per cent. of these apparently diploid males are sterile and the remainder produce but few daughters. With a single exception they have all bred as dominants which might be explained by assuming their spermatozoa to be diploid.

The question that presents itself is "Why are these biparental, apparently diploid individuals, males?" A logical answer at present is a postulation of an X chromosome as in many other forms. It is quite possible that further research will disclose a mutation behaving differently from those already studied and that this will indicate a sex chromosome which, by its haploid or diploid condition, determines sex more or less irrespective of other chromosomes involved.

Cytological work upon *Habrobracon* is difficult. Haploid males possess about eleven very minute chromosomes, diploid females about twenty-two. Spermatogenesis is like that of the hornet. The first division is abortive, the second apparently produces two functional spermatozoa. Abortive first maturation divisions have also been observed in the testes of biparental males and it is conceivable that this process would result in diploid sperm, an idea consistent with genetic results. Daughters of biparental males would then be triploid, which might account for their high percentage of abnormality and sterility.

The question of the method of sex determination in Hymenoptera, which seemed to be settled so long ago, bids fair to be one of the last to be fully understood.

## X-RAY MUTATIONS IN HABROBRACON

By P. W. Whiting

*Department of Zoology, University of Pittsburgh*

In an attempt to produce mutations the wasps have been treated with different dosages of X-ray. There is little if any effect on duration of life or general vitality. Treated females tend to become sterile but produce a few offspring immediately after treatment.

Treatment of mated females decreases ratio of females among their progeny, probably by injury to sperm in seminal receptacles. Treatment of males reduces fertility or causes sterility. Treated males are mated to untreated females. The ratio of females among the progeny is an index of the fertility of treated males.

Very little of interest has appeared among the male offspring of treated females, although it might be expected that on account of male haploidism recessive mutations would readily become visible here. Possibly the lack of visible mutations may be due to simultaneous lethal mutations or other lethal changes which would be immediately fatal to a haploid organism. Sterilizing effect may be in part due to induction of lethal mutations.

Female offspring of treated males, as also female offspring of treated mated females, appear to carry lethals as evidenced by their low fecundity or the low male ratio among their offspring. Of one hundred and forty-one tested offspring of treated wasps, two gave visible mutations, "small-head" and "miniature," while at least twenty-eight showed conditions indicating lethals.

## LINKAGE OF THE SEMI-LETHAL X-RAY MUTATION "MINIATURE"

By P. W. Whiting

*Pittsburgh, Pennsylvania*

A daughter of an X-rayed male Habrobracon by an untreated female produced normal and "miniature" sons. Miniature reduces general body size and antennal length and changes the outline of the anterior wing. Miniature females are apparently sterile. Heterozygous females are normal in appearance and hence the mutation is recessive. Such females produce normal and miniature sons, but the latter are less than 50 per cent. of expectation. Miniature is therefore semilethal. Miniature females are obtained by mating miniature males with heterozygous females. The mutation is linked with locus for orange eye-color, giving about 10 per cent. crossovers. About one-sixth of the miniature that fail to mature develop to a pupal stage in which eye-color can be identified. Crossovers appear in lethal pupae in substantially the same ratio as in miniature and normal adults. Progeny (males) from virgin daughters of black miniature by orange normal approximate the following ratio: straights—orange 99, miniature 45, pupae 9; and crossovers—type 11, orange miniature 5, orange pupae 1.



## ARE HABROBRACON MALES DIPLOID FOR THE X-RAY MUTATION "SHORT"?

By Magnhild M. Torvik

*University of Pittsburgh*

The mutation "short" was derived from a daughter of an X-rayed male by an untreated female. Whether this mutation was caused by the rays is doubtful since there were also recorded two short sons from the untreated mother. These, however, may have been diploids receiving the factor short from their treated father. Short appears to be partially dominant in the male as the following experiments demonstrate.

Orange-eyed, short-winged females were crossed to type (black, long) males. The wings of the three sorts of offspring—orange males, black males and black females—were measured in order to determine whether the black males were diploid for wing length as well as eye color.

Measurements of costal veins of right mesothoracic wings were made with camera lucida. In order to correct for the factor of individual variations in size the ratio of costal length to head width was used instead of costal length alone. Thirty-three individuals of each type were measured. Costal length divided by head width varied around the mean $3.215 \pm 0.017$ in the orange males, $3.336 \pm 0.023$ in the black males and $3.551 \pm 0.025$ in the black females. The mean for the black males is $0.121 \pm 0.028$ greater than the mean for the orange males. This difference is 4.23 times as great as its standard error and seems, therefore, to be a significant difference. On this basis we would conclude that the black males are diploid for costal length. Their wings are significantly longer than those of their haploid brothers and hence show paternal influence.

The mean for the black males is $0.215 \pm 0.03$ less than the mean for the black females—a difference which is 6.34 times as great as its standard error. This, therefore, is an even more significant difference. It may be explained on the basis of sex. There may be a partial reversal of dominance in the case of the diploid male. Or, there may be more than one factor involved in determining the wing length of the female and the male may still be haploid for one or more of the factors involved.

## WHAT IS THE X-RAY MUTATION "CREAM"?

By C. H. Bostian
*University of Pittsburgh*

The mutation "cream" eye-color arose from an orange female, treated with X-ray on March 1, 1928. This female produced six sons, five showing the expected eye-color, orange, and the sixth having eyes ivory in appearance.

Ivory arose from the orange stock originally and hence it was supposed that the mutant might be caused by a second mutation from orange to ivory. To see whether or not cream was the same as ivory, as it appeared to be, the mutant was mated with females of ivory stock. He produced not ivory daughters as expected, but orange. When mated to these daughters, he produced both orange and cream daughters in approximately equal numbers.

These results can be explained on the supposition that the original mutant was not ivory but a second recessive, cream, resembling ivory but caused by a change in a different locus.

When cream males were crossed with black stock females, the black daughters, isolated as virgins, produced four types of males: black, dark orange, light orange, and cream. The orange can easily be distinguished as dark or light. These facts are consistent with the idea that cream is in an independent locus, but ratios are not orthodox, differing widely and indicating further complications.

On the basis of two factors, cream would be a double recessive co, black would be CO, dark orange Co, and light orange cO. An ivory male would have the formula $Co^i$, and $co^i$.

Thirty-nine orange females, produced by crossing ivory stock to cream and ivory stock to orange grandsons of cream males, were bred out, nineteen as virgins and twenty which had mated with brothers. A total number of 837 orange sons and 861 cream sons were given. These numbers indicate a 1:1 ratio, but the fraternities grouped themselves into three main classes, representing ratios of one orange to three cream, one orange to one cream, and all orange. In addition to the main classes there were several classes departing from the normal ratios expected on



the assumption of two factors being involved. For example, two fraternities composed of sixty individuals had three orange to one cream, a ratio not at all in harmony with a two factor relationship.

These departures from the normal, though not being composed of large enough numbers in the data thus far gathered to be of great importance, are not the only stumbling blocks in the way of a simple two-factor relationship.

It has already been brought out that cream males mated to black stock females give in the $F_2$ four kinds of males: black, dark orange, light orange, and cream. If the cream was due to a simple two-factor arrangement and other kinds of males were of the formulae suggested, these males would be expected to fall in a ratio of equal numbers, assuming the absence of linkage. From over sixty black females heterozygous for cream, a very few of the ratios were 1:1:1:1, but most of them were quite variable, and often the number of cream was equal to the sum of all the other three types.

In some cases where black stock females were mated to cream males, only black and cream sons were given in the $F_2$. In such cases the cream must have been of the same composition as the ivory. In cases where cream and ivory occur in the same fraternity, they are indistinguishable but can be differentiated by breeding from them.

It already has been mentioned that orange can be derived from a cross of cream and ivory. It was then interesting to see what a cross of orange by orange would throw. Of twenty-six crosses of dark orange females to dark orange males, nineteen gave all orange females, as expected. Two gave orange and cream females in about equal numbers. Of the other two, one cross gave six black, six orange, and three cream females, and the other, two black and four orange.

The orange which when crossed gave only orange must have been homozygous, or very nearly so. Those giving black and cream, in addition to the expected orange, must have been heterozygous.

Crosses of dark orange females with light orange males give a much larger percentage of black females. Thirteen such crosses were made, using females of the same fraternities as those mated to the dark orange males. Only one of the later crosses gave all orange females; six gave all black; one black and orange; one orange and cream; and four black, orange, and cream.

From these results it is seen that the cross of dark orange females to light orange males produces black females about five times as often as when a dark orange male is used.

Five of the reconstituted black females, isolated as virgins, gave sons of the four types, in different ratios. Since they were from different crosses they would not be expected to give like ratios.

Five crosses of dark orange females to cream males have given two fraternities including black females. This result is hardly in accord with a two-factor relationship. In these two cases the cream males might have been so exceedingly light orange that they could not have been distinguished from cream. If such was the case, the two-factor arrangement might fit this particular bit of data.

In order to study further the difference between dark and light orange males, crosses were made with them and black stock. All the $F_1$ daughters were black as expected. Eighteen of these daughters whose fathers were dark orange, gave only black and orange sons, except in one case, where four creams were produced in a fraternity with twenty orange and seven black sons. The daughters of light orange males gave different kinds of progeny, however. Seven produced all four types of sons. Two others gave such small numbers that it cannot be said that they would not have given cream sons also.

Two facts give evidence that light orange is different from dark orange. Black daughters with dark orange mothers are more frequently produced by light orange than by dark orange fathers. Cream appears in $F_2$ from black stock females more frequently when these are crossed with light orange than dark orange.

Exactly what this difference is, and precisely what the mode of inheritance of cream is, remains a question until further analysis is made. Perhaps the behavior of this sport will be found due to variable genes, non-disjunction, tetraploidy, a two-factor relationship with linkage, or a combination of several of these. At present, we are still asking ourselves, "What is the X-ray mutation cream?"

## RATIOS OF DIPLOID MALES IN HABROBRACON

By D. R. Charles

*University of Pittsburgh*

The tendency of Habrobracon to produce diploid males is evidently hereditary, as shown by two lines of evidence.

In the first place, inter-stock crosses throw ratios of these males definite and constant for any pair of stocks used. In general, the more closely related the stocks, the higher the ratio of diploid males. This ratio is expressed as the per cent of diploid males among total diploids, both male and female. For example, A. R. Whiting has shown that, in crossing one stock to each of four others, the most closely related gave a significant ratio of diploid males of 11 per cent; two, less closely related, of 7 per cent, and the most distant stock, of only 3 per cent.



The second line of evidence is that diploid males frequently turn up in pairs, or sometimes larger groups, as though due to a recombination of recessive factors in their parents. In breeding some two thousand wasps for the problem here discussed, a significant figure of 26 per cent of all crosses producing diploid males was found as the incidence of more than one such male in the same fraternity.

This hereditary tendency seems to work through the gametes of both sexes. As shown above, females of one stock can be crossed to males of different stocks, with ratios of diploid males in the progeny depending upon the relationship between the parent stocks. Since the only variable here is the residual heredity of the fathers, they must vary in their ability to produce diploid males. Conversely, males of one stock can be crossed to females of a number of other stocks, with analogous results. So this points to the fact that eggs produced by females of different stocks vary in their tendency to produce diploid males, as do the sperm of the males.

An attempt was made, by X-raying females of two stocks recessive for reduced wings and orange or ivory eyes, to alter the normal ratio of diploid males among their offspring. The females were mated after treatment to males of a stock dominant for long wings and black eyes. So the diploid male offspring, with eyes and wings like their fathers', could easily be distinguished from their haploid brothers with the maternal characters.

To establish the normal ratio of diploid males produced by these crosses, identical matings were made, except that the females had not been exposed to the action of X-rays.

Three hundred and ninety-five females were irradiated in four groups: one at 35 KV and 8 ma; two at 50 KV and 8 ma, and one at 76 KV and 8 ma. The time of exposure varied from five minutes to ten hours. Under the longer exposures at 35 KV and any treatment at 50 and 76, females go completely sterile after producing few, if any, offspring. As a result the entire group of 395 treated females produced only 1,063 progeny, while 97 control females produced 1,096.

Such wide range of dosage was used to find one at which the treated females produced the smallest fraternities, which would still be of value. It is at an analogous dosage that Muller finds the greatest number of mutations in Drosophila. Since some factor in the egg is responsible in part for the production of diploid males, it was thought that this dosage, producing the maximum germinal instability, would be the most favorable for altering the normal ratio.

From counts of the offspring of these treated females, the ratio of male diploids for each of the four treated groups was calculated, as was that of the fraternities from untreated females, raised at the same time. In no group was any statistically significant difference found between the ratios of diploid males produced by treated and untreated females.

In all four groups considered together, the ratio of diploid males was $5.66 \pm 1.06$ per cent. The progeny control females showed a ratio of $3.84 \pm .86$ per cent. The difference between these is $1.82 \pm 1.37$ per cent, which is not statistically significant.

The ratio of females to total offspring in the progeny of the rayed and unrayed groups likewise show no statistically significant difference. A. R. Whiting has shown this ratio to be negatively correlated with ratio of diploid males.

So from these two sources it may be concluded that, within the limits of the dosage used, X-raying females of the two stocks involved has no significant effect in changing the ratio of diploid males among their off-spring. This is probably applicable to all similar crosses that might be made in Habrobracon.

## ERRORS IN TEXT-BOOKS IN BIOLOGY AND ZOOLOGY USED IN HIGH SCHOOLS AND COLLEGES IN PENNSYLVANIA

By H. A. Surface
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(Paper not submitted)



## SOIL FERTILITY PROBLEMS INVOLVED IN THE DEVELOPMENT AND MAINTENANCE OF FAIRWAYS AND PUTTING GREENS

By J. W. White
*State College*

The modern greenskeeper in his desire to fulfill the exacting demands of his club with respect to weed-free fairways and putting greens, is following a system of soil management entirely contrary to the fundamental principles of soil science. Little does he realize that his soil is a living thing, abounding in countless numbers of micro-organisms of both the flora and fauna kingdom. He does not understand, therefore, that a fertile soil is one so managed that a close symbiotic relationship exists between the soil population and that of the higher plants. Science has told him that bent grasses will thrive on a soil too acid for the growth of most weeds and that frequent applications of an acid-forming fertilizer such as sulphate of ammonia will create and maintain the acid reaction desired. He has been told further to use sparingly fertilizers containing phosphorus and potassium for they encourage the invasion of weeds and under no circumstances should he use any form of lime for fear of reducing soil acidity. Lime, he is told, is good for weeds, but little value to grasses. His inherent tendency is not only to fulfill these recommendations but to carry them to extremes. The practical greenskeeper knows that mercury compounds are effective in combating fungus diseases and discouraging earthworm pests, for the pathologist and the entomologist have told him so and he has found it true. He can not understand, however, why in certain cases his putting green fails to respond to an application of mercury.

The soil scientist has not told him that through the excessive use of sulphate of ammonia and fungicides he has produced a sterile soil or one toxic to the roots of his bent grasses; that an application of lime in moderation would restore the grass when the trouble is due to excessive acidity.

At a recent greenskeepers' short course held at Penn State the fundamental principles involved in the production of grasses were discussed in detail. It was emphasized that lime is essential for the best development of Kentucky blue grass fairways along with nitrogen and phosphorus; that the most feasible way to discourage weeds is to treat the soil so as to produce a dense vigorous sod and thus leave no room for weed invasion. The greenskeepers were told that the excessive use of nitrogen on the acid greens produced a grass physiologically weak—susceptible to fungus diseases. They were told of actual cases where lime had restored the grass to normal growth after mercury had failed. They were shown many charts which told that limestone had increased the growth of Kentucky blue grass over 100 per cent and had reduced the weeds 43 per cent. The keen interest shown by the greenskeepers during the short course, together with the large number of letters later received urging a more extensive course next year, serve to emphasize the desire for more knowledge concerning the fundamental principles of soil fertility.

## THE SO-CALLED DEPTH OF SLEEP

By H. M. Johnson and G. E. Weigand

*Mellon Institute of Industrial Research, University of Pittsburgh*

The earliest of modern experimental work published on the depth of sleep was that of Kohlschütter, who in 1862 described an ideal curve of sleep. This has been almost universally accepted as a representation of the way in which an individual takes his sleep.

The wide-spread acceptance of this curve may be shown by the fact that it is to be found in almost all text-books of physiology and psychology which deal with the question of sleep, and also by the fact that some theorists have said that in as much as the curve shows the major portion of sleep occurs in the first two hours of the stay in bed, it might be a saving of time to take one's sleep in short naps of about two hours' duration.

The method employed by Kohlschütter, and most of the other investigators, was that of sensory stimulation to the point of awakening. In this particular case auditory stimulation was used. That is, the subject was awakened by means of a sound, the intensity of which was measured. He argued that the more work a sound had to do on a subject in order to produce a constant effect, the more deeply asleep the subject was. He then plotted the intensities of the liminal sounds against the times of the night at which they were determined, and relabeled his ordinates "depth of sleep."

That this curve is a statistical artifact may be brought out by a consideration of Kohlschütter's unselected data. This does not show the descending limb of the curve to be the simple logarithmic one as represented by the classical curve, but has several maxima, spaced so as to suggest a rhythmic fluctuation of irritability. So it might seem that the principle of selection may have been operating quite markedly in this



case. As Dr. Swan, of the Simmons Fellowship, points out in an article to appear shortly in the *Psychological Bulletin*, Kohlschütter rejected about 45 per cent of his original data—all too meager to begin with—since it consisted of only 74 measurements made on one sleeper during eight nights.

The chief reason set forth for the rejection of the measurements is that the subject had recently stirred so that the measurement was made shortly after a secondary increase in the depth of sleep. In some cases he regarded a stir made thirty minutes before the reading as being too recent. In the case of the most typical member of a group of subjects studied by the present writers, over two-thirds of the total time spent in bed was characterized by stirring more often than once in thirty minutes.

Mönninghoff and Piesbergen, using practically the same method as that of Kohlschütter, reported that a curve fitting their data was of the form of a Roman M. That is—the intensity of the stimulus required to awaken a subject has two maxima, one early and one late in the night separated by a minimum. The second maximum, although high, was not as high as the first.

Michelson, still using the method of measuring the intensity of the sound stimulus required to awaken a subject, reported evidences of a fluctuation in the so-called depth of sleep. If his curves were inverted by assigning negative signs to the ordinates so that they expressed the degree of wakefulness, rather than the depth of sleep, it would resemble some of our own in its major characteristics.

Neyroz and de Sanctis, using a method of tactile stimulation that caused awakening, found evidences of marked fluctuations. They decided that their results were a matter of faulty technique rather than variations in the irritability of the subject.

Howell measured the changes in the volume of the arm and found that, after an initial increase in volume, rhythmic variations occurred. His results, however, cannot be given too great a consideration as they were obtained on only one subject during about four hours of one night.

The present writers have, for the past three years, been employing another method for the investigation of the course of sleep, which is that of automatically registering the major movements made by a subject during the entire time spent in bed. This method has the decided advantage over that of stimulating a subject in that it does not interrupt the normal course of sleep.

Our subjects do not distribute their movements in a manner which corresponds with the heightened degree of irritability for given periods of the night that other investigators have shown.

All of the experimenters that have been mentioned report an increased intensity of the stimulus required to awaken a subject within the first hour to an hour and a half after retiring, which they say indicates that the depth of sleep is greatest at this period. In this particular consideration our observations correspond with those of the older writers. We find our subjects tending to become more and more quiet during the first hour after retiring until they reach a minimum of activity. If we cared to reason as others have, we might say that the lower the curve is at any point, the greater the quietude at that point and that our curve represents the temporal course of the depth of sleep.

After this initial decrease of motility, our findings differ considerably from those reported by others. In all of the work previously mentioned, the results show a tendency toward more shallow sleep. Or, to put it differently, after the initial increase in the intensity of the stimulus required to awaken a subject, subsequent awakenings are accomplished by smaller stimuli.

A consideration of Kohlschütter's curve will show this point even more clearly. The peak of the curve occurring one hour after retiring corresponds to a strong stimulus. One hour later, or two hours after retiring, the awakening is accomplished by a stimulus approximately one-eighth as great, and so on throughout the night. This is also evident in the representation of his complete data. The same observation holds for the other investigators.

Our results do not support this contention. It seems that after the initial minimum of motility is reached, the tendency of the curve may be in any one of three possible directions—that is, if we may consider the straight line best fitting our results and not the rhythmic variations which we shall speak of later. The curve may tend toward increased motility as the night progresses after the initial decrease, it may tend toward decreased motility, or it may tend to remain at about the same average level throughout the night.

In addition to these various types, we have found in a few of our subjects a tendency to delay the initial minimum of motility until the second or third hour after retiring, after which it is toward increased frequency. It might be mentioned that this type of curve has been noted most frequently in individuals of a psychopathic or highly nervous disposition. There is one other type of curve we have found on one subject, an insane patient who showed minimums of activity at the beginning and the end of the night, with a maximum occurring in the middle.

A common feature of all of our curves is a pronounced rhythm, which cannot be disregarded. This activity pattern is fairly characteristic of



the individual, being little affected, relatively by experimental variables which may alter the mean level of the curve by as much as twenty-five per cent. Kohlschütter apparently observed the rhythmic nature of his findings when all data were included, but felt the necessity of explaining it. Lacking a logical explanation, he arbitrarily disregarded it. Later experimenters followed his example, and sought other explanations for the fluctuations in their results.

It seems in the light of this evidence that, regardless of the method employed, there is a rhythmic variation in the manner in which an individual spends his time in sleep. Thus, this variation found in the reactivity of the subject towards stimulation during the course of the night, is comparable to the rhythm demonstrated in his tendencies toward motility. Of these two experimental methods, one depends upon external stimulation, the other is relatively free from it. Yet both result in a characteristic rhythm. Hence, these rhythms would not seem to occur as a result of outside stimulations, but apparently are brought about by changes which take place within the organism.

Many interesting problems are suggested in the attempt to explain the causes of the fluctuations. The effects of digestive disturbances—bodily temperatures—cramping of the muscles, and so on, have all been advanced as probable factors contributing to these rhythms. These are interesting speculations, whose confirmation must depend upon further experimentation.

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## FURTHER NOTES ON THE PLANT GEOGRAPHY OF WESTERN PENNSYLVANIA

By O. E. Jennings
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(Abstract)

Apparently the limits of range of some of the plants in Western Pennsylvania are due to differences in soils, such as is the case with the pitch pine (*Pinus rigida*) and the scrub pine (*Pinus virginiana*), whose northwestern limit in Pennsylvania seems to be the southern edge of the glaciated region. Sometimes climate seems to be the limiting factor, as, perhaps, is the case with the papaw (*Asimina triloba*), which ranges up to the Conemaugh River valley from the south with there an east-west line as its frontier, but swings into the State again in a narrow zone along the immediate shore of Lake Erie and passes through into New York State. Another tree probably limited by climatic conditions is the white pine, absent from a curved indentation into the middle of the western part of the State and probably correlated with a scantier rainfall during the hotter part of the year.

Historical (geological) reasons best apply to the distribution of the tamarack (*Larix laricina*), canoe birch (*Betula papyrifera*), cassandra (*Chamaedaphne calyculata*), and many other northern plants left stranded in swamps and other cool isolated stations with the warming up of the climate after the close of the Glacial Period. The same reasons apply, from the other direction, to plants which, like the white oak (*Quercus alba*) are probably still advancing northwards following the Glacial Period, and which, in this case, have not yet ascended the higher domed area of most of McKean and western Potter counties.

Sometimes geographical barriers determine the limits of range, as seems to be the case with the sweet buckeye (*Aesculus octandra*) which occurs commonly along the western and southern banks of the Ohio River in its course northwesterly from Pittsburgh. This tree ranges into Western Pennsylvania from Ohio and West Virginia, but is limited to the west side of the Monongahela and the Ohio in Pennsylvania. Apparently this wide river-barrier is an effective one here for the buckeye.



## *HOMALOCENCHRUS VIRGINICUS* A SENSITIVE GRASS

By O. E. Jennings

The white grass or white grama (*Homalocenchrus virginicus*) was discovered by Mrs. O. E. Jennings last year to be quickly sensitive to plucking. Further observation shows that it always exhibits certain leaf movements following the breaking or cutting of the stem.

The grass is a native of moist shaded places and usually has the rather short wide leaves spreading from the stem at a rather wide angle. When the plant is plucked, by breaking or cutting off the stem, the leaf-blades in a fraction of a minute bend towards the stem, then the blades fold together upwards, hinging along the middle, much as an open book might be closed. This latter movement is finally followed by a twisting of the folded leaves spirally. Sometimes the leaves are fairly tightly twisted within about a minute from time of plucking.

No explanation is yet offered as to the reason for such movements, but it is tentatively suggested that it may be due to changes in the sap pressure within the stem when it is cut or broken.

## A SURVEY OF THE FOREST SOILS OF THE MONT ALTO STATE FORESTS

By J. T. Auten
*State Forest School, Mt. Alto*

This study was begun about five years ago under the direction of the Soils Department of Iowa State College for a Ph.D. thesis. It includes a soil survey and map of 23,000 acres of forest, and studies in texture, hygroscopic moisture, ash, nitrogen, phosphorus, acidity, chemical invoice of fertility added and removed by chestnut oak, analyses of run-off water, studies of capillary moisture, etc. Bacterial, fungi, and actinomyces counts were made during a growing season and fertilizer tests were made during a three-year period on conifers in nursery soil.

Paper is to be published elsewhere.

# EDUCATION AND THE RADIO

By Robert T. Hance
*University of Pittsburgh*

The dream of the university has been achieved. Registrations of ten, twenty, thirty thousands of students, acres of campus, classrooms in awesome architectural array are no longer particularly impressive. The world has become the campus, every home is located on it and by virtue of its location has become the classroom. No restrictions or prerequisites guard the sanctitity of the subject material, attendance is not checked, no examinations held and no fees or tuition charged. The class members admit themselves, section themselves on the basis of ability to understand and enjoy and seldom report that they have been among those present. Indeed with a little stretch of the imagination we might say that this ultra-modern set of students has gone back to the pedagogical ideal of Mark Hopkins on one end of the log with the learners on the other. Here the log has been transformed into a radio wave with Mark's end at the microphone and the other end is every radio receiver whose dials are tuned to Mark's wave length. And when all is said and done the output of any instructor that is not tuned within his class's receiving range is wasting his substance upon the desert air whether this air be circulated by efficient ventilators through walled classrooms or whether it undulates through space.

The University of Pittsburgh Radio Studio of KDKA has now had five years of experience and its programs are being received regularly in most of the States of the Union and with interesting frequency in many parts of Europe, Northern Canada, Australia and the Malay States. In the case of the last named point one of my own talks that went out at 7 P. M. Pittsburgh time was picked up at 7 A. M. by the local radio enthusiast. Candor raises the question whether the talk was the happiest possible introduction to a new day. An eye-opener it was intended to be but hardly a curtain raiser. Obviously education by radio presents its problems.

The audience that is willing to leave the dials alone when an informational talk is on is an interesting one, to judge from the letters that come in. Its members range all the way from the highly cultured to more or less intellectual cranks. I have recently carried on a correspondence with one member of my radio class, of whom I had certain suspicions in the beginning, and who ultimately turned out to be excellent material for a Freudian psychologist. One may be quite certain that a fair section of



one's radio class is made up of one's professional colleagues who thus have a marvelous opportunity to check the technique of the lecturer. The speaker needs but little imagination to see his far-flung and varied audience stretched out before the microphone and in time it becomes almost as much of a spur as does a real audience.

The varied types that we know are listening in forces a revaluation of subject matter that is, I think, very healthy for every one concerned. At present there can be but little question that, at least as far as science is concerned, the talks must be very largely suggestive and inspirational rather than complete in detail. This if really successful will achieve the real goal of education, namely, the desire to dig out the facts for oneself. Training that aims at anything else is largely a waste of time anyway; so perhaps what we are inclined to regard as radio necessities may have a pretty fair pedagogical excuse. Other subject material may be handled much as it is in the classroom and may be attended with great success. I have in the past heard courses in languages sent out by one of the departments of the Universities of New York City that impressed me as admirable. The vivacity of the instructor made him seem to be just behind the loud speaker—a truly great feat of teaching, considering the hopelessness of any mature individual getting excited over what to him can be but little better than baby talk.

Obviously, since a tuned out educational talk is wasted, the talk must be sufficiently fascinating to hold the listeners. It cannot be too long, it must be couched in understandable language, it must be told in more or less story style and must be related to things already known by the listeners. To put over without the use of a blackboard any conception of such things as the laws of heredity, or of the growth of an embryo from the fertilized egg is a problem to intrigue any teacher. Yet I think it can be done with fair success and the results are of considerable use to the radio lecturer when facing his more tangible audience.

Indeed the organization of a series of radio talks on the principles of biology has caused me to change the sequence of events in our general course in Zoology. In our class rooms we are usually not much concerned with catching the interest of our students. They cannot get away. But if we bow to the psychology of a radio class why not accord the same courtesy to our freshmen. In the instance under discussion it has seemed to work. To begin with why brunette parents may legitimately have blonde children is far more exciting than to begin with the classic but invisible amoeba.

The last thing that the radio does for the speaker is to teach him that time, like the brook, may flow on but, unlike it, not forever. If he has fourteen minutes at his disposal it isn't fifteen, much less thirty minutes. When the Sure Catastrophe Washers are lurking in the offing the professor either finishes on the second or his dissertation on longevity is apt to fade into the introductory wise crack of the next feature—"It is unnecessary to kill your wife. Catastrophe Washers will do the dirty work." One frequently longs for a similar mechanism to fade out the Marathon speakers of the scientific meetings.

When I first heard of radio talks by university instructors I was quite skeptical. I listened in and was soon convinced of the marvelously scholarly job that was being accomplished. The fourteen minute talks were packed with material and yet were fascinatingly told. This was indeed carrying education to the public, for in all likelihood the university has an audience of from 100,000 to 150,000. Every department is represented and the subjects presented range from clothing to philosophy, from folk songs and their meaning to the whys and wherefors of the living machine. These talks are published by the University of Pittsburgh and sold at cost. Forty-seven volumes have been brought out to date, the breadth of which is indicated by the following titles:

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|---|---|
| Some High Light in Modern Physics | The Contemporary Novel |
| Conversations with a Philosopher | The Machines We Are |
| The Framework of the World | Man and the Earth |
| The Story of Our Courts | Criminology |

The Rôle of Chemistry in Everyday Life

Do people listen to these talks? Make a mistake in a talk and see how quickly it is picked up. Is the audience appreciative? I know of no better evidence than the letter from the guardian of a war-blinded soldier. He writes that the boy is going through college and that "we find the publications very helpful and your work over the radio is simply indispensable." Such a vision is compensation many times over for the ten to twenty hours of labor that each fourteen-minute talk requires. Those of us who have obtained our education rather easily and have accepted it as our birthright seldom fully realize the desire for it of those who do not have it. For this group the future is happily illumined with education by radio.



# SURVEY OF ALGAE IN PONDS ON PRESQUE ISLE, ERIE, PA.—SUMMER, 1928

By Richard V. Morrissey, B.S.
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## Introduction

This paper is presented with the view of showing the kinds of genera of algae which may be found in the various ponds and pools on Presque Isle. These ponds are of different ages, some just breaking away from the edge of the lake shore, others being much farther advanced, some having developed to a stage where the area is merely a wet meadow. With one exception all the material was collected on August 4, 1928.

I wish to acknowledge the aid of Drs. O. E. Jennings and J. L. Cartledge in this undertaking.

A brief description follows with a list of genera identified in each pond. The map shows a sector of the new and more recent end of Presque Isle.

## Beach Pond

This pool is just inside the shore edge, and during rough weather it has been filled from the lake. At one point it is not over twelve yards from the lake edge. This pool is about 100 yards long and twenty yards across in the widest place, tapering at the ends. Around the edge of the pool for about four feet the water was shallow and then dropped rather steeply to a depth of eight to ten feet. The algae could be found on old logs in the pool. Chara in fruit could be seen on the edge nearest the fog horn; *i.e.*, the northern end.

Identifications: Several types of Diatoms, *Scenedesmus* sp., Desmid, *Chara* sp., *Merismopedium tenuissimum*.

## Pond 1

This pond is in a very early stage of separation from the lake. A rather wide inlet is still open into the pond from the open lake. Around the edge of the pond is the beginning of the cottonwood (*Populus deltoides* and *P. heterophylla*) preceded on the sand by one of the species of Oenothera and *Melilotus alba*. The algae in this pond cling to the roots of the young poplar seedlings where the water is quiet. There are small beds or meadows of Chara on the bottom of the pond.

Identifications: *Oedogonium cardiacum*, *Spirogyra* sp.

POND 2

This pond is a little farther advanced, being a longer pond with a narrower inlet. It was probably formed earlier than the preceding one, although the water was flowing more swiftly. Chara dominates the floor of this pond as well as Pond 1.

Identifications: *Oedogonium cardiacum,* several types of Diatoms.

POND 3

An open arm extended into the bay from this pond which evidently started as three small ponds and then emerged into one larger pond making a rather wide opening into the bay side of the lake. Beds of Chara prevailed although some Myriophyllum was coming in and overshadowing the algae.

Identifications: *Volvox* sp., three types of Diatoms, Desmids, *Ophiocytium parvulum.*

POND 4

This pond begins to show a very definite stage in the evolution of the ageing ponds just described. It is distinctly older, and the pond line vegetation is more advanced. The narrow-leaved cat-tail *Typha angustifolia* is dominant along the edge for a width of about five feet. Many sedges and rushes also are present. Both of these associations indicate that the pond is considerably older than the three ponds mentioned above. But rather interesting is the fact that Chara still holds sway with but very little, if any, evidence of Spirogyra. This pond is filling in from the outside rind, and it is not quite certain whether *Pontederia cordata* will form the next succession, or whether it will turn into a typical wet meadow zone. This pond might be considered a sub-climax for these five ponds in order of advancement.

Identifications: *Coleochaete irregularis, Chroococcus cohaerens,* several types of Diatoms.

POND 4a

This pond is rather large and somewhat boot-shaped, inverted, with the neck open into the lake. The water flows in a current into the pond, where it is quite deep, and extends around the crook or foot of the boot to a cat-tail marsh. In this pond these algae were found: *Oedogonium cardiacum, Spirogyra* sp., two types of Diatoms, *Merismopedium glaucum, Micrasterias laticeps, Chroococcus cohaerens.*

POND 4b

This rather symmetrical pond is probably the smallest of the group of ponds extending from the tip of the peninsula to the fog horn in a southeast-northwest line. It is one of the older ponds probably cut off a number of years ago from Pond 4a. The surrounding vegetation seems to indicate it to be approximately the same age as Pond 4a. Since it is inland and completely shut off from the lake it might advance to a climax stage, when the pond completely disappears, leaving either wet meadow zone or swamp-like vegetation. At present the *Typha angustifolia,* narrow-leaved cat-tail is dominant along the rim of the pond, and extends toward the center. A large mass of duck-weed is found floating on the surface.



Identification: *Ulothrix flacca,* three types of Diatoms.

POND 5

Pond 5 is entirely surrounded by land and has been cut off from Pond 4a years ago. This is one of the larger ponds on the newly formed end of Presque Isle and may be over one hundred years old. It is oval and about 70 yards long and 50 yards wide. On one side of the pond is a Juncus zone, and on the other side a wet meadow zone. There are no cat-tails in this pond, and it is deep in the middle. Algae found here are: *Spirogyra* sp., *Gloeocapsa arenaria, Staurastrum dilatum.*

POND 5a

This pond has been cut off from Pond 5. It contains a large mass of dominant cat-tails. Some very good conjugating Spirogyra could be seen in this pond and several types of Diatoms.

POND 5b

This pond is almost closed off from Pond 5, and shows the cat-tail Typha and Juncus formations. On the border of this pond is a reddish slime looking like ore dust that has settled on the sandy bottom, although it might be large masses of spores that give this orange tinge.

Identifications: *Spirogyra* sp., *Oscillatoria tenuis, Gloeocapsa arenaria,* several types of Diatoms.

A second series of ponds which are, on the whole, more advanced in age than the preceding series will be considered.

POND C

This pond is long and narrow, extending more or less parallel to the shore-line. The banks are covered by the wet meadow zone and sedges. Algae recognized: *Cladosphora* sp., two types of Diatoms, *Spirogyra* sp., *Chlamydomonas gracilis, Tetraedron tetragonum, Chara* sp.

### Pond O

This pond is very similar to C except smaller and narrower. The vegetation along the border is about the same, also. *Volvox* sp., two types of Diatoms were found.

### Pond D

This pond is very symmetrical, being about forty yards in diameter, and did not contain many algae. The algae here seem to have been disturbed so that only a mass of spore material could be seen. For the most part the pond was cut up with muskrat burrows in the cat-tail vegetation. Only spore masses on flaky green material could be identified.

### Pond E

This pond contained numerous pads of yellow water lilies in bloom, sedges along its borders and a rather typical wet meadow zone. Identifications: *Ulothrix* sp., *Cosmarium* sp., *Vaucheria geminata,* two types of Diatoms, *Staurastrum cocciunum.*

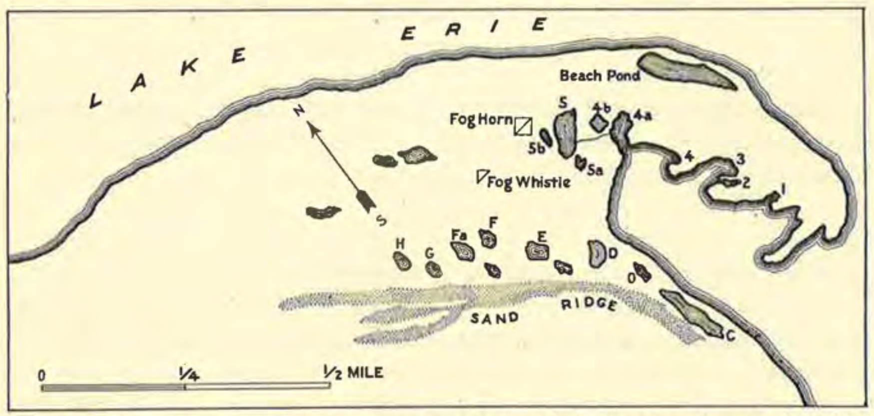


Fig. 1. Tip end of Presque Isle, Erie, Pa. (After O. E. Jennings' map of 1928.)

### Pond F

This pond was very similar to E, and no sample was taken of the algae in this pond.

### Pond Fa

This pond is also similar to the two preceding ponds; not much change in type of vegetation and a characteristic inland pond, containing *Chroococcus turgidus, Gloeocapsa arenaria, Ulothrix implexa.*



### Conclusion

There are several points of similarity between the age of the pond and the algae contained in it:

1. In the most recently formed ponds, Chara is a dominant form.
2. Seldom were any blue-green algae, Cyanophyceae, found in the youngest ponds.
3. Spirogyra seemed to be found in well developed, quiet water ponds.
4. Diatoms were the one form common in most ponds of all ages.
5. There appears to be no close correlation between the age of the pond and the form of algae to be expected there.

### Annotated List of Algae Classified in Order Under Each Class

Cyanophyceae:

1. *Chroococcus turgidus*
2. *C. cohaerens*
3. *Gloeocapsa arenaria*
4. *Merismopedium tenuissimum*
5. *M. glaucum*
6. *Oscillatoria tenuis*

Chlorophyceae:

1. Desmids
2. *Microsterias laticeps*
3. *Cosmarium* sp.
4. *Staurastrum dilatum*
5. *S. concinnum*
6. *Spirogyra* sp.
7. *Ophiocytium parvulum*
8. *Chlamydomonas gracilis*
9. *Volvox* sp.
10. *Tetraedon trigonum*
11. *Scenedesmus* sp.
12. *Ulothrix flacca*
13. *U. implexa*
14. *Oedogonium cardiacum*
15. *Coleochaete irregularis*
16. *Cladophora* sp.
17. *Vaucheria geminata*
18. Diatoms
19. *Chara* sp.

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# THE THEORY OF CRYSTAL ETCHING AND ITS SIGNIFICANCE IN THE CLASSIFICATION OF CRYSTALS

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It is well over a century since German scientists made their first attempts to elucidate the structural makeup of crystals by applying the etch method. The pioneer labors of Widmannstätten who first applied corrosives to the polished sections of meteorites, and the early works of such scientists as Daniel, Moh, Leydolt and Von Kobell upon some of the simpler alkali salts opened the way for a new and fascinating means of investigating the symmetry of crystals. This lead in crystal research was soon taken up and the method improved and extended by such mineralogists as Baumhauer, Becke, Tschermak, Beckenkamp and others whose contributions have long since been recognized as of particular significance in the development of this interesting means of testing crystal symmetry through partial dissolution of fundamental crystal planes. Very few English or American mineralogists have been attracted to this field of endeavor until the last decade or so, which marks the discovery and development of X-ray analysis of crystals. This new means of approach to the identity of atomic structures within a crystal has called up several interesting questions arising from conflicting data obtained in the study of certain crystalline substances. The etch method, which is considered by many a reliable means of determining crystal symmetry, has not in all cases shown perfect agreement with results obtained by X-ray and other methods; and in most cases these discordances have not been satisfactorily explained. It would seem, however, that future investigation, in its attempts to harmonize these conflicting results, will improve scientific methods of studying crystal structures and eventually arrive at the truth concerning the reliability of all methods used in testing the symmetry relationships among crystals.

In view of the very special nature of this kind of investigation and the inaccessibility of published material bearing upon it, the writer believes that a brief discussion of the results of some of his studies of etching phenomena and their relationship to the symmetry of crystals may prove helpful.

In attempting to form a definite concept of crystal solution the reader must keep in mind that the properties of crystals, whether they be thermal, physical or chemical, are directional and are controlled by interatomic forces characteristic of the structure. The scalar properties of crystals, such as specific gravity, are independent of direction and therefore are not confined to the crystal kingdom alone, but are characteristic of amorphous minerals as well. However, all other properties whether of continuous or discontinuous vectorial nature are characteristic of crystalline solids and all substances to be crystalline must possess them. The manner in which a crystalline substance cleaves, the manner in which it reacts to heat or light, the way in which it crystallizes from solution, or dissolves in some suitable solvent, is in every case characteristic of that particular substance—just as characteristic, in fact, as is its chemical constitution. These properties, then, become a means of identification because they are inseparably linked to the interatomic forces within the structure. The manner in which characteristic planes are developed when a substance is crystallizing from the gaseous or liquid state is of fundamental importance in its identity, but the characteristic way in which these crystal planes react to solvents in which they are immersed is certainly one of the very important properties of crystals and one which is actually the basis of the etch method.



In crystal etching those crystals are most desirable which are lustrous and generally free from surface irregularities. In most cases such crystals are small and not easily obtainable for all species, but one is not restricted wholly to their use, as perfect cleavage planes often prove more satisfactory than external crystal faces. But in either case it is quite necessary to avoid rough irregular surfaces, as these usually permit too rapid solution which results in a corroded face, due to intergrowth of etch pits.

In the etching process it is quite obvious that all faces of one crystal form, being of like constitution, should react in the same manner to any solvent used with the result that all etch figures in their mature stage of growth be alike in facial arrangement and orientation. However, when these figures are compared to those produced, by the same solvent, upon a face of a different crystal form, usually striking differences are observed, not only in facial arrangement but also in manner of orientation. If other planes of the crystal are examined it is noticed that further variation in form of etching occurs, each one of the seven fundamental forms, if all be present, possessing etch figures which are peculiar and characteristic to the atomic configuration of the face upon which they occur. For any given solvent the faces of different crystal forms yield etch pits which are constant for those planes, the shape and orientation of the etching in each case revealing the symmetry of the plane upon which it is developed. By a comparative study of the etch figures of several commoner faces occurring on a crystallized substance the complete symmetry of the structure may be deduced and the classification of the crystal effected. Photographs 1 and 2 demonstrate the variation of the etching with change of crystal form. The etch figures shown in these photographs represent those occurring, in the first case, on the prism (120) and in the second, on the base (001) of gem topaz when that mineral is brought into contact with a one to one fused mixture of potassium bisulphate-powdered fluorspar for a period of twenty to thirty minutes. That these faces on topaz are of unlike atomic configuration is evidenced in the dissimilar character of the etch figures. Not only do they reveal two different forms for topaz, but they clearly indicate the complete number of symmetry planes characteristic of the structure. Photo 1 shows etchings which are symmetrical to a horizontal plane, it being clear that opposite ends of the figures are mirror images of each other. However, Photo 2 reveals two symmetry planes at right angles, both of which are normal to the third or equatorial plane of symmetry mentioned in the first photograph, proving the presence of three planes of symmetry at right angles to one another which is characteristic for the holosymmetric class of the orthorhombic system of crystals in which topaz, upon other evidence, has been placed.

The crystal forms of calcite likewise show an interesting variation in the character of the etch figures, as may be seen in Photos 3, 4 and 5, which represent respectively the etched faces, rhombohedron (1011), scalenohedron (2131), and the unit first order prism (1010), as produced by citric acid. Those etchings occurring on the unit rhombohedron and the unit prism are plainly symmetrical to a vertical plane. The figures occurring on the scalenohedron, however, are fundamentally different from those of either the prism or the rhomb in being asymmetrical. It may be observed, also, that the etchings of two adjacent scalenohedral faces are so oriented as to be mirror images of one another. The conclusion to be derived from this condition is that a symmetry plane passes through the crystal edge formed by the intersection of these two planes, and if extended to cut the prism and the rhomb, the symmetry as above mentioned for the etchings of these forms conforms perfectly with the hexagonal symmetry relationships already established for calcite. The etch figures thus produced on three of the faces of hexagonal calcium carbonate show very clearly the individuality of the atomic arrangement of these forms and indicate their relative solubilities.

Now let us consider briefly the changes in the character of the etchings of any one crystal form with variation of the solvent. If the method



is reliable and etch figures are more than mere surface phenomena it is to be expected that the solvent action on any crystal plane will be constrained in accordance with the interatomic forces which control the chemical and physical properties of that plane. And furthermore it is not to be expected that the atoms constituting this plane should react in identically the same manner to all solvents regardless of their chemical constitution, concentration or temperature. Those acids which are chemically similar may be expected to produce results which are very often quite similar as regards the outline and orientation of the etchings produced; however, when two acids such as hydrochloric and citric are employed it would not be surprising to obtain two very different sets of etch figures, but both reflecting the same symmetry. After much experimental labor along this line the writer has reached the conclusion that chemical variation of the solvent employed is always attended by some variation, great or small, either in the shape of the etch figure or in its orientation, or both; but the symmetry of the same is an invariant. For the demonstration of this fact see Photos 6, 7 and 8.

Photo 6 represents the etched prism face (1120) of willemite after immersion in sodium hydroxide fusion for twenty-five seconds. If the same form of willemite be etched by immersion in a potassium hydroxide fusion, the figures appear as in Photo 7. When sulphuric acid is employed etchings which are distinctly different result (see Photo 8). Here a comparison may be made involving the etching phenomena produced on the same crystal form with three different solvents, and although a change in the character and shape of the figures is obvious, it is none the less noticeable that in every case the symmetry indication is the same. The etchings produced by the alkali fusions are, perhaps, somewhat alike, but the figure "a" of Photo 8 has very little in common with either those developed by the sodium fusion or the potassium fusion. In all three cases there is no figure apparent which is characterized by symmetry planes. The mineral willemite, according to diagnostic faces recorded, has been classified as hexagonal alternating revealing no symmetry of reflection within its structure. The etch figures by their asymmetric character conform to this classification. The composite symmetry (rotation and reflection) characteristic of the major axis is likewise demonstrated by the reciprocal positions of the etchings on any two adjacent prism faces.

This fact of symmetry invariance with change of solvent upon the same form is further illustrated in Photos 9 and 10. In this instance the mineral is calcite and the crystal form whose configuration is to be tested is the second order hexagonal prism (1120). The solvent employed in

Photo 9 was concentrated citric acid which produced distinct figures asymmetrical in character with the longer axis extending horizontally across the crystal face. Photo 10 represents the etchings produced by hydrochloric acid (on same form). The asymmetric outline is apparent in all figures, but they are certainly different in shape and orientation from those produced by citric acid. They also reveal crack beak development at the acute angle of the rhombic pits, a characteristic not observed when citric acid was employed (suggesting chemical control for these peculiar solution phenomena not uncommonly observed during etching experiments). From a theoretical consideration of calcite symmetry the plane (1120) possesses an atomic configuration which is without symmetry planes, a condition which is suggested by the etchings developed on this face by the two solvents above mentioned. It is not always necessary to change the chemical nature of the solvent in order to effect a change of figure; it may often be observed that on some forms the orientation of the etch figure is varied through concentration and temperature changes only of the solvent employed. The etching experiments of both Baumhauer and Daly have strikingly illustrated the rotation tendency on the part of etchings to adjust themselves to changes in concentration of the solvent. The above discussion leads to the conclusion that solubility is only a relative term, and directions which for one solvent may represent maximum solution, for another may mean minimum solubility. In either case solution takes place in harmony with the symmetry requirements exhibited by the substance.

There is one other factor to be considered in crystal etching, which, if not carefully looked to, may at times cause some difficulty in the symmetry interpretation. This concerns the evolutionary changes through which a figure may pass before reaching the mature stable form. The writer has rather frequently observed transitional changes in the growth of etch figures, and in some instances the results of incipient solution are manifest in peculiar etch forms not wholly consistent with the established symmetry. The cause of this condition is not always readily explainable, although it seems very probable that minor surface irregularities may effect a temporary distortion of the etch pit. Other irregularities are to be found in crystals which are intricately twinned; or they may arise through intergrowth of etch pits when solution has proceeded too far. Generally the investigator soon becomes familiar with these exceptional forms and learns to discriminate between those pits which reflect the true symmetry and those which are anomalous. Transitional changes[1] of etch

[1] Nature, origin and interpretation of etch figures of crystals: John Wiley & Sons, N. Y. (Honess), pp. 29–33.



figures may be readily observed if one immerses a suitable beryl crystal in a fusion of potassium hydroxide for only a few seconds. In the very first stages of solution shallow circular pits are formed which, compared to the mature etching, are exceedingly complex and represent cavities bounded by many small pyramidal faces. With continued solution, however, the circular outline becomes more and more angular as the process of facial replacement goes on, until the stability etching is reached. This final form is much increased in size and comparatively simple, being bounded by only six hexagonal pyramidal faces characteristic of the crystal class. In some cases the primitive figures possess the same outline as the mature forms, when the process of maturing is usually a broadening and deepening of the original pits. The dome face of barite reacts in this manner if allowed to lie for a period of twenty hours in cold sulphuric acid. A similar change may be witnessed in the basal etchings of apatite when a crystal of this substance is placed in such solvents as concentrated tartaric or dilute hydrochloric acid.

Photos 11 and 12 show very clearly the transitional changes which etch figures experience during the process of maturing. Photo 11 represents the unit first order prism (1010) of the gem aquamarine as etched by a fusion of potassium hydroxide. It is obvious that incipient solution is more pronounced parallel to the major axis of the crystal as the immature figures "a" and "b" possess very little depth but have a decided elongation parallel to the vertical crystallographical axis C. The planes of the prism zone (at the sides of the pits) so pronounced in the stability form "d" are evidently accentuated during the later stages of solution. Etchings "b" and "c" are clearly transitional forms intermediate between "a" and "d." The symmetry requirement for this plane is apparently met by the figures during all stages of growth; and that the atomic configuration of this crystal face is symmetrical to two planes at right angles is obvious when the facial arrangement of etching "d" is considered. This deduction is in agreement with the hexagonal symmetry established for this mineral.

Photo 12 shows the etching phenomena as produced upon the trigonal prism (1010) of the gem tourmaline by a fusion of potassium bisulphate and fluorspar. Figures in all stages of growth may be seen and, like beryl (aquamarine), solution is more rapid in the direction of the vertical axis. Maturing of the etchings consists largely in the development of the lateral facets which slightly increases the width and depth of the original forms. The figures marked "a" are the result of solution in the early stages; "b" is the final etch form. The unlike terminations of the mature etch figure are significant, as this development indicates the absence of a horizontal symmetry plane through the crystal face upon which these figures are produced. The symmetrical development of the figures right and left is also significant as it reflects a vertical symmetry plane through the crystal face. These facts portrayed by the etching phenomena are in full accord with the established symmetry for the Ditrigonal Polar class.

It is evident, then, that the shape of the etching is often dependent upon its age or the stage which it has reached in the process of maturing, and, that certain irregularities may arise in figure growth during some of the transitional changes which do not permit of ready explanation. That the final solution phenomena are diagnostic of symmetry conditions within the structure there seems little doubt.

That crystal etching may be effected by natural solutions is evidenced in the corroded and pitted character of many crystals when they are examined in their natural habitats. These etchings of natural origin are often of exceptional size and distinctness, suggesting a rather prolonged period of solution effected by weak solvents. The writer in his crystal studies has occasionally noticed most beautiful etching designs produced by natural solvents on such minerals as apophyllite, emerald, calcite, aragonite and others, some of which are shown in Photos 13 and 14. The remarkable etchings of Photo 13 were produced by natural waters acting upon the prism face of apophyllite collected in the trap quarries at Paterson, N. J. The symmetry as shown by these etch forms is clearly that of two planes at right angles which accords with experimental results obtained by hydrofluoric acid, all of which meet the symmetry conditions established for this species. Etching "a" represents a symmetrical intergrowth of two figures.

The beautiful hexagonal forms shown in Photo 14 are those produced by some natural solvent upon the basal face of a South American emerald. These etch pits are definitely limited by hexagonal pyramidal faces characteristically symmetrical to six planes of symmetry which accords with all experimental results obtained on this mineral. The nature of the solvent, then, seems not to affect the final result for artificial and natural etchings have, in practically all cases where definite conclusions could be reached, never failed to show the expected agreement.

Solution phenomena, therefore, are of primary importance when considering the symmetry content and classification of crystals. Other means of testing crystal symmetry are known, such as X-ray analysis, electrical excitation, and the testing of circular polarization and other optical phenomena, but the application of all of these is more or less restricted. The synthetic production of crystals has not been given the attention it deserves. The factors controlling the equilibrium of forms and the development of diagnostic faces have not been sufficiently tested to warrant the formation of set rules. However, chemical variation of the solutions to be crystallized is no doubt one of the important factors in the development of growth forms, and it would seem the field holds much promise and fascination. Natural solutions when crystallizing develop the most general crystal forms only exceptionally and incidentally these are most helpful in classification. On the other hand, these diagnostic planes are frequently observed during the process of dissolution; in fact, it is their presence in many cases which actually identifies the hemihedrism of the substance.



The etch method thus appears to be applicable to all kinds and classes of crystalline substances, and the readiness with which it may be employed in connection with the validity and magnitude of the results obtained, undoubtedly has been chiefly responsible for its development in crystal studies.

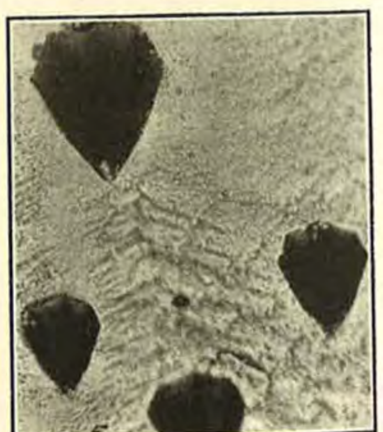
PLATE I

1 x300
Topaz (120), Etched by Potassium Bisulfate-Fluorspar Fusion

2 x300
Topaz (001), Etched by Potassium Bisulfate-Fluorspar Fusion

3 x30
Calcite (1011), Etched by Citric Acid

4 x180
Calcite (2131), Etched by Citric Acid



5 x300
Calcite (1010), Etched by Citric Acid

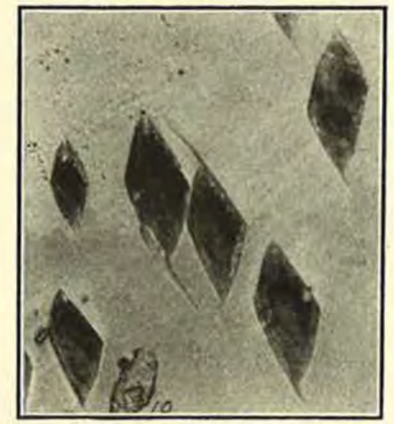
6 x300
Willemite (1120), Etched by Sodium

PLATE II

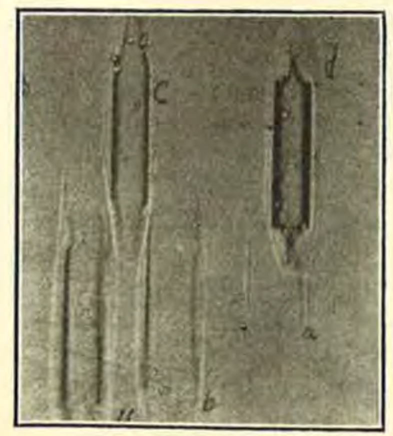
7 x300
Willemite (1120), Etched by Potassium Hydroxide Fusion

8 x300
Willemite (1120), Etched by Sulfuric Acid

9 x300
Calcite (1120), Etched by Concentrated Citric Acid



10 x300
Calcite (1120), Etched by Hydrochloric Acid



11

PLATE III


13 x180
Apophyllite (100), Etched by Natural Solution


14 x120
Beryl (0001), Etched by Natural Solution

PHOTOMICROGRAPHS OF ETCH FIGURES ON CRYSTALS



# SOME PENNSYLVANIA PIONEERS IN SCIENCE

BY A. H. ESPENSHADE

Pennsylvania has been the nursery of great Americans. To stimulate your interest and to arouse your pride in Pennsylvania, I am tempted to call the roll of some of the great men who were Pennsylvanians either by birth or by adoption. I feel fairly sure that most of the names in this impromptu and incomplete roll-call are familiar to you. I begin with four great Indians—Tammany, Tedyuscung, Shekillimy, and his son Logan. If you were military men, you would be interested in learning something about Samuel Brady, Thomas Mifflin, Arthur St. Clair, Anthony Wayne, Peter Gabriel Muhlenberg ("the fighting parson"), Stephen Decatur, John F. Reynolds, George G. Meade, George B. McClellan, and Winfield Scott Hancock. In a great industrial commonwealth we should have to mention such merchants and captains of industry as Stephen Girard, John Wanamaker, George Westinghouse, William Cramp, Charles M. Schwab, and Andrew Carnegie.

Then think of the long list of statesmen and public men: William Penn, Benjamin Franklin, John Dickinson, Conrad Weiser, George Clymer, Robert Morris, Simon Cameron, Andrew Gregg Curtin, James A. Beaver, Hugh H. Brackenridge, Jeremiah Black, Albert Gallatin, James Buchanan, George M. Dallas, Galusha A. Grow, David Wilmot, Alexander McClure, Jay Cooke, Edwin M. Stanton, Philander C. Knox, Thaddeus Stevens, and James Gillespie Blaine.

Though you may admit that a fairly good case could be made for Pennsylvania as a nursery for soldiers, industrial leaders, and public men, you are wondering what can be said of those who have won distinction in art, letters, and science. As for art, it is noteworthy that Benjamin West, Rembrandt Peale, and Edwin Abbey were all born in Pennsylvania; that John Sartain was transplanted from London to his new home in Philadelphia; and that Gilbert Stuart lived in Philadelphia for ten years or more. In literature the list is much longer and more imposing. Among our colonial worthies are Lindley Murray, Samuel Ramsay, the first historian of America, Charles Brockden Brown, the first American novelist, Thomas Paine, the mighty propagandist of the American Revolution, Francis Hopkinson and his son Joseph, author of "Hail Columbia," and Benjamin Franklin, printer and author. A few of the later writers were Bayard Taylor, Thomas Buchanan Read, Lloyd Mifflin, Stephen Collins Foster, S. Weir Mitchell, Owen Wister, Joseph Jefferson, Reginald Wright Kauffman, Zane Gray, and Agnes Repplier.

Who were the most notable Pennsylvania pioneers in science? What did they accomplish? I shall not try to make anything like a complete list, and I am concerned only with the pioneers, the early leaders in scientific study, experiment, research, exploration, and invention, who did their work and won their distinction well-nigh a hundred years or more ago. Here are the names of eleven Pennsylvania pioneers in science whose achievement and distinction ought to be known to us, who are their beneficiaries: John Bartram and Lewis David de Schweinitz, two great botanists; Alexander Wilson and John James Audubon, the ornithologists; Benjamin Franklin, physicist; Joseph Priestley and Thomas Cooper, the chemists; David Rittenhouse, mathematician and astronomer; Benjamin Rush, physician and surgeon; Robert Fulton, inventor; and Elisha Kent Kane, the arctic explorer. I can devote only about two minutes to the career and the achievement of each of these great men.

In fairness to these pioneers there is one fact that should be emphasized: with them the study of science was not a profession or calling or the main business of life. That bright day had not yet dawned when a young man could enter upon a scientific career as a definitely recognized vocation. Each of these men had his regular work and occupation by which he earned his livelihood. In those early days, scientific study and research was not a vocation, but rather an avocation, a pastime, a hobby, to which one devoted such leisure as he might spare from his regular occupation. Bartram and Audubon were farmers. Muhlenberg, de Schweinitz, and Priestley were ministers. Wilson was a schoolmaster. Rush and Kane were busy physicians. Cooper was a lawyer. Fulton was trained as a portrait painter. Rittenhouse was a clockmaker. Franklin was a printer and tradesman. All were regular workers in other fields than science.

It ought also to be added that most of them were public-spirited citizens, and that in a new and growing commonwealth, some of them had to play a very important part in civic and political affairs. Unlike our modern men of science, not one of them could give more than a fraction of his time and energy to his favorite scientific pursuits.

### John Bartram

John Bartram, who deserves to be called the father of American botany, was born near Philadelphia 230 years ago. When thirty-two years old he built with his own hands the beautiful house of cut stone known as the "Bartram homestead," which still stands at Kingsessing on the banks of the Schuylkill. John Bartram was a Quaker farmer with an



ordinary education. He became interested in plants and learned Latin in order that he might study Linnaeus's *Treatise on Botany.* "I began to botanize all over my farm," says Bartram. "In a little time I became acquainted with every vegetable that grew in my neighborhood, and next ventured into Maryland, living among the Friends." Ten years later he explored the wildernesses of New York and Canada, living among the Indians; and in 1751 he published in London the first book of travels written by a native American. His enthusiasm as a collector of rare and new specimens led him far afield into the wilds of North America. When nearly seventy years old, at great risk to health and life, John Bartram traveled thousands of miles in the wildernesses of Florida, Virginia, and the Carolinas. He kept up an active correspondence with all the great botanists of his day, sending thousands of specimens to Europe. Linnaeus called him "the greatest natural botanist in the world." Bartram's Garden, the first botanical garden in America, which was originally laid out around the Bartram homestead, now contains more rare trees and shrubs than any other spot in the world. It is owned by the City of Philadelphia and is under the care of the University of Pennsylvania.

John Bartram's son William, besides being almost as famous a botanist as his father, was also a student of bird life and Indian ethnology. He devoted much time and thought to the garden laid out by his father. He was the artist who drew the illustrations in Barton's "Elements of Botany." Many of the most beautiful plants of North America were first made known by his illustrations. As an ornithologist, he published the most complete list of American birds before the time of his friend, Alexander Wilson, whom he encouraged to take up the study of birds.

### Lewis David de Schweinitz

Among the scores of pioneer botanists in Pennsylvania the Moravian teacher and preacher, Lewis David de Schweinitz, deserves to rank second only to John Bartram. Born in Bethlehem, Pennsylvania, in 1780, educated in Germany, he became an enthusiastic student of botany in his boyhood and continued his studies until his death at the age of fifty-four. He traveled widely and was always a tireless field worker and collector. He was a great research worker, especially in the realm of mycology. He added more than 14,000 new species to American flora, 12,000 of which were fungi. Mycology had been very little studied before the time of de Schweinitz. He wrote extensively, publishing his studies and discoveries in Latin and in English. He was a member of various learned societies in England, Germany, and France. He was not only a botanist but a student of other sciences, and an educator of high standing. He refused the presidency of the University of North Carolina. His herbarium, which at the time of his death in 1834 was the largest private collection of plants in the United States, he bequeathed to the Academy of Natural Sciences in Philadelphia. It comprised 23,000 specimens of phanerogams and many thousand cryptogams. Many of these specimens had been obtained, by correspondence and exchange, from remote parts of the world. "They included the Baldwin Collection from Florida, Brazil, and La Plata, which de Schweinitz had bought and in which he had found three thousand species not before in his herbarium."

### Alexander Wilson

Alexander Wilson, the Scotch schoolmaster at Darby, has attained world-wide fame as the first great ornithologist in America. He had been a weaver and a peddler, and something of a poet and artist, before he migrated to Philadelphia in 1794 at the age of twenty-eight. Through his friendship with William Bartram he became interested in the study of birds. In 1804 he walked twelve hundred miles to Niagara and back, studying bird life, making drawings, painting pictures of birds, and jotting down notes. Four years later appeared the first volume of his great treatise on "American Ornithology." Henceforth he spent much of his time in quest of birds and of subscribers for his great work. During the nine years from 1804 to his untimely death in 1813 he traveled all over the eastern and middle parts of the United States, suffering hardships, poverty, even lack of food. He completed the plates and the text for nine volumes of his treatise, which was published by Bradford at a cost of $120. At the age of forty-seven, Wilson's career was cut short by death due to overwork and exposure. He literally gave up his life in the prosecution of his studies.

### John James Audubon

The scientific work of Alexander Wilson was carried on by his friend, John James Audubon, who first met Wilson at Louisville, Kentucky, in 1808. Audubon, who was born of French parents in New Orleans, in 1780, had been an assiduous student of bird life for more than ten years before he met Wilson. Though a citizen of the world, Audubon lived longer in Pennsylvania than anywhere else, spending ten years of his life on his Millgrove estate of 285 acres on the banks of Perkiomen Creek, given to him by his father. In the preface to his monumental work on



"The Birds of America," which was published at a cost of $1,000 for the four folio volumes of plates, Audubon gave the following account of his Millgrove estate: "In Pennsylvania, my father, in his desire of proving my friend through life, gave me what Americans call a beautiful plantation, refreshed during the summer heats by the waters of the Schuylkill River and traversed by a creek called the Perkioming. Its fine woodlands, its extensive fields, its hills crowned with evergreens, offered so many subjects to agreeable studies, with so little concern about the future as if the world had been made by me. My rambles invariably commenced at break of day; and to return wet with dew and bearing a feathered prize was, and ever will be, the highest enjoyment for which I have been fitted." Audubon's house on his Perkiomen estate became a veritable museum, filled with stuffed birds, festooned with strings of birds' eggs, and adorned with matchless drawings and paintings of birds, which were afterwards reproduced in his books. As soon as the first volume of the plates was printed, Audubon began to write his invaluable "Ornithological Biographies," the letter-press for the plates, consisting of five octavo volumes, published in Edinburgh between 1831 and 1839. He spent his last days in New York City, and was buried in Trinity churchyard. No American of the pioneer period except Franklin was so generally honored as Audubon by the learned and scientific societies of Great Britain and the Continent.

### Benjamin Franklin

Few Americans can rival Benjamin Franklin in greatness and in the extent and value of his services to mankind. Starting from humble beginning, he became, by industry and merit, one of the greatest men that ever lived. Though born in Boston, he belongs to Pennsylvania, whither he came as a lad of seventeen. The facts of his life are so well known that I need not enumerate them. No other American ever attained distinction in so many varied fields of activity. Franklin deserves to be honored as the greatest Pennsylvanian, attaining preeminent distinction not only as a scientist, but also as publisher, journalist, inventor, educator, economist, man of letters, diplomat, patriot, and statesman. Our interest in him is naturally divided between his public services and his scientific pursuits.

He was clerk of the Pennsylvania Assembly from 1736 to 1747. Then, for fourteen years in succession, he was elected a member of the Assembly, in which he was an outspoken opponent of the proprietary government. For ten years he was in England as the colonial agent of Pennsylvania and other colonies. In 1775, by appointment of the Continental Congress, he became our first Postmaster-General. From 1776 to 1785 he served his country on various diplomatic missions to Europe; and on his return, at the age of seventy-nine, he was elected Governor of Pennsylvania for three years. The importance and the extent of his public services are attested by the fact that he signed the Declaration of Independence, the treaty of alliance with France, the treaty of peace with Great Britain, and the Constitution of the United States.

Benjamin Franklin liked to think of himself as a natural philosopher. The term scientist was not then used in its modern sense. In 1743 he was instrumental in founding the American Philosophical Society in Philadelphia, in which he brought together a group of inquiring minds interested in the study of natural phenomena. I suppose that nowadays such an organization would be called a scientific association. Franklin first took up the study of electricity in 1746. In this year he made definite improvements in the Leyden jar. A note in his diary shows that in 1749 he had conjectured that thunder and lightning were electrical phenomena. Soon after he invented the lightning-rod, which was long known as "Franklin's rod." His celebrated experiment with the kite, by which he proved his point that lightning was an electrical phenomenon, was made in 1752. The next year the Royal Society awarded him the Copley medal for his discoveries. In the same year he exploded the old-time friction theory of electricity and propounded the theory of plus and minus charges. We still pay tribute to him in using the terms positive and negative.

Franklin's mind was so catholic in its grasp that he was interested in all scientific phenomena; and his ingenious mind was always eager to turn scientific knowledge to some practical account. As early as 1742 he invented the "Franklin stove," which saved fuel and heated the whole room, being constructed on the same principle as the modern hot air furnace. "In navigation he suggested many new contrivances, such as water-tight compartments and floating anchors to lay a ship to in a storm." He made a notable contribution to medicine in the invention of bifocal eyeglasses, and he was himself the proud possessor of the first pair ever made.

Franklin's work and influence as a pioneer in science live on to-day in two great organizations founded by him in 1743 for broadening the field of knowledge—the American Philosophical Society and the College of Philadelphia, now the University of Pennsylvania. For nearly two centuries these two great Philadelphia institutions have fostered science and promoted scientific research. There is a rich harvest to-day because Franklin first sowed the seed.



### Joseph Priestley

Joseph Priestley, teacher, scientist, and author, was born in Yorkshire, England, in 1733. At the age of twenty-two he became a Unitarian minister; but he was always more of a student and teacher than a preacher. When he was past thirty, Benjamin Franklin, then in England, started him in his scientific studies. Priestley had Franklin's encouragement and help in preparing his "History and Present State of Electricity," which won him recognition as a scientist, membership in the Royal Society, and the honorary degree of LL.D. from the University of Edinburgh, before he was thirty-four years old. Though his main occupation was teaching, he devoted much time to his two hobbies, Unitarian theology and scientific research. He made numerous discoveries in chemistry, the most important being the discovery of oxygen gas in 1774. He also discovered nitric oxide, nitrous oxide, carbon monoxide, hydrochloric acid, ammonia gas, and sulphur dioxide. His special interest was in the field of what he called "pneumatic chemistry."

Fond of theological and political controversy, he became the champion of liberal thought in England. His voluminous writings and his advanced ideas aroused so great a popular clamor that a mob burned his meeting-house and his home in Birmingham in 1791. His library, his scientific apparatus, and many of his manuscripts were destroyed. Three years later, that is, in 1794, at the age of sixty-one, Priestley left England forever, eventually settling in Northumberland, Pennsylvania, where he spent the last ten years of his life in making chemical experiments and in writing his "Church History" and his "Notes on the Scriptures." He was everywhere well received in the United States. He was frequently honored by the American Philosophical Society and by many other learned bodies. He declined the professorship of chemistry at the University of Pennsylvania. He kept up his experiments in his own laboratory until the very end of his life, making several important discoveries. He must have had ink in his blood, for his miscellaneous and theological writings alone fill twenty-six volumes. The old Priestley house at Northumberland still stands in an excellent state of preservation. It is perfectly fair to call Priestley a Pennsylvanian, for he had shaken the dust of England from his feet; and he was perfectly happy in his new Pennsylvania home, where he quickly identified himself with the interests of his community, state, and nation. President Jefferson was his warm friend and admirer.

### Thomas Cooper

Closely associated with Priestley in Pennsylvania was another expatriated Englishman, Thomas Cooper, a lawyer and political agitator, whose hobby was chemistry. He was born in 1759 and educated at Oxford. He early became a partisan of the ideas of the French Revolution. In religion he was a freethinker. In politics he was a radical democrat. Burke denounced him in the House of Commons. Branded as a dangerous agitator and threatened with political persecution in England, he followed Priestley to Pennsylvania in 1795, and began the practice of law in Northumberland County. The finest tribute on record as to his ability is found in the words of President John Adams, his bitterest enemy, who described Thomas Cooper as "a learned, ingenious, scientific, and talented madcap." For an attack on President Adams's administration, published in the Reading *Advertiser* in 1799, Cooper was convicted under the "Alien and Sedition laws," fined $400, and sentenced to jail for six months. His liberal views on religion, his radical political opinions, his castigation of the Federalists, and his scientific pursuits all endeared him to Thomas Jefferson, who became his ardent admirer and supporter.

As one reviews Thomas Cooper's career after the lapse of a century, it is hard to think of him as a political firebrand. We are interested in him mainly as a pioneer chemist in Pennsylvania. There can be no doubt that he became a great teacher of chemistry in the new world at a time when scientific leaders were few and feeble. While hobnobbing with the French Revolutionists, he had somehow found time to study chemistry in France. While practicing law at Northumberland, he worked on terms of the most friendly intimacy with Priestley. He spent twenty-four years in Pennsylvania. Thomas Jefferson wished to make him professor of chemistry in the University of Virginia, but the clergy of that State would not tolerate him. He spent four years in Pennsylvania as a capable and successful teacher of chemistry. For three years, from 1811 to 1814, he taught chemistry in Dickinson College. During the year 1818–19 he was professor of chemistry in the University of Pennsylvania. This position he resigned to accept the professorship of chemistry in South Carolina College. The next year and for twelve years thereafter he was president of that institution. Thus he disappears from the Pennsylvania scene. One notable service that he rendered to the chemists of his day, while he was a resident of Pennsylvania, was the editing of the four-volume edition of Thomas Thomson's "System of Chemistry," which was published in Philadelphia in 1818.

### David Rittenhouse

David Rittenhouse, self-taught mathematician and astronomer, great-grandson of a refugee Mennonite preacher from Holland, was born on a farm near Philadelphia in 1732. He was without schools or teachers, his sole educational equipment being a chest of tools and a few books containing the elements of arithmetic and geometry, and some mathematical calculations. With this slender outfit to start with, and wholly without teachers or formal instruction, he became one of the greatest mathematicians and astronomers of his time. As a boy on the farm, mathematical problems engaged all his spare time. He covered fences and the sides of buildings with his calculations. At the age of twenty he had devised the method of fluxions, of which he for a long time thought himself to have been the originator. He studied Latin and Greek, and soon mastered Newton's "Principia." The clocks that he made were famous for their accuracy. With his own instruments he made the initial observations for the English astronomers, Charles Mason and Jeremiah Dixon, when they drew the famous boundary line between Maryland and Pennsylvania; it was Rittenhouse who later completed their unfinished work. He studied variations in the oscillations of the pendulum, and devised a method of compensation. In 1770 he made the most perfect orrery that had ever been constructed, which is now in the possession of Princeton University. Of this ingenious contrivance, John Adams declared, "It exhibits almost every motion in the astronomical world." The University of Pennsylvania paid him £400 sterling for an orrery built on the same model. He was the first American to introduce the use of spider lines in transit instruments. He made and published observations on the transit of Venus which occurred on June 3, 1769; and a great European scientist has declared that "the first approximately accurate measurements of the spheres were given to the world, not by the schooled and salaried astronomers who watched from the magnificent royal observatories of Europe, but by an unpaid amateur and devotee to science in the youthful province of Pennsylvania."



In many ways his mechanical ingenuity and scientific knowledge were turned to practical patriotic account at the outbreak of the American Revolution. He filled many public offices: he was our first State Treasurer, from 1777 to 1789; he was a member of the Board of War; he was the first Director of the United States Mint. Princeton conferred on him the degree of LL.D. England made him an honorary member of the Royal Society. In 1790 he succeeded Franklin as president of the American Philosophical Society. When Thomas Jefferson followed him in this office six years later, he remarked, "We have supposed Mr. Rittenhouse second to no astronomer living; in genius, he must be first, since he was self-taught."

### Benjamin Rush

Though Benjamin Rush, the beloved physician, deserves to be classified among scientists, he should also be listed with great educators, patriots, and publicists. I cannot do more than make a bare list of his chief activities and distinctions. He was born in Philadelphia in 1745. At the age of fifteen he was graduated from Princeton College. He studied medicine in Philadelphia, Edinburgh, London, and Paris, and became the most eminent physician and teacher of medicine in his day. In 1769 he became professor in the Philadelphia Medical College, with which he was connected for more than thirty years, filling successively the chairs of chemistry, the theory and practice of medicine, medical and clinical practice, and the practice of physic. He helped to teach more than two thousand medical students. He founded Dickinson College and the Philadelphia Dispensary. His eager mind was far in advance of his time in all scientific, educational, and social matters. He ardently advocated free public schools, temperance, and the abolition of slavery. He signed the Declaration of Independence. During the Revolution he was Surgeon-General of the Middle Division. In the yellow fever epidemic of 1793 it is estimated that he saved the lives of fully six thousand people, nearly dying of the disease himself and sticking to his post when all but two other physicians had fled from the city. He was treasurer of the United States Mint at Philadelphia during the last fourteen years of his life.

He was an honored member of nearly every medical, scientific, literary, and benevolent society in the country, and of many foreign societies. He wrote five volumes entitled "Medical Inquiries and Observations." His last book was an elaborate treatise on "Diseases of the Mind." His published works fill eight large volumes, covering an immense range of subjects, from North American Indian lore to speculations on the origin of animal life.

Benjamin Rush, more than any other man, stimulated the study of medicine in the United States, and started Philadelphia on its career as one of the world's great centers of medical education.

### Robert Fulton

Robert Fulton, the son of a Kilkenny Irishman, was born in Little Britain, Lancaster County, in 1765, in a little stone house that is still standing. He got his first knowledge of mechanical matters by frequenting the Lancaster gun works as a boy during the American Revolution. At the age of twenty-one he went to England and studied painting under Benjamin West. Like that other great experimenter, Samuel F. B.



Morse, he was both an artist and an inventor. He soon became a student of applied science in the realm of mechanics, and was always deeply engrossed with varied engineering problems. He went to France to interest Napoleon in the submarine torpedo, which he had just invented, little dreaming of the deadly havoc it was destined to work more than a century later. In England he took out many patents, ranging from a machine for spinning flax to various ingenious devices for improving canal navigation.

All the while his mind was actively occupied with the unsolved problem of adapting steam to the propelling of boats. He returned to the United States in 1806, and the next year *The Clermont* steamed from New York to Albany. Robert Fulton had at last made navigation by steam practicable. His fame and genuine service to humanity should not be lessened or slighted because poor John Fitch and half a dozen others had anticipated him in their attempts to apply steam to navigation. Robert Fulton never became rich from his inventions. At the time of his death six steamboats were afloat on the Hudson, and the first steamship was under construction for trans-Atlantic traffic.

### Elisha Kent Kane

The career of Elisha Kent Kane, scientist and explorer, was brief and meteoric. Born in Philadelphia in 1820, the son of a famous jurist and attorney-general of Pennsylvania, he studied at the University of Virginia, and at the age of twenty-two was graduated in medicine from the University of Pennsylvania at the head of his class. He early distinguished himself in physiological research. Having a roving foot, he became a surgeon in the navy and traveled widely in many unbeaten paths, making explorations in China, journeying from Bombay through India to Ceylon, from Rio de Janeiro to the base of the Andes, investigating the true inwardness of a volcanic crater in Luzon' to its very bottom, exploring the west coast of Africa, and taking a walking trip in Greece, besides making journeys to Persia, Syria, and Egypt. In an age when exploration in remote parts of the world was both hazardous and unusual, he won fame as a scientific explorer before he was twenty-six years old. Though his constitution was much depleted by African fever contracted while exploring Dohomey, he became a surgeon in the army and took part in the Mexican war, in which he was wounded and again stricken with fever.

In 1850, on two days' notice, he joined the Grinnell Arctic expedition sent out in search of Sir John Franklin. After returning from this fruitless quest, he organized an Arctic exploring expedition in 1853 under his own command, taking with him Dr. Isaac Hayes, of West Chester, another Pennsylvanian, who afterward became a famous Arctic explorer. Dr. Kane's explorations and scientific observations in the Arctic were more valuable and important than those of any previous explorer. After more than two years he returned to find himself one of the most famous men of his generation. His published account of "The Second Grinnell Expedition" appeared in 1856. Gold medals were awarded him by the State of New York, by the Royal Geographical Society of London, and by the United States Congress. He had made invaluable contributions to the world's scientific knowledge, and had reduced to geographical certainty more than one thousand miles of the Greenland coast. He died in 1857,—a martyr to science at the age of thirty-seven.

After thus rapidly sketching the careers of a few of the Pennsylvania pioneers in science, it seems appropriate to pay respectful and grateful tribute to their disinterested motives, to their high courage in attacking different problems, to their persistent industry amid uncongenial surroundings, to their hard struggles to do something worth while without adequate material means and appliances, and to the solid worth of their work. They were not mere dabblers. They were true pioneers, who fought a good fight. They knew how to devise, safeguard, and check their experiments. They had open minds, eager in the quest of new truth. They knew the true meaning of research, the joy that comes with a new discovery. They widened the field of knowledge. They applied their scientific discoveries to the arts of life. They were not only students, investigators, discoverers, and inventors; they were also teachers. They blazed the trail through the wilderness, and they passed the torch on to others. It would ill become us to think or to speak slightingly of their relatively meager accomplishment; for these pioneers of science in Pennsylvania, animated thus early by the true scientific spirit, have laid the solid foundation on which you are building today.

## A DECADE OF APPLIED BOTANY IN PENNSYLVANIA

By E. L. Nixon

*State College*

(Paper not submitted)



## TEACHING PHYSICAL CHEMISTRY AT PENNSYLVANIA STATE COLLEGE

By W. P. Davey and M. J. Lisse

(Paper not submitted)

## THE HELDERBERG GROUP FROM CENTRAL PENNSYLVANIA TO SOUTHWESTERN VIRGINIA

By Frank McKim Swartz

*Pennsylvania State College*

### Introduction

The rocks exposed in the Helderberg escarpment on the eastern flank of the Catskill Mountains of New York were, with their contained fossils, made famous by the work of James Hall in the middle of the last century. Used in a more general sense in Hall's day, the term Helderberg was redefined in 1899 by Clarke and Schuchert to include the Coeymans, New Scotland, and Becraft limestones, formations embraced by Hall in the "Lower Helderberg." Still later, the Keyser limestone, which underlies the Coeymans limestone in Maryland and the adjoining States, was also included in the Helderberg Group, a usage here followed. Another change was the placing of the Helderberg in the Lower Devonian, whereas Hall placed it at the top of the Silurian.

The Helderberg Group of New Jersey was described by Stuart Weller in 1903; that of Maryland by C. K. Swartz, Charles Schuchert, and others in 1913; and in 1917 J. B. Reeside, Jr., described the Helderberg of central Pennsylvania, as exposed at seven localities, from Tyrone on the west to Grovania, near Bloomsburg, on the east. In the past six years the writer has visited several of the Maryland, New Jersey, and New York sections; and has in addition studied some thirty previously undescribed sections, mostly located in West Virginia and Virginia, but also including several in Pennsylvania. (See fig. 2.) The chief purpose of the investigation has been to determine how far the lithologic and faunal divisions recognized in Maryland could be traced to the north and south; perhaps its greatest interest lies in the way it demonstrates lateral changes in the lithologic characters of these ancient sediments, and accompanying facies developments in their faunas.

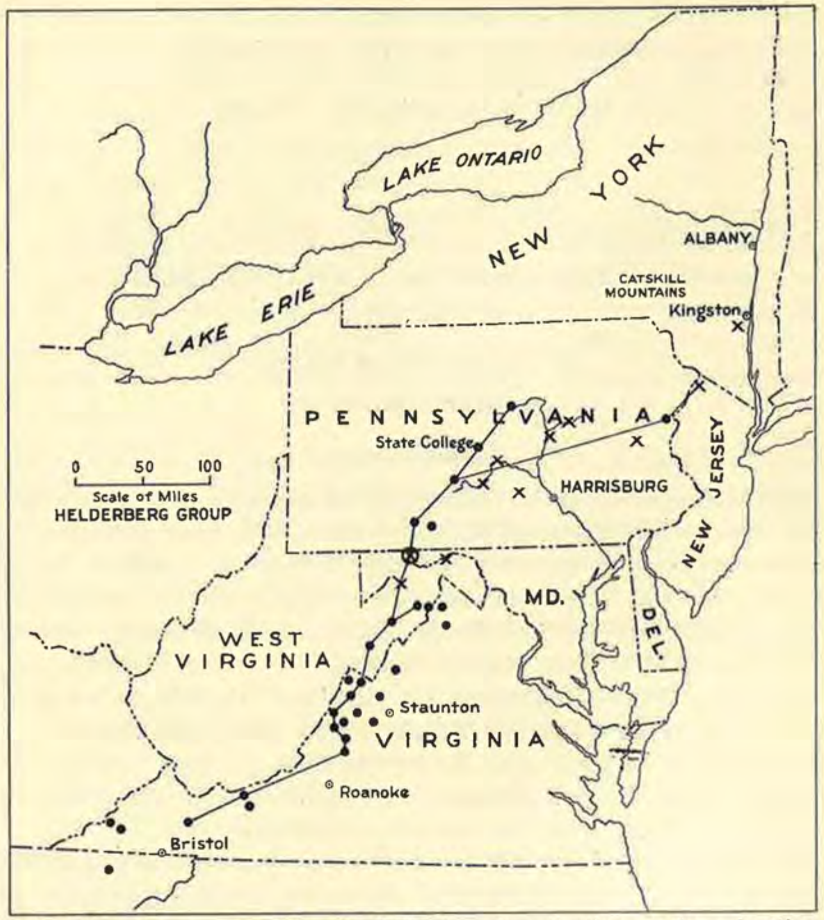



FIG. 2. Map of area covered by the Helderberg investigation; × shows location of section visited; ● shows location of section studied; the line connects sections represented in figs. 3 and 4.

## KEYSER LIMESTONE

In western Maryland, the starting point for this investigation, the Helderberg consists of the Keyser, Coeymans, and New Scotland limestones, the Becraft limestone being absent there, although present farther east near Hancock, Md. The Keyser limestone is 290 feet thick, and consists of a lower more massive portion, much of which weathers with a peculiar lumpy appearance, and an upper thinly laminated portion, weathering platy to a large extent. The laminated beds of the upper portion are suggestive of the Tonoloway limestone, which underlies the



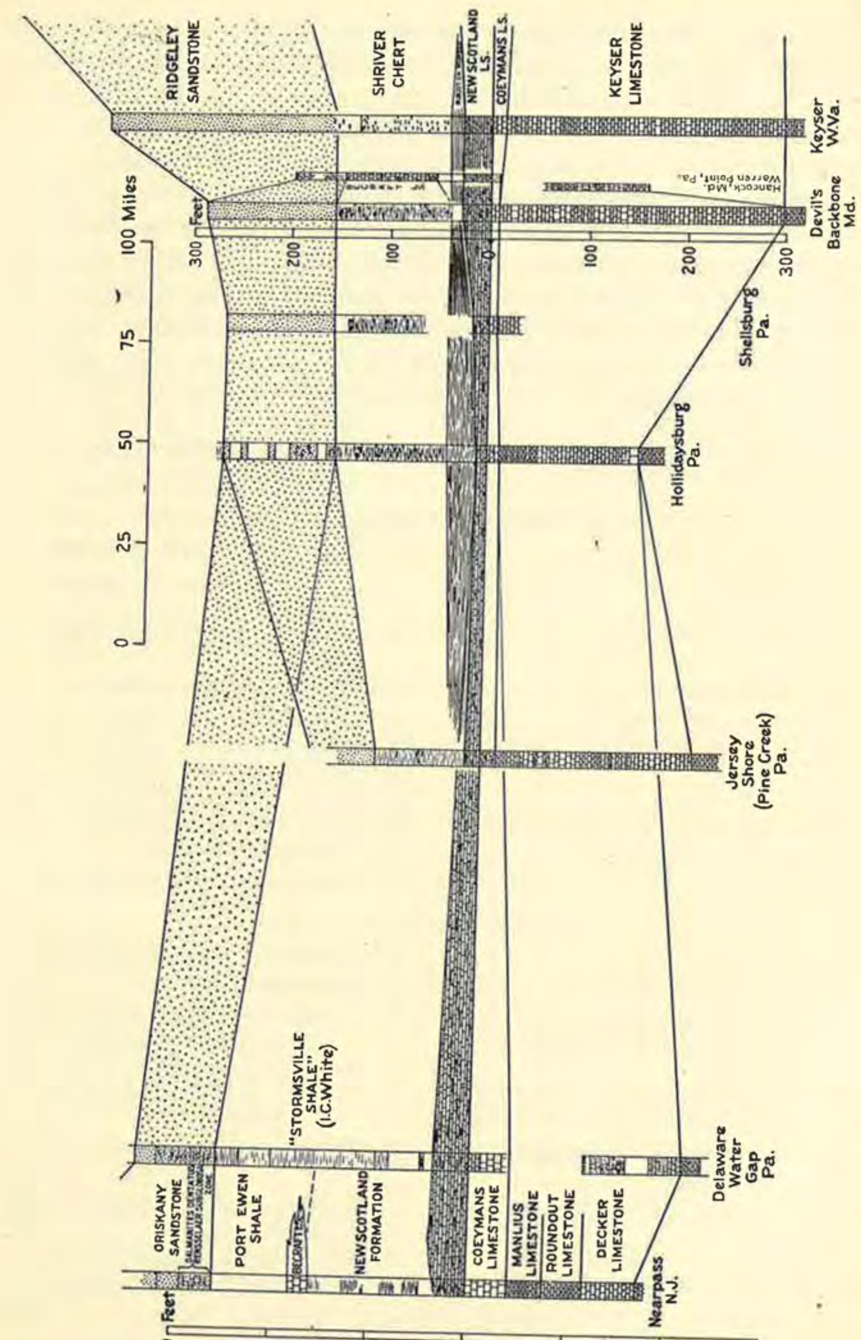



FIG. 3. Stratigraphy of the Helderberg Group from western Maryland to New Jersey.

Keyser in the Maryland region; being similar not only in their lithologic character, but also in the comparative sparseness of its fauna. Furthermore, the fauna simulates that of the Tonoloway in the presence of *Tentaculites gyracanthus,* and Ostracodes of the genus Leperditia.

The lower more massive portion is more abundantly fossiliferous, and up to a short distance below its top is characterized by *Chonetes jerseyensis,* whose range has been used to delimit the *Chonetes jerseyensis* zone. The upper half of the Keyser lacks *C. jerseyensis,* and was in Maryland termed the *Favosites helderbergiae* var. *praecedens* zone, because of the occurrence of that coral at many horizons. Faunal subzones, based on species of smaller vertical range, and traceable through many sections, have been recognized in both Maryland and Pennsylvania:

| Maryland (C. K. Swartz) | Central Pennsylvania (J. B. Reeside, Jr.) |
| --- | --- |
| **Favosites helderbergiae var. Praecedens Zone** | |
| 13. Leperditia subzone. | 17. Upper Leperditia subzone. |
| 12. Corrigansville Stromatopora subzone. | |
| 11. *Tentaculites gyracanthus* subzone. | 16. *Tentaculites gyracanthus* subzone. |
| 10. Corrigansville lower Stromatopora subzone. | 15. Stromatopora subzone. |
| 9. *Rensselaeria mutabilis* subzone. | 14. *Rensselaeria mutabilis* subzone. |
| | 13. *Pholidops ovata* subzone. |
| | 12. Lower Leperditia subzone. |
| 8. Keyser coral reef subzone. | 11. Coral subzone B, with *Cladopora rectilineata.* |
| | 10. *Spirifer vanuxemi* subzone. |
| **Chonetes jerseyensis Zone** | |
| | 9. *Calymene camerata* subzone. |
| 7. Bryozoan subzone. | 8. Bryozoan subzone. |
| 6. *Gypidula coeymanensis* var. *prognosticus* subzone. | 7. *Gypidula coeymanensis* var. *prognosticus* subzone. |
| | 6. *Dalmanella clarki* subzone. |
| 5. *Spirifer modestus*—Cystid subzone. | 5. *Spirifer modestus* subzone. |
| 4. Rawling's Stromatopora reef subzone. | 4. Stromatopora subzone. |
| 3. *Cladopora rectilineata* subzone. | 3. Coral subzone A, with *C. rectilineata.* |
| 2. Rhynchospira subzone. | 2. Rhynchospira subzone. |
| 1. Warrior Mountain coral reef subzone. | 1. *Camarotoechia? lamellata* subzone. |



There are several other species whose occurrence is of equal or greater importance in subzonal work. Thus *Stenochisma deckerensis, Uncinulus convexorus,* and *Nucleospira swartzi* are abundant in and confined to the lower part of the *Chonetes jerseyensis* zone, ranging through the subzones 2 to 5 as above listed. With *Spirifer modestus* they are the most characteristic species of the lower Keyser from central Pennsylvania to west central Virginia. *Merista typa* is another very important species occurring in and above the Gypidula zone. *Camarotoechia gigantea* occurs at this horizon in Maryland, becoming more important to the south. *Meristella praenuntia* is one of the most characteristic species of the upper Keyser.

Of the subzones above noted, those of *Steochisma deckerensis, Merista typa, Calymene camerata, Pholidops ovata,* and the upper Leperditia, were located at the section ½ mile east of Hollidaysburg, along the highway to Huntington, where the Helderberg makes a high bluff along the roadside. This is one of the finest exposures of the whole lower Devonian to be seen anywhere in central Pennsylvania. The freshness of the exposure hampers collecting in the Keyser, and it would be desirable to spend additional time on the slope above the bluff, where the ledges are more weathered.

The faunal subzones of the Keyser were not adequately located in the section along Pine Creek, near Jersey Shore, during my visit of one day. The most important subzones recognized were those of *Stenochisma deckerensis* and *Cladopora rectilineata* (of Reeside's coral subzone B). The *Stenochisma* subzone is better exposed in a more weathered condition at several localities near Williamsport, where it contains *Chonetes jerseyensis, Stenochisma deckerensis, Nucleospira swartzi, Atrypa reticularis,* etc.

In eastern Pennsylvania, the lower part of the Keyser is well exposed near the Delaware Water Gap, where it is composed of impure sandy limestone, alternating with calcareous quartz conglomerates, in which the quartz pebbles are as much as ¾ inch in diameter. The lower Keyser age of these beds is indicated by the occurrence of *Stenochisma deckerensis, Spirifer modestus,* and *Chonetes jerseyensis*; although all of those species are rare, apparently due to the local adverse habitat conditions at the time of deposition. The same sandy phase of the lower part of the Keyser can be seen at Palmerton. The presence of these shore phases in the lower part of the Keyser at Delaware Water Gap and Palmerton throws some doubt on the theory that the absence of the Lower Devonian deposits along this belt of outcrop toward Harrisburg is due to faulting; their absence is quite possibly due to an unconformity.

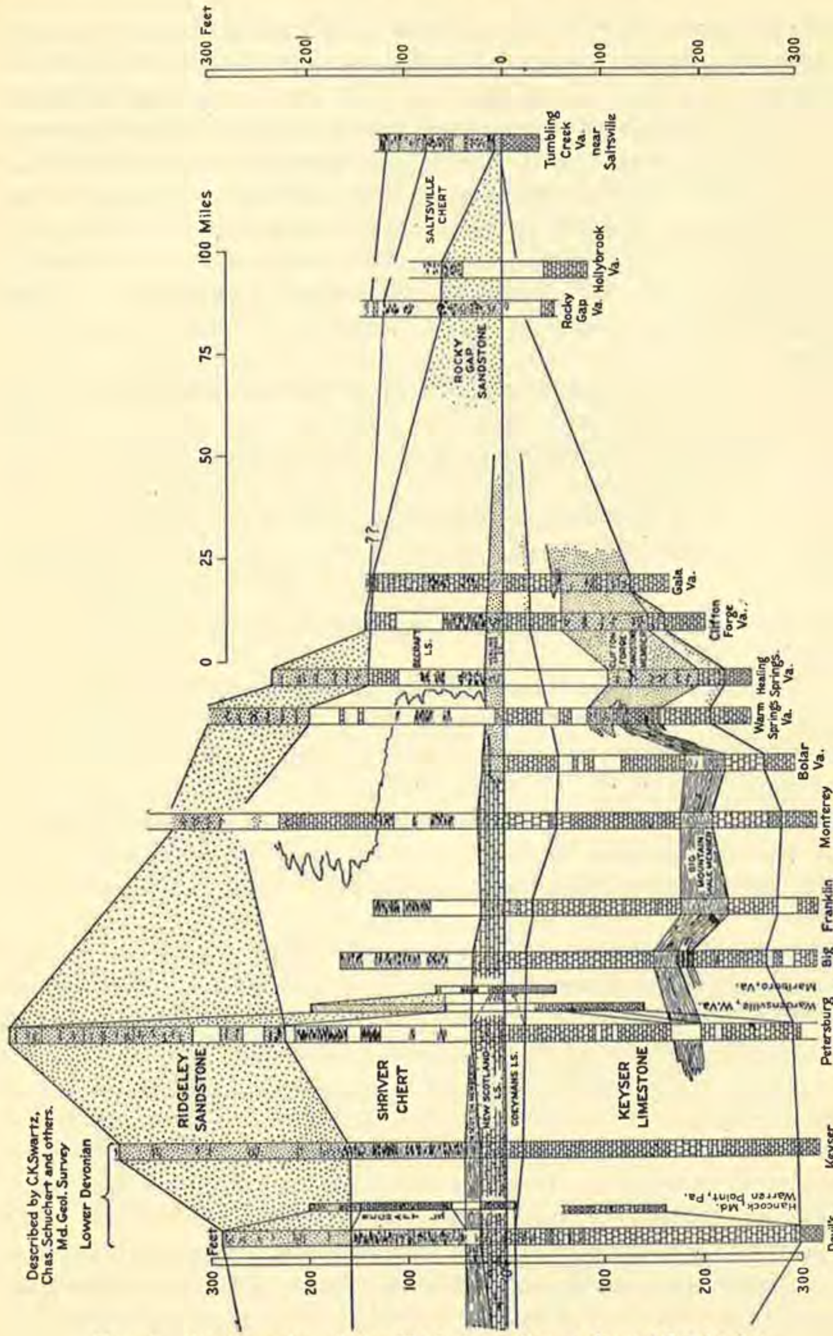



FIG. 4. Stratigraphy of the Helderberg Group from Maryland to southwestern Virginia.



The lower part of the Keyser of Pennsylvania can be definitely correlated with the *Chonetes jerseyensis* bearing portion of the Decker limestone ("Decker Ferry" of Weller) of northwestern New Jersey, where *Stenochisma deckerensis* and other fossils of the lower part of the Keyser occur in the lower part of the *C. jerseyensis* zone. The small Gypidula ("Pentamerus") *circularis* described by Weller from the upper part of the *C. jerseyensis* zone very likely represents the *Gypidula coeymanensis* var. *prognosticus* subzone of Maryland and Pennsylvania. The subzone of *Cladopora rectilineata* of the upper part of the Decker of New Jersey seems to be equivalent to Reeside's Coral subzone B. The relation to the upper Keyser of the Rondout and Manlius(?) limestones of New Jersey is less clear; but the occurrences in the Rondout of *Leperditia gigantea,* and in the Manlius(?) of *Tentaculites gyracanthus* suggest equivalency with the horizons of the upper Keyser where those species occur.

The most obvious of the lithologic variations in the Keyser limestone as it is traced southward into West Virginia and Virginia are indicated in fig. 4. The intertongueing of the Big Mountain shale and Clifton Forge sandstone members with much of the lower and middle portions of the Keyser limestone is of particular interest. The time relations of these beds were very precisely determined by tracing through a series of faunal horizons, of which the following are the most significant (compare the Md.-Pa. lists):

FAVOSISTES HELDERBERGIAE VAR. PRAECEDENS ZONE

13. *Whitfieldella prosseri* subzone (at Franklin, W. Va. only).
12. *Tentaculites gyracanthus* subzone (at Petersburg, W. Va. only).
10. *Rensselaeria mutabilis* subzone.

11. *Camarotoechia altiplicata* and *Nucleospira ventricosa* subzone. (equivalent to 13–10)

9. *Meristella praenuntia* subzone.
8. Petersburg Stromatopora reef subzone, probably same as Clifton Forge reef subzone.
7. Coral subzone, with *Cladopora rectilineata.*

CHONETES JERSEYENSIS ZONE

6. *Merista typa* subzone.
5. *Camarotoechia gigantea* subzone.
4. *Gypidula coeymanensis* varieties *prognosticus* and *similis* subzone.
3. *Spirifer modestus, Stenochisma deckerensis, Uncinulus convexorus, Nucleospira swartzi* subzone.
2. *Cyphotrypa corrugata, Stropheodonta bipartita* subzone.
1. *Whitfieldella minuta* subzone.

The Big Mountain shale and Clifton Forge sandstone members are underlain by a persistent tongue of the lower nodular member of the Keyser, carrying the fossils of zones 1, 2, and particularly 3, while several of the subzone 3 fossils range up into the Big Mountain shale, and the lower part of the Clifton Forge sandstone intertongues with much of the limestone beds containing subzone 3.

The subzones 4, 5, and 6 occupy the basal part of the limestone overlying the Big Mountain shale. Near Warm Springs, Va., subzone 5 passes into the upper tongue of the Clifton Forge sandstone, which is rather shaly at that locality, while subzone 4 occurs in a limestone bed a few feet lower. Subzones 7 and 8 occur in the limestone above the Clifton Forge sandstone near Warm Springs and Clifton Forge.

An important lateral change in lithologic nature was observed in the upper part of the Keyser also. Thus in Maryland and Pennsylvania the upper part of the Keyser is a dense laminated sparingly fossiliferous limestone; while south of Petersburg, W. Va., it becomes purer, and is thick bedded and more or less crystalline, frequently with masses of coral and many fragments of crinoid stems. The change to the crinoidal condition appears to represent a change to more truly marine conditions, more favorable to marine life. This change in environmental conditions is also indicated by the disappearance of the Leperditia, Tentaculites, and Pholidops subzones, all of which were probably brackish water dwellers; and by the appearance of a more abundant brachiopod fauna, including *Camarotoechia altiplicata* (represented by a small variety), *Nucleospirea ventricosa,* and, more rarely, *Cyrtina dalmani* and *Spirifer perlamellosus* var. *praenuntius.* These four species are of further interest because they are either identical with or are very closely allied to species not known from below the Coeymans limestone farther north, and provide some additional evidence for placing the Keyser limestone in the Helderberg Group.

The Keyser was not seen south of Gala, near Clifton Forge, Va. The Keyser is definitely absent near Saltville and Big Stone Gap in southwestern Virginia, where beds that are not older than the Coeymans (and are probably younger) were seen in contact with the Tonoloway limestone, which underlies the Keyser limestone farther north.

### Coeymans Limestone

In Western Maryland the Coeymans is about 13 feet thick, and is massive, crystalline, and highly crinoidal. Its character is such as to make it comparatively resistent, and it forms the backbone of the "Devil's Backbone" at the classical section of the Helderberg Group near Cumberland, Md. The most diagnostic fossil of the Coeymans is *Gypidula coeymanensis,* which is generally profuse.



The contact with the underlying Keyser is very sharp, and is made more apparent by the sudden change from the dense platy limestone of the upper Keyser to the massive crinoidal crystalline limestone of the Coeymans. The contact appears to represent a short erosional unconformity.

The Coeymans maintains in central Pennsylvania essentially the same thickness, lithologic character, and fauna. For such a thin formation it is persistent over a surprisingly large area. As in Maryland, the contact is generally sharp; and at Hollidaysburg, at least, its erosional character is further indicated by a slight unevenness, and by the presence in the basal portion of the Coeymans of fragments of dense limestone of upper Keyser type.

As shown by Reeside, the Coeymans passes into a calcareous sandstone at Grovania, near Bloomsburg; in spite of the change in habitat indicated by the change in lithology the Coeymans fauna is persistent. In eastern Pennsylvania, in the vicinity of the Delaware Water Gap, the Coeymans is again a massive crystalline crinoidal limestone, containing many horizons in which *G. coeymanensis* is profuse. It has a thickness of 50 feet at this locality. The Coeymans is also a massive crinoidal limestone in New Jersey and southeastern New York.

Going south from Maryland the Coeymans is a massive, crinoidal, and crystalline limestone at least as far south as Clifton Forge, Va., varying in thickness from about 15 to 50 feet. *Gypidula coeymanensis* becomes rare toward the south, no specimens having been found south of Hot Springs, Va. In the Monterey-Warm Springs-Clifton Forge area a useful and locally persistent faunal subzone is provided by an abundance at the top of the Coeymans of *Meristella arcuata* and *Rhipidomella oblata.* With the change of the upper Keyser from the dense laminated type of lithology, as seen in Maryland, to the crinoidal crystalline condition, the contact between the Coeymans and the Keyser no longer appears to be so sharp. However, possible evidence of disconformity is seen in the sandy character of the lower part of the Coeymans in the Clifton Forge area.

The Coeymans limestone was not seen as such south of Clifton Forge, Va. The calcareous sandstone at Rocky Gap (indicated in fig. 4 as Rocky Gap sandstone) is most likely of Becraft age. At the top of the concealed interval below this sandstone a few limestone cherts were found with internal casts of a Meristella that is probably *M. arcuata.* Although this occurrence is suggestive of the *M. arcuata* zone at the top of the Coeymans in the Clifton Forge area, correlation is not assured.

### New Scotland Limestone

Throughout the area studied the Coeymans limestone is everywhere overlain by beds of the age of the New Scotland shaly limestone of southeastern New York, as is shown by the presence of *Spirifer macropleurus, Spirifer perlamellosus, Dalmanella perelegans, Streptelasma strictum,* and other fossils. In western Maryland the New Scotland consists of a lower limestone member about 25 feet thick, and containing a moderate amount of interbedded whitish chert; and an upper fissile gray shale member, 15 to 29 feet thick. The limestone contains a large fauna, including the species cited above; the shale is much less fossiliferous, but specimens of several of the above species have been found in it.

In central Pennsylvania the New Scotland includes similar limestone and shale members; but the limestone contains less chert, and frequently is somewhat shaly. The New Scotland fauna is everywhere well represented in the limestone member. There is sometimes difficulty in recognizing the shale member because it tends to be concealed, due to its nonresistant character.

At the Delaware Water Gap the limestone member is thin and shaly, with only a small amount of interbedded chert; the chert is darker colored than is that of the southern area. The New Scotland fauna is present, but specimens are not very abundant. The shales overlying the limestone member continue upward to the Oriskany (= Ridgeley) sandstone with little if any change in lithologic character; in other words, there is no distinction of a fissile shale below, and a cherty shale above, as there is in Maryland and central Pennsylvania. This shale was named the Stormville shale by I. C. White in his report to the Second Geological Survey of Pennsylvania. The Stormville shale appears to be equivalent to the shale member of the New Scotland, the Becraft limestone, and the Port Ewen shale of the Nearpass, New Jersey, section, as described by Weller. The relations of the Stormville shale of eastern Pennsylvania and the Shriver chert of central Pennsylvania have not been worked out in Pennsylvania. Comparison with the apparent relations of the Shriver and Becraft of the Virginias suggest that the upper part of the Stormville is Shriver in age.

South of Maryland the limestone member of the New Scotland becomes more massive, containing very little mud material, but an increased amount of the whitish chert. This limestone is profusely fossiliferous, with an abundance of *Spirifer macropleurus* and many other New Scotland species. The shale member of the New Scotland was not seen; perhaps due to non-exposure in northeastern West Virginia, but definitely to non-existence in west central Virginia.



There is a very sudden change in the lithology of the New Scotland in the thirty miles south of Monterey, Va. At Monterey the New Scotland is a massive limestone, 30 feet thick, containing much interbedded whitish chert, and an abundance of fossils. At Healing Springs the New Scotland is a calcareous sandstone (in part a sandy limestone) about 20 feet thick, and here called the Healing Springs sandstone member of the New Scotland. One specimen of *S. macropleurus* was found in this sandstone at Healing Springs, and another near Warm Springs. Transitional intertongueing of the cherty limestone and the calcareous sandstone can be seen at Dry Run, near Warm Springs, and at Bolar.

Northeast of the Dry Run section another interesting modification was seen in the New Scotland, in an exposure at Bells Valley, Va. At this locality the New Scotland is a massive crystalline crinoidal limestone, and is continuous with the underlying Coeymans limestone. Correlation of the upper part of this limestone with the New Scotland is based chiefly on the presence of *Spirifer macropleurus,* which is abundant; while beneath the range of *S. macropleurus* was found the *Meristella arcuata* subzone of the upper part of the Coeymans.

The New Scotland was not recognized south of Gala, near Clifton Forge, Va. The lower part of the sandstone at Rocky Gap (Rocky Gap sandstone of fig. 4) may be of New Scotland age, but correlation is uncertain.

### Becraft Limestone and Shriver Chert

In western Maryland the interval between the New Scotland and the Ridgeley sandstone is occupied by an impure shale with much interbedded impure dark-colored chert, and containing few fossils. This cherty shale was named the Shriver chert by C. K. Swartz in 1913. Farther east, beyond Hancock, Md., the New Scotland to Ridgeley interval is occupied by a limestone with much interbedded black chert, and containing *Spirifer concinnus* and other fossils indicating essential equivalency with the Becraft limestone of southeastern New York and the adjoining part of New Jersey. Although the cherty shale and the cherty limestone occupy apparently the same stratigraphical position, it has been generally considered that the limestone is entirely older than the cherty shale, chiefly because the contained faunas are very distinct.

In fact, the Shriver chert, although it is older than the Ridgeley and therefore more nearly of the age of the Becraft than is the Ridgeley, actually contains fewer species suggestive of the Becraft fauna than does the Ridgeley. The reason for this is to be found in the nature of the Shriver fauna, which is small both in individuals and species, particularly when compared with the faunas of the other formations of the Appalachian Lower Devonian. Furthermore, the known Shriver fauna is for its geologic age notably deficient in corals, orthid brachiopods, and trilobites. As all of these would be expected in a typical marine assemblage of Lower Devonian animals, it seems that the Shriver fauna was not truly representative, but was modified and handicapped by the habitat conditions in the area of Shriver deposition. Accordingly, the Shriver fauna loses much of its value for correlation, and the relations of the Shriver and the Becraft must be worked out by careful study of the intermediate sections.

This has not been attempted in Maryland. In Virginia, however, a cherty limestone with a Becraft fauna is found above the New Scotland at Clifton Forge, Healing Springs, Bells Valley, and some neighboring localities. A tongue from the upper part of this limestone is present at Warm Springs and Monterey above bedded impure chert of Shriver rather than Becraft type, although they contain less mud than is typical in Maryland. The demonstration of the Shriver age of these chert beds is difficult because they, like the typical Shriver, contain so few fossils. They do, however, seem to be continuous with the Shriver chert of Maryland, as shown by intervening sections. Stratigraphic considerations, therefore, suggest that the Shriver chert and the Becraft limestone (at least the Becraft of Maryland and Virginia) are essentially equivalent in age, the faunas being different because of differences in habitat conditions.

The Becraft limestone of Maryland and Virginia is much thicker than that of New York and New Jersey, measuring 100 feet or more, whereas that of New York and New Jersey is about 30 feet thick. A study of the faunas suggests that the lower part of the southern Becraft is of the age of the type Becraft, whereas the upper part seems to be younger. Thus the upper part of the Becraft of Virginia carries Spirifers which are very close to *Spirifer concinnus,* but which are somewhat larger, more alate, and bear several more ribs on the lateral slope. The upper part of the Becraft of Virginia also contains *Cyrtina varia* and *Rensselaeria subglobosa,* both of which occur in the lower part of the Oriskany formation of New York and New Jersey, considerably above the type Becraft.



One fragment from this horizon at Monterey is probably *Dalmanites dentatus,* another species of the lower part of the New York-New Jersey Oriskany. This would suggest that the Shriver chert and the Maryland-Virginia Becraft are in part truly Becraft, and in part post-Becraft in age. It should be added that both the Shriver and the Maryland-Virginia Becraft are overlain by the Ridgeley sandstone, containing *Spirifer arenosus* and other fossils of the true Oriskany.

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## PLATE I

(All figures about 5/8 natural size, except fig. 26, 3/5)

Figs. 1–6. *Stenochisma deckerensis* (Weller). 1 to 4 dorsal views, 5 ventral, 6 side. Lower part of Keyser limestone, Williamsport, Pa. (1), Hollidaysburg, Pa. (2), Monterey, Va. (3), Franklin, W. Va. (4), Delaware Water Gap, Pa. (5), Petersburg, W. Va. (6).

Fig. 7. *Chonetes jerseyensis* Weller. Ventral valve. Lower part of Keyser limestone, Williamsport, Pa. The shell is broken below the umbo. Note cardinal spines and the anterior curvature of the lateral ribs.

Fig. 8. *Spirifer octocostatus* Hall. Dorsal view. Lower part of Keyser limestone, Petersburg, W. Va.

Figs. 9, 10. *Uncinulus convexorus* Maynard. Dorsal and side views. Lower part of Keyser limestone, Big Mountain, W. Va.

Figs. 11–13. *Gypidula coeymanensis* var. *similis* F. M. Swartz. Exterior, side and interior views of ventral valves. This variety from the middle part of the Keyser limestone of west central Virginia is much closer to *G. coeymanensis* proper than is the variety *prognosticus* from the middle Keyser of Md. and Pa. Middle part of Keyser limestone, Little Mt., near Monterey, Va. (11, 12), Warm Springs, Va. (13).

Figs. 14–16. *Merista typa* (Hall). Exterior and interiors of ventral valves, the interiors showing the characteristic "shoe-lifter process," the arched septum. Middle part of Keyser limestone, Big Mt., W. Va. (14), Little Mt., Va. (15, 16).

Fig. 17. *Meristella praenuntia* Schuchert. Dorsal view. Upper part of Keyser limestone, Petersburg, W. Va.

Fig. 18. *Nucleospira swartzi* Maynard. Dorsal view. Lower part of Keyser limestone, Big Mt., W. Va.

Figs. 19, 20. *Spirifer modestus* Hall. Dorsal and ventral views. Lower part of Keyser limestone, Big Mt., W. Va.

Figs. 21, 22. *Camarotoechia gigantea* Maynard. Ventral and dorsal views. Warm Springs and Monterey, Va.

FIG. 23. *Gypidula coeymanensis* Schuchert. Side view. Coeymans limestone, Mt. Union, Pa.

FIGS. 24, 25. *Meristella arcuata* (Hall). Exterior and weathered interior of ventral valves. Note deep muscle scar of ventral valve. As seen in the rock, *M. arcuata*, *Gypidula coeymanensis* and *Merista typa*, are often difficult to tell apart. The weathered interiors exhibit very diagnostic features. Coeymans limestone, Big Mt., W. Va. (24), New Scotland limestone, Big Mt., W. Va. (25).

FIG. 26. *Spirifer macropleurus* (Conrad). Cardinal view, valves open; umbo of ventral valve broken. New Scotland limestone, Pine Creek, Pa.

FIGS. 27, 28. *Dalmanella perelegans* (Hall). Side and ventral views. New Scotland limestone, Monterey, Va.

FIG. 29. *Spirifer concinnus* var. *progradius* F. M. Swartz. This a larger more alate form than *S. concinnus* proper, with several more ribs to the lateral slope. Upper part of Becraft limestone, Back Creek Mt., west of Warm Springs, Va.

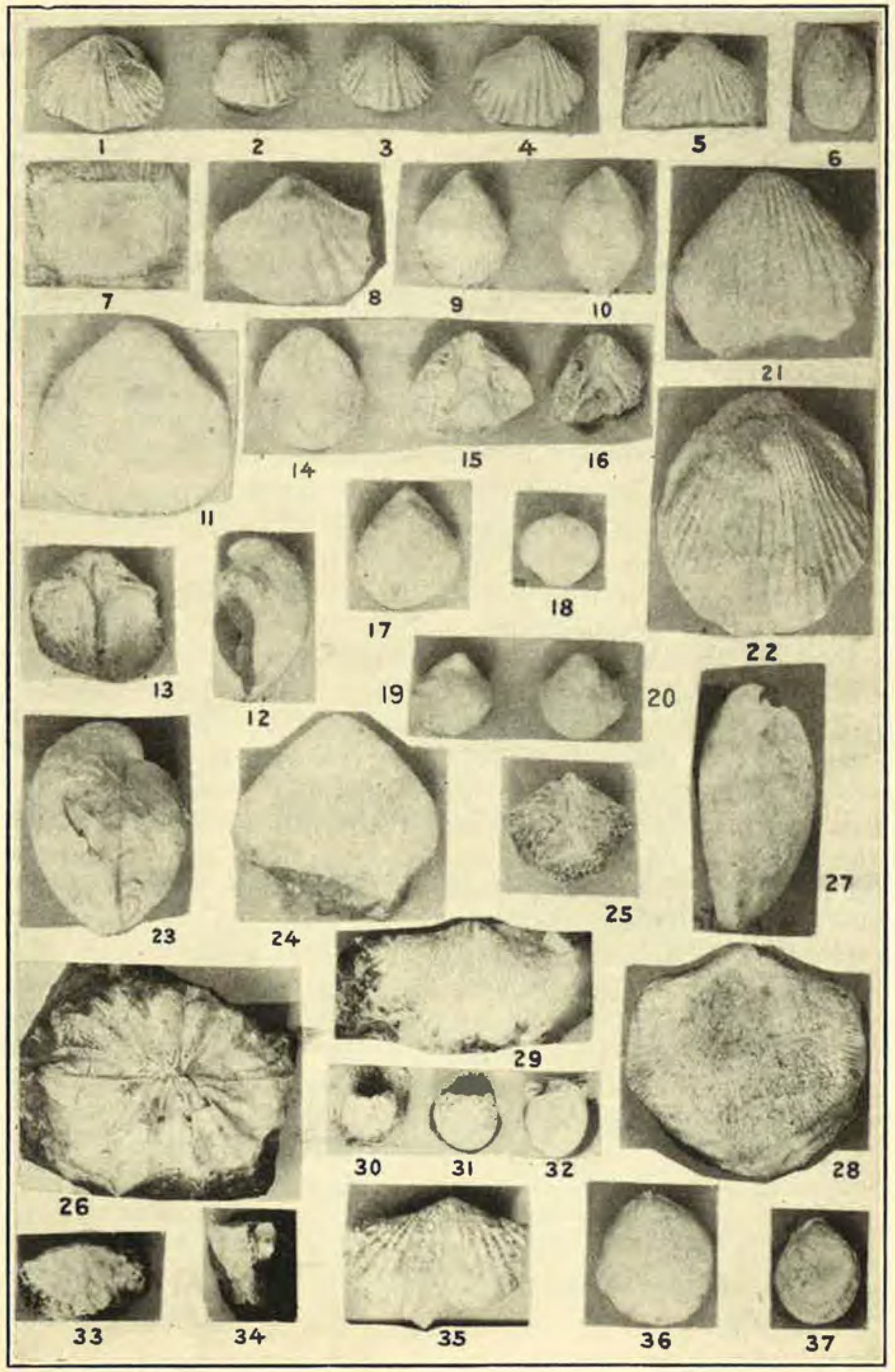
FIGS. 30-32. *Edriocrinus pocilliformis* Hall. Side views of dorsal cups. Becraft limestone, Nearpass, N. J. (30), lower part of Becraft limestone, Clifton Forge and Gala, Va. (31, 32).

FIGS. 33, 34. *Cyrtina varia* Clarke. Ventral and side views of ventral valves. Upper part of Becraft limestone, Back Creek Mt., near Warm Springs, Va.

FIG. 35. *Spirifer cyclopterus* Hall. Ventral view; right margin broken. Upper part of Becraft limestone, Back Creek Mt., near Warm Springs, Va.

FIGS. 36, 37. *Rensselaeria subglobosa* Weller. Dorsal views. Upper part of Becraft limestone, Back Creek Mt., west of Warm Springs, Va. (36); lower part of Oriskany (*Dalmanites dentatus* zone), Nearpass, N. J.

PLATE IV



# LYGODIUM PALMATUM IN PENNSYLVANIA

By D. S. Hartline

*State Teachers College, Bloomsburg, Pa.*

A plea for the preservation of a swamp near Hazleton, Pa., in which this climbing fern is native but disappearing because of human activities.

# THE POSSIBLE BIOLOGICAL SIGNIFICANCE OF THE INCREASED ACTIVITY OF X-RAYED TYROSINASE

By Robert T. Hance

*Department of Zoology, University of Pittsburgh*

During the past few years the writer has approached the problem of the biological effect of X-rays from several different angles. The investigation that has seemed most suggestive resulted in the production of white hairs on pigmented mice following the proper exposure. Since the chemistry of organic pigment formation is to some extent known it seemed possible that color change might be an index to the biochemical or biophysical reactions resulting from X-radiation. This pigment, melanin, is produced through the interaction of two substances, a color base called tyrosine and an oxidase enzyme, tyrosinase. The whole process can readily be demonstrated in a test-tube. Since the hair that replaced the original colored hair on the rayed mice was white it was evident that either the color base, the enzyme or both had been affected. Since tyrosinase is not particularly complex chemically and as enzymes have previously been altered through X-radiation a study of tyrosinase was indicated. As there is little or no free tyrosinase in the skin of mice it was necessary to turn to mushrooms and potatoes that contain it in large available quantities. When either of these plants is ground up in water and then filtered, a mixture of the filtrate with a solution of tyrosine results in melanin formation within a few hours.

Interestingly enough the exposure of either mushrooms or potatoes to X-rays before their extraction with water increases the activity of the enzyme in direct relation to the length of the exposure. In other words, within certain limits, the longer the enzyme in these plants is radiated the more melanin is produced when mixed with the solution of tyrosine. Here then is one of the first demonstrations of a quantitative biological effect of X-rays.



The above reaction resulting in an increased pigment production at first thought seems to be directly opposite to that obtained with mice where color is inhibited. There is, however, little if any free tyrosinase in the skin of the mouse. It seems, therefore, quite probable that in the case of the mouse the rays have affected and inhibited the source of enzyme production in the cells, while in the plants the enzyme itself has been exposed. In support of this suggestion are animals more recently rayed with a much lighter dose whose coats came in perceptibly darker than they were originally, thus bringing this phase of the work into complete harmony with the results obtained with mushrooms and potatoes. Obviously then the difference in reaction lies partly in the structure of the organism and partly in the adjustment of the dosage.

The increased activity of radiated tyrosinase, itself an oxidase, suggested a change in the powers of oxidation. The well known blackening of peeled potatoes when exposed to air prompted a test of the effect on the tyrosinase of definite exposures of potato mush to air. All exposures up to thirty minutes resulted in an increased melanin production when the air exposed enzyme was added to solutions of tyrosine. Longer exposures to air result in a progressive lessening of melanin production when the usual mixtures were made. As the potato mush becomes steadily darker with time the above reaction is interpreted as indicating that the enzyme is steadily used up in reaction with the tyrosine normally present in the potato and that consequently there is less and less to react with the tyrosine solution in the test-tube as time goes on. These experiments demonstrate a similar stimulation of tyrosinase when exposed to air as to X-rays.

The possibility that these changes in the oxidizing power of tyrosinase by X-rays might be reflected in the metabolism of exposed living organisms was borne out in preliminary respiration tests of mushrooms, potatoes and mice. These tests while somewhat crude have nevertheless shown quite definite and constant increases in the rate of respiration. These increases range between 20 and 30 per cent. While this increase in metabolism may be something entirely apart from the activation of tyrosinase, since both involve oxidative processes, they are very suggestive. Recently I have found the activity of yeast to be greatly accelerated under light X-radiation and retarded under long exposure. Mr. Snyder, of the Department of Zoology, has recently found the germination and early growth of sweet corn to be considerably accelerated following short exposures to X-rays and somewhat slowed after exposures of an hour or longer.

These lines of evidence: namely, the increased activity of tyrosinase following X-radiation; the similar activitation of this substance following mere exposure to air; the increase of the rate of respiration in radiated organisms, and with the increased activity of yeast and of corn under certain exposures; all strongly suggest that X-rays stimulate the oxidative processes of biological phenomena.

## *PIMPINELLA MAGMA* IN PENNSYLVANIA

By E. M. Gress
*State Botanist, Harrisburg*

This paper has been submitted for publication in Rhodora.

## DEMONSTRATION OF THE METHOD OF ULTRA-VIOLET MICRORADIATION

By E. A. Wolf
*Pittsburgh*

(Paper not submitted)

## PERIODICITY IN FUNGI

By Illo Hein
*State Forest School, Mt. Alto*

(Paper not submitted)

## THE DISTRIBUTION OF FISHES IN A TYPICAL PENNSYLVANIA STREAM

By Geddes W. Simpson
*Bucknell University*

The following bit of research was directed by Dr. Stewart in an endeavor to determine the causes of the death of fry planted in Buffalo Creek, Union County. A desire to know what fish actually inhabited the creek was also a factor.

While the information gathered is, perhaps, not new to the world of science, it is new for the particular territory studied and it is hoped that



it may serve as a guide to the scientific study of other creeks in other places. Thus it will be possible to restock most economically.

A seining permit having been obtained from the Game Commission, a fifteen foot ¼-inch seine and a thirty foot 1-inch mesh seine were used in determining the fish present. Thirty-eight places were seined from one to four times, resulting in thirty species being found and identified in the twenty miles of the main creek and a total of fifty miles in its four tributaries. All five of these streams rise in the mountains to the north of the main creek.

The distribution of fish seems to be determined by:

1. Food factors.
2. Temperature; influenced by light conditions, rapidity of flow, depth, etc.
3. Available retreats.
4. Enemies.

Trout were found in about 43 miles of the stream, always in the cooler waters of the upper reaches. Pickerel were found below the areas inhabited by the trout. There seems to be a sharp line between these two species, for only once were they found together.

Due probably to food and temperature conditions, bass and trout were found in different parts of the stream.

On the other hand, the black-nosed dace and the horned dace were found together eleven different times.

Some fish of limited range include:

1. The long-nosed dace, which was found only in rapids.
2. The bullhead, which was found only on mud bottoms.
3. The carp, which was found only near the mouth.
4. The sunfish-bass-pickerel group, which was found where the water was sunny, sluggish, warm and weedy.

Of the thousands of blue-gills, crappies, trout and others planted in Buffalo Creek in the past, only a very few have survived. In this particular creek this is believed to be due to:

1. Habitat. Freshets in particular probably sweep the fry into the river.
2. Lack of pools and other hiding places.
3. Lack of marsh land where insects may breed.
4. Prevalence of pickerel which prey on the fry.
5. Temperature conditions not suited to young fish.
6. Shallow condition of stream in mid-summer.

To restock scientifically one must know what conditions are present in the creek to be restocked and whether or not they are favorable to the species to be introduced. Otherwise the effort is wasted.

## HABITS OF AMPHIBIA IN WINTER

By Charles E. Mohr
*Bucknell University*

A study of the winter habits of our amphibia is a promising field for the naturalist in Pennsylvania and has received some attention recently at Bucknell University. The mountain ponds scattered through the Seven and Fourteen Mile Narrows in Union and Centre Counties were the most fruitful in this study. Numerous springs and streams also offered splendid opportunities for careful observations.

Although the interest during the past six months, from October to April, has been focused on salamanders, three frogs have been observed under winter conditions and will be noted.

Bull frogs, *Rana catesbeiana,* green frogs, *Rana clamitans,* and leopard frogs, *Rana pipiens,* have all been taken from deep springs. They have been buried in the muck and have come to the surface only when disturbed.

I have arbitrarily grouped the thirteen species of salamanders observed according to habitat:

I. A few salamanders are active throughout the year. These species are primarily aquatic.

Cave or long-tailed salamander—*Eurycea longicauda.*

Those living in springs have been observed during every month of the year. There are no winter records of those specimens which prefer a terrestrial habitat.

Purple salamander—*Gyrinophilus porphyriticus.*

These are active throughout the year in springs, and probably also in precipitous mountain streams such as Kitchen Creek.

Newt—*Triturus viridescens.*

The adult form may be found throughout the winter under the ice of ponds and dams. Immature specimens, the red eft form, were taken during March, under the bark of pine stumps.



II. Some salamanders spend the winter, others all their larval life, in the water.

Red salamander—*Pseudotriton ruber.*

The grayish, spotted larvae spend the first two and a half years of their life in springs. Of seventeen larvae taken from a single spring on February 26, the specimens were grouped in three distinct sizes, averaging 40, 65 and 95 mm.

Dusky salamander—*Desmognathus fuscus fuscus.*

Many Duskies spend the winter in ponds. They were taken in November under stones and logs in dried up ponds, and, in January, in water under the ice in the same ponds. Duskies may also usually be found under stones partly submerged at the edge of small streams.

Two-lined salamander—*Eurycea bislineata bislineata.*

The larvae have been taken in and about springs throughout the year. The adults have been found only under stones in moist, unfrozen earth close to streams or springs.

III. A few salamanders are entirely terrestrial, hence they can be found in a terrestrial habitat during the winter. They may usually be found under stones, very seldom under logs, probably because stones retain some of the sun's heat. Logs soak up water and freeze solidly to the ground.

Red-backed salamander—*Plethodon cinereus erythonotus.*

Specimens taken as late as December 15 were active when picked up. Fourteen specimens observed March 23 were under stones, under the bark on the stumps of large pine trees, or in the rotten wood. A few were pursued several inches as they retreated through the passages of the porous wood, and several were taken from the heart of a stump.

Slimy salamander—*Plethodon glutinosus.*

The only specimen of this fall-breeding species was taken in March beneath the bark on a pine stump.

Mountain salamander—*Desmognathus fuscus ochrophaeus.*

The mountain salamander, which is easily distinguished from the dusky by a straight-edged stripe down the back, is partial to high altitudes. While it was found commonly during the summer at Eagles Mere, under rocks and stones in rich forest distant from water, a prolonged search of the identical locality in the late fall failed to bring a single specimen to light.

IV. Several salamanders spend most of their life on land, migrating to the ponds in late winter or early spring to mate and lay their eggs.

Four-toed salamander—*Hemidactylium scutatum.*

This species lays its eggs in the sphagnum moss at the edge of ponds about the middle of April. The winter is spent on land.

A new first record for this species, March 23, was established this year, when a specimen was taken under a large stone twenty feet from the water. Dr. S. C. Bishop gives April 7 as his early record for this species. Two were found last year on April 2, under stones in deciduous woods, three yards and sixty yards from water.

Spotted salamander—*Ambystoma maculatum.*

Both the spotted and Jefferson's salamanders may be easily taken at night as they migrate to mountain ponds to breed. Dr. Bishop reports that the first warm rains and a temperature above 32°, at night, is sufficient to start them off and to open the ice-covered ponds at the margins. "Subsequent freezing does not bother them much, and I have found both species depositing eggs in water on the surface of the ice."

Our first specimens this year were taken March 23. During the next few days the small milky white spermatophores became numerous. The first eggs were not taken until March 28. The eggs are contained in a firm mass of gelatine either clear as glass or milky white. The cause of the opacity of some masses is not definitely known. Of 650 masses observed last year, 225 were clear, the other two-thirds were opaque. Larvae from both types were hatched in the laboratory.

Jefferson's salamander—*Ambystoma jeffersonianum.*

Spermatophores of *A. jeffersonianum* have never been found and its early egg-laying suggests the possibility of an autumnal fertilization. The first specimens were taken on March 24. Eggs discovered at the same time were less than two days old; accordingly the time of the deposition may be closely estimated.

The eggs, which have a conspicuous close-fitting envelop, are always in clear gelatine. The eggs in each mass are less numerous than those of *A. maculatum,* and the gelatine is much less firm. They are often arranged spirally about roots, twigs or grass.

Marbled salamander—*Ambystoma opacum.*

Dr. Surface's records of the marbled salamander from three eastern counties are the only records we have for Pennsylvania. However, the capture on March 24 of Ambystoma larvae, 21 mm. in length, in mountain ponds together with newly laid eggs, indicated the presence of a fall breeding species.



The marbled salamander is known to lay its eggs in dry depressions in the late fall. They hatch when rain fills the ponds. They live under the ice during the winter, and by March 24 have lost their balancers, have fore legs with three digits, and are developing hind legs. Two rows of white spots on the sides of our specimens correspond to the markings on slightly larger larvae of *A. opacum* collected in North Carolina.

Specimens of the larvae were sent to Dr. S. C. Bishop for identification. His letter, received a few hours before this paper was given, confirmed our findings: "Your larvae have all the ear-marks of *A. opacum.*"

Further records of this species for Pennsylvania are earnestly desired.

## CEPHENOMYIA, A PROBABLE CAUSE OF DEATH AMONG DEER

By N. H. Stewart

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(Abstract)

The discovery of seven maggots of the parasitic fly, Cephenomyia, in the nasal chambers of a dead deer suggests that the deer are affected with myiasis. Many deer have been found dead in the woods from causes not fully determined. Some people believe starvation is the leading cause, but it is possible that this head maggot is responsible for many deaths among our deer.

Inquiry reveals that this parasite has been found in Alaska, Maine, Colorado and Minnesota and is therefore doubtless distributed over the intervening country. The symptoms include inflamation of the lining of the nasal chamber. Persons are needed to examine deer found dead in Pennsylvania. This may be done, after obtaining permission of a game warden, by dividing the head of such deer. Coffee brown and bright red areas of the lining membranes indicate the infection. It is hoped that in the winter and spring of 1929–30 conclusions may be reached as to how far this parasite weakens or actually causes the death of the animals affected. Any information obtained should be forwarded to the author.

Larva from Deer (Cephenomyia)

# HIGHWAY PROTECTION AND BEAUTIFICATION

By John W. Keller
*Highway Forester*

The Commonwealth of Pennsylvania has been a leader in durable road construction and maintenance of highways since the beginning of the good roads movement, and as a consequence it has constructed thousands of miles of concrete and macadam roadways. However, while thus engaged, its major activities have been in the creation of the road itself rather than in protecting and beautifying the environs, with the result that the State finds itself outclassed by its neighbors in a phase of highway development and refinement interesting to everyone who traverses these arteries of communication.

Wayne County, Michigan, probably has done more in this direction than any similar organization. Its master plan provides for super highways 204 feet wide, intermediate roads 120 feet wide and a supplementary system of thoroughfares of lesser widths. The roadsides are being planted with ornamental trees, flowering shrubs, vines and grasses, which are worked into the landscape in such a manner that they have the appearance of a well-kept country estate, while steep slopes are sodded and gentle slopes covered with vines and shrubs. The Board of County Road Commissioners is the group of public officials who are sufficiently civic-minded to maintain a Forestry Unit made up of five trained foresters, one landscape architect, one field superintendent and eight tree foremen, under whom work groups of six to fifteen laborers. A member of this personnel is a public utility forester whose duty is to supervise the placing of utility poles and issue permits for trimming, planting and removal of trees.

The State of Massachusetts is a close rival to the Lake State in a movement to prolong the life of its highways and improve their surroundings. The organization having to do with the furtherance of such plans is headed by a highway landscape supervisor, under whose direction natural growth is protected and maintained, as well as planted from a nursery whose major purpose is the propagation of plants peculiar to the State. Spraying and tree surgery are naturally very important phases of this supervision. An interesting sidelight is thrown on this highway beautification program in the insistence that the State's personality be reflected and natural plants be a major part of the planting scheme.

A third idea for catering to the aesthetic in highways is being carried out by Connecticut. In this little state two landscape architects draft plans which are carried out by numerous tree wardens, who are members of a landscape division in the Highway Department. Landscape labor crews are stationed at various locations and confine their efforts to planting, trimming and caring for trees and shrubs, the maintenance crews having little or nothing to do in this direction. That this work may be in no wise hindered or endure a handicap, the State has vested in its chief highway executive authority to take possession, in the name of the State, of trees along the highways, or those in woodlands bordering State highways. The plan is strengthened by the requirement that the Highway Commissioner give written consent to the cutting, pruning, trimming or removal of any natural growth.



California seems to have left nothing undone to make of itself an ideal vacation land. The love of a Californian for his State is proverbial and well it might be, for here, as in few other States, public-spirited organizations are planting trees which, after the first growing season, are taken over and maintained by the Highway Department. The value of the State's highways is enhanced both as to beauty and utility, the former through the efforts of an arborculturist who is employed to train and direct highway foremen in the care and protection of trees. That this is done is shown in the preservation of many fine old roadside trees, even to the extent of relocating the highway; and this seems to be but a beginning, for plans are now under consideration which will place in each highway district a trained man who will give his exclusive attention to the planting and trimming of trees and shrubs.

Having completed the circle of those States whose work in highway beautification is the most outstanding, we return to our own Commonwealth, for since such activities have been carried on for years by other States and have the approval of the Federal Government as well, it would seem that the time has arrived in the development of Pennsylvania's road building program when some attention should be given to those aspects of road building not strictly economic. To this end a Forestry Unit has been organized, the personnel being composed of a Highway Forester with headquarters at Harrisburg; under this executive operate eight division foresters, each one trained in forestry or landscape architecture, and one being located in each of the eight sections into which the State is divided. This unit is responsible for planting and maintaining all growth along the State highways. Caretakers and other highway employes receive instructions in the care of plantings, drafting detailed plans for their protection, supervising planting and maintenance crews, and—a by no means unimportant phase of the development of highway beautification—interest the public by lectures and personal contacts.

The Pennsylvania plan provides for protection plantings, beautification plantings, and opening of scenic views. The first will have to do with establishing growth on slopes to prevent erosion, planting of lines of evergreen trees to serve as permanent snowbreaks, and outlining dangerous locations, such as culverts, ditches, curves and triangle intersections. The function of protection plantings is to reduce maintenance costs, as well as warn traffic of danger, and as a consequence of its being primary it will be undertaken first.

Beautification plantings are just what the term implies and will consist of planting shade trees in avenue arrangement on straight stretches of roads, placing of screens of low-growing shrubs to cut off views of railroad embankments, automobile graveyards, public dumps, quarries and any other view which is a blot upon the landscape. Roadside monuments, traffic signs and weighing grounds will have as a background mass plantings and shrubs, trees and perennial flowers. That the public may have a part in this creation of beautiful landscapes, local individuals or organizations desiring to cooperate will have the benefit of advice from the Department as to selection of planting stock, delivering it to the roadside where it will be planted and maintained by the Department.

Every motorist has had the experience of passing within a few feet of a beautiful panorama without suspecting its existence for no other reason than that the vista was obscured by a dense mass of low-growing trees and shrubs. Within a few years it is hoped that an occurrence of this kind will be infrequent as the third and final step in the plan is developed and obstructions to scenic views of major import are removed.

## Slopes

The cause of slides on slopes along the highways is usually from alternate freezing and thawing, or an excessive amount of moisture in the soil which makes it heavy, gravity causing it to seek a lower level. The soils most difficult to handle are the micaceous or chloritic, which are greasy and fine grained, such as are found in southeastern Pennsylvania; and limestone that weathers down to a fine clay loam, easily penetrated by water and becoming slippery when wet. This latter soil is found in the Cumberland Valley eastward to Allentown. A third are the sand and clay loams prevalent throughout the State, and the most frequent cause of slides. These annoyances to road builders can be covered by plants to check surface erosion, the roots serving to hold the soil and prevent slides, which at times have become so much of an annoyance that it has been necessary to hold the soil by mechanical means until root systems become established. Another method of preventing slides is to remove the excessive water by drains. Where it happens that steep slopes have at their base a supply of water which would tend to undermine them, the soil has been kept in place by willow or poplar poles placed perpendicularly on the slopes three feet apart, with the large ends in the water at the base of the slope. It is necessary that the poles be partly buried in the ground, and they may be held in place by nailing or wiring to strips laid horizontally on the slopes. Poles should be cut from live trees in March and placed in position in April. If this is done, sprouts will come out along the entire length of the pole, cover the slope and prevent erosion of the soil. At the same time the poles will be throwing out roots at the base, which will also serve to fix the soil. This method has been very successfully employed in difficult slopes along railroads, highways and water courses. It is not advised, however, for use in soils that dry out during the summer. In such places rooted plants must be used, willow or poplar roots from two-inch trees, planted to a depth of several feet and the top cut off six to ten inches above the ground, serving the purpose very well. Within a short time such roots become firmly established below the point of washing, and the large number of sprouts on the trunks prevent slides. If roots from these vigorous growers are not available, a two-inch plank supported by posts three feet apart driven into the ground from four to five feet will hold the soil for several years. These methods are, of course, nothing more than temporary measures, and should be used only where excessive erosion causes continuous annoyance and expense. The slopes should, at first opportunity, be planted at two-foot intervals with a rugged planting, such as matrimony vine, care being taken that the soil about the roots is fertile and has had a liberal application of fertilizer.



Steep, long slopes are frequently a source of trouble, even though the amount of soil dislodged is not large enough to endanger traffic. Where the shale or slate soils have been loosened by alternate freezing and thawing, and washed by heavy rains, and the slope is so steep as to prevent planting on its face, native honeysuckle or creeping roses planted along the top and trained down the face of the slope will, in four to ten years, completely cover it and hold the soil. These, as well as matrimony vines, will have a definite utility value if used in agricultural localities on the top of short slopes steeper than 45 degrees. A gentler slope may be effectively treated by planting flowering shrubs, such as weeping forsythia, coralberry and matrimony vine, one-third of the distance from the top.

A complete reversal of this treatment is necessary in wooded areas. Jersey tea, nine bark, witch hazel, laurel, azalea, St. John's wort, red osier, hard pine and Japanese larch will do well on the face of the slope, but not at the top because of root competition. Where the soil slides, a mechanical support such as a wood or metal post should be used as a preventive until the roots of plantings become established. Fills subject to washing by streams or torrential rains may be planted with rugged matromony vine or honeysuckle, outside of the guard fence, and trained down the slope. These vines are very hardy and withstand rough treatment as injuries by floating ice or other agencies will cause them to become more dense and prolific.

In agricultural localities slopes of soils fixed or partially fixed lend themselves to planting over their entire area with honeysuckle, creeping roses, matrimony vines, weeping forsythia, coralberry, periwinkle, pachysandra, winter berry, Boston ivy, cotoneaster, or similar vines and spreading shrubs, but the same treatment should be given slopes in wooded areas as is recommended for those of shale or slate soils.

In the treatment of slopes it should be rembered that all plantings should be placed in a perpendicular position, as related to the horizontal, not perpendicular to the slope, since plants grow toward the sun regardless of their position.

During the past year the Pennsylvania Department of Highways spent approximately $500,000 in the removal of slides from water courses, and while it is not believed that the planting of slopes will entirely eliminate this expenditure, undoubtedly it will be materially reduced. It is common for stones and ground to be washed on the highways from nearby fields, and it is to prevent such happenings that the effort is being made to establish plantings which will serve individual purposes and meet specific conditions.

### Live Snowbreaks

In the Northwest the railroads have established hundreds of miles of live snowbreaks, which are more effective than temporary snow fences. It has been found that the annual cost of erecting, maintaining and removing such temporary snow fences exceeds the final cost of establishing evergreen trees. While it may not be practical to plant live snowbreaks at all locations where the drifting of snow is to be prevented, as along highways passing through high-priced agricultural land, it would seem to be good stewardship to employ them in locations where the topography causes heavy drifts each winter, if this can be done at a cost equal to or lower than that of the temporary snow fence. The railroad experience



has been that American arbor vitae, Norway spruce and Scotch pine, from 12 to 18 inches high in two or three rows 4 feet apart, 40 to 60 feet from the highway, and maintained at a height not to exceed 10 feet, develop into the most effective snowbreaks.

### Miscellaneous Protection Plantings

Stakes of wood or iron driven into the ground in front of culverts prevent snow plows from damaging the concrete headwall. Specimen regals privet, Jap barberry or plants of similar growing habits, not easily broken by weight of excessive snow, planted on both sides of a culvert and maintained at a height of four feet, serve the same purpose, have a better appearance, and make unnecessary the annual placing and removing of temporary posts.

The culvert entrances necessarily are ditches and their slopes have a tendency to wear away and fill up the water courses. Vines and trailing shrubs on these slopes hold the soil and are most effective in keeping open underground drains. They must not, however, be permitted to grow into the culverts and thereby impede drainage. Plants that are hard to maintain or keep under control should not be used for this purpose.

Motorists are prone to drive over the point of a "Y" road intersection rather than around it, and if plantings are placed at such an intersection, on an area raised ten inches above the roadway, they will serve as an accident preventive and add a touch of the beautiful. Forsythia, spirea, duetzia, snowberry and other flowering shrubs, with a few evergreens, kept at a height which will not obstruct the view, greatly improve such locations. To prevent careless drivers from maltreating the plants, a few concrete posts ten inches above the ground can be advantageously employed. This feature of highway beautification may be maintained by interested individuals without cost to the Department.

Dangerous curves can be rendered less so by planting a mass of low-growing evergreens, such as laurel, yew or privet, outside the water courses or guard fence. Care should be exercised that they do not obstruct a desirable view. Shrubs also may be so placed as form a background for danger signs.

### Beautification

From the standpoint of ease of transportation, a smooth, durable road is all that is required, but the modern highway is a part of our advanced civilization and must have more than a utility value. Our homes, churches and cities are beautified at great cost and the time is fast approaching when our highways will be similarly treated. The public is developing civic pride. This pride demonstrates itself in demands made upon the Department of Highways by organizations and individuals for beautification plantings.

However much beautification may be in demand it must, for the present, take second place as protection plantings needed in all parts of Pennsylvania will absorb available planting funds. That the ideas of those proffering suggestions may be carried out, a policy of cooperation has been adopted, which permits the Department to draw plans recommending suitable plants and locations, as well as maintain the trees, shrubs and vines which individuals may provide. In 1928 more than 4,000 trees were planted under this policy and for this year there is a promise of the work being materially amplified.

The first impression of the average citizen when referring to roadside planting is that it has to do exclusively with shade trees in avenue arrangement. The idea of the "world and his wife" is most aptly outlined in the June, 1928, issue of the "Kiwanis Magazine," from which the following quotation is taken:

> "To change a punctured tire—to eat a roadside lunch—to pause and view the scenery—to stop and let the engine cool—to tell her how nice she is—to take a sip of water out of the thermos bottle. A shady spot! The old winding country road is no more, the rambling brookside and forest-lined dirt road are things of the past. The new highway has sacrificed beauty to the great god Speed. What a boon to the world on wheels would be a row of trees planted in that right-of-way space between the edge of the cement road and the barbed wire fence. No man who has driven a motor car through a shady road and removed his hat to let the shade-cooled breezes sweep through his hair can fail to see the beauty of roadside trees."

America is far behind European countries in the shaded roadway. The lines of stately poplars between which one drives on the French highway are never to be forgotten by those who have beheld them. The flowering trees which border the roadways of England are a delight to tourists and natives as well. The time is not far distant, however, when American motorists will enjoy similar delights, for certainly avenues of stately trees are desirable along straight stretches of highways where the trees are so located that they will not interfere with the safety of traffic, cut off desirable views of the adjacent landscape, or interfere with the rights of land owners or utility companies having a legal right to use the highway.

Avenues of shade trees are not effective as a break to drifting snow, nor do they have a value for lumber or fruit production. In reality, they justify themselves only because they furnish shade, are pleasing to the eye, and cool the air by cutting off the direct rays of the sun.



Some owners of land adjacent to the highways look favorably upon roadside plantings, and have planted trees, shrubs, vines and flowers upon their properties. Others do not favor shade trees because the land immediately beneath the branches does not produce as heavily as land in the open. This latter point is well taken and each owner must determine whether or not shade trees will increase the value of his property and reimburse him for the loss in production. However, the interest of both classes of land owners must be respected and consideration given to their views. This being true the department of Highways seeks the fullest cooperation of both groups.

Surface rooted trees have a tendency to raise the concrete and to break the durable roadway. Such trees should never be planted close to the highway. Trees which will cut off a view in such a way as to endanger traffic should have all branches removed to a height of fifteen feet or more. It is not beyond the realm of the possible to screen from the view of passing motorists by the use of flowering shrubs such as red bud, dogwood, hawthorn or lower growing shrubs, such as forsythia, spirea and duetzia, the undesirable views of public dumps, railroad embankments and automobile graveyards. Curative measures, such as this, are part of the scheme of highway beautification in Pennsylvania.

The Pennsylvania Historic Commission and many local historical organizations have placed numerous monuments along the highways throughout the State. In most cases these monuments are artistic, but their setting is barren and uninteresting. The expense of base plantings, which will enhance the beauty of the monument, is not large and certainly is justified, since they call attention to the monuments themselves.

The Department's activities require the location of weighing grounds in many parts of the State. These now protrude themselves upon the highway and their utility value is lessened by the very fact that they are so unbeautiful. Converted into beauty spots by a few flowering plants that will make these places a mass of bloom in summer and evergreens to brighten the winter landscape, their value may be increased.

In the annual mowing of level roadsides and gentle slopes outside the water courses, native perennial flowers have been crowded out by weeds and hardy grasses. A bit of color may be introduced at such locations by planting shasta daisies, phlox and other flowering perennials which, while they spread rapidly and may cause trouble for the adjacent land owners if permitted to escape into nearby fields, can be readily controlled with proper care.

The time has arrived in Pennsylvania's road building program when expenditures incident to protection and beautification of the roadsides can no longer be regarded as luxuries. Any cost incident to the planting and care of trees, shrubs, vines and flowers will be returned through a reduction in the costs of highway maintenance. The public is fast realizing that a thing to be useful must not necessarily be ugly. Color is everywhere. It has taken its place in the household as never before. It has invaded the circumspect and conservative field of automobile design. A riot of color in one's surroundings is no longer considered bad taste. Why then should not color be brought into the scheme of building highways? Beauty has a definite place in the life of everyone and it is no longer possible to disregard it. Pennsylvania has been in the vanguard of highway builders. Its methods have been imitated and copied at home and abroad. It cannot afford to be a laggard in highway protection and beautification.

## PHOTORECEPTORS IN MYA ARENARIA L.

By V. Earl Light
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It has been known for some time that the long-neck clam, Mya arenaria, responds to light by withdrawing the tip of the siphon when it is stimulated by increased illumination.

Various investigators, however, in ascertaining the reaction time in this animal, arrived at different conclusions. None of these workers took into account the location and nature of the structures involved in the perception of light. The facts here presented are results of an investigation designed to ascertain the location, structure and function of the photosensitive tissue in Mya.

The investigation was conducted along two lines: First, the location of the photosensitive region was found by a series of experiments in which the reaction of the animals to light, under various conditions, was observed. Second, a histological study of the photosensitive region was made in order to verify the location of the photosensitive tissue, and to learn something concerning the structure and probable function of this tissue.

By subjecting the siphon to lateral illumination and to illumination directed into them, it was found that the animals are more sensitive to illumination of the inner surface than of the outer surface of the siphons; and the reaction time was found to be shorter with the siphons open than with them closed. This indicated that the photosensitive tissue is located somewhere near the inner surface of the siphons.



Illumination of relatively equal portions of siphons laterally, indicated that the tip is more sensitive than the middle and the middle more sensitive than the base. This, however, proved not to be true, as will be seen later. Illumination of the water alone near the tip of the siphon caused a reaction in the majority of the tests when the siphons were open, thus again indicating that the photosensitive tissue is near the inner surface of the siphon. A comparison of the reaction time when small areas of the siphon are laterally illuminated, with the reaction time when large areas are illuminated, shows a more rapid reaction in the latter case, thus indicating that the time of reaction is dependent upon the quantity of photosensitive tissue illuminated.

The distribution of photosensitive tissue near the inner surface of the siphon was ascertained by subjecting animals to illumination with various lengths of siphon removed. The reaction times of animals were obtained before removing any portion of the siphon, then a quarter of the length of the siphon was removed in each animal, and the reaction times obtained. In the same way, a week later, another quarter of the length of the siphon was removed, and the reaction times were taken. At weekly intervals thereafter three-quarters of the length of the siphon, and the entire siphon were successively removed, and the reaction times obtained after each operation. The cut off portions of siphon were prepared for histological study after each operation.

The reaction times obtained by the method just described showed that the animals are more sensitive at the middle of the siphon than elsewhere, and that the sensitivity decreases both toward the tip and toward the base of the siphon with very little sensitivity at the base. This indicates that there is more photosensitive tissue near the middle of the siphon than elsewhere.

A histological study of cut off portions of siphons shows that there are specialized cells just beneath the inner epithelial layer of the siphons. These cells are pear-shaped, take on the characteristic silver-nitrate stain for nerve tissue, and are connected with nerve fibers branching from sixteen large nerves which extend the length of the siphon.

The number of these specialized cells found in various portions of the siphon correlates with the reaction time obtained for the corresponding positions on the siphon, *i.e.*, the cells are more numerous near the middle of the siphon where the reaction time is shortest, and diminish in number both toward the tip and toward the base of the siphon, where the reaction time increases.

The pear-shaped cells vary considerably in size and shape, from 9 to 15 $\mu$ in length and from 5 to 10 $\mu$ in width, and usually have a single connection with a nerve fiber, although occasional cells are found with two nerve fiber attachments.

A rather large structure, characteristic of these cells, is found in the distal end of each cell. These structures are hyaline in nature and are surrounded by a neurofibrillar network. Light, reflected from a flat mirror through these structures, is brought to a focus on the neurofibrillar network, irrespective of the direction in which the light passes through them. The neurofibrillar network is connected directly with neurofibrils anastomosing through the cytoplasm of the cell and connected with the nerve fiber entering the cell. The hyaline interior of these structures is in reality a lens, which focuses the light on the neurofibrillar network surrounding it. This network has been called a "retinella," and because of the ability to refract light and focus it on the retinella, the specialized structures have been called "optic organelles."

The pear-shaped cells are similar in structure and function to the visual cells in the leeches, and the photoreceptors in the earthworm. Available data indicate that they function as photoreceptors and that the fibrillae of the retinella are direct receptors of light stimuli.

The pigment spots found in considerable number on the distal third of the siphon, and thought by some workers to be eye-spots, are, owing to simulation of the background, probably protective in nature rather than functional in photoreception.

The habits of the animal are such that photoreceptors located along the inner surface of the siphon enable the animal to protect itself against its enemies.

## PROBLEMS INVOLVED IN MAKING AN ENTOMOLOGICAL SURVEY OF A LITTLE KNOWN REGION

By S. H. Williams
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(Paper not submitted)

## THE CORONA

By John H. Wayman
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A demonstration of the speaker's idea of the corona, illustrated by chart and electric light.