PROCEEDINGS

OF THE

PENNSYLVANIA ACADEMY OF SCIENCE

VOLUME VI

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HARRISBURG, PENNSYLVANIA
1932

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OFFICERS

1932–33

President .... SAMUEL H. WILLIAMS, Pittsburgh
Vice-President .... JOHN C. JOHNSON, West Chester
Secretary .... T. L. GUYTON, Harrisburg
Assistant Secretary .... V. EARL LIGHT, Annville
Treasurer .... H. W. THURSTON, JR., State College
Editor .... R. W. STONE, Harrisburg

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PENNSYLVANIA ACADEMY OF SCIENCE

MINUTES OF THE EIGHTH ANNUAL MEETING OF THE PENNSYLVANIA ACADEMY OF SCIENCE

WEST CHESTER, PENNSYLVANIA—MARCH 25 AND 26, 1932

The eighth annual meeting of the Pennsylvania Academy of Science was called to order at nine o'clock, March 25, 1932, in Science Hall, State Teachers College, West Chester, Pennsylvania, Dr. E. M. Gress, presiding. The academy was welcomed to West Chester by Dr. John C. Johnson, Professor of Biology of the college. At a brief business session, the reports of the secretary, treasurer, editor and of special committees were called for. The secretary and editor gave their reports; the treasurer being absent a statement of the finances of the Academy was read by the secretary.

The following committees were appointed by the president:

Nominating Committee: Robert T. Hance, Chairman; D. S. Hartline, Geo. H. Ashley.

Resolutions Committee: R. N. Davis, Chairman; E. A. Ziegler.

REPORT OF THE SECRETARY, PENNSYLVANIA ACADEMY OF SCIENCE, 1931–1932

The seventh annual meeting of the Pennsylvania Academy of Science was held in Harrisburg, April 3 and 4, 1931. The meeting was presided over by Professor D. S. Hartline, President, Bloomsburg. Reports of the secretary and treasurer were heard and adopted. Forty-seven papers were presented before the Academy at this meeting.

The evening lecture was given by Dr. H. J. Rose, Director of the Koppers Research Corporation, Pittsburgh. He told of the by-products from the coke ovens in the coking of bituminous coal.

A trip was made to Indian Echo cave in the limestone formations at Hummelstown. A new part of the cave not previously opened to visitors was seen by the members of the Academy.

Sixty-five persons were elected to active membership in the Academy. A large percentage of these are members of the American Association for the Advancement of Science.

Upon motion, the president was empowered to appoint a committee or committees to consider the matter of dividing the Academy into sections. Accordingly with this thought in mind, the following men were appointed as sub-chairmen on the program committee:

Dr. N. H. Stewart, Zoology; Dr. Thomas D. Cope, Physics; Dr. Alexander Silverman, Chemistry; Dr. Joseph B. Reynolds, Mathematics; Mr. Ralph W. Stone, Geology; Professor D. S. Hartline, Education; Dr. J. P. Kelley, Botany.

The president was further instructed to appoint a committee to look into the matter of a depository for our publication, and ways and means of establishing an exchange list. This committee is composed of Dr. George H. Ashley, Chairman, Dr. T. L. Guyton and the president as an ex-officio member.

Suitable resolutions were presented by the resolutions committee, thanking Dr. Rose for his address and thanking the superintendent of the Department of Property and Supplies for the use of the auditorium in the South Office Building.

The nominating committee recommended the following as officers for the year 1931–1932:

President—Dr. E. M. Gress;
Vice-President—Dr. Samuel H. Williams;
Secretary—Dr. T. L. Guyton;
Treasurer—Dr. H. W. Thurston;
Editor—Mr. R. W. Stone;
Ass't. Secretary—To be selected by the secretary;
Executive Committee—The elected officers and
Professor D. S. Hartline,
Dr. R. T. Hance,
Dr. F. D. Kern,
Dr. E. A. Ziegler,
Dr. Norman H. Stewart.

Upon invitation from authorities of West Chester State Teachers College, it was decided that West Chester would be selected as the place for the eighth annual meeting.

The time and place for the summer meeting for 1932 was put in the hands of the executive committee, who decided to accept the invitation of Mr. R. N. Davis, Director of the Everhart Museum, Scranton, and make that place the headquarters. The date was August 14 and 15.

Moosic Lake and Nay Aug Park were the places of interest visited the first day. Moosic Lake is a typical mountain lake and is surrounded by an extremely interesting cover of plants. Nay Aug Park has much to offer in the way of geology and has within its boundaries a hard coal mine which is fitted for exhibition purposes.

In the evening a lecture was given by Professor H. A. Itter, Lafayette College, in which he discussed the origin of the drainage system of eastern Pennsylvania and New Jersey.

On August 15, the members visited a coal mine in the northern part of Scranton and then visited the famous Archbald pothole, which is undoubtedly of glacial origin. It is 45 feet deep and about 35 feet in diameter. At present, there are no indications of a stream near the hole.

At a brief business session, three persons were elected to active membership.

The president appointed the following membership committee: Dr. S. H. Williams, Chairman, Dr. Robert P. Marsh, Dr. J. A. Foberg, Miss Cora A. Smith, Dr. Rodney H. True, Professor Elna Nelson, Dr. Vernon Haber and Dr. John T. Gamble.

The local arrangements committee for the eighth annual meeting at West Chester, March 25 and 26, 1932, is composed of the following: Dr. John C. Johnson, Chairman, Dr. S. C. Schmucker and Dr. Paul McCorkle. The entertainment committee is as follows: Professor J. Arthur Lewis, Chairman, Miss Thelma J. Greenwood, and Miss Dorothy Schmucker.

Volume V of the Proceedings was mailed to the members in September. This contained 142 pages of papers and abstracts presented at the annual meeting in 1931.

The Academy was represented at the meeting of the American Association for the Advancement of Science held in New Orleans, by Dr. J. Ben Hill. A report of this meeting will be given later.

During the year the secretary has received three resignations and 26 members were dropped from the roll for non-payment of dues.

T. L. GUYTON, *Secretary*

Treasurer's Report

March 24, 1932

Receipts

Balance on hand April 1, 1931	$ 510.22
Dues received April 1, 1931–March 24, 1932	634.00
A. A. A. S. rebates	12.00
Miscellaneous—postage	.26
	$1,273.08

Disbursements

For Proceedings Vol. 5	$ 635.47
Stationery	48.65
Secretary's account	143.66
Treasurer's account	31.50
Summer meeting 1931 and miscellaneous	25.00
Cash in bank	388.80
	$1,273.08

(Signed) H. W. Thurston,
Treasurer.

This report was read to the Academy by the secretary and was not subject to an audit, this to take place later.

The editor's report briefly summarized the importance of having the papers well prepared and abstracted, and the titles boiled down to the fewest possible words.

The following papers were then presented:

Study of an Epidemic of Poliomyelitis in Lancaster County, Pennsylvania. W. G. Hutchinson, Franklin and Marshall College.

Amphipod Responses to Environmental Stimuli. William Hudson Behney, University of Vermont.

Malignancy in a Splenectomized Rat. Clarence A. Horn, Albright College.

A Thermotropic Gradient Apparatus. M. W. Eddy and D. I. Gleim, Dickinson College.

Ecological Studies of Serpentine-barren Plants. Edgar T. Wherry, University of Pennsylvania.

The Influence of Visual Fusion on Mental Integration. Charles Selzer, State Teachers College, West Chester.

A List of the Sawflies of the Subfamily Tenthredininae of Pennsylvania. Homer C. Will, Juniata College.

A List of the Synonymy of the Subfamily Tenthredininae. Homer C. Will, Juniata College.

Fossil-hunting Grounds in Pennsylvania. Bradford Willard, Pennsylvania Topographic and Geologic Survey.

What Relations May Properly be Established Between the State Academy and the Local Science Clubs. Karl F. Oerlein, Upper Darby Senior High School.

Twinning in a Chick Embryo. Earl Hoover, Lebanon Valley College.

Stem Anatomy of Tomato, *Lycopersicum esculentum* L. Ruth S. Clark, University of Pennsylvania.

The Meaning of the Uncertainty Principle. Enos E. Witmer, University of Pennsylvania.

Dust on Lath and Plaster. T. D. Cope, University of Pennsylvania.

Family Stock Betterment, with Reference to Left-handedness. Alfred Gordon, Philadelphia.

Address of the President: The Pennsylvania Academy of Science and the Field of Research. E. M. Gress, Pennsylvania Department of Agriculture.

Some Observations on Seed Production on Presque Isle, Pennsylvania. Richard V. Morrissey, University of Pittsburgh.

Further Studies in the Physiology of the Prostate Gland. (By title only). B. H. Kettelkamp, University of Pittsburgh.

Toy Fishes in the Laboratory. (By title only). William A. Schubert, University of Pittsburgh.

Chromosomal Lengths in Five Varieties of the Garden Pea (*Pisum sativum*). (By title only). H. A. Bruce, University of Pittsburgh.

Cell Size in Relation to Chromosome Lengths in Garden Peas. (By title only). H. A. Bruce, University of Pittsburgh.

Results of Recent Physiographic Studies in Pennsylvania. Geo. H. Ashley, State Geologist, Harrisburg.

Pennsylvania Fireballs in 1931. Chas. P. Olivier, University of Pennsylvania.

The Toxicity of Thorium to the White Lupine and Its Antagonisms. Rodney H. True and L. E. Yocum, University of Pennsylvania.

The Spiracular Circulation in the Dogfish. R. A. Torgesen, J. H. Guy and K. L. Kelley, University of Pittsburgh.

Observations on the Pelvic Musculature of *Necturus maculosus*. (By title only). Howard K. Wallace, University of Pittsburgh.

Additional Hepaticae from Central Pennsylvania. Thomas M. Little, Picture Rocks, Pa.

Color Variations in Castilleia in the Higher Altitudes. John C. Johnson, State Teachers College, West Chester.

X-Ray Studies of Rubber. Paul McCorkle, State Teachers College, West Chester.

Some Scientific Problems in Game Propagation. Samuel H. Williams, University of Pittsburgh.

Origin of Pennsylvania Caves. R. W. Stone, Geological Survey.

Cave Concretions. R. W. Stone, Geological Survey.

Are the Southern Plant Frontiers in Pennsylvania Advancing or Retreating? (By title only). O. E. Jennings, Carnegie Museum, Pittsburgh.

Recent Paleobotanic Investigations near Pittsburgh. William C. Darrah, Carnegie Museum.

The Status of Paleozoic Pteridosperms. William C. Darrah, Carnegie Museum.

Ecological Notes upon the Flora of an Old Lake Basin. (By title only). LeRoy K. Henry, Carnegie Museum, Pittsburgh.

Mycorrhizas of Deciduous Trees. (By title only). LeRoy K. Henry, Carnegie Museum, Pittsburgh.

Notes on Plant Indicators of Mull Forest Soil in Northwestern Pennsylvania. (By title only). H. J. Lutz, The Pennsylvania State Forest School.

Heat Radiation from Metallic Surfaces at Angles. E. Raymond Binkley, Western Reserve University, Cleveland, Ohio.

Laboratory Work in Elementary Science. Robert T. Hance, University of Pittsburgh.

Selecting and Training Teachers. Robert T. Hance, University of Pittsburgh.

Some Characteristics of Pigeon Chromosomes. Robert T. Hance, University of Pittsburgh.

Some Tree Antagonisms. George S. Perry, Department of Forests and Waters.

Specialization Hazards. Max Trumper, Medical Arts Building, Philadelphia.

The Development of a Technique for Brain and Skull Operations in Young Rats. Marcus H. Green, University of Pittsburgh.

The Digestive Epithelium of the Aphid, *Macrosiphum Pisi*. (By title only). Forrest W. Miller, University of Pittsburgh.

The Demonstration of Muscle Contraction in Insects. (By title only). B. R. Speicher, University of Pittsburgh.

A Marvel in Arithmetic. R. N. Davis, Everhart Museum, Scranton.

Maturation Phenomena in the Mouse. (By title only). Paul R. Cutright, University of Pittsburgh.

The Proper Study of Mankind. (By title only). Paul R. Cutright, University of Pittsburgh.

David Rittenhouse. M. J. Babb, University of Pennsylvania.

The Genus Danthonia in Pennsylvania. John M. Fogg, Jr., University of Pennsylvania.

Variations in Color Pattern in the Amphibian, *Triturus viridescens*. (By title only). H. H. Collins, University of Pittsburgh.

Observations on the Life History of the Amphibian, *Triturus viridescens*, in Western Pennsylvania. (By title only). H. H. Collins, University of Pittsburgh.

Morphological Anomalies in the Amphibian, *Triturus viridescens*. (By title only). H. H. Collins, University of Pittsburgh.

Some Effects of Roentgen Radiation on the Amphibian, *Triturus viridescens*. Pressley L. Crummy, University of Pittsburgh.

Histogenesis of Blastema Cells Following Amputation of the Tail of the Newt, *Triturus viridescens*. (By title only). Eugene Cutuly, University of Pittsburgh.

Effects of Captivity on the Salamander, *Triturus viridescens*. Helen M. Hilsman, University of Pittsburgh.

Seasonal Changes in the Gonads of the Amphibian, *Triturus viridescens*. Helen M. Hilsman, University of Pittsburgh.

The Differential Susceptibility of the Amphibian, *Triturus viridescens*, to Implanted Mammalian Tissues. Henry Idzkowsky, University of Pittsburgh.

Vital Stains in Relation to Differential Sensitivity to Light in the Amphibian, *Triturus viridescens*. (By title only). J. Lorain Jones, University of Pittsburgh.

The Pigmentary System of the Amphibian, *Triturus viridescens*. K. L. Kelley, University of Pittsburgh.

Some Observations on the Regeneration of Appendages in the Amphibian, *Triturus viridescens*. (By title only). James R. Stiefel, University of Pittsburgh.

Transplantation of Head Glands in the Vermilion-spotted Newt, *Triturus viridescens*. (By title only). Walter G. Urban and H. H. Collins, University of Pittsburgh.

Effects of Removing the Thymus Gland from the Domestic Hen. Eugene Miller, Bucknell University.

Observations on the Seasonal Distribution of Pennsylvania Bats. Chas. E. Mohr, Reading Public Museum and Art Gallery, Reading.

Cosmopolitan in Botany. (By title only). F. D. Kern, Pennsylvania State College.

Studies on Apples and Pears Resistant to Fire Blight. (By title only). E. L. Nixon, Pennsylvania State College.

The Migration of Bacillus amylovorus in the Tissues of the Quince. (By title only). H. A. Wahl, Pennsylvania State College.

Some Problems in the Study of Fleshy Fungi. (By title only). C. S. Parker, Pennsylvania State College.

A field trip was made to the conservatories of the Pierre Du Pont estate at Longwood. Typical plants exemplifying practically all of the plant zones were seen growing in this conservatory. The time allotted to the visit was entirely too little to do justice to the wonderful display.

On Friday evening, March 26, at 8:30 p. m., a lecture was given by Dr. Elmer O. Kraemer and the E. I. Du Pont De Nemours and Company on Present Trends in Colloid Science. The subject was presented in a most interesting and instructive manner and was greatly enjoyed by all present.

On Saturday morning, the program of paper reading was continued until 11:30, when Dr. Pennell, University of Pennsylvania, gave a brief summary of the plant zones in the West Chester vicinity. The address and the one given by Professor M. J. Babb on David Rittenhouse were of particular interest to a meeting in the vicinity of West Chester.

At a final business session, the following resolutions were adopted by the Academy:

> *Be it resolved*, That the Academy thanks the West Chester State Teachers College and Dr. John C. Johnson for the fine way that the meeting has been entertained. We instruct the secretary to write a letter of thanks to the Du Ponts for our entertainment at their celebrated gardens. All who took part in the program and thus insured the success of the meeting, and especially the speaker of Friday evening, Dr. Elmer O. Kraemer, are tendered our sincere thanks.
>
> *Whereas*, There is a marked disposition of public school administrative officers to overcome the inflexible salary provisions of the present school code, in the interest of necessary expense reduction, by terminating the tenure of experienced teachers in favor of teachers of less experience and lower training, therefore,

Be it resolved, That the Academy recognizes a serious injury to the teaching of science in the public schools caused thereby, and recommends the adding of a flexible provision to the code to permit local salary contracts during the present financial emergency.

R. N. DAVIS
E. A. ZIEGLER

The membership committee proposed the following names with a recommendation that they be elected to active membership. They were so elected.

Alvin S. Alderfer, 1925 Moore Street, Huntingdon.
Sister Sara T. Archibald, Rosemont College, Rosemont.
Dr. Geo. D. Beal, Mellon Institute, University of Pittsburgh, Pittsburgh.
Lyle V. Beck, University of Pittsburgh, Pittsburgh.
Maurice H. Bigelow, 3409 Terrace Street, Pittsburgh.
Prof. Irwin Boeshore, Macfarlane Hall, University of Pennsylvania, Philadelphia.
Harold A. Bruce, University of Pittsburgh, Pittsburgh.
Dr. N. W. Cameron, State Teachers College, West Chester.
Pressley L. Crummy, University of Pittsburgh, Pittsburgh.
William C. Darrah, 5620 Rippey Street, Pittsburgh.
Lawrence B. Derickson, 149 Green Street, Westmont, Johnstown.
Dr. Robert A. Diehm, 1115 Radcliffe Street, Bristol.
Alfred G. Dietze, 38 Cycle Avenue, Uniontown.
Dr. E. R. Eller, Carnegie Museum, Pittsburgh.
Dr. M. C. Elmer, University of Pittsburgh, Pittsburgh.
Dr. John M. Fogg, Dept. of Botany, University of Pennsylvania, Philadelphia.
Donald M. Fraser, 533 Prospect Avenue, Bethlehem.
Dr. Mont. R. Gabbert, University of Pittsburgh, Pittsburgh.
A. W. Gauger, Pennsylvania State College, State College.
Prof. D. I. Gleim, Mechanicsburg.
Dr. Alfred Gordon, 1812 Spruce Street, Philadelphia.
Miss Thelma J. Greenwood, State Teachers College, West Chester.
William O. Hickok, IV, 25 N. Front Street, Harrisburg.
Helen M. Hilsman, 1300 Macon Ave., Swissvale, Pittsburgh.
Henry Idzkowsky, 123 Blackhawk Street, Pittsburgh.
William R. Johnston, 505 W. King Street, Shippensburg.
Dr. T. J. Kean, 1630 N. Sydenham Street, Philadelphia.
Kenneth L. Kelley, University of Pittsburgh, Pittsburgh.
Dr. Elmer K. Kilmer, Main Street, Perkasie.
Prof. Joseph S. Knapper, Albright College, Reading.
Arthur N. Leeds, 5321 Baynton Street, Germantown, Philadelphia.
Prof. J. Arthur Lewis, State Teachers College, West Chester.
Lloyd N. Lewis, Star Route, Ligonier.
Leo A. Luttringer, Jr., 1203 N. 16th Street, Harrisburg.
Norman L. Munn, University of Pittsburgh, Pittsburgh.
Dr. Norman C. Ochsenhirt, Jenkins Arcade, Pittsburgh.
Edmund A. Pratt, 1600 Arch Street, Philadelphia.

George A. Reinert, Pine Grove.
Prof. A. L. Rhoton, Box 403, State College.
Norman C. Riggs, R. D. 9, South Hills, Pittsburgh.
Marcus J. Sallinger, 3114 Niagara Street, Pittsburgh.
R. J. Schlosser, 1516 Sassafras Street, Erie.
Frederick B. Schunk, 813 Birch Street, Scranton.
Marchant N. Schaffner, 224 Peffer Street, Harrisburg.
Dr. John V. Shankweiler, Muhlenberg College, Allentown.
Dr. William G. Shemeley, 1724 Spruce Street, Philadelphia.
Prof. A. W. Shively, Huntingdon.
Dr. S. Barton Sklar, Empire Building, Pittsburgh.
George E. Snyder, University of Pittsburgh, Johnstown.
Dr. Walter Steckbeck, University of Pennsylvania, Philadelphia.
Harry J. Swanger, 20 Maple Street, Lebanon.
Dr. Herbert S. Warren, 3800 Chestnut Street, Philadelphia.
Dr. Max H. Weinberg, 6093 Jenkins Arcade Bldg., Pittsburgh.
Prof. Paul L. Whitely, Franklin & Marshall College, Lancaster.
Dr. Thos. E. Winecoff, State Game Commission, Harrisburg.

The place for the ninth annual meeting was discussed. The only invitation was from the State Teachers College School at Slippery Rock. It was the opinion of most of the members present that probably Slippery Rock would not be a satisfactory place for the annual meeting, but it might be utilized for the summer session. Upon motion, it was decided to leave the selection of the place of meeting in the hands of the executive committee. This was also decided in the matter of time and place of meeting of the summer session.

The nominating committee reported as follows and the secretary was instructed to cast a ballot in favor of the nominations:

President—Samuel H. Williams, University of Pittsburgh.

Vice President—John C. Johnson, West Chester State Teachers College.

Secretary—T. L. Guyton, Bureau of Plant Industry.

Assistant—V. Earl Light, Lebanon Valley College.

Treasurer—H. W. Thurston, Pennsylvania State College.

Editor—R. W. Stone, Geological Survey.

(Signed)

Robt. T. Hance, Chairman, D. S. Hartline, G. H. Ashley.

The newly elected president was escorted to the chair, and after a few remarks he adjourned the session.

T. L. GUYTON, *Secretary*

STUDY OF AN EPIDEMIC OF POLIOMYELITIS IN LANCASTER COUNTY, PA.

By W. G. Hutchinson[1]

Franklin and Marshall College, Lancaster

A study of the distribution of poliomyelitis in Pennsylvania will show that in years when the disease appears only as endemic throughout the State, there may be one or more rather localized epidemics. The year 1929 was not an epidemic year for poliomyelitis in Pennsylvania. The total of 197 cases and 56 deaths is not high in comparison with the totals of other non-epidemic years. However, during that year there occurred in Lancaster County 57 cases or nearly 30 per cent of the total number of cases reported for the State. There accordingly seemed good opportunity for a study of the epidemiology of the disease in this particular county.

The study has been based upon vital statistics furnished by the State, County, and City Departments of Health, supplemented by rather complete information obtained by personal visits to the homes in which the disease occurred. Of the 57 cases it was impossible to get information in regard to four. The nature of the information secured by questioning and by personal observation may be outlined as follows:

Name, age, and sex of patient.
Name of attending physician.
History of the case.
  Date of first symptoms.
  Nature of first symptoms.
  Health of patient prior to the disease.
    Normal diet.
    Previous illnesses and operations.
  Date of quarantine and release.
  Condition of patient at time of visit to home.
  Previous poliomyelitis in family.
Foods.
  Milk.
    Source, method of delivery, pasteurization.
  Meats.
    Names of dealers from whom obtained.
  Fruits and vegetables.
    Where obtained.
    Preparation before eating.
  Other foods.
    Where obtained.
  Patronage of large city markets.
Contacts.
  Ages of other children in family.
    Their activities during the sickness.
  Visitors from out of town for previous two weeks.
  Visits of patient or family out of town for previous two weeks.
  Local contacts for previous two weeks.
  Church and school attended.
  Occupation of employed members of family.

[1] The writer wishes to express thanks for valuable suggestions, advice, and criticism to Dr. D. H. Bergey and Dr. H. F. Smyth of the Department of Hygiene, University of Pennsylvania.

Sanitation.
  Water supply.
    If well,—nature of covering, proximity to stables, barns, toilets.
  Garbage disposal.
  Sewage disposal.
  Pet animals and farm animals.
    If any sickness among them—nature of symptoms.
Insects—especially stable flies and mosquitoes.
Evaluation of sanitary conditions of home.
Description of neighborhood.
  Residential or slums, etc.
  Proximity to stables, barns, dumps, stock yards, etc.

The information obtained in Case No. 1 will be described briefly.

Case No. 1. Girl—2 years. Quarantined May 3. Died May 12.

On May 1 the first symptoms developed, the child apparently suffering from a bilious attack. On May 3 paralysis of the right arm, right leg, and neck muscles developed.

Prior to the illness the child had been in fair health but was not strong. The diet had possibly been deficient in fruit and milk.

Food had been obtained principally from one of the large city markets. Pasteurized milk was obtained from the same dairy which supplied two other cases.

Two other children in the family, five and seven years of age, were well during the sickness. The older one was attending school but was kept at home when the nature of the disease became known. There had been no out-of-town visitors nor had any member of the family been out of town for several months. On May 1 the child was taken to a department store where she came in contact with a large crowd. The following day, although not well, she was taken to a circus. A physician was summoned that evening. Paralysis developed the following day and death followed in nine days. In so far as could be determined no one coming in contact with the child or the family contracted the disease. In fact the next recorded case was not reported until nearly two months later.

The city water supply was used. Garbage and sewage disposal were controlled by the city. There were no pet animals in the home. A considerable number of stable flies had been noticed, but no other insects in any abundance. The general sanitary conditions of the home appeared to be poor. The family lived in one of the poorest localities in the city, the house being situated very near the city stock yards and close to the Pennsylvania Railroad.

Analysis of data. Of the 57 cases reported in Lancaster County, seven were fatal. Thus the mortality was about 12 per cent. Of the 53 cases intensively studied, 23 were urban and 30 rural. Five urban cases and two rural cases were fatal. Figures 1 and 2 show the distribution of the cases and the development of the epidemic according to the date of onset of the disease. The dates of onset corresponding to case numbers are as follows:

May, 1; June, 2; July, 3–8; August, 9–34; September, 35–46; October, 47–50; November, 51–53.

The first case in the epidemic occurred near the Pennsylvania Railroad and the city stock yards. The next few cases developed in rather widely separated sections of the city. The spread out into the county followed lines of local travel. There was little noticeable spread along the main lines of through travel such as the Pennsylvania Railroad, Reading Railroad or the Lincoln Highway.

The seasonal distribution of urban and rural cases is shown in Table 1. The epidemic began in the city on May 1. The second case developed on June 23. This long interval between cases might suggest that there had been a number of "missed cases." The first rural case developed three months after the first urban case. Studies of larger epidemics (1) (2) have shown that where the epidemic started it tended to die out first, while in sections where cases developed later in the season the epidemic might be more protracted. A similar tendency may be seen in this epidemic in that the rural outbreak occurred later and more cases developed in the late months than in the city outbreak. The peak of the epidemic both urban and rural will be seen to be in August. A study of seasonal distribution of poliomyelitis throughout Pennsylvania since 1910 shows that the maximum number of cases have usually occurred in September, although occasionally in August or October.

TABLE 1

Seasonal Distribution of Poliomyelitis in Lancaster County, Penna.—1929

	Urban	*Rural*	*Total*
May	1	0	1
June	1	0	1
July	6	0	6
August	10	16	26
September	3	9	12
October	1	3	4
November	1	2	3
Total	23	30	53

The disease was found to affect individuals from six months to 23 years of age. Table 2 shows the distribution of cases according to age.

The most frequent age was found to be between two and three years and the average age was between five and six years. It will be noticed that the age distribution for urban and rural cases is somewhat different. This probably has little significance, however, in view of the relatively small number of cases studied. The distribution of fatal cases according to age is shown in Table 3.

TABLE 2

Age Distribution of Poliomyelitis in Lancaster County, Penna.—1929

Age	*Urban cases*	*Rural cases*	*Total cases*	*Age*	*Urban cases*	*Rural cases*	*Total cases*
0– 1	0	1	1	12–13	0	0	0
1– 2	2	4	6	13–14	0	1	1
2– 3	8	3	11	14–15	0	0	0
3– 4	3	5	8	15–16	0	0	0
4– 5	3	3	6	16–17	1	0	1
5– 6	0	2	2	17–18	0	0	0
6– 7	2	3	5	18–19	0	1	1
7– 8	1	0	1	19–20	0	0	0
8– 9	0	1	1	20–21	0	0	0
9–10	1	2	3	21–22	0	0	0
10–11	0	0	0	22–23	0	0	0
11–12	2	3	5	23–24	0	1	1
					23	30	53

TABLE 3

Age Distribution of Fatal Cases of Poliomyelitis in Lancaster County, Penna.—1929

Age	*No. of Cases*
0– 1	1
1– 2	0
2– 3	2
3– 4	1
4– 5	1
16–17	1
17–18	1
Total	7

TABLE 4

Sex Distribution of Poliomyelitis in Lancaster County, Penna.—1929

	MALE	
	Cases	*Per cent.*
Urban	15	28.3
Rural	10	18.9
Total	25	47.2
	FEMALE	
	Cases	*Per cent.*
Urban	8	15.1
Rural	20	37.7
Total	28	52.8

The distribution of cases according to sex is shown in Table 4. Here again, due to the limited number of cases studied, it is likely that the difference in distribution among rural and urban cases is of little significance. However, the sex distribution among fatal cases is rather striking. Eighty-six per cent of the fatal cases were males; 14 per cent females. This high mortality among males has been indicated in other epidemiological studies (2), (3), (4), (5).

All the cases in Lancaster County during 1929 were among native American whites.

In no case was more than one child in a family sick with the disease, although in many cases the other children had been exposed. In a few cases there is a possibility of abortive or non-paralytic cases occurring in the same family with a quarantined case, but none which were diagnosed as poliomyelitis. In one family a child had died of the disease in the 1916 epidemic, the father had had the disease when a young man, and a second child had a very severe case in the 1929 epidemic.

There has been little opportunity in this study to make any estimate of the incubation period of the disease. In two cases, however, in which there could be little question of indirect contact infection, the period appeared to be not over five days.

Possible Means of Spread. The data obtained from the personal visits have been rather carefully analyzed with special reference to factors which might be responsible for the spread of the epidemic.

Milk supply. If the total number of cases is grouped according to the source of the milk supply, the groups are found to correlate rather closely with the size of the dairy and would appear to have no significance in the spread of the disease.

There appears to be no connection between the use of raw milk and the spread of the infection. Of 53 cases, 27 used raw milk and 26 used pasteurized milk. No instances were found where cases had occurred on farms from which milk was sold on milk routes. A few cases occurred on farms from which milk was shipped to a large dairy and pasteurized before sale.

The possibility of carriers on milk routes has been considered. The data do not seem to indicate any connection with the spread of the disease. Cases supplied with milk from the same dairy were usually distributed along different routes.

In no case where milk was obtained at home was there any history of sickness among the cows.

During July and August especially a number of children suffered with "summer complaint." The milk supply was blamed by numerous parents obtaining milk from several different sources. Many of these cases were not visited by physicians and it was impossible to investigate them. These are mentioned simply as possibilities of abortive or non-paralytic cases of poliomyelitis. A study of the records of reportable diseases has not brought out a greater prevalence of any disease that might be considered "summer complaint" than in previous years.

Water supply. No connection between the water supply and the epidemic was found. In only one case was a well found to be poorly covered and insanitary.

Food supply. It is perhaps important to note that in all but a few cases the food supply was obtained chiefly from the large Lancaster markets. At the time of the epidemic the majority of food in the markets was not covered but was so exposed that it could be handled by any one. Since the virus of poliomyelitis occurs in the respiratory tract, it seems very likely that the disease may have been spread at least in part by coughing or sneezing in the vicinity of the food or by handling the food. In September, 1929, a regulation was put into effect to remedy this situation.

Insects. There seemed to be no definite connection between the spread of the disease and the abundance of stable flies, house flies, mosquitoes, and other insects. In some cases there had not been as many insects observed as during previous summers. Of course information of this kind is apt to be most unreliable.

An examination of Figure 1 reveals an interesting and what may perhaps be an important relation to insects. As stated above the first case developed in a family living near the stock yards and the Pennsylvania Railroad. Six other cases later developed within five blocks of the stock yards. Four of these were fatal cases; the other two were rather mild cases. This grouping of fatal cases in one particular section of the city may of course have been purely incidental. It seems to be an outstanding fact, however, that the only five deaths in the city should be within five blocks of the stock yards. In one of the two families in the county in which there were fatal cases the father of the child had been to the Lancaster stock yards a short time before the onset of the disease. If insects are associated in any way with the spread of the disease, it is very probable that they are only one of the several factors concerned.

Animals. There appeared to be no correlation between the spread of the disease and the number or kinds of pet animals or farm animals kept by the families. No instances of paralytic symptoms in farm animals or pet animals were reported.

Contacts. Instances of indirect contact infections were found in five cases. Two families had been visited by friends coming directly from Roanoke, Virginia, where there was an epidemic at the time. The friends returned after a visit of two or three days and in both instances

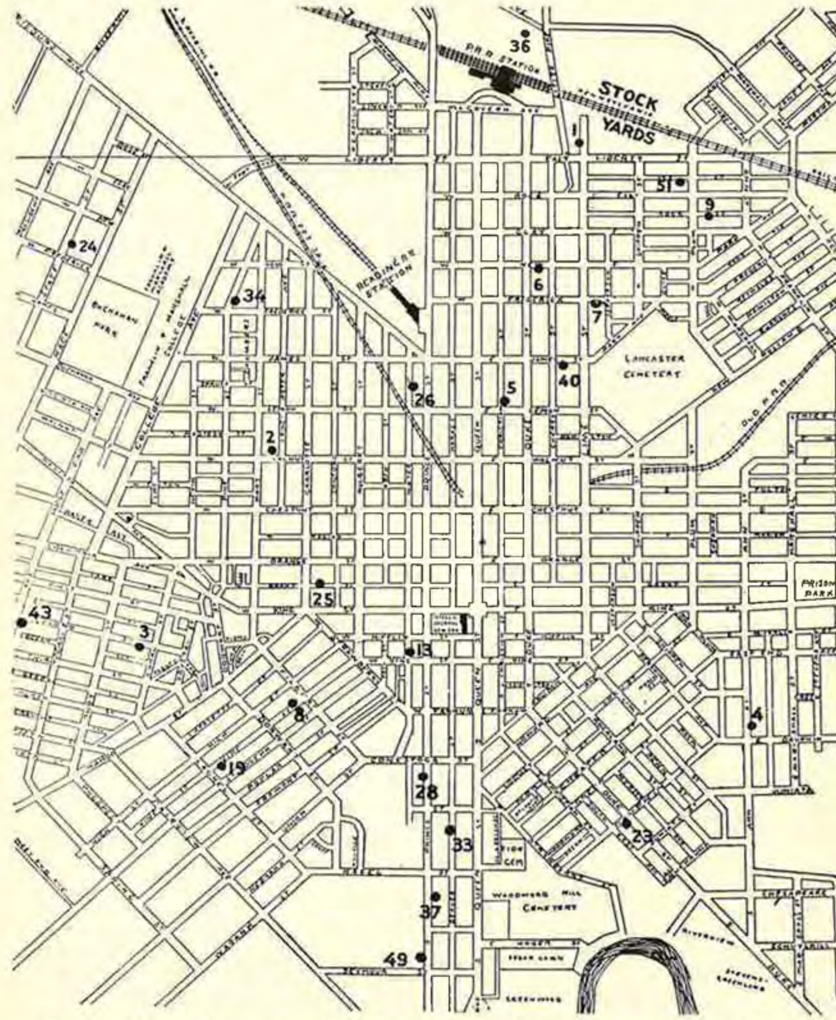

FIG. 1. Map of Lancaster City showing spread of epidemic of Poliomyelitis.

a child in the family here became sick within a very few days. The visitors were apparently in good health and showed no symptoms of disease after returning home. Perhaps these cases should be considered as carrier contacts rather than as indirect contact infection.

In two other cases children had been allowed to play with sick children—in one case because the disease had not been diagnosed as anything of an infectious nature at the time, in the other case because the three week quarantine had been removed. In neither case did the child that had come in to play develop the disease, but another child in that family developed the disease in not over five days after the first contact.

In one case it was reported that the child had been to a Lancaster dentist who a few days previously had treated a child who was probably in the early stages of the disease.

FIG. 2. Map of Lancaster County showing spread of epidemic of Poliomyelitis.

Possible contact in crowds could be considered in a number of cases. In some instances the individuals had been to public swimming pools or to the city parks or amusement parks. There was some possibility of indirect contact among cases attending the same church. Some cases of indirect contact as have been cited suggest the probability of human carriers of the disease.

As many other similar investigations have shown, some method of simple diagnosis of abortive cases and a method of identification of carriers must be worked out before the means of spread of poliomyelitis can be definitely understood.

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AMPHIPOD RESPONSES TO ENVIRONMENTAL STIMULI

Wm. Hudson Behney
University of Vermont, Burlington, Vt.

Almost every one who has done any aquatic collecting amongst the vegetation along the shores of lakes and ponds is familiar with the large numbers of small crustacea known as amphipods which are to be found there. They furnish an important item in the food of aquatic vertebrates, especially fishes. As one professional fisherman on Lake Champlain said to me recently, "When the fish are not biting good I cut one open and if his belly is full of those 'bugs' I pull up my lines and go back to shore. It ain't no use trying to catch fish when they're eating them things." These amphipods are omnivorous, eating vegetation, living or dead, the dead bodies of other animals or even those of their own number who have died. They live well when brought into the laboratory and placed in an aquarium with living plants and a layer of bottom debris. Their behavior under various stimuli show a nicety of adaptation to their environment which is not always so easily demonstrated in other forms of animal life.

The species *Eucrangonyx gracilis* was used in the following experiments. Another common species, *Hyalella knickerbockeri* gave similar results in those experiments which were tried on both species. As is true of many other invertebrates, these animals show a definite reaction to light. When placed in an aquarium with clear water and with the light coming from one side only, they will respond by immediately moving to the opposite side of the aquarium. In a series of ten experiments in

which 22 individuals were used and a total of 150 readings made with water temperatures of 12° to 30° C. from 90 to 97 per cent. of the individuals moved to the side away from the light. In this case the source of illumination was a 60W. incandescent lamp placed about six inches to one side of the aquarium, the light passing through a 4-inch heat condenser before entering the aquarium.

The degree to which the animals are slaves to light is shown by the following experiment. A small rectangular battery-jar aquarium was fitted with a movable shield of heavy black paper. This shield could be moved up or down, at the will of the experimenter, so that either the upper or lower half of the aquarium would be lighted while the other half was dark. The source of illumination was a 200W. lamp placed in a position similar to the 60W. of the previous experiment. Twenty-five amphipods were placed in the aquarium which was then filled to the top with water. The shield was then moved up or down at intervals of one minute so that the upper and lower halves of the aquarium were alternately light and dark. The number of amphipods in the lighted half was noted in each instance. In one series of readings of ten trials, never more than three amphipods remained in the lighted area, whether it was upper or lower half of the aquarium. The average number in the lighted area was 1.8 and in the darkened area 23.2. This response was practically an instantaneous one. As soon as the shield was shifted the amphipods would swim up or down into darkness.

When 31 individuals were placed in an aquarium with tap water and kept in darkness, the greater number of them remained on the bottom of the aquarium. This is shown by a series of one-half minute readings taken with the aid of a ten W. lamp which was turned on for the few seconds necessary to locate the amphipods. On the average only 20 per cent of the total number of amphipods in the aquarium were in the upper half.

The chemical condition of the water has a marked influence over this behavior. When 10 specimens were placed in an aquarium under similar conditions but with 'foul,' smelly water taken from an aquarium which had gone bad, 95 per cent. of the individuals were found in the upper half (pH 5.9). Practically all of these were within half an inch of the surface. Foul water with other pH values gave similar results but with different percentages of the animals in the upper half. Passing carbon dioxid through tap water and then placing the amphipods in it also resulted in an upward movement. Here a pH of 5.6 found 77 per cent. of the individuals in the upper half. After air had been permitted to bubble through the water for a few minutes the amphipods again went to the bottom as they did in the tap water. When acetic acid was added to tap water so that the pH stood at 3.0– the animals again moved to the surface so that 82 per cent. were found there. Boiling the water to remove most of the dissolved oxygen present did not seem to have any-effect upon them. They occupied about the same positions that they did in ordinary tap water.

The reactions of the amphipods to light rays on a horizontal plane were observed in the various media in which the vertical distribution had been studied. The aquarium in this series of trials was illuminated by the light from a 60W. lamp placed six inches to one side and passing through the heat filter before it entered the test aquarium. The results are shown in the accompanying table:

Responses of E. gracilis to light

No. of animals	Trials	Media	pH	Percentage on side toward light
22	150	Tap water	7.3	3–10%
6	9	Foul water	5.9	83%
38	14	"	7.1	99%
10	14	"	7.8	65%
12	13	Water + CO_2	6.0	85%
12	15	Dil. acetic acid	3.0–	71%

It may be seen from this table that the usual thing under ordinary circumstances would be for the amphipods to keep away from the light. A comparison of the results obtained for the various materials present in the water show that there is a reversal of the behavior toward light just as the tendency to remain near the bottom was removed when these same impurities were present in the water.

In an endeavor to determine the reaction of *E. gracilis* to temperature, twenty of them were placed in a tall (20-in.) glass cylinder. The water in the upper portion was warmed by an electric heating element while the base was cooled by immersion in an ice and brine mixture. In a series of readings the water at the top varied from 25° to 30° C. and at the bottom from 9° to 14° C. The average temperature at which the amphipods were found in the cylinder was in the region of 23° C.

The reactions of these creatures to the lower extremes of temperature are of interest. A small number of individuals were placed in test-tubes which were then partially immersed in an ice-brine mixture. As the temperature in the tubes gradually dropped the animals became less active. This loss of activity became very evident at 6° C. and at 4° C. the swimming movements cease, the animals sink to the bottom but are still able to crawl about there. Below 4° C. they remain inactive. When the water is permitted to warm up a few degrees they again resume activity at about the same point at which they left off.

Examination of these reactions shows us the extent to which they would prove of benefit in enabling the amphipod to survive in its environment. It tends to remain out of the direct light where it would be observed by its enemies, seeking its food in the shadow of the bottom débris or of the dense vegetation along shore. When it does become exposed it moves away from the lighted area into the shadow again. Mechanical agitation of the water, which might be caused by some fish moving along looking for food, stimulates the amphipod to swim to the bottom and bury itself in the débris where it would be less likely to be taken. The reversal of the usual negative reaction to light is of interest. If the amphipod remained negative to light under all conditions it would stand less chance of surviving than if it could conveniently change its behavior when this was the lesser of two evils. Such extremely unfavorable conditions as those described for the various substances dissolved in the water, would cause the death of the animals if they were not removed to purer water. The reversal of the usual responses to light and gravity now bring the amphipod near the surface where conditions are more likely to be favorable to its continued existence. The contact of the water with the air permits the passage of such gaseous substances as carbon dioxide into the atmosphere. The same temporarily positive response to light would tend to take the animal into more open water for a time and thereby increase the possibility of danger from enemies, but removing the danger of more certain death from toxic substances.

Their reaction to temperature would tend to bring them into the shallow water in the summer time where they would be more likely to find a plentiful supply of food. It would also take them out of such waters and into deeper water when the winter approached and the shallow water began to cool and freeze to a greater extent than the deeper waters. The point at which the swimming activity ceases and the temperature at which the specific gravity of water changes is approximately the same. At 4° C. and below when the cooler waters begin to rise to the surface instead of sinking, the amphipods lose their ability to swim and sink to lower and warmer areas. To lose this swimming ability at 10° C. might cause the animals to be trapped in the lower depths of the body of water. On the other hand if it retained its ability to swim as long as the water was liquid it might become frozen in the ice and destroyed.

MALIGNANCY IN A SPLENECTOMIZED RAT

By Clarence A. Horn
Albright College, Reading

On December 1st, 1930, a male albino rat weighing 231.5 grams, aged 1½ years, was splenectomized. The rat recovered normally from the operation. His weight gradually increased, so that by December 1st, 1931, he weighed 310 grams. During this period of one year, he ate well of a well balanced diet. The behavior of the rat changed considerably; instead of being active, he became very inactive, taking very little interest in the other rats in the cage, which were of the same age; some were litter mates. He also became easily fatigued during any forced activity.

Early in December, 1931, an enlargement appeared in the neck region, which grew very rapidly. December 18th the growth was removed, which weighed 7.3 grams. The tumor was located anterior and lateral to the left lobe of the thyroid gland. The animal recovered quickly from the operation, after which his behavior remained about the same. However, the tumor cells which still remained at the site of growth grew again very rapidly, so that on January 9th, 1932, the growth was again removed, now weighing 23.6 grams in a period of 23 days.

Parts of this growth were transplanted into the omenta and mesenteries of a year-old, normal, white male rat weighing 257 grams. On February 25th, 1932, the tumor was removed, which in this time grew with a much slower rate, weighing 11.7 grams, in a period of 47 days. Part of this tumor was again transplanted into the mesenteries of a normal male white rat weighing 207.5 grams, nine months old.

The tumor was diagnosed as a sarcocarcinoma (mixed tumor). This tumor is found rarely in humans in the submaxillary gland.

Discussion: It seems the tumor grew more rapidly in the splenectomized rat than in the normal rat as is evidenced by the increase in weight of the tumor in terms of time. In the splenectomized rat an increase of weight of tumor of 23.7 grams in 23 days or 1.02 grams per day, while the growth in the normal rat was 11.7 grams for a period of 47 days, a rate of 0.25 grams per day. The rate of growth of the same tumor in the splenectomized rat was four times greater than in the normal rat.

At the time the tumor appeared in the splenectomized rat, the rat was 2½ years old, at which time it had lived nearly half of its life, for the average length of life of a rat is eight years. If the cancer age of man, which is 35 years and over, figuring 56 years as the average span of life, is applied to the rat, the splenectomized rat, as far as age is concerned would be more susceptible to malignancy than the normal rat. Again, natural susceptibility of the two rats must also be considered in accounting for the difference in growth. Otherwise the factors are the same for the two animals.

During the removal of the tumors it was noticed that the necrotic materials present in the normal rat was of a thick yellowish-green consistency and many times greater in amount than in the splenectomized rat. The necrosis present in the splenectomized animal was of a thin serous type and surprisingly small quantities.

A THERMOTROPIC GRADIENT APPARATUS WITH SOME PRELIMINARY STUDIES ON PLANARIA PHAGOCATA GRACILIS HALDEMAN, NEWT TRITURUS VIRIDESCENS RAFINESQUE AND EARTHWORM LUMBRICUS TERRESTRIS LINNAEUS

By Milton Walker Eddy and David Ivan Gleim
Biological Laboratory, Dickinson College

Animal behavior studies frequently involve thermotropic experiments. The following is a description of a simple thermal gradient, which can be constructed at small cost, and at the same time give reasonably satisfactory results with small aquatic and land forms.

Gradient Apparatus. The apparatus was constructed of 26-gage galvanized iron and had a length, over all, of 67 cm. and a width of 20 cm. The pan from which observations were taken was 60 cm. long and 20 cm. wide, with a depth of 5.5 cm. The outer edge of the pan was vertical for 4 cm., then bent in at an angle of 45° to prevent land forms from crawling over the sides. The angular portion of one side served as a mount for the seven thermometers used in securing temperature readings. The bottom of the observation pan was given a coat of flat white paint to increase visibility, and ruled in 10 cm. squares. At one end was a trough 11 cm. long, 20 cm. wide and 23 cm. deep. This trough extended under the pan for 3 cm. Beneath the pan were three baffle plates, spaced 15 cm. apart. The one in the middle was 10 cm. high, the one near the cool end was 8 cm. high and the one near the warm end was 4 cm. high. Three sides and the bottom of the apparatus were enclosed by a wooden case, the fourth being open for the insertion of a gas burner. The wooden case provided insulation and retarded the circulation of air. The thermotropic gradient apparatus as illustrated in figure 3 shows it assembled for use, while in figure 4 the pan and trough

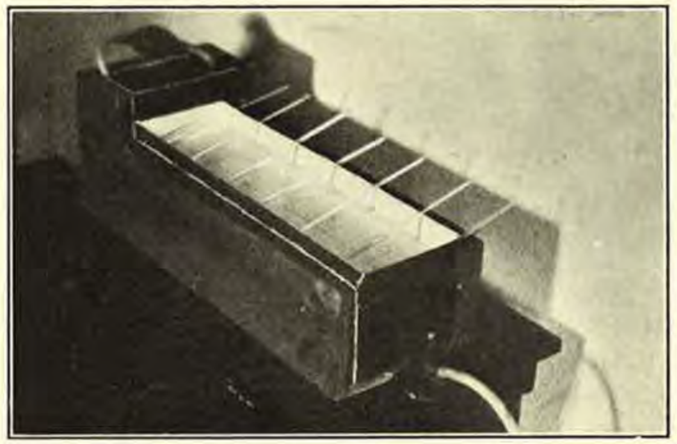


FIG. 3. The thermal gradient apparatus assembled and ready for use.

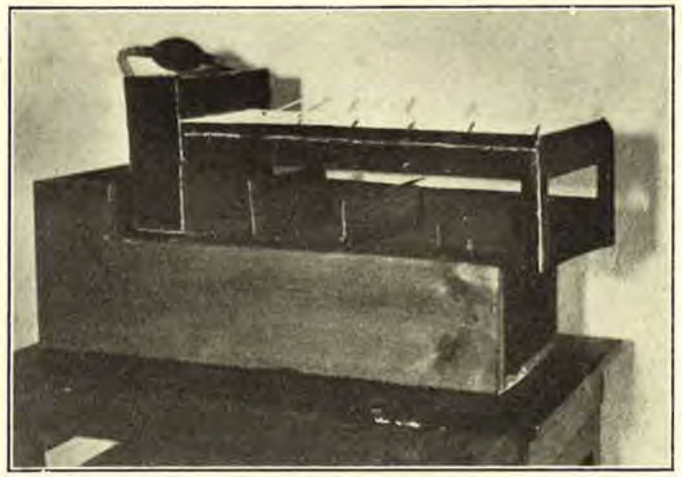


FIG. 4. The thermal gradient apparatus removed from the wooden insulating case to show construction.

were removed from the wooden insulating cover in order to show construction.

Method of Temperature Control. Ice and brine was placed in the trough to secure the lower ranges of temperature. This mixture must

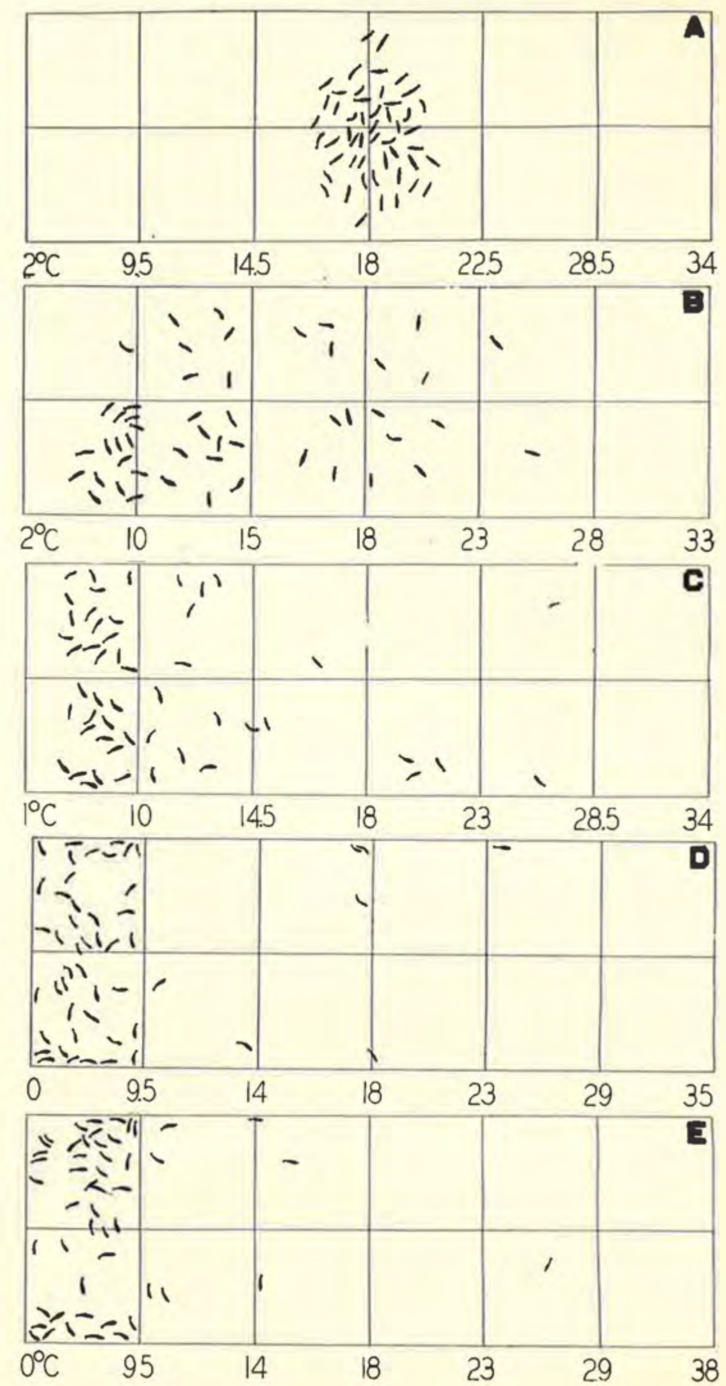
be circulated, otherwise maximum cooling could not be secured. The simplest way to obtain this was by means of a bulb syringe. A temperature of 0° C. was easily maintained at the cool end. Dry ice, as a cooling medium, was also used with a mixture of salt and ice, producing a temperature of 0° C. with the formation of ice at the lower end of the gradient pan. No mechanical circulation of the brine was necessary when dry ice was used, as this substance caused it to circulate rapidly while evaporating. The warm end of the gradent was heated by means of a small gas burner.

For use, it was found best to establish the gradient before the animals were introduced. For aquatic animals, water was placed in the pan to a depth of 1 cm. The trough was then filled with a mixture of dry ice, salt and ice, the first being placed on the bottom. About a pound of dry ice was sufficient for an experiment of two hours. Enough water was then placed in the trough to reach the bottom of the pan and a sufficient quantity of salt to keep the trough from freezing. The burner was lighted, and in thirty minutes a gradient was established.

Thermotropic Response of Planaria. The reaction of planaria, *Phagocata gracilis* (Haldeman), to heat, was examined by placing 50 specimens in the center of the gradient pan and their positions indicated on a piece of paper ruled into twelve 10 cm. squares, corresponding to the squares in the pan. After a ten-minute interval, their change of positions was again noted and at subsequent ten-minute intervals of time the location of the animals was charted until they came to a position of uniform optimum thermotropic response.

Figure 5, A, shows the positions of 50 planaria at the time they were placed in the thermotropic gradient pan. After a ten-minute interval, the animals shifted to the temperature gradient as illustrated in (fig. 5, B). At the end of the next ten-minute interval of time, 43 of the animals had shifted into a temperature range of from 1° to 14.5° C. (fig. 5, C). Ten minutes later 5 planaria were found in regions above 14° C. as shown in figure 5, D, and the majority of those at the lower temperatures were between 0° and 9.5° C. Figure 5, E, illustrates a similar condition ten minutes later, at which time the experiment was discontinued.

Spring-fed streams from which the planaria were collected, had, during the months of January, February and March, 1932, an average temperature of 9.5° C., an oxygen content of 8.6 cc. per liter and a hydrogen-ion concentration equivalent to a pH of 7.6. Animals kept in the laboratory for a month or more at a temperature of from 20° to 22° C. responded in a manner similar to those just collected.



When planaria were placed in the pan before a gradient was established, they had a marked tendency to aggregate while the gradient was being formed. This was especially noticeable when the number of animals used in the experiment was as large as from 200 to 300. The aggregations were close and were principally found in regions where the temperature had finally reached the range of from 5° to 20° C. Low temperatures had a tendency to retard the activity of planaria, locomotion being an index. Their speed was considerably slower than normal as they approached a temperature of zero. When planaria entered the temperature range of the gradient above 30° C., there was a marked twisting and turning of the body, and if they were not able to escape from this region death occurred.

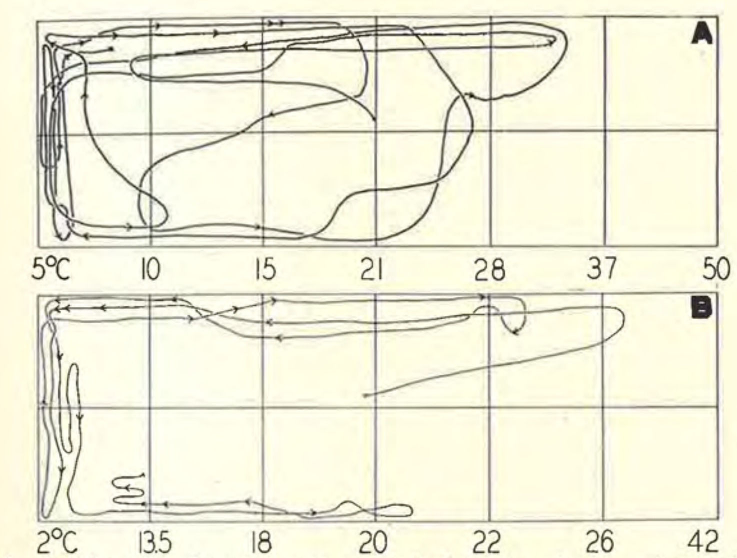


FIG. 6. A. The path of a newt over a period of twenty minutes. Arrows indicate direction of locomotion at minute intervals.

B. The path of an earthworm during the course of an experiment. Arrows indicate direction of locomotion at minute intervals.

FIG. 5. Positions of planaria in thermal gradient apparatus.

A. Positions of fifty planaria upon introduction into the center of the thermal gradient pan.

B. Positions of planaria ten minutes after introduction. The direction traveled is, in general, toward the cooler regions of the gradient.

C. Positions twenty minutes after start of experiment.

D. Positions thirty minutes after start of experiment. Eighty-six per cent. of the planaria had migrated to a temperature range of from 0° to 9.5° C.

E. Positions forty minutes after start of experiment. The positions are similar to those in figure 5, D.

Response to Temperature in the Newt. Newts, *Triturus viridescens* Rafinesque, are well suited for experiments in this gradient apparatus. The paths of these animals were usually plotted for a period of twenty minutes, an arrow being used to designate their positions and the direction of locomotion at the end of each minute interval. Figure 6, A, is indicative of their activity. This drawing shows that the newt had an optimum temperature range below 21° C. This had frequently been observed in the field.

Temperature Reactions of the Earthworm. The thermotropic response of the earthworm, *Lumbricus terrestris* Linnaeus, can be secured by placing a piece of wet filter paper on the bottom of the pan and covering with about 2 mm. of water. Figure 6, B, records an earthworm's path, similar in character to results in many corresponding experiments. This shows that a considerable portion of time was spent by these earthworms at temperature ranges of from 2° to 20° C.

This paper is presented primarily to illustrate a thermotropic gradient apparatus, its simplicity of operation, the possibility for its use in intensive research on small animal forms, in addition to laboratory experiments on animal behavior.

ECOLOGICAL STUDIES OF SERPENTINE-BARREN PLANTS—I. ASH COMPOSITION

By Edgar T. Wherry

Associate Professor of Botany, University of Pennsylvania

Many areas classified from the agricultural standpoint as barrens support a characteristic and often luxuriant native vegetation. This is particularly true of the serpentine-barrens of eastern Pennsylvania, which owe their name to their development over outcrops of the highly magnesian metamorphic rock, serpentine. The origin of the barrenness of the soils derived from this rock has been briefly discussed by Hilgard[1] and studied in detail by Gordon and Lipman.[2] The agricultural deficiency of these areas was found to be connected not with any toxic effect of the magnesium ion, but with the inadequate supply of the ordinary nutrient elements, especially potassium and phosphorus, in the soils. These authors did not discuss, however, the remarkable ability of certain native plants to thrive on serpentine-barrens.

[1] Soils: 36, 1906.
[2] Soil Science, 22: 291, 1926.

In connection with the writer's investigations of plant distribution in the eastern United States, it seemed of interest to obtain data as to the chemical composition of the ash of those growing in such barren situations; and on recommendation of the Faculty Research Committee, a grant of funds was made by the Board of Graduate Education and Research to aid in doing so. This money was used to defray the expenses of having made a series of accurate analyses of certain soils and of the ash of several plants growing on them, the analytical work being carried out in a highly satisfactory manner by Mr. Horace J. Hallowell, a consulting chemist of Philadelphia. The plants were selected for study so as to be representative of important classes, as follows: One fern, one conifer, one monocot, one primitive dicot, and two specialized dicots. In each case, one sample was collected from a serpentine-barren, and another of morphologically similar material from either Piedmont or Coastal Plain woods. My thanks are due to Dr. Francis W. Pennell, who has made a special study of the plants of the serpentine-barrens, for aid in locating several of those here investigated.

The species of plants which grow on the serpentine-barrens have migrated there from other geological formations in the same general region, so the first subject to which attention was directed was the composition of the soil in various localities of these plants. The serpentine-barren soil analyzed consisted of material which adhered to the roots of one of the most characteristic species of such areas, namely Moss Phlox (*Phlox subulata* L.) collected 1½ miles northeast of Unionville, Chester County, Pennsylvania. To represent the soil of Piedmont woods, a sample was similarly obtained from the roots of Spike Gayfeather (*Liatris spicata* (L.) Willd.) ¾ mile south of Crozierville, Delaware County, Pennsylvania. The underlying rock here is gabbro, but the plant proved to be morphologically indistinguishable from that growing on serpentine a few miles away. Coastal-plain woods soil was shaken from the roots of a clump of Moss Phlox identical in aspect to that on the serpentine at Chews Landing station, Camden County, New Jersey. These soil samples were sifted through a screen with meshes 1 mm. in diameter to remove coarse rock fragments and plant débris, and the nitrogen and acid-soluble mineral elements were determined by the official methods of the Association of Official Agricultural Chemists, the results being presented in Table 1. Subsequent tables give the data as to the composition of the ash of the several plants studied, manganese and chlorine having been determined by official methods, the remaining elements by those recommended in Washington's Chemical Analysis of Rocks.

TABLE 1

ACID-SOLUBLE CONSTITUENTS OF SOILS SUPPORTING THE PLANTS INVESTIGATED

	Serpentine-barren	Piedmont woods	Coastal-plain woods		Serpentine-barren	Piedmont woods	Coastal plain woods
K_2O	0.18	0.09	0.14	SiO_2	0.08	0.12	0.07
Na_2O	0.03	0.12	0.05	N, total	0.47	0.30	0.27
CaO	0.43	0.20	0.24	N, as NH_3	0.06	0.02	0.04
MgO	17.03	0.33	0.26	N, as NO_3	none	none	none
Fe_2O_3	8.40	3.01	2.26	pH (colorim.)	6.0	5.5	5.0
Al_2O_3	1.32	4.50	1.04	act. acidity	10	30 +	100
P_2O_5	0.32	0.22	0.17				

Formed as they have been under essentially identical climatic conditions, the acid-soluble portions of the three soils are not markedly different in character, except that particles of serpentine distributed through the first yield relatively large amounts of magnesia and iron oxide.

TABLE 2

COMPOSITION OF THE ASH OF BRAKE (*Pteridium latiusculum* (DESV.) MAXON)

Constituents	Coastal-plain woods		Serpentine-barren		Change	
	Per cent. of ash	Per cent. of plant	Per cent. of ash	Per cent. of plant	Amount	Per cent.
K_2O	3.38	0.19	10.40	0.685	+0.495	+260
Na_2O	1.57	0.09	2.15	0.14	+0.05	+ 55
CaO	10.02	0.57	7.98	0.525	–0.045	– 8
MgO	6.76	0.385	14.45	0.95	+0.565	+149
MnO	0.40	0.02	0.35	0.02	......	......
Fe_2O_3	1.45	0.08	0.66	0.04	–0.04	– 50
Al_2O_3	2.40	0.135	1.05	0.07	–0.065	– 48
P_2O_5	2.32	0.13	2.47	0.16	+0.03	+ 23
SO_3	2.47	0.14	1.68	0.11	–0.03	– 21
Cl	0.06	0.005	1.84	0.12	+0.115	......
SiO_2	69.36	3.955	57.86	3.805	–0.15	– 4
O = Cl	–0.01	......	–0.40	–0.025	......	......
Sum	100.18	5.70	100.49	6.60	+0.925	+ 16
Localities	West of Albion, Camden Co., N. J.		South of Lima, Delaware Co., Pa.			

Notable features: Ratio, basic to acidic oxides, 1 : 3; potash low, silica high; result of migration into serpentine-barren, marked increase in total ash, potash, and magnesia.

TABLE 3—COMPOSITION OF THE ASH OF PITCH PINE (*Pinus rigida* MILLER)

Constituents	Coastal-plain woods		Serpentine-barren		Change	
	Per cent. of ash	Per cent. of plant	Per cent. of ash	Per cent. of plant	Amount	Per cent.
K_2O	27.90	0.76	19.02	0.39	–0.37	– 49
Na_2O	5.66	0.155	1.34	0.025	–0.13	– 84
CaO	17.98	0.49	19.05	0.39	–0.10	– 20
MgO	6.01	0.165	16.64	0.34	+0.175	+106
MnO	0.80	0.02	0.60	0.01	–0.01	– 50
Fe_2O_3	0.96	0.025	1.27	0.025	......	......
Al_2O_3	10.97	0.30	4.16	0.085	–0.215	– 72
P_2O_5	12.79	0.35	10.74	0.22	–0.13	– 37
SO_3	6.68	0.18	10.42	0.21	+0.03	+ 17
Cl	0.67	0.02	1.44	0.03	+0.01	+ 50
SiO_2	8.96	0.24	15.86	0.32	+0.08	+ 33
O = Cl	–0.14	–0.005	–0.29	–0.005	......	......
Sum	99.24	2.70	100.75	2.04	–0.66	– 24
Localities	Atsion, Burlington Co., N. J.		Nottingham, Chester Co., Pa.			

Notable features: Ratio, basic to acidic oxides, 3 : 1; potash high, silica low; result of migration into serpentine-barren, marked decrease in total ash and in potash, but increase in magnesia.

TABLE 4—COMPOSITION OF THE ASH OF CATBRIER (*Smilax rotundifolia* L.)

Constituents	Coastal-plain woods		Serpentine-barren		Change	
	Per cent. of ash	Per cent. of plant	Per cent. of ash	Per cent. of plant	Amount	Per cent.
K_2O	29.69	0.615	39.06	0.55	–0.065	– 16
Na_2O	2.22	0.045	4.35	0.06	+0.015	+ 33
CaO	31.50	0.65	14.68	0.205	–0.445	– 68
MgO	4.00	0.08	17.01	0.24	+0.16	+200
MnO	0.82	0.015	0.63	0.01	–0.005	– 33
Fe_2O_3	1.59	0.035	0.87	0.01	–0.025	– 71
Al_2O_3	2.01	0.04	0.40	0.005	–0.035	– 88
P_2O_5	7.85	0.16	8.94	0.125	–0.035	– 22
SO_3	14.61	0.30	11.01	0.155	–0.145	– 48
Cl	0.66	0.015	1.54	0.02	+0.005	+ 33
SiO_2	5.64	0.115	1.91	0.025	–0.09	– 78
O = Cl	–0.14	......	–0.30	–0.005	......	......
Sum	100.45	2.07	100.10	1.40	–0.67	– 32
Localities	West of Albion, Camden Co., N. J.		Williamson School, Delaware Co., Pa.			

Notable features: Ratio of basic to acidic oxides, 3 : 1; potash high, silica low; result of migration into serpentine-barren, marked decrease in total ash and lime, but a 200 per cent. increase in magnesia.

TABLE 5—COMPOSITION OF THE ASH OF BLACKJACK OAK (*Quercus marilandica* MUENCH)

Constituents	Coastal-plain woods		Serpentine-barren		Change	
	Per cent. of ash	Per cent. of plant	Per cent. of ash	Per cent. of plant	Amount	Per cent.
K_2O	22.52	0.605	16.65	0.365	–0.24	– 37
Na_2O	5.12	0.135	1.37	0.03	–0.105	– 78
CaO	28.40	0.76	31.24	0.685	–0.075	– 10
MgO	6.49	0.175	18.84	0.41	+0.235	+134
MnO	0.97	0.025	1.08	0.025	......	......
Fe_2O_3	2.83	0.075	1.00	0.02	–0.055	– 73
Al_2O_3	5.88	0.16	1.92	0.04	–0.12	– 75
P_2O_5	8.13	0.22	8.32	0.18	–0.04	– 19
SO_3	8.11	0.22	8.79	0.19	–0.03	– 14
Cl	0.39	0.01	0.18	0.005	–0.005	– 50
SiO_2	11.76	0.315	11.41	0.25	–0.065	– 21
O = Cl	–0.08	......	–0.04	......	......	......
Sum	100.52	2.70	100.76	2.20	–0.50	– 19
Localities	West of Albion, Camden Co., N. J.		Williamson School, Delaware Co., Pa.			

Notable features: Ratio, basic to acidic oxides, 3 : 1; potash high; silica low; result of migration into serpentine-barren, decrease in total ash and potash, but considerable increase in magnesia.

TABLE 6—COMPOSITION OF THE ASH OF MOSS PHLOX (*Phlox subulata* L.)

Constituents	Coastal-plain woods		Serpentine-barren		Change	
	Per cent. of ash	Per cent. of plant	Per cent. of ash	Per cent. of plant	Amount	Per cent.
K_2O	14.21	0.72	7.50	0.465	–0.255	– 35
Na_2O	5.27	0.27	4.48	0.275	+0.005	+ 2
CaO	22.66	1.15	17.52	1.085	–0.065	– 6
MgO	3.00	0.15	7.71	0.475	+0.325	+217
MnO	0.17	0.01	0.07	0.005	–0.005	– 50
Fe_2O_3	2.70	0.14	1.07	0.065	–0.075	– 54
Al_2O_3	6.73	0.34	5.18	0.32	–0.02	– 6
P_2O_5	4.59	0.23	2.84	0.175	–0.055	– 24
SO_3	3.29	0.17	1.32	0.08	–0.09	– 53
Cl	3.50	0.18	1.86	0.115	–0.065	– 36
SiO_2	34.06	1.73	51.20	3.16	+1.43	+ 83
O = Cl	–0.70	–0.03	–0.40	–0.02	......	......
Sum	99.42	5.06	100.35	6.20	+1.125	+ 22
Localities	Chews Landing, Camden Co., N. J.		NE. of Unionville, Chester Co., Pa.			

Notable features: Ratio, basic to acidic oxides, about 1 : 1; result of migration into serpentine-barren, marked increase in total ash, magnesia and silica, but a decrease in potash.

TABLE 7—COMPOSITION OF THE ASH OF SPIKE GAYFEATHER (*Liatris spicata* (L.) WILLD.)

Constituents	Piedmont woods		Serpentine-barren		Change	
	Per cent. of ash	Per cent. of plant	Per cent. of ash	Per cent. of plant	Amount	Per cent.
K_2O	16.02	1.355	9.11	0.735	–0.62	– 46
Na_2O	0.81	0.07	1.30	0.105	+0.035	+ 50
CaO	17.60	1.485	6.80	0.545	–0.94	– 63
MgO	5.46	0.46	19.62	1.58	+1.12	+265
MnO	0.35	0.03	0.31	0.025	–0.005	– 17
Fe_2O_3	0.38	0.03	0.84	0.07	+0.04	+133
Al_2O_3	1.03	0.085	0.12	0.01	–0.075	– 88
P_2O_5	2.22	0.19	1.15	0.09	–0.10	– 53
SO_3	4.25	0.36	4.04	0.325	–0.035	– 10
Cl	3.07	0.26	0.61	0.05	–0.21	– 81
SiO_2	49.64	4.19	56.80	4.565	+0.375	+ 9
O = Cl	–0.67	–0.055	–0.13	–0.01	......	......
Sum	100.16	8.46	100.57	8.09	–0.37	– 4
Localities	S. of Crozierville, Delaware Co., Pa.		Williamson School, Delaware Co., Pa.			

Notable features: Ratio of basic to acidic oxides, 2 : 3; result of migration into serpentine-barren, great increase in magnesia, and moderate decrease in lime and potash.

TABLE 8—ASH-COMPOSITION OF HAIRY CERASTIUM (*Cerastium arvense villosum* (MUHL.) HOLL. & BRIT.) ON TWO DIFFERENT SERPENTINE-BARRENS

Constituents	Staten Island[3]	Unionville, Pa.	
		Percentage of ash	Percentage of plant
K_2O	......	29.63	1.79
Na_2O	......	4.32	0.26
CaO	9.35	3.59	0.22
MgO	19.79	20.72	1.25
MnO	......	0.10	0.005
Fe_2O_3	......	2.30	0.14
Al_2O_3	18.58	5.98	0.36
P_2O_5	......	9.19	0.555
SO_3	......	3.50	0.21
Cl	......	7.77	0.47
SiO_2	39.85	13.82	0.835
O = Cl	......	–1.69	–0.10
Sum	......	99.23	6.00
Ratio, B : A	......	2 : 1.	......

[3] Bull. Torrey Bot. Club, 14: 49, 1887.

In this case the plant is endemic on serpentine, so no comparison with occurrences on another type of soil can be made, but analyses of it from two serpentine-barrens 100 miles apart show that while the amount of some constituents varies from one locality to another, the magnesia content remains essentially constant at around 20 per cent.

Summary.—Ash analyses have been made of six widely different plants growing in serpentine-barrens and in nearby Piedmont or Coastal-plain woods. In all cases there was a marked increase in magnesium oxide content when the plants invaded the highly magnesian soil of the barrens, accompanied by changes in other constituents showing no regularity. The ash of an endemic *Cerastium* from two different barrens showed uniformity only in high magnesia content.

Plants in which the ash-composition has been studied	Ratio, bases to acids	Results of migration into serpentine-barren	
		Increase in MgO, %	Changes in other constituents
Brake (*Pteridium latiusculum*)	1:3	149	Total ash and potash increased.
Pitch Pine (*Pinus rigida*)	3:1	106	Total ash and potash decreased.
Catbrier (*Smilax rotundifolia*)	3:1	200	Total ash and lime decreased.
Blackjack Oak (*Quercus marilandica*)	3:1	134	Total ash and potash decreased.
Hairy Cerastium (*C. arvense villosum*).	2:1	......	....
Moss Phlox (*Phlox subulata*)	1:1	217	Total ash and silica increased.
Spike Gayfeather (*Liatris spicata*)	2:3	265	Potash and lime decreased.

A LIST OF THE SAWFLIES OF THE TENTHREDININAE (HYMENOPTERA) OF PENNSYLVANIA*

HOMER C. WILL
Juniata College, Huntingdon, Pa.

This list has been prepared from records obtained from specimens in the collection of the Carnegie Museum, Pittsburgh (C. M.); from records obtained from the collections of the United States National Museum (U. S. N. M.); from collections in the possession of the State Department of Agriculture, Bureau of Plant Industry, Harrisburg, Pa. (S. D. A. Pa.); from the collections of the Academy of Natural Sciences of Philadelphia (A. N. S. Phila.); and from records listed in the literature (Lit.). Those obtained from specimens in the collection of the Carnegie Museum are based on identifications made by the writer; those in the United States National Museum from identifications made, in the main, by Mr. S. A. Rohwer; those in Harrisburg on identifications made by a number of workers; and those in the Academy of Natural Sciences, Philadelphia, are the types of Norton and the elder Cresson. The systematic arrangement of the genera follows closely the classification proposed by Rohwer (1911).[1] The list records six genera and 46 species and varieties from the State.

* Contribution from the Zoological Laboratory, University of Pittsburgh.

SUBORDER CHALASTOGASTRA

SUBFAMILY TENTHREDININAE

Bivena MacGillivray

Bivena delta (Provancher). Jeannette (H. G. Klages) (C. M.); Pittsburgh, June (C. M.); Allegheny Co., June (C. M.); Pa. (2079) (C. F. Baker) (U. S. N. M.).

Bivena semilutea (Norton). Highspire, May (W. S. Fisher) (U. S. N. M.); Harrisburg, May (P. R. Myers) (U. S. N. M.); New Cumberland, May, June (P. R. Myers) (U. S. N. M.); Harrisburg, June (P. R. Myers) (U. S. N. M.); Roxboro, May (F. Haimbach) (U. S. N. M.); Olney, May, June (U. S. N. M.); Philadelphia, May (U. S. N. M.); Pa. (2014) (C. F. Baker) (U. S. N. M.); Hummelstown, May (J. N. Knull) (S. D. A. Pa.); Rockville, June (J. G. Sanders) (S. D. A. Pa.); Delaware Co., May (A. N. S. Phila.); Swarthmore, June (A. N. S. Phila.); Philadelphia, June (A. N. S. Phila.)

Lagium Konow

Lagium atroviolaceum (Norton). Westmoreland Co., July (C. M.); Jeannette (H. G. Klages) (C. M.); Pittsburgh, June (C. M.); Allegheny Co., (Zarobsky) (C. M.); Washington Co. (G. A. Ehrmann) (C. M.); Oak Station, Allegheny Co., May (C. M.); Inglenook, June (Champlain) (U. S. N. M.); Harrisburg, June (S. D. A. Pa.); Rockville, June (S. D. A. Pa.); Colemanville, July (S. D. A. Pa.); Inglenook, July (H. B. Kirk) (S. D. A. Pa); Castle Rock, Delaware Co., June (S. D. A. Pa.); Cove, July (S. D. A. Pa.); Penn. (A. N. S. Phila.); Philadelphia Neck, June (A. N. S. Phila.).

Lagium peratrum (Dyar). Pa. (2079) (C. F. Baker) (Type, U. S. N. M.); Pa. (1572) (U. S. N. M.); Pa. (2159) (C. F. Baker) (U. S. N. M.); Roxborough, June (U. S. N. M.).

Lagium tardum (Norton). Pittsburgh, June (C. M.); Ligonier, June (C. M.); Jeanette (H. G. Klages) (C. M.); Pa. (2014) (C. F. Baker) (U. S. N. M.); Glepside, July (C. T. Greene) (U. S. N. M.); Roxborough, June (U. S. N. M.);

[1] Rohwer, S. A. "A classification of the Suborder Chalastogastra of the Hymenoptera." Proc. of the Entomolog. Soc. Wash. vol. 13 (1911), no. 4, pp. 215–226.

Harrisburg, June (Champlain) (U. S. N. M.); Inglenook, June (U. S. N. M.); Hunter's Run, July (U. S. N. M.); Highspire, June (S. D. A. Pa.); Harrisburg, June (S. D. A. Pa.); Inglenook, July (H. B. Kirk) (S. D. A. Pa.); Inglenook, June (Daecke Collection) (S. D. A. Pa.); North Cumberland, June (S. D. A. Pa.); Harrisburg, June (H. B. Kirk) (S. D. A. Pa.).

Zalagium Rohwer

Zalagium cinctulum (*Norton*). Penn. (A. N. S. Phila.).

Macrophya Dahlbom

Macrophya alba (*MacGillivray*). Pa. (1572) (C. F. Baker) (U. S. N. M.); Inglenook, June (U. S. N. M.); New Cumberland, May (P. R. Myers) (U. S. N. M.).

Macrophya albomaculata (*Norton*). Pittsburgh, June (C. M.); Pa. (1572) (C. F. Baker) (U. S. N. M.); Jeannette (H. G. Klages) (S. D. A. Pa.); Germantown, Phila., June (H. S. H.) (S. D. A. Pa.).

Macrophya bilineata MacGillivray. Allegheny Co. (G. A. Ehrmann) (C. M.); Pittsburgh, June (C. M.); Westmoreland Co., July (C. M.).

Macrophya cassandra Kirby. Inglenook, June (P. R. Myers) (U. S. N. M.).

Macrophya confusa MacGillivray. Carrick, Allegheny Co., June (C. M.); Allegheny Co., May (C. M.); Jeannette (H. G. Klages) (C. M.); Pittsburgh, June (C. M.).

Macrophya crassicornis Provancher. Pa. (1573) (C. F. Baker) (U. S. N. M.).

Macrophya epinota (*Say*). Pa. (1572, 2014, 2159) (C. F. Baker) (U. S. N. M.); Harrisburg, May (P. R. Myers) (U. S. N. M.).

Macrophya errans Rohwer. Ingram, June (W. D. McIlroy, Jr.) (C. M.); Pittsburgh, June (C. M.); Pa. (1572) (C. F. Baker) (Type, U. S. N. M.); Pa. (2079) (C. F. Baker) (U. S. N. M.).

Macrophya externa (*Say*). Roxborough, May (U. S. N. M.).

Macrophya fascialis Norton. Carlisle, June (P. R. Myers) (U. S. N. M.); Gleps'de, June (C. T. Greene) (U. S. N. M.).

Macrophya flavicoxis (*Norton*). Pittsburgh, June (C. M.); Jeannette (H. G. Klages) (C. M.); Westmoreland Co., May (C. M.); Allegheny Co. (C. M.); Jeannette (H. G. Klages) (U. S. N. M.); Pa. (1573) (C. F. Baker) (U. S. N. M.); North East, Pa., June (S. A. Rohwer) (U. S. N. M.); Pa. (1572, 2079, 1579) (C. F. Baker) (U. S. N. M.); Lindley, Phila., June (Daecke Collection) (S. D. A. Pa.); Penn. (A. N. S. Phila.); Delaware Co., June (A. N. S. Phila.); Glenside, May (A. N. S. Phila.).

Macrophya formosa (*Klug*). Westmoreland Co., July (C. M.); Pa. (2079) (C. F. Baker) (U. S. N. M.); Inglenook, June (P. R. Myers) (U. S. N. M.); Roxboro, Phila., June (U. S. N. M.); Colemanville, July (S. D. A. Pa.); Inglenook, July (Daecke Collection) (S. D. A. Pa.); Hunter's Run, June (Daecke Collection) (S. D. A. Pa.); Glenside, Montgomery Co., June (S. D. A. Pa.); Foxbury, June (H. B. Kirk) (S. D. A. Pa.); Weaver, June (Daecke Collection) (S. D. A. Pa.); Inglenook, July (H. B. Kirk) (S. D. A. Pa.); North Bloomfield, June (Champlain) (S. D. A. Pa.); Harrisburg, June (H. B. Kirk) (S. D. A. Pa.); Charter Oak, June (J. N. Knull) (S. D. A. Pa.); Carlisle, July (E. Daecke) (S. D. A. Pa.); Lehigh Gap, June, July (H. L. V.) (S. D. A. Pa.); Edge Hill, June (A. N. S. Phila.).

Macrophya gonyphora (*Say*). Pa. (A. N. S. Phila.).

Macrophya incerta (*Norton*). Allegheny Co. (C. M.); Crisp (C. M.); Pittsburgh (C. M.); Pa. (1572, 1573) (C. F. Baker) (U. S. N. M.); Inglenook, June (U. S. N. M.); Arenattsville, May (S. W. Frost) (Leaf miner on *Anemone quinquefolia*) (U. S. N. M.); Corry, May (S. D. A. Pa.); Inglenook, June (J. N. Knull) (S. D. A. Pa.); Germantown, May (H. S. H.) (S. D. A. Pa.); Penn. (A. N. S. Phila.).

Macrophya intermedia (*Norton*). Dauphin, July (S. D. A. Pa.); Castle Rock, June (H. S. Harlock) (S. D. A. Pa.); Swarthmore, May (A. N. S. Phila.); Penn. (A. N. S. Phila.).

Macrophya lineatana Rohwer. Jeannette (H. G. Klages) (C. M.); Pa. (1572) (C. F. Baker) (Paratype, U. S. N. M.).

Macrophya mixta MacGillivray. Pa. (1573, 2014) (C. F. Baker) (U. S. N. M.).

Macrophya nigra (*Norton*). Westmoreland Co., July (C. M.).

Macrophya nigristigma Rohwer. Harrisburg, June (P. R. Myers) (Type, U. S. N. M.); Highspire, June (P. R. Myers) (Paratype, U. S. N. M.).

Macrophya pannosa (*Say*). Allegheny Co. (G. A. Ehrmann) (C. M.); Jeannette (H. G. Klages) (C. M.).

Macrophya pulchella (*Klug*). Pittsburgh, June (C. M.); New Cumberland, May (P. R. Myers) (U. S. N. M.); Germantown, June (S. D. A. Pa.); Castle Rock, May (Daecke Collection) (S. D. A. Pa.); Jack Run, Allegheny, June (A. N. S. Phila.).

Macrophya punctata MacGillivray. Sunbury (U. S. N. M.).

Macrophya succincta Cresson. Ashbourne, April (H. L. V.) (S. D. A. Pa.).

Macrophya tibiator Norton. Allegheny Co., (G. A. Ehrmann) (C. M.); Pittsburgh, May (C. M.); Moon Township, Allegheny Co., (C. M.); Washington Co., (G. A. Ehrmann) (C. M.); Jeannette (H. G. Klages) (C. M.); Pa. (2014) (C. F. Baker) (U. S. N. M.); Highspire, May (P. R. Myers) (U. S. N. M.); Harrisburg, June (P. R. Myers) (U. S. N. M.); Inglenook, July (U. S. N. M.); Middletown, May (S. D. A. Pa.); Highspire, April (S. D. A. Pa.); Harrisburg, May (S. D. A. Pa.); Carlisle, May (S. D. A. Pa.); Inglenook, June (S. D. A. Pa.); North Mountain, June (C. W. J.) (S. D. A. Pa.); Swarthmore, June (A. N. S. Phila.); Pa. (A. N. S. Phila.).

Macrophya trisyllabus (*Norton*). Pittsburgh, July (C. M.); Jeannette (H. G. Klages) (C. M.); Allegheny, June (C. M.); Laurel Hill, Somerset Co., (Hugo Kahl) (C. M.); Sandy Lake, Mercer Co., (Hugo Kahl) (C. M.); Westmoreland Co., (C. M.); Inglenook, Dauphin Co., Sept. (P. R. Myers) (U. S. N. M.); Highspire, June (P. R. Myers) (U. S. N. M.); Harrisburg, June (P. R. Myers (U. S. N. M.); Speeceville, July (P. R. Myers) (U. S. N. M.); Jeannette (H. G. Klages) (U. S. N. M.); Rockville, June (S. D. A. Pa.); Glenside, June (S. D. A. Pa.); Perdix, June (Daecke Collection) (S. D. A. Pa.); Inglenook, June (S. D. A. Pa.); Riverview, June (S. D. A. Pa.); Jack Run, Allegheny Co., June (A. N. S. Phila.); Pa. (A. N. S. Phila.); Pa., Delaware Co., June (A. N. S. Phila.).

Macrophya trosula (*Norton*). Pa. (1572) (C. F. Baker) (U. S. N. M.); Carlisle, June (P. R. Myers) (U. S. N. M.); Penn. (No. 12474) (S. D. A. Pa.); Pa. (J. McF.) (S. D. A. Pa.).

Macrophya zabriskiei Rohwer. Inglenook, June (P. R. Myers) (U. S. N. M.).

Macrophya zonalis Norton. Pittsburgh, June (C. M.); Jeannette (H. G. Klages) (C. M.); Westmoreland Co., July (C. M.).

Tenthredo Linnaeus

Tenthredo basilaris Say. Ingram, August (W. D. McIlroy, Jr.) (C. M.); Pittsburgh, June (C. M.); Penn. (No. 12474) (S. D. A. Pa.); Johnstown, August (No. 3227) (S. D. A. Pa.): Penn., August (S. Sterling) (A. N. S. Phila.).

Tenthredo dubius (Norton). Pocono Lake, July (U. S. N. M.).

Tenthredella Rohwer

Tenthredella angulifera (Norton). Castle Rock, June (Daecke Collection) (S. D. A. Pa.).

Tenthredella antennata (Kirby). Charter Oak, June (H. B. Kirk) (U. S. N. M.); Mt. Alto, May (J. R. Stear) (S. D. A. Pa.).

Tenthredella grandis (Norton). Pittsburgh, June (C. M.); Perkasie, June (S. D. A. Pa.); Germantown, Phila., June (H. S. H.) (S. D. A. Pa.); Pa. (A. N. S. Phila.).

Tenthredella leucostoma (Kirby). Crisp, July (C. M.); Pittsburgh, June (C. M.); Westmoreland Co., July (C. M.); Jeannette (H. G. Klages) (C. M.); Ligonier, July (C. M.).

Tenthredella lobata lobata (Norton). Westmoreland Co., July (C. M.); Allegheny Co., (Zarobsky) (C. M.); Laurel Hill, Somerset Co., August (Hugo Kahl) (C. M.).

Tenthredella rufopecta rufopecta (Norton). Westmoreland Co., July (C. M.); Allegheny Co., June (C. M.); Pittsburgh, June (C. M.); Crisp, June (C. M.); Jeannette (H. G. Klages) (C. M.); Hartstown, Crawford Co., July (Hugo Kahl) (C. M.); Tioga Co., (U. S. N. M.); Castle Rock, June (Daecke Collection) (S. D. A. Pa.); Roxboro, June (S. D. A. Pa.).

Tenthredella rufopedibus (Norton). Pennsylvania (Lit.).

Tenthredella ruma (MacGillivray). Jeannette (H. G. Klages) (Lit.).

Tenthredella signata (Norton). Pittsburgh, June (C. M.); Westmoreland Co., July (C. M.).

Tenthredella verticalis (Say). Castle Rock, June (Daecke Collection) (S. D. A. Pa.); Swarthmore, June (A. N. S. Phila.); Delaware Co., May (A. N. S. Phila.).

A LIST OF THE SYNONYMY OF THE TENTHREDININAE (HYMENOPTERA) OF AMERICA, NORTH OF MEXICO*

HOMER C. WILL

Juniata College, Huntingdon, Pa.

The Tenthredininae of North America comprise a well-known group of insects which have received considerable study. The study has been concerned primarily with additions to the fauna and to descriptions of new species.

* Contribution from the Zoological Laboratory, University of Pittsburgh.

The studies of this group have not been coordinated and unified. The student endeavoring to obtain a knowledge of the Tenthredininae has been confronted with a widely scattered literature, considerable synonymy, and many points of disagreement. The knowledge of the fauna is now sufficiently advanced and the structural characters adequately determined, to warrant an attempt to coordinate and unify the group. The writer has attempted this organization by preparing a card catalogue giving the references found in entomological literature,[1] by making a list of the synonymy, by changing the nomenclature to conform with modern ideas concerning the group, and by giving the distribution of each species.

The revision of the Tenthredininae and the clearing up of the existing mass of named species have given rise to many synonyms. In the card catalogue there are listed 347 names which are treated as valid; while 132 names are treated as synonyms. The present disposition of the names of the latter group is presented in this paper. The responsibility for each synonym is indicated in the card catalogue.

The following is a list of synonyms of the Tenthredininae arranged in alphabetical order:

Allantus afflictus Cresson—*Tenthredella afflicta* (Cresson).
Allantus albomaculatus Norton—*Macrophya albomaculata* (Norton).
Allantus annularis Norton—*Tenthredo admeta* (Enslin).
Allantus atroviolaceus Norton—*Lagium atroviolaceum* (Norton).
Allantus bifasciatus Say—*Macrophya bifasciata* (Say).
Allantus cestus Say—*Macrophya cestus* (Say).
Allantus dejectus Norton—*Macrophya dejecta* (Norton).
Allantus elegantulus Cresson—*Tenthredo arethusa* (Enslin).
Allantus epinotus Say—*Macrophya epinota* (Say).
Allantus externus Say—*Macrophya externa* (Say).
Allantus flavicoxae Norton—*Macrophya flavicoxis* (Norton).
Allantus goniphorus Say—*Macrophya gonyphora* (Say).
Allantus heraclei Kincaid—*Tenthredo alaskanus* (Enslin).
Allantus incertus Norton—*Macrophya incerta* (Norton).
Allantus intermedius Norton—*Macrophya intermedia* (Norton).
Allantus interruptus Norton—*Tenthredo asella* (Enslin).
Allantus limbatus Cresson—*Tenthredo associata* (Enslin).
Allantus niger Norton—*Macrophya nigra* (Norton).
Allantus opimus Cresson—*Tenthredo (Labidia) opimus opimus* (Cresson).
Allantus orginalis Norton—*Tenthredo (Labidia) originalis* (Norton).
Allantus pannosus Say—*Macrophya pannosa* (Say).
Allantus robustus Provancher—*Tenthredo dubius* (Norton).
Allantus subnigriceps Rohwer—*Tenthredo (Labidia) subnigriceps* (Rohwer).

[1] In the possession of the laboratories of Entomology, Carnegie Museum, Pittsburgh, Pa.

Allantus tardus Norton—*Lagium tardum* (Norton).
Allantus trisyllabus Norton—*Macrophya trisyllabus* (Norton).
Allantus trosulus Norton—*Macrophya trosula* (Norton).
Allantus varius Norton—*Macrophya varius* (Norton).
Astochus aldrichi MacGillivray—*Laurentia rubens* var. *aldrichi* (MacGillivray).
Astochus fletcheri MacGillivray—*Laurentia rubens* var. *ruficorna* (MacGillivray).
Bivena maria MacGillivray—*Bivena delta* (Provancher).
Homoeoneura delta (Provancher)—*Bivena delta* (Provancher).
Hoplocampa montana (Cresson)—*Zaschizonyx montana* (Cresson).
Hoplocampa spissipes (Cresson)—*Macrophya spissipes* (Cresson).
Kincaidia ruficorna (MacGillivray)—*Laurentia rubens* var. *ruficorna* (MacGillivray).
Labidia doanei Rohwer—*Macrophya doanei* (Rohwer). (In part).
Labidia doanei Rohwer—*Macrophya pluricinctella* Rohwer. (In part).
Labidia opimus (Cresson)—*Tenthredo (Labidia) opimus opimus* (Cresson).
Labidia opimus var. *bigemina* Dyar—*Tenthredo arethusa* (Enslin).
Labidia originalis (Norton)—*Tenthredo (Labidia) originalis* (Norton).
Lagium atroviolaceum var. *tardum* (Norton)—*Lagium tardum* (Norton).
Lagium cinctulum (Norton)—*Zalagium cinctulum* (Norton).
Laurentia aldrichi (Rohwer)—*Laurentia rubens* var. *aldrichi* (MacGillivray).
Laurentia edwardsii var. *edwardsii* (Rohwer)—*Laurentia rubens* var. *edwardsii* (Cresson).
Laurentia edwardsii var. *ruficorna* (Rohwer)—*Laurentia rubens* var. *ruficorna* (MacGillivray).
Leucopelmonus annulatus MacGillivray—*Leucopelmonus confusus* (Norton).
Macrophya Abbotii Kirby—*Zalagium cinctulum* (Norton).
Macrophya albifacies Kirby—*Macrophya trosula* (Norton).
Macrophya bicolorata Cresson—*Macrophya fumator* Norton.
Macrophya californica (Norton)—*Rhogogastera californica* (Norton).
Macrophya eurythmia Norton—*Macrophya varius* var. *eurythmia* Norton.
Macrophya fuliginea Norton—*Macrophya fuliginosa* Norton.
Macrophya jugosa Cresson—*Macrophya fumator* Norton.
Macrophya maura Cresson—*Macrophya fumator* var. *maura* (Cresson).
Macrophya nidonea MacGillivray—*Macrophya varius* var. *eurythmia* Norton.
Macrophya obaerata MacGillivray—*Macrophya oregona* Cresson.
Macrophya obnata MacGillivray—*Pachyprotasis omega* Norton.
Macrophya obrussa MacGillivray—*Macrophya fumator* Norton.
Macrophya pulchella var. *alba* MacGillivray—*Macrophya alba* (MacGillivray).
Macrophya pumila Norton—*Macrophya subviolacea* Cresson.
Macrophya sambuci Rohwer—*Macrophya nebraskensis* Rohwer.
Macrophya zonata Konow—*Macrophya alba* (MacGillivray).
Neopus 14-punctatus (Norton)—*Bivena quattrodecimpunctata* (Norton).
Pachyprotasis delta Provancher—*Bivena delta* (Provancher).
Pachyprotasis nigrofasciata Eschscholtz—*Pachyprotasis omega* Norton.
Perineura americana Provancher—*Pachyprotasis omega* Norton.
Perineura kincaidia MacGillivray—*Macrophya fumator* Norton.
Perineura turbata Rohwer—*Leucopelmonus confusus* (Norton).
Selandria gentilis Cresson—*Zaschizonyx montana* (Cresson).
Selandria montana Cresson—*Zaschizonyx montana* (Cresson).

Selandria spissipes Cresson—*Macrophya spissipes* (Cresson).
Synairema americana Provancher—*Pachyprotasis omega* Norton.
Synairema pacifica Provancher—*Macrophya fumator* Norton.
Tenthredella cynthia (Enslin)—*Tenthredella basilaris* (Provancher).
Tenthredella denotata (Enslin)—*Tenthredella basilaris* (Provancher).
Tenthredella lobata maculosa Smulyan—*Tenthredella maculosa* Smulyan.
Tenthredella rohweri Smulyan—*Tenthredella tricolor* (Norton).
Tenthredo addenda Cresson—*Rhogogastera addenda* (Cresson).
Tenthredo atravenus MacGillivray—*Laurentia rubens* (Cresson).
Tenthredo atroviolacea (Norton)—*Lagium atroviolaceum* (Norton).
Tenthredo atroviolacea var. *cinctulus* Norton—*Zalagium cinctulum* (Norton).
Tenthredo atroviolacea var. *peratra* Dyar—*Lagium peratrum* (Dyar).
Tenthredo Barnstonii Kirby—*Tenthredella semirubra* (Norton).
Tenthredo Californicus Norton—*Rhogogastera californica* (Norton).
Tenthredo cinctitibiis Norton—*Tenthredella cinctitibiis cinctitibiis* (Norton).
Tenthredo cingulata Provancher—*Tenthredella verticalis* var. *cingulata* (Provancher).
Tenthredo commata Konow—*Tenthredella perplexus* (MacGillivray).
Tenthredo concessus Norton—*Tenthredella tricolor* var. *concessus* (Norton).
Tenthredo confusus Norton—*Leucopelmonus confusus* (Norton).
Tenthredo cressonii Kirby—*Tenthredella tricolor* (Norton).
Tenthredo diluta (Cresson)—*Laurentia diluta* (Cresson).
Tenthredo dissimulans Kincaid—*Rhogogastera dissimulans* (Kincaid).
Tenthredo dubitatus MacGillivray—*Tenthredella grandis* (Norton).
Tenthredo Edwardsi Cresson—*Laurentia rubens* var. *edwardsii* (Cresson).
Tenthredo elegantula oregana Rohwer—*Tenthredella elegantula obliquata* (MacGillivray).
Tenthredo evansii Harrington—*Rhogogastera evansi* (Harrington).
Tenthredo formosa Klug—*Macrophya formosa* (Klug).
Tenthredo Harrimani Kincaid—*Rhogogastera harrimani* (Kincaid).
Tenthredo lateraria Cresson—*Rhogogastera lateraria* (Cresson).
Tenthredo lobata Norton—*Tenthredella lobata lobata* (Norton).
Tenthredo mellicoxa Provancher—*Tenthredella rufopecta mellicoxa* (Provancher).
Tenthredo neoslossoni MacGillivray—*Tenthredella cogitans* (Provancher).
Tenthredo nigricollis Kirby—*Tenthredella semicornis* (Harrington).
Tenthredo novus MacGillivray—*Tenthredella eximia* (Norton).
Tenthredo obliquatus MacGillivray—*Tenthredella elegantula obliquata* (MacGillivray).
Tenthredo pallicolus var. *beulahensis* Rohwer—*Tenthredella pallicola* (MacGillivray).
Tenthredo parvula Cresson—*Tenthredella coenobita* (Enslin).
Tenthredo pulchella Klug—*Macrophya pulchella* (Klug).
Tenthredo racilia MacGillivray—*Laurentia rubens* (Cresson).
Tenthredo refractaria MacGillivray—*Laurentia rubens* var. *ruficorna* (MacGillivray).
Tenthredo remota MacGillivray—*Tenthredella signata* (Norton).
Tenthredo rubens Cresson—*Laurentia rubens* (Cresson).
Tenthredo rubricosa MacGillivray—*Tenthredella rufopedibus* (Norton).
Tenthredo rufipes Norton—*Tenthredella rufopedibus* (Norton).
Tenthredo rufipes Say—*Tenthredella leucostoma* (Kirby).
Tenthredo rufopectus Norton—*Tenthredella rufopecta rufopecta* (Norton).
Tenthredo simulatus MacGillivray—*Tenthredella secunda* (MacGillivray).

Tenthredo Slossonii MacGillivray—*Tenthredella signata* (Norton).
Tenthredo tardus (Norton)—*Lagium tardum* (Norton).
Tenthredo terminalis Provancher—*Tenthredella chaonica* (Enslin).
Tenthredo uniformis Kirby—*Tenthredella tricolor* var. *concessus* (Norton).
Tenthredo vittatipes Cresson—*Rhogogastera addenda* (Cresson).
Tenthredopsis annulicornis Harrington—*Leucopelmonus confusus* (Norton).
Tenthredopsis atroviolacea (Norton)—*Lagium atroviolaceum* (Norton).
Tenthredopsis atroviolacea var. *cinctula* (Norton—*Zalagium cinctulum* (Norton).
Tenthredopsis atroviolacea var. *tarda* (Norton)—*Lagium tardum* (Norton).
Tenthredopsis confusa (Norton)—*Leucopelmonus confusus* (Norton).
Tenthredopsis delta (Provancher)—*Bivena delta* (Provancher).
Tenthredopsis Evansii Harrington—*Rhogogastera evansi* (Harrington).
Tenthredopsis quattrodecimpunctata (Norton)—*Bivena quattrodecimpunctata* (Norton).
Tenthredopsis ruficorna MacGillivray—*Laurentia rubens* var. *ruficorna* (MacGillivray).
Tenthredopsis semilutea (Norton)—*Bivena semilutea* (Norton).
Tenthredopsis transversa MacGillivray—*Prototaxonus transversus* (MacGillivray).

FOSSIL-HUNTING GROUNDS IN PENNSYLVANIA[1]

BY BRADFORD WILLARD

Pennsylvania Topographic and Geologic Survey

INTRODUCTION

"Where can I find fossils?" How often I hear that question,—in my office, while a-field, in conversations with school teachers, scouts and their leaders, tourists, farmers, nature lovers,—from people whose interest in geology is such that they wish to gather prehistoric shells for themselves or to show to others. Because of this recurring query, this paper is written in order that there may be available lists of a few localities in Pennsylvania where those interested can collect fossils easily and in considerable variety and abundance.

Fossils are not found in all rocks nor in all parts of Pennsylvania. Generally speaking, the rocks of the portion of the State lying south of the Appalachian Mountains have few or no fossils; either because they are so old as to antedate the coming of abundant life to the earth so that they never had fossils, or they have been formed under conditions such that nothing could live, or they may have been so changed since they were formed that any fossils once present are now destroyed. However, the remainder of the State is almost entirely underlain by bedded rocks which often carry fossils, because, first, these strata were deposited in the sea or in fresh water where life was plentiful; and, second, subsequent to forming, these strata have been little altered. The fossiliferous rocks of the State are divided into systems, which together make up the geologic column. A knowledge of the system names is not essential in collecting, but it is important to the geologist.

[1] Published with the permission of the State Geologist of Pennsylvania.

ABBREVIATED GEOLOGIC COLUMN FOR PENNSYLVANIA

System Names		Commonest Fossils
Quarternary		Mammals
Triassic		Reptiles
Permian Pennsylvanian Mississippian	"Carboniferous"	Coal plants Invertebrates Amphibians
Devonian		Marine invertebrates Fishes Plants
Silurian		Marine invertebrates Fishes, a few
Ordovician		Marine invertebrates
Cambrian		Marine invertebrates

The kinds of fossils are legion. Most of us are acquainted with the coal plants, beautiful, fern-like leaves and pitted stems of which are common souvenirs of the coal fields. Backboned animals, the mammals, birds, reptiles, amphibians and fish, although not usually familiar to us as fossils, are well-known in the flesh as our deer, hawks, turtles, frogs or trout, respectively. The backboneless animals or invertebrates are mostly mollusks and brachiopods that once helped people the ocean which long ago covered much of our State. In many ways the mollusks resemble those of our seashores today, but strange forms, too, very unlike most living types, are known. The brachiopods, the delicate bryozoans and the crinoids are common fossils. Besides these there were creatures allied to our crabs, lobsters, shrimps and scorpions. Worms, too, were present, but backboneless land animals were very rare, limited chiefly to a few insects found among the coal plants.

Of the several groups of fossiliferous rocks of Pennsylvania, the Quaternary, Triassic, Ordovician and Cambrian may be here disregarded. Although to the specialist all of these systems have here and there yielded very interesting and sometimes abundant remains, their occurrence is too rare for present mention. The other three systems, the three parts of the Carboniferous taken collectively, the Devonian and the Silurian, commonly carry fossils, although many of their strata are barren or nearly so. Let us consider the possibilities of collecting fossils from these, beginning with the youngest or uppermost.

Carboniferous

The Pennsylvanian system or Coal Measures proper and the associated rock groups immediately above or below are fossil-bearing strata familiar to any one who lives in a coal-producing region. Plants may be collected from the shale ("slate") of mine dumps in many of our western and southwestern counties, in the Broad Top, and in the Anthracite Field. The plants are preserved in fresh-water-formed beds, which to the west interfinger with others laid down in the ocean. Often these salt-water-formed beds are limestones carrying lamp-shells and clam- or snail-like mollusks. Below the Coal Measures, fewer plants are found, seldom enough to form workable coal. Conversely, the remains of marine animals become more plentiful, particularly in western and southwestern districts. Because the Coal Measures are wide-spread and their fossils so common, no particular localities will be cited. However, the comparative rarity of plant remains in the underlying Mississippian beds warrants mention of one place where they may be collected.[2]

DAUPHIN COUNTY

1. *Dauphin:* 3 miles north along secondary road from Route 11, across Peters Mountain; mines in Mississippian coal (very unusual); abundant plant remains in dumps south of road ascending south slope.

Devonian

The surface rocks of north-central, central, and northeastern Pennsylvania beyond Kittatinny or First Mountain, save for the anthracite basin and its environs, are dominated by Devonian strata. These reach northwest into Ohio, north and northeast into New York and New Jersey, and cross the south-central part of Pennsylvania into Maryland. The oldest (lowest) Devonian rocks are limestones, sometimes filled with small fossils. The Devonian black shales tend to be barren, with local exceptions, but the Lower, Middle and Upper Devonian brown, gray or buff sandstones and shales are often highly fossiliferous. The red rocks of the youngest (Upper) Devonian are generally barren save for local fish and plant beds. The list that follows shows some of the more accessible localities where fairly abundant Devonian fossils may be collected with relative ease. Localities are confined generally to northeastern Pennsylvania and are arranged alphabetically by counties.

[2] In describing each locality the following data are given in so far as they apply: (a) nearest town, (b) nearest state highway, (c) specific location, (d) age of rocks, (e) character of rocks, (f) kind or kinds of fossils to be expected.

BRADFORD COUNTY

2. *Austinville:* west from Route 14; abandoned iron mines; Upper Devonian red hamatite; brachiopods; fish plates (outside armor) have also been reported here.
3. *Burlington:* on Route 6; old lime kiln and quarry north of road; Upper Devonian "limestone"; broken brachiopod shells in red matrix.
4. *Leraysville:* on Route 467, 2 miles south, west side of road; Upper Devonian red "limestone" in abandoned quarry as at locality 3; broken brachiopod shells.
5. *Monroe:* on Route 414 west; road cuts 1 mile west of Franklindale; Upper Devonian red beds; fish remains fairly abundant in débris thrown out in road building.
6. *Towanda:* on Route 220 north, many exposures in road cuts; Upper Devonian gray sandstone; fossils sparsely scattered for miles, mostly brachiopods.
7. *Towanda:* Route 187 northeast and out side road 1 mile southeast of juncture of Routes 187 and 467; quarries; Upper Devonian red beds; interesting association of plants, fish, and brachiopods.

COLUMBIA COUNTY

8. *Bloomsburg:* along Route 11; east along north side of river parallel to R. R. is Limestone Ridge with quarries; Lower Devonian limestone; occasionally fossiliferous but usually sparingly so, remains of small pteropods and ostracods dominate.
9. *Light Street* and *Orangeville:* on Route 339, road cuts; Middle and Upper Devonian brown sandstone and shale; occasional fossil bands as at sharp turn east 1¼ miles southwest of Orangeville, mostly brachiopods.
10. *Rupert:* along Route 42 southwest to Catawissa, many cuts; Upper and Middle Devonian, gray to brown sandstone and shale; occasional, highly fossiliferous bands chiefly brachiopods including some rare forms. Similar exposures along R. R. east of river.

DAUPHIN COUNTY

11. *Rockville:* out Route 11, 5½ miles north of Harrisburg, quarries east of road; Middle Devonian coarse, yellowish sandstone; large brachiopods and mollusks plus a few rarer forms.

LYCOMING COUNTY

12. *Montoursville:* east of town in sand pits; Lower Devonian weak, coarse, whitish sandstone; abundant, large, well-preserved brachiopods easily collected. Fossiliferous, Lower Devonian limestones also exposed in this neighborhood and eastward.

McKEAN COUNTY

13. *Shinglehouse* (Potter County): along Route 44 northeast, road cuts; Upper Devonian sandstone and pebble beds; brachiopods and mollusks.

MONTOUR COUNTY

14. *Columbia County Line:* at Route 11, quarries north of highway; Devonian limestone; corals.

MONROE COUNTY

15. *Analomink:* route 90 south at bridge over Brodhead Creek; Middle Devonian dark shale forms ledges in creek; moderately fossiliferous, various forms.
16. *Anamolink:* 1 mile south at juncture of Routes 90 and 190, cut banks east of highway; Upper Devonian gray sandstone and shale; very fossiliferous, brachiopods, etc. Northward, pass into non-fossiliferous red and gray-green, Upper Devonian beds about Analomink.
17. *Deckers Ferry:* at Wallpack Bend 2 miles southeast of Bushkill; excellent exposures along road over hill to abandoned ferry landing, thence up stream along Delaware River; Lower Devonian limestone and sandstone with great variety of fossils. One of most instructive collecting places in the County.
18. *Delaware Water Gap Village:* route 612 northwest across Godfreys Ridge to Stroudsburg, ascending from south, road cuts; Lower Devonian limestone, sandstone and shale successively; the lower and middle members fossiliferous as at localities 21 and 22.

19. *East Stroudsburg:* south along D. L. and W. R. R., first large cut. Dangerous locality,—narrow cut and heavy travel. Middle Devonian limestone exposed with fragments of crinoid stems having star-shaped centers.

20. *East Stroudsburg:* along Route 209 to Bushkill, several creeks descend from north and expose Middle and Upper Devonian sandstone and shale; usually fossiliferous, especially in vicinity of various falls; brachiopods and mollusks. Many of these localities are private property to which access for collecting is impracticable.

21. *Godfreys Ridge:* at ridge end west from North Water Gap (formerly Experiment Mills), abandoned quarries west of Route 611 south of R. R. crossing; Lower Devonian limestone often highly fossiliferous with ostracods and brachiopods. Overlying the limestone are Lower Devonian sandstone and pebble beds with large brachiopods as casts collected with difficulty.

22. *North Water Gap* (formerly Experiment Mills): north along N. Y. S. and W. R. R., continuous cuts in Lower Devonian limestone, then sandstone, and then shale; lower and middle members quite fossiliferous but preservation unsatisfactory in most cases.

23. *Stroudsburg:* quarry, north side of town; Middle Devonian black shale, usually barren, here almost uniquely fossiliferous with hundreds of small brachiopods, mollusks (including squid-like forms), and occasionally other animals, all well-preserved.

24. *Stroudsburg:* on Route 90, 3 miles north of town, west side Brodhead Creek valley, road cuts; Middle Devonian "coral reef"; multitude of corals, usually as weathered-out cavities in muddy matrix together with many other fossils including occasional trilobites. Excellent and easy collecting in road cuts and from rock thrown out in road building.

NORTHUMBERLAND COUNTY

25. *Dewart:* on Route 14, 1 mile north, abandoned quarry across R. R. to east; Lower Devonian brown sandstone; many large, well-preserved brachiopods.

26. *Milton:* east and northeast along Limestone Ridge; quarries; Lower Devonian limestone; occasionally small fossils abundant, but chief interest is "coral reefs".

27. *Northumberland:* northward along R. R. parallel to Route 111; Upper Devonian shales and some sandstone; fossils rare, but occur in bands about 800 feet north of first stairs to R. R. yards, 400 feet north of second stairs, and 400 feet north of this point; remains chiefly small, well-preserved mollusks and brachiopods.

28. *Selinsgrove Junction:* along Route 14 and R. R. south below Shamokin Creek for 6 miles; fossiliferous beds begin south of point where highway turns east; Lower Devonian limestone cliffs often highly fossiliferous; good collecting at old quarries along R. R. south of bridge across river; Middle and Upper Devonian sandstone and shale, fossiliferous in bands beginning opposite river ledges south to Hallowing Run. Great variety of invertebrates from this complete section. New highway cuttings east of R. R. in barren beds.

PERRY COUNTY

29. *Dellville:* west bank Sherman Creek 5 miles south-southeast of New Bloomfield; Upper Devonian red to brown sandstone with large lamp shells and blue-white fish plates.

30. *Duncannon:* northwest along Little Juniata Creek valley, road and R. R. to Roddy and across hills to Newport; many exposures, as at road fork north of King's Mills, Hickory Ridge, the Narrows, north slope Buffalo Ridge, etc.; Middle and Upper Devonian sandstone and shale; large variety of fossils.

31. *Half Falls Mountain* and *Girty's Face:* along Route 11, west side of river, road cuts for several miles; Middle and Upper Devonian sandstone; brachiopods and mollusks.

32. *Juniata Valley:* along Route 22, north along east bank above Amity Hall, first exposures are barren red beds, then chocolate, then brown or buff sandstone and shale; Middle and Upper Devonian; often highly fossiliferous north of the red beds; lamp-shells, mollusks, occasional fragments of trilobites, crinoids, bryozoans and pterodods.

33. *Juniata Valley:* also Route 22, east side of river near Half Falls Mountain at Amity Hall sign, great rock slide (talus slope); Middle Devonian, coarse, gray sandstone; large brachiopods.

34. *Juniata Valley:* on Route 22, east side, ¼ mile south of Newport Bridge, along north bank of brook valley east of road; Upper Devonian sandy shale; porous band of battered fragments of crinoids, brachiopods and bryozoans, etc.

35. *Juniata Valley:* west side at Trimmer's Rock about 1½ miles southeast of Newport; Middle Devonian coarse to fine, gray sandstone on road and along R. R.; abundant fauna, chiefly brachiopods and mollusks. Good collecting beside track.

36. *Little Mountain:* at mountain crest, north from locality 42; Lower Devonian coarse, light-brown sandstone filled with casts of elliptical brachiopods.

37. *Little Mountain:* east and next to R. R. and north from locality 42 along track to Marysville; Middle and Upper Devonian brown sandstone and shale, then red beds, highly fossiliferous, sandy shale; abundant bryozoans, crinoid stems, etc.

38. *McKee:* along road 2 miles northwest of New Bloomfield, abandoned quarries; Lower Devonian limestone; numerous and varied fossils.

39. *New Bloomfield:* southeast along Route 5 toward Duncannon, occasional cuts; Middle and Upper Devonian sandstone and shale, the former often highly fossiliferous in bands with many barren beds between. A careful search procures large variety.

40. *New Bloomfield:* east along R. R. at first road crossing, sand pit; Lower Devonian beds with occasional fossils. Next east is Middle Devonian greenish shale with ostracods.

41. *Sterretts Gap:* on Route 33, north from refreshment stand at spring toward Shermandale, road cuts; Middle and Upper Devonian gray sandstone with brachiopods.

42. *Susquehanna Gap:* from Route 5 across R. R. west opposite stone arch bridge, abandoned quarry between First and Little mountains; Middle Devonian black shale and brown to gray sandstone, the latter moderately fossiliferous; brachiopods dominate.

PIKE COUNTY

43. *Matamoras to Milford:* along Route 6; talus at cliffs north of highway often fossiliferous; Upper Devonian brown sandstone; chiefly brachiopods and mollusks; particularly plentiful immediately north of Matamoras.

44. *Millrift to Matamoras:* along Route 963, occasional road cuts; Upper Devonian sandstone, rather inferior collecting, mollusks.

45. *Milford:* on Route 962, northwest, ledges at McCarthy's Corner and 1¼ miles west thereof; Upper Devonian brown sandstone and shale; many small mollusks.

POTTER COUNTY

46. *East Sharon:* 1 mile southeast; Upper Devonian sandstone; abundant invertebrates and many plants.

47. *Galeton:* on Route 144, south along South Branch Pine Creek; Upper Devonian gray sandstone and shale; fish plates, plants, mollusks.

48. *Honeyoye:* ½ mile east along secondary road; Upper Devonian sandstone; abundant invertebrates and a few plants.

49. *Roulette:* ½ mile west along R. R.; Upper Devonian gray sandstone and shale; numerous, broken shells.

SUSQUEHANNA COUNTY

50. *New Milford:* along Route 11, south, and on R. R. to Wyoming County line, numerous cuts; Upper Devonian green and red sandstone and shale; occasionally a peculiar stratum of mixed quartz pebbles, gray shale fragments and broken fish bones and plates, the last *usually* poor.

51. *Susquehanna:* northeast on Cascade Creek at Erie R. R. bridge, fine section; Upper Devonian gray sandstone; large brachiopods in some beds.

TIOGA COUNTY

52. *Cowanesque Valley:* few fossiliferous outcrops in valley, but tributary creeks expose Upper Devonian gray sandstone and shale; many invertebrates and sea weeds ("fuscoids"). Specific localities: (a) North Branch Thornbottom Creek imme-

diately west of juncture with South Branch in creek bottom. (b) Baldwin Creek valley. (c) Bill Hess Creek valley along B. and S. R. R. track at curve north into valley; highly fossiliferous. (d) Along Yarnell Brook valley

53. *East Charleston:* in vicinity of town; Upper Devonian gray sandstone exposed in stream beds and banks; chiefly brachiopods, some large and unusually well preserved.

54. *Jemason Creek Valley:* on Route 249, 3 miles south of Phillips, bank across creek from road; Upper Devonian gray shale; brachiopods and others; unusual occurrence as possibly oldest fossils exposed in the county.

55. *Keeneyville:* creek valley northwest of village: Upper Devonian gray sandstone; lamp-shells. Occasional limy beds hereabout contain cup corals in abundance.

56. *Lawrence Township:* several stream valleys afford exposures of Upper Devonian brown sandstone and shale with numerous brachiopods, mollusks, etc., slabs covered with hundreds of shells common. Specific localities: (a) Bear Creek valley, along stream and road, fossil cephalopods above old slaughter house. (b) Along brook valley ½ mile south of Beeman (formerly Lathrop). (c) Lane Creek valley from Tioga Junction east for 3 or 4 miles; highly fossiliferous outcrops in creek, on road, and along R. R. (d) Elkhorn Creek valley.

57. *Mansfield:* at hilltop 3 miles west on road to Mardin, old iron mines; Upper Devonian red, hematitic oölite containing brachiopods.

58. *Mansfield:* on Route 111, 6 miles north at Mill Creek, south bank east of road and in débris removed in road building; Upper Devonian red beds; many fish plates and small, white brachiopods, an unusual association.

59. *Tioga:* along Erie R. R. north from station to abandoned highway bridge, cuts; Upper Devonian sandstone and shale highly fossiliferous; various, well-preserved brachiopods and mollusks dominate.

60. *Wellsboro:* town quarry south from village square in hill side; Upper Devonian sandstone; numerous brachiopods.

61. *Wellsboro:* along Route 6 east to Tioga River valley, showings of upper Devonian red, gray and brown strata chiefly in road cuts: (a) At top of first long rise east of Wellsboro, cuts south of highway. (b) Half way between Pitts and East Charleston, fossiliferous hematite, like that at locality 57, in cut south side of road where highway has been straightened. (c) 1½ miles west of Tioga River bridge, road forks at branches of Elk Run, along North Fork of which are cliffs; Upper Devonian sandstane; brachiopods.

UNION COUNTY

62. *Winfield:* west of town, large quarry; Lower Devonian limestone; abundant, small mollusks (snails) and ostracods, especially in rock faces of northwest corner of pit.

WAYNE COUNTY

Present information indicates that there are no fossils in this county in the surface rocks other than odd fish plates or fragmentary plants.

Silurian

Our Silurian strata are rather less fossiliferous than our Devonian and are more limited in surface distribution. Kittatinny or Blue Mountain, a comparatively narrow band immediately north thereof, and irregular, mountainous strips in central Pennsylvania are the principal regions of outcrop. The system generally begins with nearly or quite barren, reddish, gray, or brown sandstone or conglomerate, followed, particularly to the east, by red beds which run up into the Middle Silurian. The fossils of these members are limited usually to a few species. The red Clinton iron ores of the Susquehanna and Juniata valleys are

fossiliferous or associated with fossiliferous beds above, among, or beneath them. The system is usually terminated by fossiliferous limestones, which, for brevity, are here generally considered under localities treating with the Lower Devonian.

BERKS COUNTY

63. *Schuylkill Gap:* along Route 120 entering gap 1½ miles north of Hamburg; coarse, gray sandstone of Lower Silurian; 75 feet north of top of Ordovician shale in greenish beds are "worm trails" (Arthrophycus).

COLUMBIA COUNTY

64. *Bloomsburg:* the town is situated among Silurian strata, partly fossiliferous, especially those associated with the Clinton iron ores formerly mined here, as along Fishing Creek; Middle Silurian brachiopods, etc., at old mines and in road cuts north of town.

JUNIATA COUNTY

65. *Thompsontown:* on Route 22, 3 miles east, east side of road and river; small, abandoned quarry; Middle Silurian green shale; a few, scarce, poorly-preserved brachiopods.

MONROE COUNTY

66. *Delaware Water Gap:* on Route 611, first sharp turn west at gap entrance; Lower Silurian, coarse gray sandstone interbedded with thin, black shale which occasionally carries fragments of eurypterids.

NORTHUMBERLAND COUNTY

67. *Watsontown:* quarries northeast of town; Middle Silurian, dark brown, soft, sandstone and shale; abundant, well-preserved brachiopods, etc.

PERRY COUNTY

68. *Millerstown:* on Route 22, 1 mile north, gully up mountain side to east; Lower Silurian coarse, light-brown, heavy, sandstone; "worm trails" (Arthrophycus) profuse.

69. *New Bloomfield:* on Route 5, ½ mile east of town, portion of abandoned highway south of present road, cut banks at east side; Middle Silurian red shale; fragments of fish plates; unusual.

UNION COUNTY

70. *Lewisburg:* on secondary road, 1½ miles south, sharp turn west up stream valley from river; Silurian limestone in brook bed along road side; abundant brachiopods and corals.

Appendix

The following references may help in hunting fossils and studying collections:

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Shimer, H. W., An introduction to the study of fossils, 1920.

WHAT RELATIONS MAY PROPERLY BE ESTABLISHED BETWEEN THE STATE ACADEMY AND THE LOCAL SCIENCE CLUBS?

By Karl F. Oerlein

Upper Darby Senior High School

It is with some hesitation that I come before you today because I feel out of place on a program given over largely to reports of scientific research. This paper can lay no claims either to scientific research or to new ideas. It is simply the request for a service which the State Academy can give and which the local science clubs would be glad to receive. If, therefore, this paper strikes a sympathetic chord it will have served its purpose.

In various States, a movement has grown to affiliate the local science clubs, in one way or another, with the State Academy. The problem of affiliating these local clubs with the State Academy divides itself naturally into two aspects. The one aspect deals with those clubs found in our senior and junior high schools. The other aspect deals with adult science clubs—those clubs not related to any school such as, for example, The Physics Club of Philadelphia. While the adult clubs are important and an affiliation with them would be mutually beneficial, it is the high school group that I feel more competent to discuss.

The attempt to form closer bonds between the high school science clubs and the State Academies has led to the Junior Academy movement.

What has been the result of this affiliation in other states?

The Junior Academy movement has been growing steadily. Prior to 1919 such organizations were unknown. In that year, however, the Illinois State Academy, in attempting to take an active part in the science education of the secondary schools, paved the way for the Junior Academy. By 1927 the Illinois Junior Academy became not only an effective, well organized and a vitally important part of the general program of the State Academy, but it was entirely self-supporting. The Illinois Junior Academy has been doing pioneer work in this field since then. Its success has led other states to consider the movement also. At the present time there are Junior Academies functioning in Indiana, Iowa, Kansas, Oklahoma, Texas and Tennessee. In North Carolina, Ohio, West Virginia, Alabama, Kentucky, New Hampshire and Virginia, definite steps are being considered to organize a junior branch. Mr. Astell, research Associate, School of Experimentation, Teachers College, Columbia University, has made an extensive survey of the Junior Academy. He concludes that the movement has been highly successful and that mutual advantages have resulted through the affiliation. For example, in Texas, although the Junior Academy is but a little over a year old, it has already resulted in an intensive survey of science teaching in that state. This survey caused the reorganization of the science section in Texas. Another illustration: Early efforts of the Illinois Junior Academy movement are now bearing fruit. Some of the boys and girls who were associated with the Junior Academy of four or five years ago are now entering the Illinois high schools as teachers of science and they, in turn, are carrying their enthusiasm to the present group of high school science pupils.

At the Cleveland meeting of the American Association for the Advancement of Science definite steps were taken to coordinate the activities of the various Junior Academies by the appointment of a national executive committee. This committee, headed by Dr. Otis W. Caldwell, of Columbia University, as chairman, consists of the chairman of the junior organization in each state. This is an indication that the Junior Academy movement has taken on national significance and that it has been recognized by the American Association for the Advancement of Science.

In what ways can the Academy of Science benefit the local high school science clubs?

Article 1, section 2, of the constitution of our Academy mentions specifically, among others, these three objectives:

The diffusion of knowledge concerning the various departments of science.

The promotion of intercourse between those engaged in scientific research.

The assisting in developing and making known the material educational and other resources and riches of the commonwealth.

The Junior Academy affords excellent opportunity for the Senior Academy to fulfill to even greater extent the objectives as set forth in its constitution.

In 1919 J. L. Pricer, then secretary of the Illinois State Academy of Science, stated, "Education in science is so vital to the general welfare of every phase of science that it seems to me that every member of the academy should have some interest in the problems of science education in the secondary schools. Therefore, I believe that the academy should have a permanent committee of three on science education in the secondary schools. It should be the function of this committee to make annual reports to the academy on the status of secondary school science, and on occasion to call on the academy for cooperation and help in the solution of certain problems." This expression gave rise to the first junior academy of science. If the problems of the place of science in education were vital then they are no less important now.

The modern secondary school program is today crowded with many subjects and activities. Each formal object must struggle for its existence. A modern high school is practically never closed. Pupils arrive early to participate in extra-curricular activities, such as band practice or monitor service. Pupils leave late in the evening because of a play, a club meeting or a Hi-Y dinner. Even the traditional Saturday holiday has been broken into by activities such as athletic contests, geological hikes or nature study strolls. Extra-curricular activities are experiencing the same struggle for existence as the formal subjects.

Many outside agencies, both desirable and undesirable, attempt to influence the school program. One agency wishes more time for its particular interests, while another is anxious to see its specific interest enlarged. Now, I do not infer that the Academy of Science should become an agency of this type. Indeed, science education has more than justified its place in the American high school program. At the same time, the Academy can ill afford to stand by and leave its influence entirely to chance. The Academy should adapt measures to encourage and foster the local science clubs. The inspirational leadership which the Academy can give to these local units is, perhaps, easy to realize but difficult to measure.

Consider also the number of pupils interested in science who graduate each year from our high schools. What they do, what they will become, and what their interests will be, is largely a matter of the training received and contacts made while in school. An early contact with the Academy, established through the local club, would furnish to these scientifically inclined graduates an outlet for their interests which ought, eventually, lead to membership in the Academy.

In our schools, considerable emphasis is now being placed on the proper use of leisure time, the preparation for worthy home membership and the development of good citizenship. This is, in effect, character education. Perhaps the most effective way to develop these desirable objectives is through genuine hobbies. Scientific hobbies, especially for boys, possess unusual value for this purpose. Here is a real opportunity for service. The Academy, by virtue of its unique position in the state, can furnish valuable guidance to the local science club members in selecting worthwhile hobbies.

What are some of the more specific ways by which the Academy can establish closer contacts with secondary school science clubs?

1. By holding an annual meeting and exhibit arranged especially for high school pupils. This could be arranged along with our spring meeting. Devices, pieces of apparatus, posters and essays, by pupils of affiliated clubs would be exhibited.

2. By furnishing lecture service. This would require making a list of members of the academy who would volunteer to give talks suitable for high school groups. Affiliated science clubs would be furnished with this list from which selections could be made at the convenience of the lecturer.

3. By supplying copies of suitable lectures gratuitously to affiliated clubs. Dr. Little's lecture, "The Fifth Estate," is an excellent example of what I mean.

4. By supplying book lists. Such lists as recently compiled by the American Association for the Advancement of Science are typical.

5. By helpful bulletins, issued from time to time giving helpful suggestions and keeping the associated clubs in contact with the Academy.

In return for these many services it is not unlikely that science teachers throughout the State will be quick to realize the advantages of membership in the Academy.

Finally, the best way to summarize the entire relationship is to regard the proposed affiliation of the local science clubs with the Academy of Science as similar to that which now exists between the Academy of Science and the American Association for the Advancement of Science. There remains, then, only the establishment of the Junior Academy, as the final link in a strong chain of integrated effort for science education.

TWINNING IN A CHICK EMBRYO

By Earl Hoover

Lebanon Valley College

The egg yielding the twin embryo was incubated for approximately 72 hours. This was the only embryo that showed any exceptional abnormality in over 500 eggs incubated in 1931. It is possible that the twinning was caused by marked variation in the temperature during the first or second day of incubation.

The twinning progresses caudal cephalad. This assumption is suggested by the presence of a single amnion and incomplete brain development also by the absence of vitelline arteries and optic vesicles on the one. The two members have no organic connection although their cephalic regions lie in close contact.

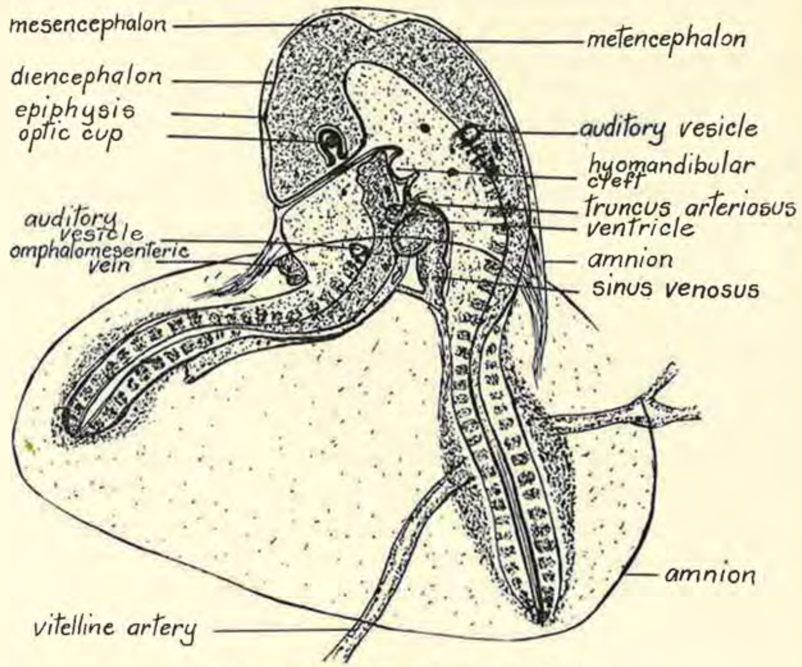


FIG. 7. Twin chick embryo, dorsal view.

The bodies represent different phases of development the one containing 31 somites and the other 33 somites. This statement is rather indefinite due to a possible misinterpretation as to the segmentation of mesoderm in the tail region. Normal chicks at this age have 35 somites.

The nervous system of the 33 somite member is nearly normal. Brain differentiation has progressed normally as far forward as the telencephalon which is more flattened than usual probably caused by the 31 somite member which crowds the larger and prevents free anterior growth of the telencephalon. Normal optic cups arise lateral to the telencephalon. Normal auditory vesicles are present, also an epiphysis.

The brain of the 31 somite member is decidedly subnormal. Brain differentiation is not very noticeable and the telencephalon and diencephalon are very rudimentary and no epiphysis or optic vesicles are present, but auditory vesicles arise lateral to the myelencephalon. The entire brain may be interpreted as lying in a 180° dorsoventral twist, if

interpreted in this manner brain differentiation appears much clearer.

The circulatory system of both members is comparatively well developed, each member possessing a heart, and an intra- and partial extra-embryonic circulatory system. Omphalomesenteric veins are well developed in both members and send out branches to both sides of the blastoderm. The 31 somite member has no vitelline arteries but they are normal in the 33 somite body. The latter has also well developed anterior and posterior vitelline veins but they are absent in the former. The omphalomesenteric veins lie further cephalad than normal in each body which is due to the subnormal caudad progression of the cephalic fold.

The flexion and torsion of each body is incomplete as each member crowds the other and prevents positional changes. Torsion in both bodies is abnormal and in the larger member it seems to have progressed sinistral rather than dextral. Cranial and cervical flexures are subnormal, further flexion would be hindered by the 31 somite body which lies

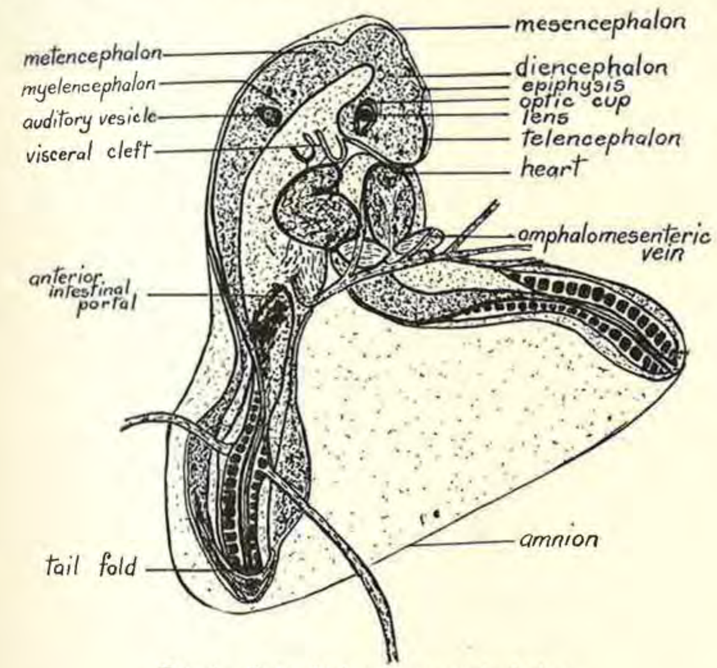


FIG. 8. Twin chick embryo, ventral view.

in close contact, while torsion is abnormal in the mesial region. Due to crowding there is very little flexion in the 31 somite body but torsion progresses caudad past the mesial region.

The tail fold has progressed normally in the 33 somite chick but has not made its appearance in the 31 somite member. The cephalic folds have appeared in both chicks and progressed caudad forming subcephalic pockets but are subnormal in their caudad extension.

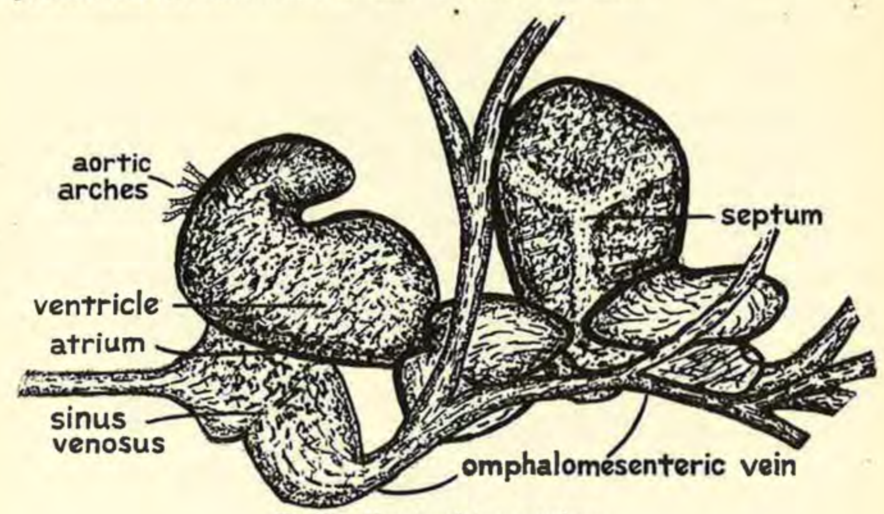


FIG. 9. Hearts of two members.

A single amniotic fold grows caudad over both members and terminates subnormally in the heart region. A single amniotic fold also develops in the posterior and lateral caudal regions but has not made any marked cephalic progress.

Most of the area vasculosa including the sinus terminalis unfortunately was not preserved, however, the bit of area vasculosa that remains in the mounted specimen appears normal.

STEM ANATOMY OF TOMATO, *LYCOPERSICUM ESCULENTUM* L.[1]

RUTH S. CLARK

Department of Botany, University of Pennsylvania

The tomato has so recently attained its wide-spread popularity as an esculent that it is not surprising its anatomy has not formerly been

[1] This paper is part of a thesis presented to the Faculty of the Graduate School of the University of Pennsylvania in partial fulfilment of the requirements for the degree of Master of Science. Further details and illustrations can be noted by reference to the thesis entitled "Morphology and Anatomy of the Tomato Plant" (*Lycopersicum esculentum* L.) With Special Reference to the Internal Phloem.

studied. The group to which the tomato belongs boasts several economically important food plants whose anatomy has only lately been studied, such as the potato in 1917, and the eggplant in 1931. It was particularly to note the similarity, if any, to these related plants that the present study was undertaken, with special reference to the origin and development of the internal phloem.

The fact that the presence of internal phloem has been noted in many families does not make it less easy to discover its origin. It has its beginning in the tomato in the rather long transition area, for while seen clearly developed in the mature stem, it most certainly is not to be seen in the diarched stele of the root. Therefore by taking successive transverse sections of the transition area (hypocotyl) we shall be able to note the progress and development from root to stem.

Let us examine a section at the ground line. Here the elements are arranged in diarched manner typically root-like. The protoxylem elements may be slightly out of the straight line and the phloem areas may be showing signs of dividing, but the general aspect is close to root structure.

At approximately mid-height of the hypocotyl, which is from one and one-half to two inches in length, great changes can be noted. The four bundles are practically if not entirely separated, each with its own external patch of phloem. Then somewhere between these converging xylem bundles are seen two (splitting) or four discrete areas of phloem —destined to become the internal phloem. As yet they are not fully orientated to their position on the inner edge of the xylem elements.

Just under the cotyledonary outgrowths a transverse section shows the elements characteristically arranged as for the mature stem, the external phloem, cambium, xylem, and internal phloem in order, outermost inward.

May I recall rather briefly some of the theories which have been advanced for the existence of internal phloem. Some writers believe that it is the vestigal trace of bundles which were formally complete. Other authors consider that this tissue has been built up because of the need of additional conduction tissue. This latter view has been adopted by Artschwager as the case noted in the growth of the potato—this work will be noted below.

DeBary, one of the earliest workers, believed the internal phloem was connected to the external phloem by a narrow band of sieve tubes. These were very tiny cells and often escaped notice; however their presence causes the so-called "bicollateral" bundles to be, in reality, concentric.

Worsdell is the advocate of the vestigal idea of internal phloem. He says the now existing plants showing bicollateral bundles originally possessed a scattered bundle area such as we typify in the monocotyledonous arrangement. Of this scattered system two series remain—the outermost is complete, the phloem of the second is the only remnant of that inner ring of bundles.

In the work done by Scott and Brebner they see that during the transition period successive strands of phloem split off and move outward with the converging of the xylem elements, and, fusing, form the phloem area. These authors consider the internal phloem as an asset because of its increased protection, being inside the wood cylinder, and its nearness to the pith facilitating communication with this latter tissue.

While working with the Cucurbitaceae, Holroyd said that cambioid cells develop very shortly after the first splitting of the xylem in the hypocotyl enclosing the bundle, so that it might be called a "perixylary" cambial ring. This cambium gives rise to the internal phloem, but continues to remain dormant on the sides of the bundles.

Now according to Artschwager the phloem initials are first to be noted internally, the external phloem develops at a latter period. This succession, however, is probably true only for the potato.

In my work on the *Lycopersicum esculentum*, or tomato, I am inclined to think the facts noted are most in agreement with those set forth by Scott and Brebner. There is merely a replacing of part of the first phloem areas—no secondary initials or cambial action being involved. Strands of the external phloem move inward during the transition period and become orientated at the center or base of the xylem elements. Division of the phloem cells themselves accounts for the additional internal phloem, while the splitting of areas continues the "broken ring" arrangement for this tissue. At no time could evidence of any cambium be seen.

THE MEANING OF THE UNCERTAINTY PRINCIPLE

By Enos E. Witmer

University of Pennsylvania

The development of quantum theory and relativity theory has altered profoundly the philosophic and conceptual background of physics, and is exerting a great influence on philosophy in general. An important principle that has emerged from the new quantum theory is the Heisenberg uncertainty principle. This principle states that it is impossible either to assign or to measure simultaneously both the position and the momentum of a particle to an unlimited degree of accuracy. In order to state this principle more exactly we must introduce mathematical symbolism. Let (x, y, z) be the Cartesian coordinates of a particle and p_x, p_y, p_z the components of its momentum. If Δx, Δy, Δz denote the uncertainties in the values of the coordinates, and Δp_x, Δp_y, Δp_z the uncertainties in the values of p_x, p_y, p_z, then the Heisenberg principle states that

$$\left.\begin{array}{l}\Delta x\,\Delta p_x \geqq h\\ \Delta y\,\Delta p_y \geqq h\\ \Delta z\,\Delta p_z \geqq h\end{array}\right\} \quad (1)$$

In these equations h is Planck's constant, which has the value 6.54×10^{-27} erg sec. The quantities Δx, Δp_x, etc., are not to be regarded as errors, which could be reduced by improving the technique of measurement, but as uncertainties inherent in the nature of things, or, at least, in the process of measurement and which therefore cannot be eliminated.

If m is the mass of the particle under consideration, and v_x, v_y, v_z the components of its velocity, then

$$\left.\begin{array}{l}p_x = mv_x\\ p_y = mv_y\\ p_z = mv_z\end{array}\right\} \quad (2)$$

Since m is assumed to be known

$$\Delta p_x = m\Delta v_x, \text{ etc.} \quad (3)$$

where Δv_x, Δv_y, Δv_z are the uncertainties in the values of the v_x, v_y, v_z. Substituting eqs. (3) in (1),

$$\left.\begin{array}{l}m\,\Delta x\,\Delta v_x \geqq h\\ m\,\Delta y\,\Delta v_y \geqq h\\ m\,\Delta z\,\Delta v_z \geqq h\end{array}\right\} \quad (4)$$

It is seen therefore that another statement of the Heisenberg principle is the following. It is impossible either to assign or to measure simultaneously both the position and the velocity of a particle to an unlimited degree of accuracy. The uncertainties in these quantities must satisfy eqs. (4).

All this seems very strange, of course, because it is contrary to common sense notions which have been suggested by our every-day experience. However, in the case of all particles of ordinary size these uncertainties are so small that they can be neglected. For example, in the case of a particle of a mass of 1 milligram, if we know its position to within 1 μ we have

$$m = .001 \text{ gm}$$
$$\Delta x = .0001 \text{ cm.}$$

Consequently from eqs. (3)

$$\Delta v_x = 6.54 \times 10^{-20} \text{ cm/sec.}$$

This quantity is millions of times smaller than the errors of the most refined measurement. But in the case of microscopic particles, such as atoms, protons, photons, and electrons, these uncertainties become important, because *m* in eqs. (4) is then very small.

The new quantum theory is an indeterministic theory. In order to fully appreciate the significance of this statement, we must compare the new theory with Newtonian mechanics—the accepted mechanics before the coming of relativity theory—which was a deterministic theory. In Newtonian theory if the masses, positions, and velocities of the particles in a dynamical system are known at any instant of time (and also the law of force between the particles), then it is possible to predict the state of the system at any future time or to calculate what the state of the system was at any time in the past. The astronomers do this continually in the case of the planets and their satellites. Such a system is called a deterministic system. In general determinism is that philosophy that maintains that the state of the universe at any time in the future is determined by its present state. Omar Khayyam states the idea in these lines:

> "And the first morning of Creation wrote
> What the Last Dawn of Reckoning shall read."

Laplace, the French mathematician, gave a definition of determinism that is frequently quoted. We may briefly paraphrase Laplace's statement in these words: "If a sufficiently powerful intellect knew the present state of the universe, he could predict its state at any time in the future or calculate its state at any time in the past."

Returning now to the quantum theory and the Heisenberg uncertainty principle, we note that it is impossible to determine to an unlimited degree of precision the present state of the universe, *i.e.*, it is impossible in principle to measure to an unlimited degree of accuracy both the positions and the simultaneous velocities of the particles that constitute the universe. It is therefore not surprising that the new quantum theory is indeterministic, for the "if" condition in Laplace's statement cannot be fulfilled.

There are two aspects of the Heisenberg principle, the theoretical and the experimental, which have not been separated thus far in this discussion. The theoretical aspect is this. In the new quantum theory it is impossible to *assign* to a particle simultaneously both a position and a momentum to such a degree of accuracy as to violate eqs. (1).

The experimental aspect is the following. It is impossible to *measure* simultaneously both the position and the momentum of a particle to such a degree of accuracy as to violate eqs. (1). It is interesting that the theoretical and experimental aspects should agree, for conceivably the theory might permit us to assign values to these quantities to an unlimited degree of precision, even though the measurement to such a degree of precision were impossible in principle.

If we assume the existence of photons, the experimental aspect of the Heisenberg principle can be proved. Heisenberg did this by means of his famous thought experiment with a γ-ray microscope. (By a thought-experiment is meant one which is carried through only in thought.) The proof is very simple, making use merely of the law of the conservation of momentum, the formula for the resolving power of a microscope, and the formula connecting the momentum and wave-length of a photon. This proof brings out very clearly the fact that the very act of observation itself disturbs the system under observation. In the case of macroscopic bodies, this disturbance is so small that it can be neglected, but in observing microscopic particles, such as electrons, protons, and atoms, it becomes important.

DUST ON LATH AND PLASTER

Thomas D. Cope

University of Pennsylvania

This paper deals with the parallel striations often seen on plaster, outlining the wooden laths beneath. My attention was drawn to this phenomenon years ago by a note in Poynting and Thomson's "Heat" to the effect that it is probably an instance of radiometer action. The areas backed by wood are probably warmer than those not so protected. From the supposedly warmer area an approaching dust particle is assumed to be repelled by a more vigorous bombardment of air molecules than it encounters upon approaching the supposedly colder area. More dust settles upon a colder area than upon a warmer one. Hence the striations.

Observations on many instances of the phenomenon led to the following generalizations which were published by the writer in *Nature* (Jan. 21, 1915).

The striations are surface deposits. They may be wiped off.

Striations are observed only on warmer surfaces of walls which are exposed on the other surface to out-of-doors or to colder spaces.

The steeper the temperature gradient through the wall the greater the contrast between striations and spaces between.

The lighter spaces cover the laths, the darker spaces occur between laths.

Streaks discolored by water may be observed on clean walls on the areas between laths.

It follows from the theory suggested above that on the colder side of a lath and plaster partition dust should accumulate over the laths, thus showing a reversal of conditions on the warmer side. It was inquired whether this phenomenon can be observed. The presence of streaks discolored by water raised a question as to whether the deposition of dust is in any way influenced by the condensation of water upon the same area. Experiments designed to find answers to these questions were set up. Results were left to the usual course of Nature under controlled conditions.

While these experiments were under way, my colleague, Dr. C. B. Bazzoni, planned and undertook some rapidly functioning laboratory tests to find answers to the same questions. Through a box with a lid of compoboard painted with alabastine he conducted a stream of air which could be dried, heated, charged with dry powdered lampblack, steam, or soot from a smoky burner, any combination of them at will. Warm areas and cold areas were produced on the lid by external heaters. A series of tests showed that in the presence of water vapor deposits were formed under the cold areas, the colder the area the denser the deposit. The warm areas showed lighter deposits than the areas at room temperature. In the absence of moisture figured deposits were not formed even under very favorable conditions.

These experiments and others were described in the *Journal* of the Franklin Institute (April, 1920). Speaking of the deposits Dr. Bazzoni says that these figures are "to be referred to local temperature differences on the wall surfaces which cause corresponding irregularities in the moisture deposition from the currents of damp air flowing over them. Areas with a temperature below the dew point of the vapor in the air become covered with a water film which takes up the dust particles from the air by ordinary adhesion. This dust deposit is possibly increased through deposition resulting from the checking in the velocity of the air current due to the greater surface friction over the wet areas."

The results of Dr. Bazzoni's experiments seemed so convincing to the writer that when alterations in the building obliged him to dismantle his equipment for a time, he did not consider it worth while to continue his experiments.

The excuse for recalling things done in a former decade is the fact that quite recently the whole topic has again been brought before the scientific public. In *Physics* for July, 1931, Professor W. J. Hooper, of Battle Creek College, describes a series of most ingenious experiments on the formation of dust streaks on lath and plaster, which he has performed with the support of The Wood Conversion Company of Cloquet, Minnesota.

In these experiments sections of plaster on wooden lath were sized and papered, and the papered surface exposed to soot from the smoky flame of a kerosene lamp. It developed that when the papered surface was kept warmer than the back, soot deposited in lines on the areas between the laths. When the back was maintained warmer than the papered surface soot deposited over the laths. When both surfaces were at the same temperature soot deposited uniformly, without striations. This is a most gratifying laboratory demonstration of the reversal phenomenon for which the author of this paper inquired some years ago.

Professor Hooper's experiments showed further that backing the lath and plaster with an insulating material materially reduced the contrast between sooty lines and the lighter areas between them.

It appears to be demonstrated then that the tendency of dust to settle on plaster walls in streaks over the spaces between the laths is to be correlated with the fact that these areas are colder than the areas over the laths.

The part which is taken or is not taken by the water vapor is not so clear. Professor Hooper dismisses it as of no effect on the strength of three pieces of evidence. The surfaces on which he obtained deposits of soot were, he says, always above the dewpoint of the water vapor present. An area on wall paper moistened with water at room temperature and subjected to smoking received no deposit while the surrounding dry area was heavily coated. A section of plaster on lath sized, papered, and faced with a sheet of glass and smoked showed characteristic striations on the glass when the back of the section was colder than the front.

It is to be regretted that Professor Hooper apparently did not try his experiments in a dry atmosphere laden with dry dust. Professor Bazzoni's results referred to above warrant such an undertaking. The lack of agreement among the results of those reporting on the effect of water vapor upon the formation of dust striations, makes this issue a proper field for more extended and more conclusive experiments.

FAMILY STOCK BETTERMENT, WITH REFERENCE TO LEFT-HANDEDNESS

By Alfred Gordon, M.D.
Philadelphia

In the presence of any given anomaly in structure or function, it is highly important to determine whether it is morbid and the result of an accident in the life of the individual or whether it is inherent and hereditary. In the first case the damage is confined to the carrier of the anomaly and will no more be likely to be transmitted through heredity than any diseased condition which occurred incidentally. In the second case, on the contrary, the condition is inherent and belongs to the group of etiological factors that are capable of exercising their influence on subsequent generations.

If one draws a parallel between disorders transmitted to the descendants with those present in the ascendants, almost invariably a similarity in the form is found. For example arrested development in the intellectual domain finds its source in an analogous condition of the ascendants. Various psychic disorders of the psychoneurotic individuals originate chiefly in similar psychic heredity, demonstrating thus the existence of disturbances of the same character in the ascendants. In physical heredity one observes a predisposition of an organic character, such as cerebral congestion, apoplectiform insults, abnormal impressionability of the cerebral neurones to toxic factors and many other special abnormal states. There are therefore substantial reasons for admitting that heredity, generally speaking, is expressed by transmission of similarity and more in the fundamentals of the latter than in its form. If sometimes we do observe dissimilarity of the transformation in hereditary characteristic units, we are dealing in reality only with apparent changes of form but not of basic elements. The latter are the source of the cardinal hereditary phenomena irrespective of their form. What is commonly called predisposition in morbid functions of a physical, intellectual, moral, emotional or volitional domain, is the predominant feature transmitted directly by the fundamental psychopathic or physical disorders of the ascendants. As one of the very many illustrative examples of abnormal conditions occurring in several members of the same family independently of external causes left-handedness is presented here as a specimen of physiological deviation from the generally observed right-handed function. This peculiarity of course may be acquired by any healthy individual when a continuous effort is being made for the acquisition of greater control of the left hand. But the subject of the present study is based not on special training common to all normal persons, but on the incidence of a familial trait repeating itself in consecutive generations and created by the fundamental laws of heredity.

The problem of left-handedness has been a subject of much discussion among the investigators of genetic problems. That a hereditary factor is found in many cases, there is abundance of proof judging from the records in the literature. Among the striking examples attention is called, to the record by Armé-Père concerning a left-handed woman who brought into the world 14 left-handed children (in E. Gaupp. Slg. anat. und phys. Vortr. 1. H. 4, 1909). H. Griesbach observed that when only the father or only the mother or both are dextrocerebral or sinistrocerebral, the children will also be dextro- or sinistrocerebral respectively (Deut. Med. Wchn. 1919, No. 51). E. Stier (in his book entitled "Untersuchungen über Linkshändigkeit, Jena, 1911") had formulated the following rules in accordance with the large number of his observations:

1. The transmission of left-handedness from the father is more frequent to the son than to the daughter.
2. From the mother either to the son or daughter.
3. From the father through his right-handed daughter to the boy-grandchild, rarely to the girl-grandchild.

An analysis of his studies suggests that the influence of the male is predominant; that left-handedness is a fine hereditary peculiarity which can be transmitted directly and what is more important, indirectly to the grandchildren or great-grandchildren after having missed some members of the family; that in the intermediary heredity the offspring present a mixture of the characteristics of both parents; that in the so-called neo-morphus heredity the characteristics of the offspring are not derived directly from one of the parents. Stier emphatically asserts that every left-handed person originates from some left-handed ancestor.

Other observers also speak of predominance of the male influence over the female. From the examination of 17,074 cases in this respect, M. Shaefer arrived at the same conclusion (Berl. Klin. Wchschr. 1911, 295 ff.). He claims that left-handedness is more widely spread than it is generally believed. Statistics show that 33.05 per cent. left-handedness in male originates from the father and 27.55 per cent. on the mother's side. Moreover hereditary left-handedness from both parents is met more frequently in the female offspring. Speaking generally left-handedness is encountered more frequently in females than in males. An extremely interesting observation was made by H. Klaehn in the

Southwestern section of Germany, especially in Württemberg, namely that left-handedness was closely associated with alcoholism of the population. He (and Stier concurs with him) concludes that in all such cases there is a hereditary degenerative background. (Das Problem der Rechtschändigkeit, 1925).

As to the influence of grandparents, statistics show that hereditary left-handedness in either sex alone is more pronounced in female than in male offspring (56.68–42.32). A. Schott had the opportunity to investigate the influence of hereditary left-handedness in sisters of the parents (Ztschr. f. d. ges. Neur. u. Psych. 135; 1931, p. 305). He examined 2,619 records and found a predominance in the sisters of the mother over those of the father. Every investigator in this field of knowledge must acknowledge that there is no distinct hereditary type.

As to the pathogenesis of left-handedness many theories have been advanced. V. O. Verschuer, for example, attaches much importance to the problem of bodily assymetry which is caused by mechanical and physiological factors during the process of intra-uterine development. (Z. Morph. u. Anthrop., 27; H. 2; 171 ff.; 1929). There are records in the literature which suggest a pathogenesis of brain diseases and brain trauma. Besides, we are in possession of records in which left-handedness was associated with congenital anomalies of speech, deafness, color blindness, epilepsy, mental deficiency, and other abnormalities, hereditary or congenital, of morphological character, such as assymetries of limbs, of ears, face, palate, etc.

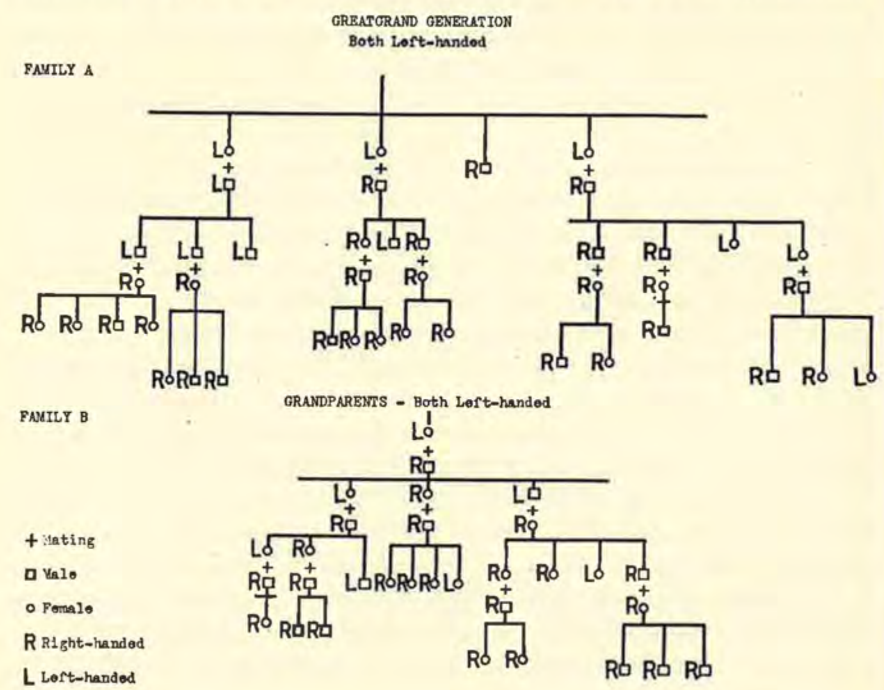
If we add also the above mentioned coincidence with widely spread alcoholism in a certain region of Germany, we are led to believe that left-handedness is observed chiefly or in the majority of cases in individuals with a degenerative background. Evidently during the process of intra-uterine foetal development the two hemispheres of the brain which control in a crossing manner the right and left hand, underwent some changes which predominate on one or on the other side. These changes are perhaps vascular or cellular or both. Having been produced originally in the ancestors, each succeeding generation will inherit the cellular and vascular predominance which endow one or the other hemisphere with greater crossed controlling power, and left-handedness is the result. To translate this thought into embryological language it means that the original germ cell which is made up of gametes destined to divide and subdivide for the formation of future bodily organs, contains through the fusion of two sex cells the special elements for building one side of the brain more vascular or more cellular in order to render it predominant in its future function. It would appear therefore that once a characteristic unit is present in the germ-plasm it will continue to be transmitted *ad infinitum* from species to species, from race to race and thus will remain pure and true to its species until the individuals are segregated. This is the fundamental principle of inheritance as proclaimed by Darwin himself.

The real value of Darwin's principle can be fully appreciated if one bears in mind the influence of selection upon the improvement of animal and vegetable races. A brilliant confirmation of this principle is found in the Mendelian laws of heredity with its dominant and recessive behavior in plants and animals. The latter conception is of a very great practical importance in health as well as in tendencies to certain diseases or in morphological abnormalities. It enables us to predict with a certain degree of accuracy the possibility of dominant and recessive inheritance of defects, of abnormalities of structure, of pathological states. We observe, for example, that if a person suffering from a disease that shows recessive inheritance, marries a person who is healthy himself and in his inheritance, all of the children must be healthy. When a person carrying rudiments of a recessive disease mates in marriage with a blood relative who also carries the same rudiments, the result will be disastrous. Consanguinity of parents therefore entails great danger for the offspring. All these observations have been made with respect to various diseases as well as to normal characteristics. But if in mating new hereditary factors arise, improvement of the species is bound to follow. Evolution of the stock consequently will follow the impelling force of selection. In such a manner the ingredients of an abnormal inheritance pattern of one of the conjugal parties are in subsequent generations represented only in a small number or not at all. A continuous effort in this direction in the following generations will lead to a marked increase of the most capable hereditary stocks and progressive improvement of the species and race. Selection is and will continue to be therefore the decisive factor, as it prevents certain undesirable inheritance patterns of one of the marital party from increasing and through the beneficial influence of the other normal half maintains the high level of the species.

It is on the basis of this principle that race hygiene is founded. Improvements in the hereditary foundations of human family-stocks are feasible, when one considers the fundamental improvement of animals under skillful selection and mating, and thus a gradual elimination of undesirable characteristic-units will be obtained. Hereditary pathological states, physiological abnormalities or defects are governed by the general laws which are identical with those which regulate the transmission of normal morphological characteristics from the highest to the lowest point of the animal scale. Morbid heredity is controlled by the same laws as physiological heredity. The knowledge of the laws of heredity and of the biological or morphological modifications is of paramount value from the viewpoint of eugenics.

Constructive eugenics is a reality based on strict application of scientific principles. In the following two examples one finds a confirmation of only one of the multiple varieties observed in all spheres of human inheritance. It concerns a gradual diminution and even disappearance of a peculiar trait in the function of the upper extremities which has been traced in several generations.

Family A.—Both great-grandparents were left-handed. There were three daughters, left-handed, and one son, right-handed. One daughter married a right-handed man and they had two right-handed sons and two left-handed daughters. The other daughter married a left-handed man and they had three left-handed sons. The third daughter married a right-handed man and they had three children: a right-handed son, a left-handed son, and a right-handed daughter. The two right-handed



children married right-handed individuals, and their children are all right-handed. The following generation presented all right-handed offspring except one case.

Family B.—Grandparents are both left-handed. There was only one child,—daughter, left-handed. She married a right-handed man. They had 2 left-handed children and one right-handed. They all married right-handed individuals. The following generation showed a tremendous increase of right-handedness. In the subsequent generation it happened that the left-handed never married. All right-handed brought into the world exclusively right-handed offspring.

THE PENNSYLVANIA ACADEMY OF SCIENCE AND THE FIELD OF RESEARCH

By E. M. Gress

"Necessity is the mother of invention" is an old saying which is no doubt true, but nevertheless pure scientific research and the discovery of principles and laws upon which inventions are based is the actual foundation of industrial and economic progress of the world. There are those who contend that the needs of society, and not the mere desire to know truth, furnish the real stimulus for scientific research.

In the early history of mankind, perhaps the need of practical application of scientific principles did precede research in pure science. No doubt, the fundamental laws of machines, such as the incline plane and the lever, were used long before the principles upon which they work were formulated into mathematical laws.

Geometry, as the derivation of the word shows, was doubtless used by man for measuring distances on the earth long before it was formulated into a pure scientific subject known as "Euclidian geometry." Although primitive and even civilized man made use of practical applications of scientific laws and principles without thinking of them as such, nevertheless as civilization advanced and these applied principles of physics, chemistry, agriculture, astronomy and general biology were formulated into fixed laws, man became more and more interested in the search for scientific truths, not with a view to applying them to the benefit of mankind but with a desire to know truth for its own sake.

When Michal Faraday discovered electromagnetic induction, he did not know that he had discovered a truth upon which the great electric industry of the world is based. He did not even think of its practical application in the motor, the dynamo and radio transmission. As Cecil

H. Desch, of the University of Sheffield, states,—"His (Faraday's) work was guided throughout by the purely theoretical conviction of the unity of natural forces, which led him to seek for the connection between electricity, magnetism, light, chemical action, and even, although at the time without success, owing to the minuteness of the effect, which was afterwards found in our own day, with gravitation."

In 1683, Anthony Van Leeuwenhoek, a Dutch linen weaver by trade, discovered the microscopic plants called bacteria. Leeuwenhoek was a naturalist by birth and spent some of his pastime in grinding lenses by which he made this great discovery. There was no urge by society or industry compelling Leeuwenhoek to search for these tiny organisms. Curiosity, or shall we call it search for truth, was the compelling force.

Stimulated by this discovery, other workers followed along the same line, and in 1762 Marcus Antonius Plenciz, a physician of Vienna, conceived the idea that Leeuwenhoek's microorganisms might cause disease in man, which led him to further research on bacteria. But the history of bacteriology is too fresh in our minds, and the benefit to mankind of such discoveries as were made by Ferdinand Cohn, Louis Pasteur and many others, too well known for further mention of this new branch of botany. Suffice it to say that the discovery of bacteriology was made by pure research work without much if any thought at first of its practical application to the benefit of humanity. While some of the subsequent discoveries in the field of bacteriology were made on the same bases, others relating to the subject were sought for because of their supposed effect upon health and disease.

The subject of bacteriology, I think, shows very definitely that pure and applied science cannot be divorced one from the other. While most of the outstanding scientific discoveries of the world have been made by those who had no thought of their practical application to the benefit of mankind, yet if the scientific principles thus discovered had not been studied and used in productive agriculture and industry, and in the preservation of health and the curing of disease, as well as in other economic and social ways, their discovery would have meant little to mankind. Indeed they would likely have been entirely forgotten.

Gregor Mendel, who was stimulated by Darwin's "Origin of Species," with which he did not fully agree, carried on his monumental experiment primarily because of his interest in the manner in which new species originate. His paper was read in 1865 and published a year later, but it was not until about thirty-five years later that its value in genetics and eugenics was discovered by other research workers in that field of biology. Little did he realize its value in the field of heredity and

its benefit to mankind in solving many of the problems which arise in plant and animal breeding.

It is true, therefore, that almost every epoch-making discovery in science was made not because of any urge from society but from a desire to ascertain scientific facts and truth. But it is also true that it was necessary for other research workers to follow up these discoveries in order to further develop them and to apply them to the needs of society.

In America and elsewhere, research in both pure and applied science has been carried on with marked results in universities and industrial laboratories. Outstanding examples are found in our own country in the Mellon Institute connected with the University of Pittsburgh, and in the laboratory of the Bell Telephone Company of New York and the laboratory of the General Electric Company of Schenectady. These laboratories recognize the value of search for new principles and laws not yet discovered, as well as for the improvement and application of principles and laws already known to science. Many colleges, universities, and industries throughout the world, and especially in America, have been engaged in similar work with the result that never in the history of mankind has such progress been made in medicine, agriculture, physics, chemistry, biology and every other branch of science.

The discovery and the application of the principles of science to agriculture and other industries have given to the world in the last few years an abundance of rubber, cotton, wheat and other foodstuffs, the automobile, the radio, the airplane and many other manufactured products.

Indeed, as we look over the various fields of science, we sometimes wonder whether there is anything left for the scientists to do. We often teach our geology, biology, physics, chemistry, mathematics, psychology, and other science as if in each the last discovery has been made.

Einstein and others have shown us in the last few years that there is still room for research in mathematics. We know a little about three-dimensional mathematics, but when we try to understand four-dimensional formulae and hear mentioned five, six and seven dimensional mathematics, we feel that our present knowledge of mathematics is quite incomplete.

When many of us studied chemistry and physics, we were taught that the ultimate division of matter was the atom. Now we have the proton and electron, and are informed that matter and energy are interconvertible. A few years ago, we cynically laughed at the alchemists' idea of the interchangeability of elements, now we calculate the age of the earth by the time in which uranium changes into other elements and finally to lead by the emission of alpha and beta particles.

Similarly in the field of biology with its many subdivisions of botany, zoology, genetics and eugenics, there are numerous problems awaiting solutions. The Pennsylvania Academy of Science, consisting of several hundred scientists, every one capable of some kind of research work, can individually and as an organization, help to solve some of these problems.

It is true that our time is pretty fully occupied with the routine of teaching or some other kind of work. But there are few of us who cannot find some time to devote to some kind of research work. A few minutes daily given to the study of a bacterium may in a few years result in the prevention and cure of such a plague as tuberculosis. A little thought given at regular intervals may give to the world a method of the biological control of some destructive plant disease or insect pest. If some physiological chemist were to concentrate his attention on the relationship of some of our economic plants to the chemical constituents of the soil, perhaps we would have another epoch-making boom to agriculture similar to the one produced by the discovery of the nitrifying bacteria of the soil and their relation to plant growth.

Let us not be afraid to do research on seemingly unimportant things, for what seems to be a very trivial discovery may presently be of great benefit to society. The two young research workers in the University of Manchester who discovered that acetone could be produced by the growth of a certain bacterium in wet corn meal, did not know that their discovery would be a factor in winning the World War and that in a few years farmers would find a market for millions of bushels of corn because of their seemingly unimportant discovery.

Never in the history of mankind in an equal length of time, have there been so many stimulating discoveries in science as have been made in the past quarter of a century. Einstein, Milliken, Jeans and a host of other astronomer-physicists have created a new field for research in physics and chemistry. The study of the atom, the discovery of radioactivity and the quantum theory, along with the discovery of the gene and the chromosome, give promise of solving some of the intricate problems of physiology, psychology, genetics and eugenics.

So intricate are many of the scientific problems awaiting solution that it becomes more and more necessary for cooperative work. The worker in biology cannot go very far until he needs the assistance of the chemist, who in turn must call on the physicist or the mathematician. Here is where our organization can be of great benefit to the individual worker.

In the exact sciences and in the industries based upon the principles of these exact sciences, the production has been so great that socially we

have been unable to keep apace. Shall we, as some have suggested, call a halt on scientific research and wait for society to catch up or shall we speed up moral, social and political progress. Certainly no one would advocate the weakening of the strong parts of a machine to put them on a par with the weak parts—better by far make the weak parts stronger. Are people starving because scientific agriculture has produced too much wheat? Are they freezing because research has produced too much cotton, wool and fuel? Certainly this does not sound sensible, and yet we have been told that a superabundance of these things is causing the depression with its consequent want and misery. If we wish a machine to run smoothly and do successfully the thing for which it was made, the scientific laws and principles involved must be obeyed so that they will not clash.

When Darius Greene made his flying machine and went out on the roof of the barn to fly it, he did not give enough thought to the two fundamental scientific laws involved, namely, the law of gravitation and the upward pressure of the air. Darius met with a terrible crash. We cannot expect to meet with success in any activity of life, be it industrial, economic, social or moral, if we do not act in accordance with the principles and laws underlying those activities.

In the field of production, the world has been obeying scientific law, but in the field of distribution and consumption the economic, social and moral laws have been ignored. We have beeen marketing our agricultural and other industrial products for the benefit of the few, many of whom have become millionaires, and not to the benefit of every unit of society.

I realize that the law of production is, perhaps, quite exact while the law of distribution of manufactured products is not so exact and well understood. Nevertheless there are such laws and is it not time that we try to avoid the economic and social crashes that have occurred in the last two decades, not only within nations but between nations, by giving more time, thought and even money on research in order to discover and apply the laws underlying the distribution of our enormous quantities of wheat and other agricultural and industrial products to the benefit of all mankind instead of to the benefit of only a few.

Where are those courses in our colleges and universities which we designated thirty years ago as "political economy" or by the general term "economics"? Are they lost in the "porridge pot" of "psychology and social studies"? If so, let us hope that the fundamental principles and laws may come out in the near future, when the smoke of conflict of difference of opinions has cleared away, more clearly refined and applicable to the needs of society.

Changing conditions may affect the operation of certain laws. Even in the exact science this is true. The fact that we can now successfully fly an airplane does not mean that the law of gravitation is no longer operating. It does mean, however, that other laws involved are better understood and are used to overcome the effect of gravitation. The bacteria which cause diphtheria, tetanus, and typhoid fever are the same bacteria and are subject to the same conditions of growth and development in the human body that existed thirty years ago, but we have learned other opposing conditions of growth and multiplication which have held them in check and rendered them less injurious.

In the field of economics, the changing conditions brought about by increased population, by improved methods of transportation and by many other national and international relationships may have rendered ineffective some of the fundamental principles of economics. Certainly they have not utterly annihilated all of these principles.

As we recall it, the subject of economics is ordinarily treated under the main topics of production, exchange, distribution and consumption. Has there been too much scientific thought given to the first or too little attention given to the last three? Maybe our money system and the laws which govern it might be a field for more research. If the Malthusian Law, the Law of Diminishing Returns, our monetary and credit principles, and other fundamental laws of economics are no longer adequate because of changing conditions of civilization, can we not find others that will cause our economic machinery to run more smoothly and more effectively.

On December 8, 1931, President Hoover in his message to Congress, in discussing the depression conditions said: "We must put some steel beams in the foundations of our credit structure. It is our duty to apply the full strength of our government not only to the immediate phases, but to provide security against shocks and the repetition of the weaknesses which have been proven."

Perhaps there are students and research workers among the members of our Academy of Science who can help construct these steel beams upon economic principles which will stand the test of changing conditions of the future.

So far as I can recall, not one paper has ever been presented in this field at any meeting of the Pennsylvania Academy of Science. Physics, chemistry, biology, mathematics and geology have all been represented, but little or nothing has been given on psychology, the social sciences and economics. Certainly there are some workers in these last named subjects among our Pennsylvania scientists, and it appears to me that

here lies a fertile field for research work and that we should make every effort to strengthen our academy in this weak spot.

Furthermore, perhaps we as scientists can even assist in stabilizing conditions by looking beyond the field of physical and economic science.

May I again quote from President Hoover's message to Congress on December 8? He says in speaking of our national and international troubles: "If we lift our vision beyond these immediate emergencies we find fundamental national gains even amid depression. In meeting the problems of this difficult period, we have witnessed a remarkable development of the sense of cooperation in the community. For the first time in the history of our major economic depressions there has been a notable absence of public disorders and industrial conflict. Above all there is an enlargement of social and spiritual responsibility among the people."

Something is wrong socially when granaries are at the point of bursting, with people even in our own wealthy nation crying for bread. Are the moral standards of the ages no longer adequate to the needs of our complex civilization, or have we failed in applying them to our intricate problems? If it is the latter, and it doubtless is, then here again members of the academy, many of whom are teachers, can do their share by guiding the youth in the observance of the moral code written on tablets of stone nearly four thousand years ago, or to the steel beam in the foundation of our social structure uttered by the greatest Teacher of all ages when He said, "Therefore all things whatsoever ye would that men should do to you, do ye even so to them: for this is the law and the prophets."

Never in the history of civilization has there been greater opportunity for research in so many fields, and never has there been greater need for clear, scientific thinking and analysis than there is today. Surely a State Academy of Science is of some value to humanity, else there is no reason for its existence. Shall we, the members of the Pennsylvania Academy of Science, not grasp this great opportunity to help solve some of the intricate problems that are perplexing our twentieth century civilization.

SOME OBSERVATIONS ON SEED PRODUCTION ON PRESQUE ISLE, PA.

By Richard V. Morrissey
University of Pittsburgh

This brief paper will indicate some of the types of seeds observed on Presque Isle, Pennsylvania's State Peninsular Park, during the summer of 1931. Because of the excellent advantages offered in studying a large number of ecological successions in a very restricted area, Presque Isle is well adapted for the study of seeds. On the beach associes we find such plants as *Cakile edentula,* the sea-rocket, *Lathyrus maritimus,* the beach pea, and others as *Artemisia canadensis,* sagebrush, and *Euphorbia polygonifolia,* seaside spurge.

Cakile edentula produces its seeds in a long pod typical of the Crucifers. The seeds are usually produced about the middle of August. *Lathyrus maritimus,* a typical legume, produces its small pea-like seeds in a pod about three to four inches in length. At maturity, the pods open with a slight twist of the valves, dispersing the seeds. However, a large percentage of these seeds examined were worm-eaten, indicating that very few seeds will produce new individuals.

On the sand dunes formed by dune grass, *Ammophila arenaria,* one finds the cottonwood, *Populus deltoides.* Seeds from this tree are cottony and blow about very easily. Strangely enough, these seeds are unable to germinate if the seed does not light in a suitable spot within a few weeks after it has been dispersed from the tree. We also find the sand cherry or plum on the first sandy ridge, forming quite a stand near the lighthouse which was the tip of the peninsula about 1865. We will refer to this again.

The year 1931 was a very good year on Presque Isle for seed development, and virtually every plant was producing seed in abundance. The white pine, *Pinus Strobus,* has not had a good seed year on Presque Isle for a number of years. This year the cones were forming in abundance. However, it takes two years for the seeds to develop so that the seeds from last year's beginning will not start to grow till the fall of 1933. Soil conditions are of major importance for pine and it takes about forty years to pile enough humus on the sand for the growth of a stand of white pine.

Lithospermum Gmelini, hairy puccoon, is of particular significance because Presque Isle is its only native habitat in Pennsylvania. Its seeds are very hard. This is indicated by the derivation of the genus name, *Lithospermum,* meaning stone-seed. Two small seeds are formed in the nutlet, and many plants which may be fighting extinction seemed to produce an abundance of seeds this last summer.

Four species of the genus *Prunus* occur here and all were very heavily ladened with fruit. The bird, or fire cherry, *Prunus pennsylvanica,* was hanging so heavy with fruit that all the cherries could not be eaten by the birds, as in former years. Probably there will be new cherry trees nearer the site of the parent trees because of the abundance of fruit dropping directly from the trees rather than having to be carried by birds to distant spots.

Prunus pumila, sand cherry or plum, occurs near the lighthouse on the high sand dunes, and this year in particular an exceptional quantity of fruit could be picked. Attempts have been made to establish this bush cherry on other parts of the peninsula by artificial means of dispersal.

Prunus serotina, black cherry, occurs in just about the same habitat as the fire cherry, and produced with its companion species, a good crop of seeds to make for future trees.

Prunus americana, wild cherry, occur scattered usually over the older portions of the peninsula.

One of the thicket species common to Presque Isle, having been established for many years, is the bayberry, *Myrica carolinensis,* a deep green leaved aromatic, partially evergreen, belonging to the sweet gale family; it was covered with greenish berries. These berries in the fall turn a gray, waxy color and it is from this wax that our real Christmas bayberry candles are made. However, it takes a very large quantity of bayberries to make a little wax, as I learned from experience.

Another plant which used to be of economic value to many of the older residenters of Erie is the cranberry. At one time, it grew abundantly near Cranberry Pond on the peninsula and the berries were gathered in the fall for sauce. This last summer, for the first time in several years, *Vaccinium macrocarpon,* was in fruiting condition over a rather large area.

Another plant which is destined to be used as a cover to hold the sand is the bearberry, *Arctostaphylos Uva-ursi,* which produced a fair quantity of red, mealy berries. However, at present, it seems that the seed can not be germinated by artificial means, and new stands have not been found starting from seed in natural conditions.

Another plant of particular interest is the blue lupine, *Lupinus perennis.* Around Decoration Day, along the depression back from Presque Isle Roadway you can see a mat of blue, the flowers of the blue lupine. In early summer the characteristic legume has formed pods with about eight to ten seeds inside. As they become ripe, the pod twists and spreads in such a fashion as to forcibly eject the seeds as if from a gun and by careful observation I have noted some of these seeds being sent out at least ten feet. As they were dispersed, a "click" was heard. From my observations I believe that this was one of the best years for this seed, since it produced such large quantities that the Park Commission attempted to plant some of the seed on the bay side of the peninsula.

The fruitful efforts of this last summer's production of seed will begin to be noticed within five years, providing a severe drought does not kill the young seedlings.

This quantity of seed produced last summer will probably save from near extinction many species which were on the wane on Presque Isle.

FURTHER STUDIES IN THE PHYSIOLOGY OF THE PROSTATE GLAND

B. H. KETTELKAMP

University of Pittsburgh

In a paper presented before the Academy last year the effects produced by feeding prostate gland substance to amphibian larvae were discussed. These effects resembled very closely, but to a less marked degree, those produced by the feeding of thyroid gland substance, and it was suggested that the recorded acceleration of growth and metamorphosis was caused by the presence of iodine in the prostate substance. This material, when injected into rats, produces changes in the reproductive capacity and general metabolism which resemble those produced by experimental hyperthyroidism. The following is a preliminary report on the effects produced by the injection of prostate gland substance.

Three different preparations of the glands of bulls were used. The first of these was a commercial preparation of the desiccated gland from which the fat had been removed. The second preparation was made from fresh glands which had been carefully trimmed, finely minced, and dried to constant weight. The third was a specially prepared protein- and fat-free substance, prepared in the same manner as that used in the experiment on amphibian metamorphosis.

These three substances were injected into young rats in varying dosages over different lengths of time. The results obtained varied with the type of substance used and the amount injected. The commercial

preparation and the protein- and fat-free substances produced the most outstanding results.

Thirty female rats received injections of the commercial product and showed no visible external effects. The body weight was not significantly altered. The animals attained full sexual maturity slightly later than the controls. They produced normal litters of which 90 per cent. died two or three days after birth. Autopsy showed that no milk was present in their stomachs. Examination of the mammary glands of the mothers, too, failed to show any signs of lactation. After continued injection all the females again became pregnant and produced litters which died of starvation soon after birth. The effects on male rats were less marked. Their body weight was not altered. There was a slight precocious sexual development evidenced by the descent of the testes into the scrotum and there was considerable variation among the group, but, since it is difficult to determine exactly when the testes descend permanently, it is doubtful if this precocity is of any significance. The prostates of these animals were slightly smaller than those of the controls. Sectioned material showed some differences in the secretory condition of the glands. The epithelium appeared to be in a less active condition. The cells were more cuboidal and the protoplasm did not possess the granular appearance by which actively secreting cells are characterized. The tubules also were not so completely filled with secretion as those of the controls. Other organs showed no effects and breeding tests demonstrated full sexual capacity.

Thirty-five animals from five litters received injections of the whole gland which had been minced and dried. Sexual development and fertility were not influenced among the males, and there were no external changes which could be attributed directly to the influence of the prostate substance. Microscopic examination of the male reproductive organs failed to show any definite changes. The prostate glands apparently were not affected. Of this group of animals 19 were females. Seven were used as controls and 12 received injections. Examination of serial sections of the ovaries showed a marked reduction in the number of Graafian follicles. The average number of follicles in all stages of development in the controls was 131 while that of the experimental group was only 91. This difference would not be due to a difference in age since there was a difference of only eight days in the age of the litters, and they were all killed within the same week.

Twelve animals received injections of the water soluble, protein- and fat-free substance. These animals showed marked changes in reproductive activity and also in external appearances. The females were rendered completely sterile. Repeated attempts to mate the injected females with the injected males, and also with normal males, failed to effect a fertilization. Males, likewise, after prolonged injection were unable to effect a fertilization with normal females. The sterility of the males was probably caused by the general emaciation of the body which was much more noticeable in them than in the females. Body weight was markedly altered. The average weight of the controls after two weeks' injection was 112 grams and that of the experimental group was 116 grams. Twelve weeks later the controls weighed 201 grams, an increase of 79.4 per cent., and the experimental animals weighed 149.8 grams, an increase of only 29.8 per cent. Diuresis was decreased 50 per cent. within eight hours after injection with prostate substance. Crystals, which have been assumed to be excreted urea, formed in abundance after the urine had stood for a short time. Although this phase of the experiment has not been completed and needs rechecking, the results are suggestive. The rate of heart beat was increased far above normal, and the respiratory rate was increased almost 40 per cent.

From the effects produced by injections of prostate substances it is highly suggestive that the gland is functionally related to the thyroid. The results obtained from feeding the gland to tadpoles gives additional evidence of this relationship. Moreover, it is definitely known that prostate hypertrophy among men is often associated with defective thyroid function.

Inhibition of mammary function in those rats which received injections of the commercial preparation is undoubtedly a direct effect produced by the gland material. It is probable that the prostate, together with the hormone of the interstitial tissue of the testes, normally inhibits the development of the mammary glands in the male. Development of the breasts in eunuchs may be caused by the removal of the inhibitory substance of the prostate which atrophies in those cases, and not by the removal of the testicular hormone, as has been previously supposed. It is possible that the interstitial tissue compensates for the removal of the prostate by secreting an additional amount of the hormone which prevents the mammary development of prostatectomized animals. Mammary gland development has been observed, however, in a few cases following prostatectomy, but the number of cases is too small to be conclusive.

The reduction of the number of follicles in the ovaries is significant. This reduction is thought to be caused by an inhibitory influence exerted

by the prostate substance. In these females, although the production of ova was inhibited, ovulation was sufficient to produce normal litters. In females which received the protein- and fat-free substance sterility is thought to have resulted from a prolonged inhibition caused by the more concentrated and active substance. Cessation of ovulation and menstruation are known to accompany thyroid disturbances in women. In view of these results it appears that the effects produced are similar, if not identical, to those produced by hyperthyroidism.

The effects on metabolism are significant and are also similar to those produced by hyperactivity of the thyroid. Previous investigators have attributed accelerated heart beat and respiratory rate following prostate injection to intravascular coagulation. It is more probable that the results of prostate injection differ from those of thyroid injection in degree only, since increased nitrogen metabolism, loss of weight, reproductive disturbances, accelerated heart beat and respiratory rate, and increased blood pressure can be induced experimentally by repeated injections of thyroid material.

TOY FISHES IN THE LABORATORY

WILLIAM A. SCHUBERT

Zoological Laboratories, University of Pittsburgh

Of all living animals ordinarily found in the laboratory, living fish in balanced aquaria seem to receive the most attention and of the fish world the toy fishes, particularly the tropical toy fishes, because of their gaudy colors and unusual activities coupled with a ready fecundity, are the most popular; the more so because the student can so easily maintain these same forms in an aquarium in his own home. There is no doubt that the balanced aquarium is an ornament in any home and a beauty spot in any laboratory, and beyond question most laboratories can well stand a little beautifying.

The term Toy Fish is applied to a group of small fish made up of many different families suitable to the small aquarium of four or five gallon capacity where they thrive and seem perfectly contented. The tropical forms are very numerous and extremely attractive. Among these we have both ovo-viviparous and viviparous fish. Here we have the *Lebestes reticulatus*, the Guppy, one of the most colorful little fish of the tropics; the *Xiphophorus helleri*, commonly called the sword tail; the *Platypoecilus maculatus* in many varieties; and a host of curious nest builders that float their eggs at the surface and give both eggs and fry the utmost attention; similarly members of the Cichlidae, the *Hemichromis bimaculatus,* the *Cichlasoma facetum,* the Pterophyllum, and others that lay adhesive eggs on plants and crockery. Both adults caring for the eggs and young, there is no sight in the aquarium more pretty than the parents surrounded by a dense mass of tiny fish, to the number of three or four hundred.

Once student interest is aroused in the care and breeding activities of fish, numerous avenues for well-directed scientific endeavor present themselves. There are aquatic ecological relationships that in many cases are not well understood, the periodic appearance and disappearance of particular types of protozoa; disease and its control. Often strange forms appear. In one of my tanks I have found as many as forty fresh water medusae, the adults of which have not as yet been studied. Another tank is at times overrun with Bryozoans.

Such problems call for more study and scientific information so that the student may be led along with increasing powers of observation and fitness for further scientific work. Here, then, is a field of popular scientific education that should not be neglected.

But further than elementary interest and education, the toy fishes are excellent material for experimental biology—material that by the very nature of the aquatic medium supplies a uniformity of environment much more nearly natural than can in most cases be supplied for experimental animals. Some forms have been used in studies in genetics and morphology, but what has been done, has not been popularized. The Betta family, the so-called Fighting fish, offers many color varieties that might be worked genetically, and since the parents care for the young nearly all may be reared without fear of parental cannibalism.

In the Cichlid family we have a ready and cheap supply of embryological material, as these fish will spawn every ten days or every two weeks, laying as many as three or four hundred eggs or even more the whole year around. For embryological work the nest builders are better in that the eggs are floated at the surface and therefore can be removed as many as desired at a time, and if the eggs are not killed they may be put back again for future study. Development is rapid, after 24–48 hours the young emerge and in three or four months are mature. With spawning so frequent and so many eggs produced there is no reason why the young may not later be used in cytological work.

Many of these fish should be suitable morphological material for regeneration work. Since many types are sufficiently transparent to make most of the organs visible, this is particularly so in the young.

Of course breeding fish is not so rapid since three or four months are necessary for maturity and hence will not replace Drosophila or Habrobracon in genetics, but if the present information is popularized there is a host of amateur aquarists with all the patience in the world ready to take up the work.

In view of the facts, that these tropical toy fishes are probably suitable material for so many phases of scientific research, and at the same time so interesting to students and all who know them, it is surprising that they have been comparatively neglected and left in the hands of amateurs.

CHROMOSOMAL LENGTHS IN FIVE VARIETIES OF THE GARDEN PEA (*PISUM SATIVUM*)

HAROLD A. BRUCE

Zoological Laboratories, University of Pittsburgh

The close relationship between adult characteristics and their chromosome carriers is still not so definitely determined as to reduce interest in experiments of that nature. The possibility of obvious genetic differences being linked with morphological differences may be determined by a study of the chromosomes during the metaphase stage of mitosis and with that in mind the following investigations were made.

It was deemed advisable for this purpose to select a plant because of the relatively great number of mitoses found in the growing root tip. The common Garden Pea offered not only a workable cell cytologically but also was an easily accessable species with a large number of varieties. Five varieties were chosen (Little Marvel, Nott's Excelsior, Improved Telephone, Alderman, Prince Edward) and these were all started at the same time under the same environmental conditions. All tips were cut when approximately two centimeters long and all were fixed in B 15, embedded in paraffin, sectioned at 10 micra, and stained in iron haematoxylin.

The cells drawn were all in the metaphase with the fourteen chromosomes lying exactly or very nearly in one plane of focus. All drawings were made at table level with a Zeiss 15 × compensating ocular, a Koristka 1/12 N. A. 1.36 objective and a Zeiss camera lucida, giving a total magnification of approximately 2700 diameters.

For each variety five tips were selected, and from each of these, five cells were drawn; making in all, one hundred twenty-five drawings for the five varieties. Each individual chromosome was measured and the total chromosomal length computed. The average total chromosomal length for each variety was then secured.

The graph Figure 10 shows a marked variation between the average total chromosomal lengths of the varieties Improved Telephone and

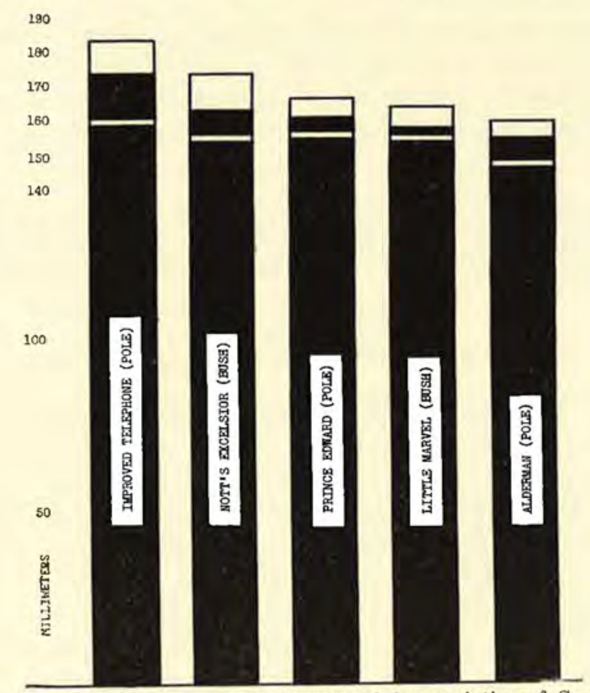


FIG. 10. Showing the total chromosomal length of five varieties of Garden Peas and also the high and low extreme of each variety.

Alderman. Here the difference in total length, considering all values in millimeters, is 19 making the Improved Telephone variety have about ten per cent. longer chromosomes than the Alderman. The other three varieties, Nott's Excelsior, Prince Edward, and Little Marvel, which lie between these two extremes, decrease, as to total length, in the order named. The outstanding difference is between the two greatest total length varieties in which the Improved Telephone has over six per cent. more chromosomal length than the Nott's Excelsior which difference is more than half the difference of the two extremes.

In any study of averages there is a tendency to draw too rigid conclusions from those means without giving due consideration to certain extreme members of each average. To avoid as much of this error as possible the graph also shows the extreme long and extreme short chromosomal length of the tips from each variety. This shows an overlapping of the high of one with the low of another and in the case of all but the Improved Telephone this condition is pronounced.

As is noted in Figure 10 two of the varieties under consideration are bush peas and the other three are pole varieties. Although it is as yet of uncertain unscientific value it is interesting to note that the chromosomal length is apparently in no way definitely connected with the tallness or dwarfness of the plant. As is shown in the graph both the longest and shortest chromosomal lengths are of peas of the tall varieties.

CONCLUSIONS

1. The Improved Telephone variety has a much greater total chromosomal length than is shown by any of the other varieties.
2. Although there is an overlapping of the highest with the lowest among the varieties, this in no way overshadows the individuality of the varieties.
3. Chromosomal length is not definitely associated with the plant height.

CELL SIZE IN RELATION TO CHROMOSOME LENGTHS IN GARDEN PEAS

HAROLD A. BRUCE

Zoological Laboratories, University of Pittsburgh

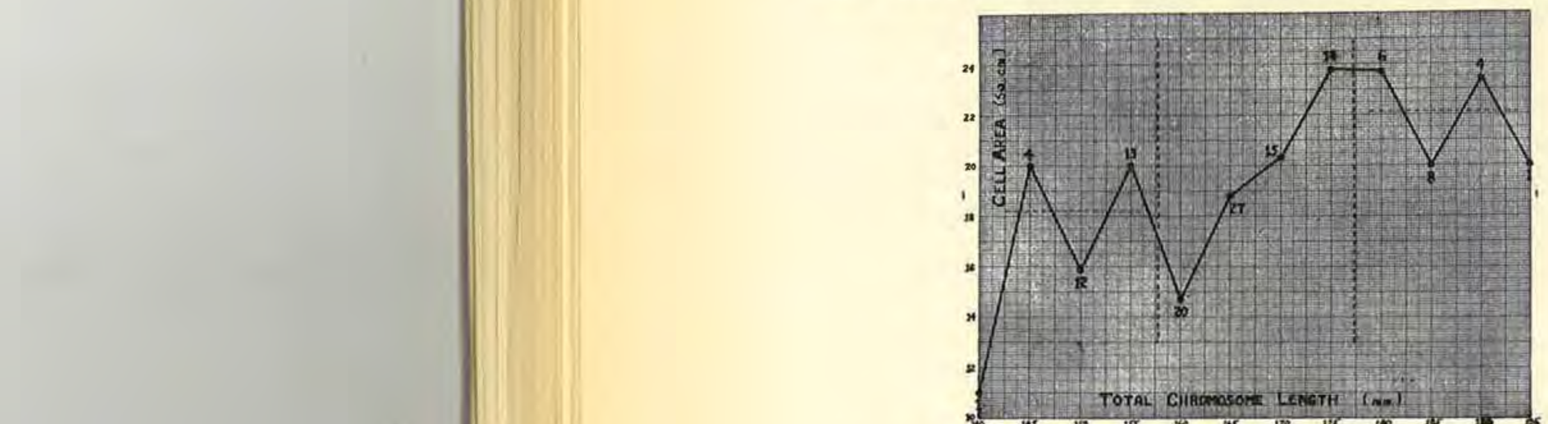
The relation of cell size to body size and of the nucleus to the cytoplasm has caused considerable discussion in the past. Considering the former, Boveri ('04) found that epithelial cells and bone corpuscles from human dwarfs and giants are of the same size as normal individuals. Conklin ('02) first clearly indicated that the size of the nucleus was affected by that of the cytoplasm. Wilson in regard to the karyoplasmic ratio states that this belief was undoubtedly carried too far; but there remain well-determined facts concerning this ratio that are of interest for many cell problems.

In a study of the effect of cellular environment on chromosome size in Ascaris, Hance ('27) shows that the length of the chromosomes is very slightly shortened during the early cleavage divisions, while the area of the equatorial cross-section of the cells becomes enormously reduced.

In this comparison of chromosomal length with cell size, the same material was used as previously in the "Chromosomal Lengths of Five

Varieties of the Garden Pea." This experiment involved the determining of the size of the cells and then comparing the cell size of each with its already known total chromosomal length. In the figures given the chromosomal length is in millimeters and the area of the cross-section of the cell, measured by a planimeter, is in square centimeters.

The cells were grouped in classes varying in total chromosomal length of five millimeters and the average cell area of all cells falling in each class is charted on the graph (Fig. 11). The 125 cells considered,



fell in twelve classes varying in chromosomal length from the 135–140 mm. class to the 190–195 mm. class with the median class 160–165 mm. From the graph which also records the number of cells in each class, one can see that more than three-fifths of the total number of cells fall in the middle four classes with a considerable decrease in the number of cells in each end group.

It is interesting to note that the four middle classes which compose the great number of cells (between the two heavy broken lines on the graph) show a gradual increase in cell size with chromosomal length. The average of the cells in each outside group was taken and (as shown by the light broken line) it was found that the cell size was smaller with the shorter chromosomal length. Although this difference, which was not nearly as pronounced as in the central region, must be noted, it should not be given too much consideration because of the fewer number of cells which possess a great variation of chromosomal lengths.

Summary

In general there is a gradual increase in cell size with chromosomal length. This increase is much more proportional in cells with a total chromosomal length near the median. Although the variation of cell size in the two extremes is apparent, it should not have too strong an influence on the previous conclusions because of the much smaller number of cells composing these groups.

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PHYSIOGRAPHIC STUDIES IN PENNSYLVANIA

By Geo. H. Ashley

Topographic and Geologic Survey, Harrisburg

[*Abstract*]

Pennsylvania, long the Mecca of physiographers, has in recent years been the scene of many physiographic studies which have materially modified a number of early conclusions.

It has long been recognized that in a broad way the physiographic features of Pennsylvania are the result of recent uplifts and stream etching of an old plain of erosion cut in a great thickness of rocks of different character, folded into different attitudes, and modified by crustal warping, faulting and glacial action. During Paleozoic time, Pennsylvania was an inland sea in which a great body of sediments was deposited, the thickness ranging from around 30,000 feet at the east to 8000 feet at the northwest. At the end of Paleozoic time these rocks yielded to pressure apparently from the southeast and were shoved westward with crushing and metamorphism in the southeast part of the State, folding and faulting in a broad belt from the South Mountain to the Allegheny Mountain and slight folding west of the Allegheny Mountain. It is assumed that in time the tops of these folds were worn down to a plain now called the Schooley peneplain[1] reflected in the present level tops of the mountains. This process was disturbed during Upper Triassic time by crustal fracturing and block movement with deep sedimentation and igneous flows (trap) affecting a belt of land in southeastern Pennsylvania. A surface just touching the tops of the mountains of today would rise fairly uniformly from about 400 feet at Philadel-

[1] Davis, Wm. M., The geologic dates of origin of certain topographic forms on the Atlantic Slope of the United States: Bull. Geol. Soc. Am., vol. 2, pp. 566.

phia to 3200 feet A. T. in southern Somerset County, indicating the extent of subsequent uplift.

It has long been assumed that the surface (Schooley peneplain) from which the present imaginary mountain-top surface was derived was of pre-Cretaceous Age. Recently the writer has concluded that the Schooley peneplain was not older than late Miocene.[2] Furthermore, Professor Johnson[3] has reached a conclusion, with which the writer agrees, that the Schooley peneplain was not the first peneplain of this region but may have been one of several and that, following one or more of these earlier stages of peneplanation, sinking from the east permitted the laying down of Cretaceous or Early Tertiary deposits over all of eastern Pennsylvania and probably all of central Pennsylvania and that the southeastward drainage system of Pennsylvania became established on this blanketed surface following its uplift. Later as the continued uplift of this surface permitted down-cutting and removal of the post-Paleozoic deposits, there came a series of partial adjustments to the underlying structure with much stream capture and diversion, resulting in a general way in the drainage of pre-Glacial time, which differed but slightly from that of today. As a result of this readjustment the lower Susquehanna is thought to have tapped and diverted first the head waters of the ancient Schuylkill and later the head waters of the ancient Lehigh (now the North Branch above Pittston). The lower Delaware is thought to have diverted the head of the Raritan to secure its present valley above Port Jervis. The capture of the upper North Branch may have come after the uplift of the Schooley peneplain as predicated upon the Wind Gap having been in the line of the ancient drainage.

On this theory part of the present southeastward flowing drainage dates from early Tertiary or Late Cretaceous time while other parts of the drainage are of later age, some of it of very recent post-Glacial Age. The whole subject is still in the conjectural stage and theories proposed today will be the subject of further study and testing and may be abandoned for other theories later on.

The actual topography of today is believed to date from the beginning of the uplift of the Schooley peneplain (in Late Miocene time?). A few points, such as the Elk Hills in Susquehanna County, the west end of North Mountain in Sullivan County, and Blue Knob in Bedford County, may be remnants of areas not completely reduced at the time of the Schooley peneplain. There has been much study to determine, if

[2] Ashley, G. H., Age of the Appalachian Peneplain, Bull. Geol. Soc. Am., vol. 41, pp. 695–700, 1930.

[3] Johnson, Douglas, W., Stream sculpture of the Atlantic Slope. N. Y., 1931.

possible, whether the uplift of the Schooley peneplain was interrupted by many long stops, during each of which partial peneplains were developed. There certainly was one such partial peneplain, to which Campbell long ago applied the name Harrisburg.[4] Mrs. Knopf has thought that there were at least four erosion plains between the Schooley ("Kittatinny") and the Harrisburg,[5] ranging from 200 to 300 feet apart vertically. The second, third, and fourth hypothetical peneplains she has named the Mine Ridge, Honeybrook, and Sunbury respectively. While such pauses would seem likely to have occurred and while there are many ridge tops that seem to substantiate such a conclusion, the writer prefers to leave the matter open, as it seems possible to explain the various elevations of long ridge tops by differential erosion on rocks of varying hardness, thickness, and attitudes. This does not apply to the Sunbury. It now appears that the hilltop surface at about 540 feet noticed by Campbell at Harrisburg is part of a younger and lower peneplain than the surface which he had in mind elsewhere and which agrees with the Sunbury of Mrs. Knopf. This older surface the writer has called the Allegheny peneplain because of its fine development on the divides of the middle Allegheny region. Mr. Campbell has recently proposed to call it the Chambersburg peneplain from its fine display on a long ridge west of that town. This peneplain is believed to coincide with the hilltop surface of all of western Pennsylvania and much of northern Pennsylvania (west and north of Chestnut Ridge and its extension), with the upland at about 1300 to 1400 feet A. T. north of Williamsport and Muncy and with many hilltops throughout central Pennsylvania, the surface declining from 2100 feet in McKean County to 1300 feet in the Pittsburgh area or to 500 feet in the South Mountain area of southeastern Pennsylvania.

Below this well preserved hilltop surface there appear to have been two other slightly developed hilltop surfaces. One of these is the surface of the concordant hilltops of the Harrisburg area at about 520 feet above sea-level, a surface which rises northward less rapidly than the higher Allegheny peneplain. The other surface is best developed on limestone and is thought to correlate with what has been called the Somerville peneplain. This lower plain is the one at 400 feet at Harrisburg and in the Lehigh Valley north of the river from Allentown and Easton. The earlier of these two plains is thought to be of early Pleistocene age

[4] Campbell, M. R., Geographic development of northern Pennsylvania and southern New York, Bull. Geol. Soc. Am., vol. 14, pp. 277–296, 1903.

[5] Knopf, E. B., Correlations of residual erosion surfaces in the Eastern Appalachian Highlands: Bull. Geol. Soc. Am., vol. 35, pp. 633–666, 1924.

and the Somerville to be about of the age of the Illinoian ice advance, as it seems to correspond with river terraces on the Susquehanna thought to be of that age.

Within the glaciated area the whole face of the earth's surface has been changed. It is now clearly recognized that at least three glacial advances entered Pennsylvania. The Illinoian advance reached about 50 miles beyond the morainal edge of the Wisconsin or Labrador ice advance in eastern Pennsylvania, though only a little beyond the Wisconsin advance in western Pennsylvania. The still earlier advance is only dimly suggested by scattered erratics on high hills and is thought to have extended beyond the Illinoian ice. In the glaciated areas rivers were diverted to new courses, lakes, water-falls, and swamps were formed, and the topographic relief of the land materially changed.

Frankly the whole subject of the physiography of Pennsylvania is undergoing intensive study with the discovery and accumulation of many new facts leading to the replacement of some of the old ideas by new conjectures or theories; but the solution of many of these problems interest and stimulate observation as to present some of the modern con- is still in the future. This paper was presented quite as much to arouse clusions.

PENNSYLVANIA FIREBALLS OF NOVEMBER 23, 1931

By Chas. P. Olivier

Flower Observatory, University of Pennsylvania

On the evening of November 23, 1931, two brilliant meteors or fireballs were seen from the vicinity of Philadelphia. The one first reported to the writer was seen at 9:15 p. m. Requests for observations were promptly published in the local papers, and as a result about one hundred letters were received. At once it became apparent that at least two bright objects had appeared early that evening, the first at 7:38 p. m. As the newspaper request had been for the 9:15 fireball, many who wrote did not trouble to mention the time of observation, so for some reports it is impossible to know which is intended.

Though the objects were in the southern sky as seen from Philadelphia, no reports were received from Maryland, and none from more than a few miles west of Philadelphia. Observers were concentrated in one area so that the azimuth angles were nearly all in one quadrant. This makes the most unfavorable condition for a solution. Out of a hundred replies a bare half dozen tried to refer the path to stars, the ideal reference points, and some of these obviously misidentified the constellations.

The writer spent several days of hard work on these data, for from the number of reports it seemed a great pity that no good solutions could be found for heights and orbits. The actual results are liable to far larger probable errors than usual.

For the fireball of 7:38, it is certain that from Philadelphia its path was from east to west in the southern sky, the angle with the horizon averaging about 25°. It was a brilliant object, and took several seconds to complete its course. It ended about 15° west of south as seen from Philadelphia, probably over Fairmount, Maryland, on the eastern shore of Chesapeake Bay. The data are too contradictory to enable us to derive heights in which we have confidence, though the fireball probably disappeared not less than 40 miles above the ground.

The 9:15 fireball was even brighter, and we have more observations for it. Direct methods of solution again falling down, due to contradictory data, a rough trial and error method was used, and heights were finally determined. It also was in the southern sky, passing from east to west. The angle was, however, steeper, and the end point lower, probably about 15 miles high, over Quantico, Virginia. The beginning point was over the Atlantic, well over 100 miles high. Several observers estimated that the apparent diameter of this fireball was about one third that of the Moon. It took probably three seconds to travel its visible path. No appreciable train was left. Both of the fireballs are said to have taken a sudden dip at the end of their courses.

The main reason why excellent results did not come from these scores of reports is that most persons have little idea of angular measurement. Also they do not know ahead of time what observations are needed. It is obvious that if perfect observations of the beginning and end points are made at two stations, a perfect solution can be found, based on the familiar theorem that any triangle can be solved if we have the base and two adjacent angles.

The main purpose of this paper is to call to the attention of persons interested in science the importance of making accurate observations on all really brilliant fireballs. Only by such cooperation can astronomers obtain data necessary for solving problems connected with them. Data needed are: the angular coordinates, expressed as altitudes and azimuths of the beginning and end points of the path; or, better still, the path plotted on a star map. Of course the observer's station and the hour and minute of the fireball's appearance must be given. Other less important data are: length of time of visibility of the fireball and of its train; its color, shape, apparent size in angular units, brightness compared to Moon or planet, and any peculiarities in its motion.

The Flower Observatory of the University of Pennsylvania is now the headquarters of the American Meteor Society and serves as depository for all such observations made along the Atlantic seaboard states from New York to Florida inclusive, but excluding New England, for which Harvard Observatory serves.

We most earnestly request the cooperation of every member of the Pennsylvania Academy of Science in making a success of this extensive work, both by reporting and by urging others to report when a brilliant fireball is seen.

THE TOXICITY OF THORIUM TO THE WHITE LUPINE AND ITS ANTAGONISMS

RODNEY H. TRUE AND L. E. YOCUM

University of Pennsylvania

[*Abstract*]

Thorium has a toxicity approximately equal to that of H and Beryllium ions. Ca ions strongly antagonize the Thorium ion. Magnesium ions have little or no antagonistic action. Alpha particles, beta and gamma rays seem to have no harmful action in concentrations here used although known to be freed in the plant.

SPIRACULAR CIRCULATION OF THE DOGFISH

BY R. A. TORGESON, J. H. GUY, K. L. KELLEY

Zoological Laboratories, University of Pittsburgh

The circulation of the spiracle in the dogfish has never been fully nor clearly described, and it is the purpose of this paper to attempt that description. The spiracle is a structure located dorso-caudad of the eye in the dogfish. This structure is present in most Elasmobranch fishes but varies considerably as to form and location in the different genera of the class. For example, the hammer head shark, *Sphyrna tudes*, seems to have a combination of olfactory and spiracular units located in the lateral lobes of the head.

Upon observing the equally intense injection mass in both the afferent and the efferent hyoidean arteries, we were led to believe that the primary circulation in the spiracle was not through a capillary plexus as had been generally accepted but that the true circulation is through anastomosing branches.

Our observations were conducted on 44 commercially injected *Squalus acanthias*, six commercially injected *Squalus sucklii*, and one prepared *Sphyrna tudes*. The spiracles were removed from the animals and dissected under the binocular microscope. This technique was supplemented by a process of tissue clearing with glycerine. The glycerine treatment made further microscopic dissection possible and also cleared the tissue sufficiently well to make whole-mount projection slides. The projection of these slides afforded an excellent method for studying and photographing the actual relationship of the blood vessels. The presence of an injection mass supplemented by the previous fixation of the available material proved detrimental for making histological studies.

The spiracle is a structure opening from the dorso-lateral surface of the head to the roof of the mouth, with an ectodermal lining. The surface is increased by a fold which is supported by two cartilages, moved by a constrictor muscle, and innervated by a branch of the glossopharyngeal nerve. Directly below the dermis on the dorsal surface of this fold lies the "capillary plexus" uniting the afferent and efferent hyoidean arteries.

The afferent hyoidean artery arises from the cranial portion of the first branchial loop and continues craniad to the spiracle giving off numerous muscular and cutaneous branches along its course. After entering the spiracle the afferent artery gives off branches which continue dorsad and rebranch. The major portion of the efferent system arises from the union of these secondary branches. The remainder of the system has its origin in the true capillary plexus. The efferent artery continues cranio-mediad to its junction with the internal carotid artery. The tissues within the fold are supplied by a small artery which arises from the medial portion of the efferent system.

A microscopic examination of the spiracular fold revealed the presence of a combination of two types of circulation, one through a system of anastomosing branches and the other through a true capillary union.

The anastomosing branches were found to be completely filled with and unharmed by the injection mass whereas the capillary plexus were either broken down, practically devoid of injection mass, or filled with blood.

Summarizing our study we find first, the primary union of the afferent and efferent hyoidean arteries is by means of the anastomosing branches. Second, the true capillary plexus is entirely secondary to the anastomoses. Third, the presence of two supporting cartilages, a constricting muscle and a branch of the glosso-pharyngeal nerve substantiate the use of the term vestigial gill as applied to spiracular structure.

SOME OBSERVATIONS ON THE PELVIC MUSCULATURE OF *NECTURUS MACULOSUS*

Howard K. Wallace

Department of Zoology, University of Pittsburgh

An examination of several laboratory manuals and textbooks in use in comparative anatomy courses revealed a number of inadequate and inaccurate descriptions, omissions, and some conflicting terminology which cause confusion among students when attempting to identify the pelvic muscles of *Necturus maculosus*. In the hope of contributing something to help clear up this situation the writer undertook a study of original sources supplemented by dissections.

The present status of these investigations is summarized below. A list of muscles of the pelvic girdle and thigh is given together with synonyms and general observations which the writer feels will aid the teacher in determining identities. The first name given is based on the work of Wilder (1912). The synonyms are taken from various texts and manuals (see Bibliography).

Puboischiotibialis; ischiotibialis; gracilis; semitendinosus; semitendinosus and sartorius combined; rectus femoris.

There should be no dfficulty in identifying this muscle. It is usually described as being marked at about its middle by a tendinous inscription at which point the fibers of the caudalipuboischiotibialis are inserted. It is the most caudal muscle on the ventral surface of the pelvic girdle. It inserts on the tibia. Distal to the raphe a bundle of fibers becomes separated off from the main mass of the puboischiotibialis and extends to its separate insertion on the fascia of the plantar (volar) surface of the foot. This bundle, the semimembranosus, is described in some manuals as the ischioflexorius.

Kingsley (1907) erroneously describes the puboischiotibialis as inserting on the distal end of the femur. Hyman (1922) describes the femorofibularis as arising on the distal portion of the puboischiotibialis. This is not correct as the muscle has direct attachment to the femur. The dorsal portion of the puboischiotibialis, undifferentiated, is described by Wilder (1912) as the ischioflexorius of other authors. Hyman (1922) describes the portion of the puboischiotibialis distal to the raphe as the gracilis. Noble (1922) homologizes the puboischiotibialis with the combined sartorius and semitendinosus in the frogs.

Puboischiofemoralis externus; combined pectineus and pubofemoralis brevis; adductor; vastus internus; adductor magnus, caput dorsale.

This large muscle arises from along the entire median line of the ventral surface of the puboischiadic plate. It has the form of a triangle with the apex extending laterally to insert along the distal two-thirds of the femur. The posterior (caudal) half of the muscle is covered by the puboischiotibialis. The muscle appears as though it might be divided into three portions. This condition has led to a number of different descriptions.

Adams (1926) names a posterior deep slip of the puboischiofemoralis externus the adductor femoris. Noble (1922) describes the adductor femoris as an element which is completely fused with the pubotibialis. Kingsley (1907) describes the adductor femoris as lying beneath (dorsal to) the gracilis with somewhat similar origin and insertion. Noble (1922) homologizes the puboischiofemoralis externus of the salamanders with the adductor magnus, caput dorsale, of the frogs.

Pubotibialis; sartorius; vastus internus; adductor magnus, caput ventrale; gracilis.

This muscle arises by a tendon from the pubis immediately in front of (cranial to) the acetabulum. It lies between the puboischiofemoralis externus and internus at its origin but distally its posterior border becomes the puboischiotibialis. It inserts on the tibia proximal to the insertion of the puboischiotibialis.

Smith (1927) calls it the sartorius. Kingsley (1907) calls it the vastus internus. Noble (1922) describes an element called the adductor femoris as completely fused with the pubotibialis. He homologizes the pubotibialis with the adductor magnus, caput ventrale of the frogs.

Ischiofemoralis; combined gemellus and obturator internus; adductor femoris.

"This small muscle arises from the outer margin of the tuberosity of the ischium and lies in the same plane as the skeletal plate, being covered ventrally by both puboischiotibialis and the posterior portion of the puboischiofemoralis externus. The fibers of this muscle converge from their origin and form a tendon, which inserts into the crista lateralis of the head of the femur."—Wilder (1912).

This muscle is not mentioned by either Smith (1927), Hyman (1922), or Kingsley (1907). The description of the adductor femoris by Adams (1926) might be interpreted as referring to this muscle. Noble (1922) homologizes the ischiofemoralis with the combined gemellus and obturator internus of the frogs.

Ischiocaudalis; ileo-caudalis; ischioflexorius.

This is the most medial of the three tail muscles. No difficulty is experienced in determining its identity.

Kingsley (1907) names this muscle the ileo-caudalis. This muscle is, apparently, the ischioflexorius of Noble (1922), and is homologized by him to the combined semimembranosus, gracilis major and minor of the frogs.

Caudalifemoralis; pyriformis; femoro-caudal.

This muscle arises in common with the caudalipuboischiotibialis from the sides of the haemapophyses of the (usually) 22nd, 23rd, and 24th vertebrae and is inserted into the shaft of the femur just distal to the crista lateralis.

Kingsley (1907) erroneously describes the semimembranosus (of this paper and of other authors) as being a part of the femoro-caudalis. Noble (1922) homologizes the caudalifemoralis with the pyriformis of frogs.

Caudalipuboischiotibialis; pyriformis; semimembranosus; caudal crural.

This muscle arises in common with the caudalifemoralis and is generally described as inserting into or on the puboischiotibialis at the raphe. Some authors explain the presence of the raphe by assuming that it serves as an insertion for the caudalipuboischiotibialis. I find that this muscle does not always insert on the raphe but sometimes to one side of it and that in other urodeles closely related to Necturus there is, apparently, no raphe present, the caudalipuboischiotibialis inserting on the fascia investing the puboischiotibialis. In Necturus a heavy fascia is attached to the dorsal surface of this raphe and seems to serve in binding the puboischiotibialis close to the femur.

Adams (1926) calls this muscle the pyriformis. Smith (1927) correctly describes this muscle as the caudalipuboischiotibialis. Then, in the description of the other two tail muscles this author incorrectly calls it the semimembranosus. She also describes the semimembranosus, but this time correctly, in another place, as a part of the puboischiotibialis which passes to the plantar surface of the foot. Kingsley (1907) names the caudalipuboischiotibialis the pyriformis as does Hyman (1922).

Noble (1922) homologizes this muscle with a muscle of the same name in the frogs. This would seem to make the use of the name pyriformis given to this muscle by many authors incorrect as Noble homologizes a muscle by the name pyriformis in the frogs with the caudalifemoralis of the urodeles.

Puboischiofemoralis internus; rectus internus; iliacus; pectineus.

In order to see this muscle in entirety the girdle must be removed from the body. It arises from the dorsal surface of the pelvic plate, part of its fibers arising in the puboischiadic fossa. The ilium divides the muscle into two general portions, the anterior or cranial portion curving around the cranial border of the ilium and the posterior or caudal portion curving around the caudal border of the ilium. Additional fibers arise on the lateral surface of the base of the ilium. These three portions all come together to form one head which is inserted along the shaft of the femur as far as the condyles. Viewed from the ventral surface part of the cranial portion is seen lying along the cranial side of the pubotibialis.

Wilder (1912) considers the fibers arising from the outer surface of the base of the ilium as the likely homologue of the iliofemoralis found in certain urodeles. Smith (1927) considers this the glutaeus minimus. Hyman (1922) describes the iliofemoralis as being situated between the ilioextensorius and the puboischiofemoralis internus. This is in reality the iliotibialis and inserts on the tibia instead of the femur as described by Hyman. Kingsley (1907) names the puboischiofemoralis internus the rectus internus. Smith (1927) calls the puboischiofemoralis internus the pectineus and describes it as arising from the anterior border of the ischiopubic plate. This description of the muscle is incomplete (refer to the description above). Noble (1922) homologizes this muscle with the combined iliacus externus, iliacus internus, pectineus, and adductor longus of the frogs.

Iliotibialis; iliofemoralis; rectus externus; rectus femoris.

This is the most cranial of the three iliacus muscles. It arises on the base of the ilium and is inserted on the tibia. Part of its fibers may arise in common with the cranial portion of the puboischiofemoralis internus on the dorsal surface of the pelvic plate.

This is the rectus externus of Kingsley (1907), the rectus femoris of Smith (1927). It is not mentioned by Hyman (1922), the author probably considering it as part of the ilioextensorius, unless the iliofemoralis, described as inserted on the femur, is considered to be the iliotibialis. Noble (1922) homologizes this muscle with the tensor fascia latae of the frogs.

Ilioextensorius; glutaeus maximus; rectus femoris; vastus externus; iliotibialis.

This is the middle one of the three iliacus muscles. It arises by a narrow tendon in common with that of the iliofibularis from the base of the ilium. It ends in a tendon which passes over the knee and divides into a tendon and an aponeurosis. The aponeurosis, in the form of a fascia, invests the muscles of the lower leg and the tendon inserts on the tibia. Adams (1926) does not describe the tendinous insertion. Kingsley (1907) describes it erroneously as inserting on the fibula. The description by Hyman (1922) is very generalized and is probably intended to include the iliotibialis and the iliofibularis. Kingsley (1907) and Smith (1927) name this muscle the glutaeus maximus. Noble (1922) homologizes this muscle with the combined cruralis and glutaeus of frogs.

Iliofibularis; ilio-femoro-fibularis; femorofibularis; biceps; glutaeus medius; semimembranosus.

This is the most caudal (posterior) of the iliacus muscles. It arises in common with the ilioextensorius and inserts on the fibula. It is considered by some authors as one of the heads of a muscle, the biceps, the other head being considered the femorofibularis. In Necturus these two muscles, which are considered as heads of the biceps, are entirely separate from one another.

This is the semimembranosus of Kingsley (1907), not described by Hyman (1922), the glutaeus medius (inserting on the femur) of Smith (1927). Noble (1922) homologizes it with the iliofibularis in frogs.

Femorofibularis; ilio-femoro-fibularis; biceps, iliofibularis.

This muscle arises on the shaft of the femur near the insertion of the caudalifemoralis and ischiofemoralis and inserts on the shaft of the fibula. It is sometimes described as one of the heads of a muscle, the biceps (see preceding muscle).

It is not described by Adams (1926) and Kingsley (1907). Hyman (1922) describes this muscle as arising on the gracilis (pubioschiotibialis). Noble (1922) does not list this muscle.

The first anatomists to describe the musculature of Necturus were Europeans. Beginning early in the 19th century, they followed one of two general schemes of nomenclature. The first, and probably the oldest, was to homologize the muscles of Necturus with those of man. The second was based upon the use of origins, insertions, appearance, action, and similar characteristics as a basis for naming the muscles. Noble (1922) has pointed out the weaknesses and mistakes of these

earlier anatomists which render their work unacceptable in the light of present day knowledge. These weaknesses and mistakes might be summarized as follows:

(1) Necturus was accepted by some as the most primitive of the urodele amphibians and the general nomenclature for the group was based upon this assumption. This was an incorrect view and led to inaccuracies.

(2) Muscles of Necturus were homologized directly with those of man. As Noble has pointed out this is not tenable in the light of modern conceptions of homology. The muscles should be homologized with a primitive condition from which Necturus has evolved and that primitive condition homologized with a primitive condition from which man has evolved. Noble (1922) describes this primitive condition of the urodeles.

(3) The range of variation within the urodeles has not been understood and certain muscles in the thigh of salamanders have not been recognized as distinct from others. For example: Wilder (1912) does not mention the adductor femoris which Noble (1922) describes as completely fused with the pubotibialis, and which is found in various stages of separation in other urodeles.

(4) Mistakes have been made in determining the innervation of muscles or nerves have not been taken into consideration at all.

The writer's dissections of different genera and species (Cryptobranchus alleganiensis, *Necturus maculosus, Triturus torosus, Triturus viridescens, Triturus dorsalis*) show a marked degree of similarity between appendicular muscles. The nomenclature and descriptions of Wilder (1912(have been found to be quite satisfactory in identifying muscles of the different animals listed above. Noble (1922) uses a group of names very similar to those of Wilder (1912) and suggests that these terms be used until his homologies have been accepted at which time terms homologous to human nomenclature can be adopted if it be so desired.

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ADDITIONAL HEPATICAE FROM CENTRAL PENNSYLVANIA

BY THOMAS M. LITTLE, A.B.

Picture Rocks, Pa.

In the proceedings of the Academy for 1931, I published a paper entitled Preliminary List of the Hepaticae of Central Pennsylvania, which consisted of 42 species collected in the vicinity of Lewisburg, Danville, and Picture Rocks. This year most of the collecting has been done near Picture Rocks and 12 additional species for this region have been found.

The new species found in this region are as follows:

Metzgeria conjugata Lind. Branch No. 2, Roaring Run, Picture Rocks.

Aplozia (Jungermannia) riparia Tayl. Pond between Picture Rocks and Tivoli.

Lophozia Muelleri (Nees.) Dumort. Quite common on shaded banks all over region.

Lophozia ventricosa (Dicks) Dumort. On stumps along branch No. 1, Roaring Run, Picture Rocks.

Sphenolobus execetus (Schmid) Steph. Miller woods, Picture Rocks.

Lophocolea alata Mitt. Along two runs between Picture Rocks and Glen Mawr.

Lophocolea bidentata (L.) Dumort. Branches Nos. 1 & 2, Roaring Run, Picture Rocks.

Cephalozia serriflora Lindb. (*C. catenulata* (Hübn.) Spruce) Forney Hollow, Picture Rocks.

Odontoschisma denudatum (Mart.) Dumort. Quite common on logs all over the region.

Cololejeuneae Biddlecomiae (Aust.) Evans. Branch No. 2, Roaring Run, Picture Rocks.

Lejeunea patens Lindb. Pevine Hollow, near Huntersville.

Jubula Pennsylvanica (Steph.) Evans. Growing very profusely on Roaring Run and its branches.

Besides these new species there were found new stations for many of the hepatics in last year's list:

Metzgerian furcata (L.) Dumort Along run above Tivoli.

Pellia epiphylla (L.) Corda. Along nearly all the runs above 1,000 feet, altitude.

Aplozia caestipicia (Lind.) Dumort. Branch No. 1, Roaring Run, Picture Rocks.

Aplozia lanceolata (Schrad.) Dum. Forney Hollow, Picture Rocks.

Plagiochila asplenoides (L.) Dumort. Profuse along Roaring Run and its branches.

Cephalozia curvifolia (Dicks.) Dum. Quite common all through Muncy Creek Valley.

Calypogeia trichomanis (L.) Corda. Common in deep woods throughout the region.

Scapania nemorosa (L.) Dum. Common on shaded banks of streams.

Radula complanata (L.) Dum. Along run near Tivoli on trees.

Porella platiphylla (L.) Lindb. On trees along Roaring Run, Picture Rocks.

Trichocolea tomentella (Ehrh.) Dum. Profuse along Roaring Run.

Lejeunea cavifolia (Ehrh.) Lindb. Profuse along run and pond near Tivoli.

Frullania Asagrayana Mont. Profuse along Roaring Run.

Frullania nisqualensis Sulliv. Was re-examined and found to be a mis-identification.

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COLOR VARIATIONS IN CASTILLEIA IN THE HIGHER ALTITUDES

BY JOHN C. JOHNSON

State Teachers College, West Chester

(*Abstract*)

Studies on the genus Castilleia of the family Scrophulariaceae in the higher Colorado Rockies seem to show an increasing brilliance in color as one ascends in altitude from about 9,000 to nearly 12,000 feet. Color variation in any species of this genus is considerable at any altitude, but seems definitely to increase in brilliance with elevation. Other influencing factors are doubtless the thinner air, cooler days, colder nights, and more rainfall at higher altitudes.

SOME SCIENTIFIC PROBLEMS IN GAME PROPAGATION

By Samuel H. Williams
Department of Zoology, University of Pittsburgh

(*Abstract*)

The propagation of game birds and animals by the thumb and rule method without regard to numerous factors of an important nature, threatens to preclude the possibility of gross production.

The importation of breeding stock opens the way for the concentration of numerous diseases, ectoparasites and endoparasitic worms, unless intensive quarantine regulations and detailed studies, experiments dealing with nutrition and causative lethal organisms, are considered.

ORIGIN OF CAVES

By R. W. Stone
Pennsylvania Geological Survey

This paper is printed in full in Pennsylvania Geological Survey Bulletin G. 3, Pennsylvania Caves, issued in August, 1932.

CAVE CONCRETIONS

By R. W. Stone
Pennsylvania Geological Survey

Balls and ellipsoids of travertine which will here be called cave concretions have been found in four of Pennsylvania's 80-odd caves. These are Hipple Cave at Waterside, Bedford County; Wm. Penn Cavern, 4 miles west of Huntingdon; Historic Indian Cave at Franklinville, Huntingdon County, and Alexander Caverns, near Reedsville, Mifflin County. The concretions occur mostly loose in nests or pockets on the floor.

In Hipple Cave the concretions are in a dry, rimstone pool and cover an area of several square feet. The rimstone is a sinuous wall of travertine about 3 inches high on two sides of a roughly triangular pool. The limestone roof is barely 1 foot above part of the pool. See Fig. 12.

Some of the concretions are free and some are partly imbedded in clay. Most of the concretions are less than one inch in diameter, but

some are nearly as large as a tennis ball. Their shape ranges from rudely spherical to ellipsoidal, or diskoidal with one side domed and the other flat. An occasional concretion is about 2 inches long and 1 inch in diameter, with circular cross-section and well-rounded ends. See Fig. 13.

Fig. 12. Cave concretions in rimstone pool, Hipple Cave, Bedford County, Pa. The rimstone is marked with arrow. The larger concretions are about 3 inches in diameter.

All are light weight and porous, and the surface is like miniature cauliflower structure. Some are distinctly rougher on the domed upper surface than on the flatter lower surface.

Cross-sections of a few concretions reveal concentric structure and a nucleus of foreign material. An elongate concretion has a 3/4 by 3/16 inch piece of stalactite at its nucleus. A diskoidal concretion 3 inches in diameter and 1 inch thick has a chip of black limestone at the center.

Being in a rimstone pool, these concretions developed in standing water. The area of the pool was 3 or 4 square yards, so large that water dropping from the small stalactites a few inches above could not have disturbed the water of the pool.

At Historic Indian Cave there is a small channel in the limestone, traversible only by crawling, in which travertine concretions lie in a shallow rimstone pool. These are like the ones found in Hipple Cave, mostly 1 inch or less in diameter, and rough surfaced. One has a rough and convex base, and a knobby top. They were formed presumably in quiet water.

At Alexander Caverns, likewise in a channel just big enough for a man to crawl through, there are several shallow pockets in the floor which contain concretions. These, however, instead of being scattered about, lie close together, in contact with each other. Most of them are $\frac{3}{8}$ to $\frac{1}{2}$ inch in diameter, roughly spherical, and with miniature cauliflower surface. Most of them are not round enough to roll well. Some of them rest in pockets shaped like honey comb. It would seem that after these concretions developed there was not enough mineralized water for their further growth, but just enough in the little basins to form septae around the underside of the concretions. If there is a foreign nucleus in these concretions in Alexander Caverns, it is so small as not to be readily detected.

These concretions developed seemingly in quiet water. There are no stalactites above the pockets and the writer saw no evidence of dripping or running water.

FIG. 13. Travertine concretions from Pennsylvania caves. Natural scale.

The largest concretion shows concentric structure and a piece of stalactite in the center. The uppermost concretion shows the rough surface. The smooth one in the upper left corner is dense cave onyx from Wm. Penn Cavern and shows a polished spot (light) on the upper surface. A cross section of a similar one from the same cave with a projecting collar is next below. The smallest concretion is typical of those in Alexander Cavern.

The structure of concretions from these three caves, revealed by cross-sectioning a few of them, is roughly concentric thin layers of minute crystals. Some layers are regular, some are wavy; the next succeeding layer may bridge rather than accord with the waves. In a diskoidal concretion the nucleus may be off-center, the layers in the lower half being thinner than those above the nucleus. Because each successive layer failed to fill completely the space between the crystals on which it rests, the concretions are porous.

In Wm. Penn Cavern two concretions of a different type were found. One is an oblate disk 1 inch in diameter and $\frac{5}{8}$ inch thick, with a smooth, frosted surface. On top and bottom there is a $\frac{1}{8}$ inch spot with a high polish; also part of the rim is highly polished. The other concretion from this cave is the same shape, slightly smaller, has a deeply frosted surface, and a collar or thin projecting band of small crystals around the greater diameter. A cross-section of this smaller concretion shows that it is dense cave onyx, translucent, in thin concentric bands around a minute nucleus of soft yellow clay-like material. These disks of course will not roll except on edge. They were formed on the floor of a grotto where water was dripping rapidly.

The point of this paper is that Hess[1] has recently published a description of cave concretions which he calls "cave pearls," and ascribed their shape to movement by disturbance of the water, perhaps implying that they were rolled. Davidson and McKinstry[2] have concluded that rolling of the particles is not necessary to form rounded calcite concretions. This paper gives further evidence that cave concretions, well-rounded as well as diskoidal, grow in quiet water. The ability of crystal growth to raise a rock fragment against gravity by developing on the lower as well as the upper side is demonstrated.

Whether bacteria aided in the development of these concretions found in Pennsylvania caves has not been studied. All of the concretions were found far underground (100 to 500 feet from the cave mouth) in absolute dark, and where the temperature ranges from 50° to 60° F.

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RECENT PALEOBOTANIC INVESTIGATIONS NEAR PITTSBURGH, PENNSYLVANIA

By William C. Darrah

Carnegie Museum, Pittsburgh, Pa.

Most of the great contributions to the study of fossil plants of the Carboniferous age in America have been made on material from Pennsylvania. But in our State the work has gone untouched for half a century.

There has been a long-standing need for a complete "type succession" of Upper Carboniferous floras that could be used as a standard with which all other contemporaneous floras might be compared. Such a type-succession should practically coincide with the type section or geographic area by which geologic and stratigraphic correlation is conventionally made.

The Upper Carboniferous Period was renamed "Pennsylvanian" by H. S. Williams because this great period of coal-formation is best and fullest represented in Pennsylvania. A glance at the names of the formations reveals the localities where the rocks were first studied—Pottsville, Allegheny, Conemaugh, and Monongahela, on top of which rests the Dunkard (Permian) in Washington and Greene counties. The lower Carboniferous or Mississippian is divided into Pocono and Mauch Chunk. Thus the entire extent of the Carboniferous and Lower Permian was first studied in Pennsylvania, and if we are deciding upon type sections, we must choose those at home.

Carnegie Museum has begun paleobotanic work on local floras to continue the accumulation of material which will lead to a completion of a satisfactory type succession.

About fifty years ago Leo Lesquereux finished the third volume of his "Coal Flora and Atlas" published by the Pennsylvania Second Geological Survey. His study continued the work begun under the First Survey in 1854. In connection with this attempt two Pennsylvanians should not go unmentioned, Mr. R. D. Lacoe, of Pittston, and the Hon. I. F. Mansfield. Both of these men sent hundreds of rare specimens to Lesquereux and it is to them that the credit should go for revealing how rich our own localities really were. Mansfield's material was collected at Cannelton in Beaver County and Lacoe's chiefly from the Anthracite area. Lacoe's priceless collection is one of the chief accessions in the United States National Museum. Lesquereux's attention was rather unavoidably directed to the Productive Coal Measures and the Anthracite series because they were commercially developed and good specimens were abundant. Consequently these regions received a greater share of study than all the others combined.

At the same time Fontaine and I. C. White published the Dunkard Permian Flora which also appeared in the report of the Second Geological Survey in 1883. Both this work and the Coal Flora are obsolete, requiring constant revision and care when used, but they stand as the basis for all other work on Paleozoic plants in America.

During the early years of the twentieth century, David White, of the United States Geological Survey, reported on the Pottsville floras, chiefly as exposed on the Kanawha River in West Virginia. In this exhaustive research he completed, in a modern sense, a type succession of earliest Pennsylvanian floras. Later in a lesser and rather incomplete manner, he reviewed the Allegheny floras (next above the Pottsville). Here really concludes a summary of what has been done previously in the general type areas, thereby leaving unaccounted for well over half of the total thickness of the Carboniferous formations.

At present we are attempting a comprehensive floral survey of only the Conemaugh series which represents the interval between the Freeport and Pittsburgh coals. The total thickness is 600 feet and within this we have made collections at 14 horizons. The lowest horizon which bears fossil plants in western Pennsylvania is the Mahoning member, composed of sandstones and shales interspersed with a couple of insignificant coals. Eighteen thousand specimens have been gathered and labelled in the field as to vertical and horizontal position. This number is made up of material collected at a dozen localities within a twenty-mile radius of Pittsburgh and a preliminary study of them reveals several surprising facts. The flora contains 56 species of typical upper Carboniferous plants, with most of them reported in the American Allegheny floras and a majority common to Europe as well.

The great majority, in fact almost 92 per cent, are fern-like but most of them doubtlessly will prove to be seed-bearing and therefore not ferns at all. The remainder, about 1500 specimens, is composed of giant scouring-rushes, seeds, lycopods, and primitive, more or less coniferous trees called "Cordaites." Because of their special value in correlation we will consider only the fern-like plants in more detail.

The early students classified fossil plants on mere carbonized impressions and we speak of types based on such remains as "form-genera." The form-genus Pecopteris is represented in our collections by 14,000 specimens of which 9,500 belong to one species (*P. miltoni Artis* sp.). The others referred to the same genus are separated in more than a dozen species. All of them are identical with forms in the Radstockian division (uppermost Carboniferous) of Great Britain, and are also similar to those plants at the boundary of the Westphalian and Stephanian series on continental Europe which are also upper Carboniferous. The Stephanian is so poorly represented in England that we cannot make a rigid comparison of our material with the Radstockian which is at least in part, Stephanian. Several of the Pecopterids range well into the Permian above, and they may suggest an age for the Mahoning considerably younger than has been generally anticipated. Even so, a number of recent finds in western Pennsylvania have cast additional doubt as to the validity of the present delineation of Upper Paleozoic formations.

While collecting fossil plants at the Clarksburg horizon near the top of the Conemaugh a small branchiosaur was uncovered. This unexpected discovery means that a typical salamander-like amphibian (a stegocephalian) hitherto only known in Lower Permian deposits of France, Germany and Czechoslovakia, has been found in rocks always regarded as Pennsylvanian. The plant fossils associated with it add little in favor of calling the beds Permian, but the abundance of a peculiar fern-like plant called *Odontopteris moori* Lesquereux, is noteworthy. This plant, although it has been found within the Conemaugh before, is characteristic of much higher strata. The discovery of a terrestrial vertebrate within this formation is not the first. In 1908 Dr. P. E. Raymond, formerly of Carnegie Museum, collected a number of bones in the Red Beds near the Ames limestone about the middle of the Conemaugh formation. The remains were sent to Professor Case, who referred them to characteristic Permo-Carboniferous genera of Amphibians and Reptiles. In the case of Branchiosaurs, however, we are dealing with a more diagnostically valuable group of animals since they appear to be strictly Permian.

The Red Beds just mentioned are brought in the discussion also. This is the first reoccurrence of deposition of red sediments since the Mississippian (Lower Carboniferous) Period, and several geologists would divide the Permian from the Pennsylvania at the bottom of this red horizon. Instead of finding a series of barren red shales and clays indicative of arid conditions, we have been able to locate sixteen species of typical Carboniferous plants, most of them of fern-like appearance. Such a meager flora based on a small number of specimens cannot be used in determining the age or environment of deposition.

The study of local fossil plants has accomplished more than the accumulation of a floral list which by its composition can be given an approximate age. To systematic and morphologic paleobotany, we have three contributions to offer.

Among the Mahoning specimens were five fragments of a species of Pecopteris which exhibit frond dichotomy near their apices. The five specimens were collected at various levels within a vertical distance of 35 feet. We believe this is more than a teratological form. It may prove to be simply a form or variety, but with a vertical distribution representing many, maybe a hundred years' duration, it hardly represents an accidental variation. A similar habit is known in numerous species of existing ferns, but here in this case we are still up in the air as to whether it is true-fern or seed-fern.

For years Neuropteris, another common type of form-genus based on leaf impressions, has been believed to possess a deciduous or caducous habit, shedding its pinnules sometimes before maturity. The full-sized pinnules have always been found isolated or detached and when a specimen is recovered with pinnules in place, the fragment is quite important. In our collections are a number of bare spiny-stemmed specimens which were doubtfully classed as rachis-impressions, but the thorny aspect made it unsafe to attach much weight to the diagnosis. One afternoon recently, a small collection was prepared for cataloguing, and in it was a specimen of Neuropteris (*N. Scheuchzeri*) with rather immature pinnules attached to a frond-rachis identical in configuration with that of the naked thorny imprints of uncertain position. The real find to be hoped for in this connection is a specimen with only half of the pinnules shed. However, we have a series to show that an abcision layer is formed which cuts the pinnule off near the departure of the midrib from the rachis. Naturally we have demonstrated the case for only one species and although several related to it are probably also caducous, at least a considerable portion of the genus did not shed its pinnules.

The third notable find is a case which might be duplicated at any time but it is only the third such on North America. Seeds were found in organic attachment with foliage of *Odontopteris moori,* the form mentioned in association with the branchiosaur. We have six examples collected at Rennerdale, Allegheny County. The seeds are small, ovoid, apparently winged bodies not unlike isolated seeds referred to Samaropsis and Carpolithes. In size they consistently measure 3 x 3.5 mm. and are borne near the margins of unmodified pinnules on the upper surface. Isolated seeds would undoubtedly be called a species of Carpolithes, that genus which should better be called the burial ground for fruits of uncertain relation.

A great number of other statements might be made about petrified plant material, museum display, a popularization of this neglected field but I have simply tried to show the recent developments in the rich, almost untouched, field of local paleobotany. The great need is more material. Museums have been content to purchase specimens from classical and now practically exhausted localities. There is a real opportunity for those in almost any portion in Pennsylvania to collect scientifically valuable specimens of Carboniferous plants, and thereby add to the common store of geological and paleontogical information.

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THE STATUS OF PALEOZOIC PTERIDOSPERMS

BY WILLIAM C. DARRAH

Carnegie Museum, Pittsburgh, Pa.

It was not so long ago when every one familiar with the vegetation of Carboniferous times marvelled at this veritable age of ferns. The leaders in paleobotany unhesitatingly classified such plants into families and sometimes even genera of existing ferns, and authors of text-books in geology expounded at length on the abundance of Marattiaceous tree-ferns of a tropical aspect during the Paleozoic Era. The similarity of the Carboniferous ferns to the living but almost extinct family of tropical Marattiaceae was so obvious that the comparison went unquestioned.

The scarcity of fruiting specimens did not impress any one in particular until 1883 when Stur suggested that at least some of these fern-like imprints might not represent ferns at all. In 1899 Potonié created a new systematic group called "*Cycadofilicales*" to include some stems showing microscopic structures intermediate between those of Ferns and Cycads. In 1903 and 1905 Oliver demonstrated the seed-bearing habit of *Lyginopteris* and for this new group coined the name "*Pteridospermae.*" About the same time David White reported on the seeds of *Aneimites* found in West Virginia, Kidston discovered seeds attached to *Neuropteris,* the form first questioned by Stur; and, *Dicksonites pluckeneti* was proved to be pteridospermic. More surprising than any of these was Winifred Goldring's discovery of the seed-habit in a Devonian species ("*Eospermatopteris*") from Schoharie County, New York. This attested to the great antiquity of the newly formed group and added more difficulties in theorizing on their evolution.

The inherent difficulty in settling their systematic position is the scarcity of actual data regarding Pteridosperms. The direct evidence is limited to a dozen different seed-bearing species, all except one of which are very imperfectly known, although such a great accumulation of indirect information has piled up that suspicion has been cast on every known frond-genus of Carboniferous age. In such forms as Neuropteris and Alethopteris the proof did not come as a shock, but when a typical cyatheid species of Pecopteris was demonstrated to be seed-bearing, the last stronghold of those who championed the existence or abundance of Marattiaceae in Paleozoic times was put in a dangerous position.

A few years ago Halle reported on five seed-bearing forms from Shansi in China. One of these was *Pecopteris wongii,* almost identical with *P. miltoni* which has long been regarded as really Marattiaceous.

The sporophyte of Pteridosperms is so typically fern-like that we are forced to link them somehow with true ferns. The resemblance is more than superficial, for when the microsporangia were discovered in 1905 these were the very structures accepted and unquestioned as the sporangia of Marattiaceae. However, one would hardly expect the microsporangia to exhibit much modification, but when we turn to the megasporangia which have to form the seed-structures, there must necessarily be an enormous change.

Dr. Benson suggests that the ovule of the Pteridosperm is simply a transformed sorus and the peculiar integument a sterilized peripheral synangium. Oliver's view differs in that he believes the integument had its origin as a new structure unrelated to anything else and contemporaneous with the origin of the seed. It is more likely a transformation of sori which has taken place many times rather than only once.

Naturally when the seed-habit of this long-lived Paleozoic plant stock was thoroughly demonstrated, systematists and taxonomists placed them within the spermatophyte phylum, thereby squeezing them into the too dogmatic, four-divisional, plant system. Oliver and Scott proposed that their new group be coordinate with Gymnosperms and Angiosperms. Scott later suggested that the Pteridosperms were really Gymnospermous and of no greater than "class" value. Finally in 1906 he defined the characters of the Pteridosperms and elevated them to a position independent of Gymnosperms. Nathorst incorporated them with the living and fossil Cycads (Cycadales and Bennettitales) and instituted the Cycadophyte phylum to include them. The relationship of seed-ferns to any Gymnosperms other than Cycads, is more remote and obscure although some of the Paleozoic Seed types are known to have been borne on the Pteridosperms in one case and on Cordaites in another.

Recently Seward in his "Plant Life Through the Ages" treated the seed-bearing ferns as a separate isolated Phylum midway between the Pteridophytes, or ferns and their allies, and the Spermatophytes, or true seed-plants. This new position was indicated by the name *Pteridospermophyta*. Whether Seward's view is ultimately adopted or not has little bearing on a discussion of the group now. No one up to this time has emphasized their proximity to ferns but instead their undoubted seed-nature. In Bower's study on the Ferns, he speaks of the growing Pteridosperm flora which was "probably derived from some more or less fern-like ancestry, but being actually seed plants, they are not to be included under the Filicales" or true ferns. This is not an extremist's view because they positively are not ferns, but they are not far removed from their former fern connections.

A summary of the available evidence seems to infer that the Pteridosperms of which we have actual record are not very closely related to living Cycads. It would be obstinate to crowd out the morphologic data which actually indicates some undoubted relationship to Cycads, but the differences between them are great ones. There are those who would bridge any gap by the fossil Cycads (Bennettitales) but Chamberlain has shown this to be quite impossible. The living and fossil Cycads do not represent a linear series but divergent branches from some totally unknown ancestral stock. Certainly it is easy to construct a hypothetical intermediate between a Marattiaceous fern and a Cycad, which, at the same time, would resemble a Pteridosperm, but in the present state of uncertainty as to Paleozoic ferns, we have no right to construct such a plant. There are many who deny the existence of any genuine member of Marattiaceae in the Carboniferous. To be more cautious, it can be said that undoubted remains of Marattiaceae first occur in the Tertiary —maybe fifty million years later than Paleozoic time.

In the majority of Pteridosperms whose seeds are actually known, the degree of seed specialization is little more advanced than a modification to prevent the megaspores from falling out of the sporangium. However in certain forms the case is not nearly so simple. In such a light we are hardly justified in extending the use of the name "Pteridosperm" beyond the limits fixed by actual records of seeds in attachment. If we broaden usage to include all those plants which look like ferns and which could theoretically bear seeds, it is easy to picture ancestries and evolutions, but a loose description of the seed-fern complex could only invite trouble.

Several hundred valid types of detached seeds are known in Paleozoic times; obviously each belongs to a separate kind of plant and the majority will likely be proved to be Pteridosperms, but until the connection of each seed is definitely known, we cannot finally fix the boundaries of the seed-fern group, neither can we make great and well-sounding generalizations about its extent.

The point in all this is that only fifteen seeds are actually known attached to fern-like fronds. These belong to ten genera of eight alleged families. In time they range through five major geologic periods, that is, from Devonian to Triassic, thereby extending into the age of reptiles (early Mesozoic). Geographically they also have a considerable distribution, having been noted in Europe, Asia, North America, and possibly South Africa. The surprising complexities and limits of this group are suggested again by the placement of the seed on the frond. They may appear terminal, marginal, or on the mid-rib of a pinnule; further, they may be on the upper or on the lower surface. Obviously not more than two or three examples of any one arrangement are known.

It is wisest at present to consider the Pteridosperms as a separate group, possibly even a phylum, but we cannot deny their fern-like ancestry or relationship. They look like ferns, even exhibiting the unfolding crozier in young fronds, called in modern ferns "circinnate vernation." The only structure in the seed-fern group not referable to some modified characteristic of a true fern is the seed itself.

After every one agreed that these peculiar extinct plants were Spermatophytes, because they bore seeds, several discoveries in other contemporaneous groups were published. First some lycopods, very obscurely related to modern ground-pines were shown to have approximated a seed-habit, and, soon after, some giant scouring-rushes were proven to have attained a similar degree of adaptation.

I believe that none of the seed-ferns of which we have definite knowledge could have given rise to a typical Gymnosperm either of a Cycad or of a conifer type. The Pteridosperms probably represent the culmination of a fern development which tended to produce seeds—a similar production having been attained by at least three other contemporaneous unrelated groups.

The seed is "a chapter in evolution," not the deciding factor for higher plant position.

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ECOLOGICAL NOTES UPON THE FLORA OF AN OLD LAKE BASIN

By LeRoy K. Henry

Carnegie Museum, Pittsburgh

During the summer of 1931, while botanizing in the vicinity of Deer Pond, Wading River, L. I., the writer found an old kettle-hole lake basin filled with vegetation. This "sunken lake" as it is popularly called, lies about one mile southeast of Deer Pond in the midst of the dense scrub oak undergrowth and scattered pitch pines of the pine-barren habitat. Since kettle-hole lakes are rather common in this glaciated section of Long Island, it may not be unusual to find one that has been filled with plant life. This former lake bed is about 590 feet in circumference and has a gradual slope on all sides with approximately a one-hundred foot grade on the south and southeast.

The normal pine-barren vegetation surrounds this former lake bed whose vegetation may be divided into four zones.

The first zone comprises those plants that grow on the sloping sides. Young pitch pines and young post, scarlet, black, and white oaks together with black scrub oaks are mixed with bayberry, *Myrica caroliniana;* sweet fern, *Myrica asplenifolia;* and ericaceous shrubs: *Lyonia mariana, Leucothoe axillaris,* and *Gaylussacia baccata.* Among these plants that grow near the base of the sloping bank are: bracken fern, *Pteris aquilina;* interrupted fern, *Osmunda Claytoniana;* marsh shield fern, *Aspidium Thelypteris;* greenbrier, *Smilax glauca;* pearly everlasting, *Anaphalis margaritacea;* golden aster, *Chrysopsis axillaris,* and *Eupatorium sessilifolium.*

The second zone occupies a gently sloping area that varies in width from two to four feet. Many small white pebbles are scattered about on this former shore, indicating the one-time action of waves. The major part of this area is covered with a mat of dewberry vines, *Rubus hispidus,* and scattered specimens of bugle weed, *Lycopus uniflorus,* and sweet goldenrod, *Solidago odora.* In the northwest section of this zone is a large colony of smartweeds: *Polygonum Careyi* and *hydropiperoides.*

In the third zone, water willow, *Decodon verticillata,* and scattered specimens of marsh St. John's wort, *Hypericum virginicum,* form a fringe or narrow strip of vegetation about the center of this kettle-hole depression.

All of the plants that grow in the central portion of this depression, compose the fourth zone. This area is covered with a dense growth of leather leaf, *Chamaedaphne calyculuta,* growing upon a mat of sphagnum moss. Upon the higher tufts of sphagnum are several bushes of the black-fruited blueberry, *Vaccinium atrococcum*; the chokeberry, *Pyrus arbutifolia*; one specimen of poison sumach, *Rhus Vernix*; a clump of swamp blueberries, *Vaccinium cormybosum*; several young red maples, *Acer rubrum*; and pitch pine trees, *Pinus rigida.* The pitch pines are of all sizes, varying from old trees that have been killed by forest fires to young ones six to ten feet high. These burned pines were about one foot in circumference, which seems to indicate that the pines came into the area upon the higher tufts of sphagnum during the swampy period and before the appearance of the leather leaf. Since it is known that pines grow very slowly, the size of these dead trees will convey some idea of the length of time since they migrated into this former lake basin.

The vegetation of the fourth zone or the kettle-hole proper represents the bog stage in a hydrosere. It is an advanced bog stage and may be looked upon as the last of the hydrophytic stages and the beginning of a mesophytic habitat.

The soil beneath the sphagnum is loose, wet and shakes when one walks over it. The water must be only a few inches below the surface as indicated by its presence around the base of the moss after a week of rainy weather. The presence of the young red maples and pitch pines seem to indicate the beginning of the forest associes, *i.e.,* the first step in advance of the bog associes. It is probable that the water table of the region lies very near the surface of this bog, so that it may never be entirely converted into dry land but remain indefinitely in this arrested stage. The survey of this empty kettle-hole lake shows how plants do convert and are gradually converting our present lakes into swamps and these latter into forests unless thwarted by the activities of man.

MYCORRHIZAS OF DECIDUOUS TREES

LeRoy K. Henry

Carnegie Museum, Pittsburgh

It is now generally accepted that mycorrhizas take the place of root hairs of forest trees and shrubs. These mycorrhizas are structures resulting from the association of mycelia of a fungus and the small rootlets of the trees.

One of the prevailing types found in woodlots is ectotrophic (Fig. 14), in which the fungal hyphae form mats of interwoven tissue around

Fig. 14. Microphotograph of cross-section of Endotrophic Mycorrhiza from *Pyrus coronaria* showing an external mat of fungal tissue.

the rootlets and also penetrate between the cortical cells by dissolving the middle lamella. In general, the external form of these ectotrophic mycorrhizas is "coralloid," *i.e.,* short coral-like clusters of rootlets. The formation of the fungal mat around the root prevents further growth in length. Then the lateral root develops more rootlets which in turn are invested with fungal hyphae. This process produces the short, stubby roots which resemble a coral formation. It is thought that infection of roots depends upon the chance proximity of the spore of a fungus that is able to form a mycorrhiza and the rootlet of the particular tree species with which it is able to associate itself. Since there are no root hairs on these infected roots, it seems evident that the mycorrhizas assume the function of absorbing water and nutrient salts for the trees.

Another type, endotrophic (Fig. 15), is also common on forest trees. These are entirely within the root cells. They may be in the form of

FIG. 15. Microphotograph of a cross-section of Endotrophic Mycorrhiza from *Vaccinium vacillans* showing individual hyphae within the root cells.

individual hyphae, or as granular bodies in the central part of the cells, or as intricate masses of hyphae that coil about one another. The granular form is thought to represent a digestive stage where the root cells are utilizing the fungal hyphae as sources of nutrition. The external form of the endotrophic type appears either as simple rootlets slightly swollen at the tips, or as short sausage-shaped constrictions borne singly or in a series. Infection is supposed to occur through the root hairs which are always present upon roots infected with endotrophic mycorrhizas.

In regard to depth in the soil, these mycorrhizas vary from one-half to five inches beneath the forest litter. Often they are merely beneath the layer of partially decayed leaves, but the majority are located in the layer of well decayed plant parts, the humus. The greater number of mycorrhizas are grayish in color, but some are yellow and some, purplish.

In making this study, collections of roots were made each month from September to June, and mycorrhizas were found among each collection, so that it would seem appropriate to say that they occur throughout the

year. McDougall (1914) believes that they die off in the fall and new infections occur in the spring. In the winter months many dried and shriveled mycorrhizas were observed, but there were always some that remained in the normal active condition.

Since both types of mycorrhizas occur in the same habitats and often in the same roots, Raynor (1927) states that Melin believes that the endotrophic type may be the initial stage in a "squeezing out" process caused by enzyme activity of the root cells. The third type, ectendotrophic, which is a combination of the two previously mentioned types, may be an intermediate stage in this gradual "squeezing out" process.

The writer has observed a similar condition among mycorrhizas from a Hawthorn shrub. Collections made in May showed endotrophic infection with small broken hyphae and large granular masses within the root cells. Another collection made in October showed a dense mat of fungal tissue with mycelia between the cortical cells and several granular masses within the outer cortical cells. This ectotrophic condition was even noticeable with a hand lens when the collections were being made; however microscopical sections showed that both types were present. Microscopical slides prepared from rootlets of Red Oak also proved to be of the ectendotrophic type.

Sections of a mycorrhiza cut in a series from the tip to five millimeters beyond, disclosed infection in all sections. In the ectotrophic type mycelia occurred at the tip of the root in the form of a fungal mantle around the outside, while, about two millimeters from the tip, hyphae began penetrating between the cortical cells forming the characteristic radially elongated cells. In the endotrophic type the hyphae and granular masses occurred near the tip as well as five millimeters or more back of it. This would indicate that infection is not localized at any one place on the rootlet, but arises wherever the germinating fungal spore and the root happen to come into contact.

The soil around the trees under observation, when tested with a La Mott Soil Teskit, gave an acid reaction, *i.e.*, a pH of 5.0 Since it is well known that fungi demand an acid substratum for best development, some lime was worked into the soil around two of the shrubs that had shown ectotrophic mycorrhizas. The lime was applied in June, at the rate of two ton per acre, and scattered evenly beneath the entire canopy of each shrub. In the fall, September, 1931, collections of rootlets were made and sections cut and strained. In these sections only endotrophic infection could be found. There were either broken up hyphae or granular masses within the cells. There was no indication of ectotrophic mycorrhizas, although roots from control shrubs were of that type. When the collections were being made, some ectotrophic types were observed on the older rootlets, many of which were black and shriveled. The pH value of the soil now proved to be 7.0 or neutral condition. It appears that the lime by neutralizing the soil halted the normal development of the existing mycorrhizas and prevented new infection from taking place during the summer. The endotrophic condition indicates that, after the external mat of hyphae had been destroyed or hindered in its development, the root cells by enzymatic activity were digesting these remaining internal hyphae which are probably rich in nutrient material.

Trees and shrubs of a woodlot located in Butler County, five miles north of Zelienople, Pa., were investigated and found to be infected with ectotrophic, endotrophic, and ectendotrophic mycorrhizas.

Ectotrophic

Alnus rugosa
Ostrya virginiana
Carya alba
Carya glabra
Carya ovata
Corylus americana
Carpinus caroliniana
Hamamelis virginiana
Castanea dentata
Quercus alba
Quercus velutina
Quercus coccinea
Cornus paniculata
Crataegus Crus-galli
Crataegus pruinosa
Vaccinium stamineum
Pyrus coronaria

Endotrophic

Cornus florida
Prunus serotina
Acer rubrum
Azalea nudiflora
Benzoin aestivale
Carya cordiformis
Ulmus fulva
Amelanchier oblongifolia
Juglans cinerea
Tilia americana

Ectendotrophic

Fagus grandifolia
Quercus rubra
Viburnum acerifolium
Crataegus macrosperma

Surely further collecting and microscopical observation will add to the list of ectendotrophic mycorrhizas and to the list of trees and shrub harboring mycorrhizas. This widespread occurrence of mycorrhizas seems to indicate that they must be of some importance in the physiological functions of forest trees and shrubs.

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NOTES ON PLANT INDICATORS OF MULL FOREST SOIL IN NORTHWESTERN PENNSYLVANIA

By H. J. Lutz

The Pennsylvania State Forest School

It seems almost axiomatic that forest vegetation reflects in its composition the climatic and edaphic conditions of its environment. This expression of the environmental conditions is clearest when the vegetation is of climax character. The indicator significance of the second-growth forests, which in so many parts of the eastern United States have replaced the original climax or near-climax stands, appears to be less clear. This may be largely explained by that fact that such second-growth stands are commonly in a state of flux; they do not represent a full expression of the site factors. The influence of the site factors on the vegetation is cumulative in effect and their full imprint is visible only in the successionally mature community.

The writer believes it reasonable to expect that tree species, due partly to their relatively long life (commonly 200–300 or more years) and their habit of comparatively deep rooting, are chiefly valuable as indicators of broad environmental differences, *e.g.*, climatic or extreme edaphic conditions. On the other hand, shrubby and herbaceous species, particularly the latter, may have considerable value as indicators of the type of humus layer and surface soil under forest stands. It should be stated that young tree seedlings may also be expected to play an important rôle in indicator vegetation. With increase in age their indicator value, so far as surface soil and humus conditions are concerned, probably decreases. Herbaceous species, due partly to their relatively short life and superficial rooting, are more sensitive than trees to gradual changes in the humus layers or mineral soil. In considering herbaceous species as indicators annuals may at first appear to have greater value than perennials. The difficulty in using annuals, however, is that their occurrence is too liable to be influenced by abnormal conditions, *i.e.*, unusual conditions persisting only for a year or so. Annuals are not an expression of the average conditions of site over an extended period of time to the same extent that perennials are. For example, an abnormally warm, or cold, or wet, or dry year may call forth a quite different annual vegetation than develops on the same site under normal or average conditions. Further, the element of chance operates strongly in determining the development of annual vegetation,—more strongly than in perennial vegetation. For these reasons the perennial herbaceous and perennial shrubby vegetation seem to hold out greater promise to the student of indicator plants than do either trees or annuals. But we must not lose sight of the fact that occasional tree species, because of shallow rooting and sensitivity to edaphic conditions, may likewise supply useful information.

Differences in edaphic conditions, particularly differences in humus layers, which, although definitely influencing rate of tree growth, are not sufficiently marked to call forth variation in tree composition, may call forth rather marked variations in the herbaceous vegetation. In other words, the lesser vegetation may serve as an indicator of quality class (site class) within a given forest type or association.

During the summers of 1930 and 1931 the writer, while instructing in the Pennsylvania State Forest School camp near Ludlow, Pennsylvania had an opportunity to observe the relationship between the occurrence of certain forest plants and that of mull forest soils. Since the most productive forest soils in northwestern Pennsylvania are of the mull type it seemed worth while to record those plants which appeared to have indicator value.

There has recently appeared an excellent paper by Romell and Heiberg[1] which clearly describes the mull type of forest humus layer and, going even farther, defines the various *kinds* of mull. These authors define forest mull as, "A porous, more or less friable humus layer of crumby or granular structure, with diffuse lower boundary, not or only slightly matted." The mull type in the areas considered by the present writer appears to be the *grain mull* of Romell and Heiberg. The general climatic and topographic conditions within the region under consideration are set forth in an earlier paper by the writer.[2]

The herbaceous species characteristically growing in the mull soil areas near Ludlow, Pennsylvania, are: *Dicentra canadensis* (Goldie) Walp., *Dentaria diphylla* Michx., *Hydrophyllum virginianum* L., *Arisaema triphyllum* (L.) Schott., *Carex platyphylla* Carey., *Erythronium americanum* Ker., *Hepatica acutiloba* DC., *Viola rotundifolia* Michx., *Viola canadensis* L., *Caulophyllum thalictroides* (L.) Michx., *Botrychium virginianum* (L.) Sw., *Panax quinquefolium* L., *P. trifolium* L., *Galium triflorum* Michx., and *Allium tricoccum* Ait. The following species also may possibly have some indicator value: *Osmorhiza Claytoni* (Michx.) Clarke, *Podophyllum peltatum* L., *Actaea alba* (L.) Mill., *Mitella diphylla* L., *Trillium erectum* L., *Tiarella cordifolia* L., and *Polygonatum biflorum* (Walt.) Ell.

[1] Romell, L. G., and S. O. Heiberg, Types of humus layer in the forests of northeastern United States. Ecology, 12: 567–608. 1931.

[2] Lutz, H. J., The vegetation of Heart's Content, a virgin forest in northwestern Pennsylvania. Ecology, 11: 1–29. 1930.

The herbaceous species which appear to stand out most clearly as indicating mull soil are: *Dicentra canadensis, Dentaria diphylla, Hydrophyllum virginianum, Arisaema triphyllum,* and *Carex platyphylla.* Other species having high indicator value but of rather limited distribution are *Panax quinquefolium, P. trifolium,* and *Allium tricoccum.*

It is of interest to note that Romell and Heiberg[3] also list most of the above species as occurring on mull forest soils in the northeastern United States. These investigators, however, commonly encountered *Dicentra Cucullaria* (L.) Bernh. and *Dentaria laciniata* Muhl. associated with *Dicentra canadensis* and *Dentaria diphylla.* The writer did not encounter this combination of species within the region studied in Pennsylvania. It seems reasonable to suggest that *Dentaria Cucullaria* and *D. canadensis* as well as *Dentaria diphylla* and *D. laciniata* may properly be considered as ecological equivalents.

The tree species characteristically growing on the mull soils which were studied near Ludlow, Pennsylvania, are: *Fraxinus americana* L., *Prunus serotina* Ehrh., *Acer saccharum* Marsh., and *Fagus grandifolia* Ehrh. To a lesser extent one also finds *Betula lenta* L., and *B. lutea* Michx.

In discussing specific indicator vegetation it is quite necessary that its local or, at best, regional application be appreciated. A species which has high indicator value in one locality, or region, may be practically valueless in another. Failure to recognize this fact probably accounts to some extent for the difficulties in which students of indicator plants frequently find themselves.

HEAT RADIATION FROM METALLIC SURFACES AT VARIOUS ANGLES

E. Raymond Binkley

An investigation of Lambert's cosine law was made of the metallic surfaces of nichrome, steel, copper, brass and aluminum from 100° to 500° C.

The apparatus, shown in Fig. 16, described in the Proceedings of the Academy, Vol. V, 1931, consists of a total radiation pyrometer and an electric heater.

Lambert's law states that when the emissivity of a metallic surface is measured in a direction normal to the surface, the emissivity should

[3] *Loc. cit.*

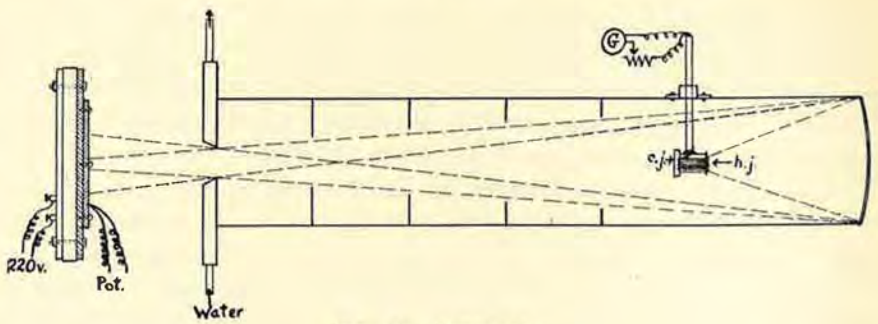

FIG. 16. Pyrometer.

remain unchanged if the surface is turned through various angles from its first position. Thus when in its normal position, as seen in Fig. 16, only heat radiated from a certain area of the surface—that included within the dotted lines (aa′)—is measured by the pyrometer, but as the surface is turned at an angle to its first position the area of the radiating surface is increased, as well as the angle included between the surface and its normal position. Since by Lambert's cosine law the total emissivity is proportional to the area of the radiating surface and the cosine of the angle through which the surface is turned, as the area is increased, the value of the cosine decreases from 0° to 90°, the total emissivity remains constant.

It is the purpose of this paper to give the results of a study of that law for the above named metallic surfaces, all of which were oxidized except polished aluminum, and which results are shown in Fig. 17.

The relative total emissivity of the surfaces was calculated by means of the following relation, derived from the Stefan-Boltzman law:

$$E = \frac{\omega\,(T_s^4 - T_r^4)}{\omega\,(T_n^4 - T_r^4)}$$

where ω is a constant, T_s, the temperature indicated by the pyrometer, T_n, the temperature of the radiating surface obtained by a thermojunction, and T_r, the room temperature, all temperatures being expressed in absolute degrees.

Consider first the curves of oxidized brass labeled I to IV, which show the relative total emissivity to remain constant to angles of about 65°, higher angles showing a gradual falling off. The curves for lower temperatures are similar, except that values of relative total emissivity decrease with lower temperatures.

The curves for all other metallic surfaces showed similar decreases in relative total emissivity with lower temperatures, and thus only one curve is given for the other surfaces.

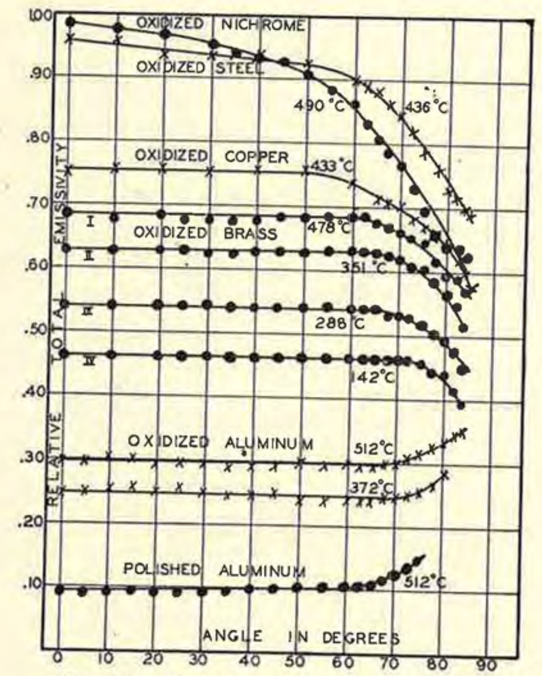

FIG. 17. Variation of the Cosine law.

Oxidized copper shows a constant relative total emissivity up to angles of 50°, but nichrome and steel indicate a decrease from zero degrees.

Aluminum, on the other hand, shows a constant emissivity up to about 60° when a rise in emissivity was noted, and likewise for polished aluminum. This effect is similar to that of magnesium oxide given in the Smithsonian Tables (values for aluminum not given) and probably due to aluminum having a low emissivity.

LABORATORY WORK IN ELEMENTARY SCIENCE

ROBERT T. HANCE
Zoological Laboratories, University of Pittsburgh

A student to graduate from the usual College of Liberal Arts must have on his record, if not in his head, at least eight credits in a laboratory science. With a broad gesture of liberality it is indicated that these credits may be in botany, chemistry, geology, physics, or zoology or any mixture of this lot. The pedagogical assumption behind this requirement naturally involves the supposed value of first-hand contact with the material side of the subject and a bowing to the wide-spread feeling that those things that we handle we know. Those of us who have stayed with our subjects sufficiently long to get away from the type of work that was considered good for our souls know that indeed we never really learned anything until we stopped talking about it and did it. It is doubtful whether any one could pass the automobile driving test after a series of illuminating lectures without the practice of actual driving. These points are so self apparent that it seems silly even to discuss them.

There are, however, an increasing number of laboratory teachers who are commencing to believe that not a few people might enjoy and be able to grasp the intricacies of automotive control without particularly caring to put this information to use. The ailing human is a more cooperative patient when he understands the principles of his treatment even though he thoroughly recognizes his complete inability to manipulate his own cure. Many teaching methods become traditional because in the hands of the originator they produced splendid results and therefore are assumed to be able to repeat in other hands, in any locality, and with a totally different student group. The laboratory instructor who is honest with himself cannot help but be irked at times by the lack of enthusiasm of his class and by the comparatively little that they seem to get from the time put in. If the instructor is unusually honest, he begins heretically to wonder whether the time spent by himself and the students, the cost of the material, and the equipment in the end add up to the informational sum that they should. The time and the money are not as important as the result.

The first possibility that suggests itself naturally involves the subject material. Can interest be sustained by redefining the goal and courageously recognizing the bumps and holes in the road leading to it? A traditional path, however, is always a hard one to resurface, but in biology the battle for the recognition of the relative virtues of type and principle methods and the materials and the sequences to be used in each rages back and forth. No decision has been even neared except in the minds of the advocates of the various systems. This, biologically viewed, is satisfactory enough since it is the teacher who puts over the system rather than the reverse, our common city school practices to the contrary notwithstanding. There can be little question that our course outlines still smack too much of the past history of our subjects when the work was laid out of those who planned to become professionals in our fields. Some of the changes of emphasis that may be introduced into

biology have been suggested in another paper (P. R. Cutright, *The Proper Study of Mankind*) given today and need not be reviewed here beyond pointing out that the more specifically human application that is made of biological material the more interest is involved. As much biology can, for example, be taught through a study of the human circulation by means of blood counts, blood pressure, and heart beats under a variety of conditions as can be dissecting the water vascular system of the starfish and in our experience the interest is bound to be higher.

Admitting that interest may be stimulated through more intelligent selection of illustrative material there still remains a group and one of considerable numbers to whom such experiences are and perhaps should be of cultural rather than of practical benefit. This group can, we are beginning to believe in Pittsburgh, be more adequately served and interested by the lecture-discussion-demonstration system than by any method involving the more tedious traditional laboratory technique. Such thoughts are obviously limited to the elementary phases of the subject since those who go on do so because of a very definite interest in the kind of experience offered in the laboratory. Some concession to the possibilities of the non-laboratory science course has been made during the past two years at the University of Pittsburgh through the admission of general students to the lectures of the various introductory courses in the sciences. This has proved neither very popular nor, as far as I can see, satisfactory for the student, since the lectures must of necessity be tied in with the laboratory work. Furthermore these students lack the personal contact with the instructor that the laboratory students have. A course should be planned for their specific needs involving not merely attendance at lectures but also meetings at periods corresponding in length to the laboratory sessions where, in small groups, intimate discussion of the problems involved would be possible. I believe particularly in the value of essay writing or of student given lectures on the subject of the moment. Before any one can adequately write or talk on a given topic he must have an adequate grasp of it, a condition not so necessary for the successful passing of a modern completion type of examination. We must revalue our laboratory work from the side of its results on new types of students. Professional students, the pre-medic, the pre-dent, and the educational novice are required to take the laboratory work in the various sciences. These groups will be with us for a long time if not permanently. The other group to whom the content of a science is of cultural interest only can, it would seem, be better cared for by a system that will draw out personal initiative than by the present one that bores so many. In partial recognition of these considerations the Curriculum Committee of the College at Pittsburgh have within the past month presented to the faculty the proposal to create a new study distribution field in which no requirement of a laboratory science would be made. It is of interest to note that there has been more objection to this suggestion from those representing the humanities than from the science group who in general favor it. The plan seems to me to be less a nervous response to the spirit in the educational air that the college must be housecleaned and turned upside down in the process than to a growing feeling that the conditions indicating the value of the laboratory for the specialized students of earlier generations does not have equal merit for the general student of today of whom we are getting increasing numbers.

SELECTING AND TRAINING TEACHERS

Robert T. Hance
Zoological Laboratories, University of Pittsburgh

In these days of shrinking budgets and dirth of vacancies the problems of placing our young Doctors of Philosophy in desirable or, for that matter, any kind of positions forces us to give attention to certain phases of our responsibilities that have not received adequate consideration heretofore. The demand for even partially trained teachers has been so large as to absorb alike our good, bad, or indifferent candidates. It has also saved us from the necessity of making unpleasant and uncomfortable decisions concerning our students with the consequence that many misfits are now holding teaching positions. These men are perhaps not so much to be blamed as are those whose kindliness got the better of their judgment. As teachers we should learn that we have a double loyalty. The first is to our profession into which we should not want to induct any but those who may best carry on its ideals. The second is to the individual who should be directed into the field that his talents best fit. The latter is not always so easy but after a reasonable experience of a year or two with a beginning teacher we should be able to predict with some certainty his likely success. If the prognostication is not good then it is but kindness to tell the individual concerned and thus to give him time to find himself in other fields.

But how shall we select our novitiates? Since we shall probably never have a purely mechanical method of appraisal we must fall back on the personal estimate. This naturally requires contact with the candidate and all the letters of recommendation that may be written cannot equal a short interview. While this is common practice for the filling of more important positions it is not so usual in the selection of those who are to be trained to fill these places. A good undergraduate record is a promise and a necessary one of continued good work in the graduate school, but an able student does not necessarily make an attractive teacher. Knowledge of one's field has been the prime requisite of a college teacher up to the present time but whether the technically proficient individual could by virtue of his personality impart his information to others has not been considered to the extent it should be. Almost any normal person can learn the facts of any subject but the attributes that make him a well-loved teacher are born in him. It is not fair to let those who obviously lack these traits go on. Thoughtfulness, consideration for others, sympathy, cooperation, neatness and cleanliness are characteristics that soon show up in the individuals of a large graduate group and are of equal importance with IQ. Not many of these desirable traits will appear in an interview but their substrata will be fairly recognizable. It is not hard to tell whether the prospective student is or is not a gentleman even though the qualities of such be widely varied. Starting with gentlemen the future is hopeful.

The training of our hopeful is simple as far as subject material is concerned, but it seems to me that it is becoming increasingly important to train by example, by word of mouth if necessary, in social customs. These in themselves may seem insignificant but their lack may close the door of opportunity to an otherwise able youngster. An authority in any field may lose much of his effectiveness as a teacher if he is seen using his knife as a spoon. Furthermore, the teacher who merely teaches the data of his science does only half a job. The thousand and one other things that tie in with his subject are the matters of importance to the students and represent the true culture of the teacher and of the world. We do not like to talk about such things but they are important and are certainly neglected. Not only should these graduate students of ours be trained in social usage but also to discriminate between the important and the unimportant, so that their class teaching may have the breath of life in it and so that their literary efforts may develop the drama rather than the soporific side of their work. These are sides of a graduate student's training that have usually been left to the individual to discover for himself. Since these phases of education seem so remote from the attainment of a mastery of the immediate subject the student, as often as not, fails to discover them as is evidenced so frequently in the uninteresting presentations of fascinating subject-matter in scientific meetings. If we succeed in even partially helping our graduate students to discover some of the cultural side of their profession we shall be able to pass them on with praises that hold nothing in reserve and can rest assured that good teaching will go forward.

SOME CHARACTERISTICS OF PIGEON CHROMOSOMES

Robert T. Hance

Zoological Laboratories, University of Pittsburgh

The interest in avian chromosomes arises from the sexual heterozyocity of the female coupled with the reports of occasional sex reversals. Add to this the physiological work of Riddle tending to show that sex, in pigeons at least, is a function of metabolism as well as of the chromosomes and we have sufficient stimulus for the cytological investigation of material that is not too favorable for study.

The present report is preliminary in a series of studies on certain pigeon and dove varieties and crosses that it is hoped will bring to light the chromosome situation in these birds that have been the subjects of so much important physiological and genetic work. My material has been secured and preserved under the best conditions from the flocks of Dr. Oscar Riddle of the Carnegie Institution of Washington.

The chromosomes of the pigeon are greater in number but rather more favorable for study than are those of the domestic fowl. The metaphase plate show the chromosomes in much the same size variations as was found in the chick. The number of chromosomes will perhaps always be difficult to determine with accuracy although the Japanese student, Oguma, reports 62 as the typical male number. My counts on material that is as well preserved as Oguma's have seldom risen much over 50 and in the few cases in which 60 or more chromosomes were found fragmentation was rather clearly indicated. As in the case of the chick the male pigeon has two chromosomes longer than the others while the female has but one of equivalent length. These observations agree with those of Oguma and it seems very likely at present that these longest chromosomes are the ones associated with, if they are not the actual determiners of sex.

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DESCRIPTION OF PLATE

The longest chromosomes in each cell are drawn in solid black. These are presumably the sex chromosomes.

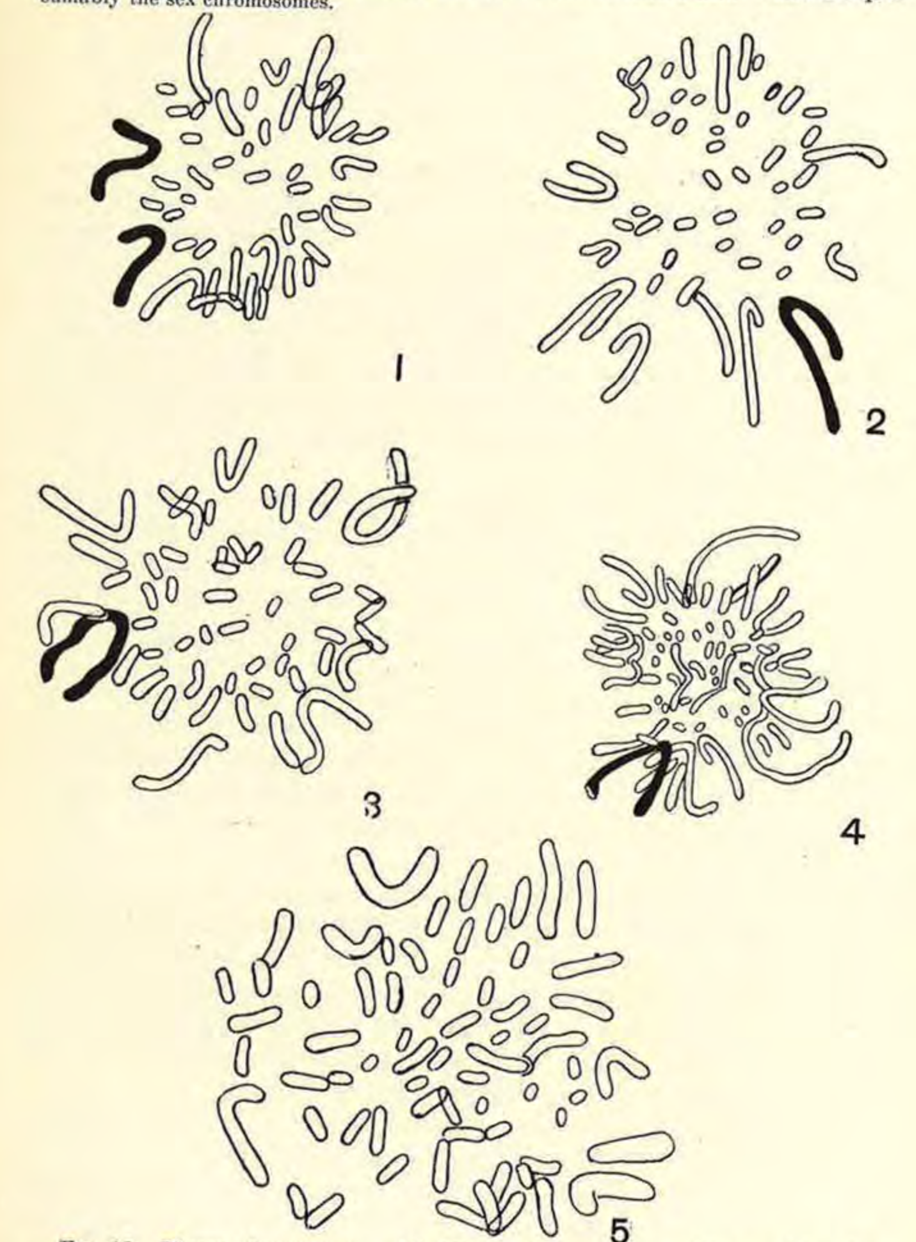

Fig. 18. Pigeon chromosomes. (1) Mitotic figure in the auditory vesicle of a pigeon embryo. 45 chromosomes. Male type. (2) One pole of an anaphase stage of mitosis found in an embryonic ovary. 47 chromosomes. (3) 51 chromosomes found in a dividing cell in the same ovary as was the cell shown in figure 2. (4) An embryonic dividing cell redrawn from an illustration in Oguma's paper. (5) A cell found in the connective tissue of a pigeon embryo showing 67 chromosomes. Taken from the same as the cell drawn in figure 1. The high number of chromosomes is probably due to fragmentation.

SOME TREE ANTAGONISMS

GEO. S. PERRY, Research Forester
Pennsylvania Forest Research Institute, Mont Alto, Pennsylvania

In the natural forest the casual observer sees only disorder and a haphazard arrangement of numerous kinds of trees, shrubs and lower plants. The forester and botanist, however, recognize certain characteristics such as demands for light, moisture, and soil fertility; or ability to resist wind and snow pressure, recover from fire, or withstand frost, as determinants which account for forest types and other plant societies. Another such factor about which speculation exists is the effect of plant secretions or toxins. Do they occur in nature to the extent that the forest structure is influenced thereby? What trees secrete or throw off toxins?

The walnuts have been definitely proven guilty of secreting root toxins.[1] The Mount Alto State Forest Nursery adjoins a plantation of black walnut on one side. Here at one time coniferous seedlings were severely damaged, and some of them killed, as far as thirty feet from the bases of the walnut trees; but after a ditch was dug and the roots cut which ran out under the nursery beds, the injury disappeared.

White Pine and Black Locust. Theoretically these trees are perfectly adapted to grow in association, but practically their mixture shows many disadvantages. It is logical that the light foliage of locust appearing late in spring and falling early in autumn would favor rather than hinder development of the fairly tolerant white pine. The fixation of nitrogen by the locust should be beneficial, and the intermixture of easily decomposed locust leaves with their high mineral content should hasten decomposition of the rather inert and abundant fall of white pine needles. Yet in practice the locust either falls a prompt victim to borer attacks, or grows slowly and is shaded out on the poorer soils, while on better sites it surpasses the white pine and becomes wide crowned and limby. Most difficult to explain is the poor growth and high mortality of pine under the thin shade cast by locust.

The data in Table I were secured in a 22-year-old plantation of white pine near Mont Alto, Pennsylvania, on an alluvial bottom with a fine sandy loam soil. Scattered black locust trees of natural origin occurred rather regularly through the stand. The locust trees were twenty years

[1] Haasis, F. W. Forest Plantations at Biltmore, N. C., Black Walnut Plantation, U. S. Forest Service, Appalachian Forest Expt. Station, Asheville, N. C. 1924.
Pa. Forest Research Institute. Guide to Forestry Studies and Demonstrations, Pa. Dep't. of Forests & Waters Research Bulletin 1, page 75. 1930.

TABLE I
GROWTH MADE BY WHITE PINE IN ASSOCIATION WITH BLACK LOCUST

Captions	Distances to Nearest Black Locust Trees (ft.)												Totals and Averages
	2 or Less	2–4	4–6	6–8	8–10	10–12	12–14	14–16	16–18	18–20	20–22	22–24	
Number of Pines measured	5	32	32	28	30	27	27	20	14	10	6	9	240
Average heights attained by living and dead Pines (ft.)	15	19	23	25	24	28	29	29	30	30	28	27	**25
Average heights attained by living Pines (ft.)	18	21	26	30	29	31	32½	34	34	36	30	35½	**30–
Per cent. of Pines (%) dead	40	50	38	57	53	37	26	30	36	40	17	44	42
Mean D.B.H. of Pines, living and dead (in.)	3.4	3.0	3.8	4.1	4.1	4.3	4.2	4.3	4.5	4.6	3.7	4.2	3.9
Mean D.B.H. of living Pines (in.)	3.8	3.4	4.1	5.2	5.2	4.8	4.7	4.5	4.8	5.5	4.0	5.4	4.5
Form coefficient for living trees $\left(\frac{\text{Height}}{\text{D.B.H.}}\right)$ *	569	741	761	692	669	775	830	907	850	785	900	730	800

D.B.H. is diameter at breast height or four and a half feet above the ground.
* Higher form coefficients indicate thrift and favorable growing conditions.
** The crowns of the locust trees averaged around eight to ten feet in radius. The average height of pines within and without a ten foot radius from the locusts in respectively 22 feet and 29 feet for all trees, and 26 feet and 33 feet for the living ones.

The form data in Table I are very informative, as it is seen the trees under locust shade, growing within a radius of ten feet from the locusts are more stocky than those beyond this zone that enjoy more light. In 75 other white pine plantations studied in detail, it has been practically the universal rule that suppressed pines are very slender, while intermediate, codominant, and dominant trees are progressively more sturdy, just about in proportion to the intensity of the insolation enjoyed. The stocky form of the dead trees is even more pronounced than that of those still living, which indicates plainly that this type of stockiness is undesirable and caused by some detrimental influence.

or less in age, but generally crooked and limby. The data were taken by choosing rows of pine at random and measuring the height and diameter of all trees living and dead, together with their distance from the nearest black locust tree.

The above facts on the form of the white pine indicates that the locust interferes with the development of the pine by limiting the water which the tree can absorb. It is not possible to state certainly whether this is brought about (1) by the locust being more efficient than pine in securing water from the soil when a deficiency exists, or whether (2) the black locust is an example of another Borgia of the forest, which poisons the drink of its mess-mates by means of some toxic excretion or effluvia, that may interfere with the processes of absorption. White pine is usually considered very capable in respect to satisfying its water needs. On the area described below and covered by Table II, the pine was able to survive the drought and also eliminate its competitors upon the dry and rather sterile knolls, but on the moister sites with deep, fertile soil, the white pine has been practically exterminated. This supports the second hypothesis that the black locust resembles black walnut, and possibly white ash, in secreting toxins inimical to some of its aggressive and shade tolerant associates.

Adjacent to the Lincoln Highway just west of Caledonia Park, Franklin County, Pennsylvania, is a mixt planting of white pine, white ash and black locust established in 1907. The mixture was made by two row strips, with spacing about 4 × 4 feet. It is located near the bottom of a north slope where moisture conditions are good except in times of extreme drought. The site was once for the most part a succession of log houses, dooryards and gardens. Except for two stony knolls which were probably used for pasture, and certainly never cultivated, the whole area was then in excellent tilth. The soil is deep and fertile. The white ash made uniformly good growth on all sites except the uncultivated knolls. On these drier, sterile, and more acid soils, the white pine has ousted all competitors and shows excellent form and vigor. On the better soil the pine always languished, but the drought of 1930 was calamitous. Trees had dwindled away for years, but 75 percent of all that remained were unable to survive the dry weather of that summer and were cut out during the winter that followed. The locust was always unthrifty and suffered from its insect enemies. A number of the few better white pine trees that persisted in 1932 were measured, as heretofore described, and distances taken to the nearest surviving locust tree. Only pine trees in rows adjacent to rows of locust were considered, since the white ash was probably the more potent competitor of most

pines in the rows next to it. Furthermore, no pines were measured that were closer to an ash or other tree than they were to a locust.

TABLE II

GROWTH OF WHITE PINE IN MIXTURE WITH BLACK LOCUST*

	Distances to Nearest Black Locust Tree (ft.)							
	3 or less	3 to 5	5 to 7	7 to 9	9 to 11	11 to 13	13 to 15	15 or more
Average height of Pines (ft.)	23.0	22.4	26.8	26.6	30.5	28.7	33.5	33.9
Average D.B.H. of Pines (in.)	3.47	3.45	4.34	4.13	5.13	4.01	5.31	5.25
Form coefficients for living trees $\left(\frac{\text{Height}}{\text{D.B.H.}}\right)$	795	779	741	772	713	858	757	774

* The crowns of the locust trees only extended out about eight or ten feet from the bole. The form coefficients average 760 for trees within 11 feet of the locust trees, while at a greater distance the average is 796.

Table II supports the conclusion that black locust is not an advisable tree for mixture with white pine, either as to effect upon the pine or benefit to itself; since on the area covered by the table, only five percent of the originally planted locust have survived and they are generally pitiable specimens.

In order to further test the influence of hardwoods on associated white pine and make comparisons of black locust with other trees, data were taken in the same pine plantation covered by Table I, but for tulip poplar, large-tooth aspen and red maple. Comparable measurements are summarized in Table III and demonstrate that these hardwoods have no such unfavorable effect on the development of white pine as does the locust.

In a nearby mixt planting of white pine and black walnut, similar measurements were made on 60 white pines, and the data analyzed in Table IV. These tables show the abnormal stockiness of white pine when influenced by the walnut or black locust, and by contrast the lack of this effect from association with aspen, tulip poplar and red maple, despite the far heavier shade of the latter trees as compared to black locust and walnut. The data strongly indicate the secretion by the locust of some active principle or toxic substance which interferes more or less with the metabolism of white pine.

TABLE III

GROWTH MADE BY WHITE PINE IN ASSOCIATION WITH TULIP, RED MAPLE AND LARGE-TOOTH ASPEN

Captions	Distances to nearest hardwood trees (ft.)										
	Less than 3	3 and 4	5 and 6	7 and 8	9 and 10	11 and 12	13 and 14	15 and 16	17 and 18	19 and 20	21 and over
Number of pines measured	3	7	7	12	13	15	16	16	18	5	8
Average heights attained by living and dead pines (ft.)	26.0	23.1	27.3	28.4	24.2	23.3	28.6	25.6	25.7	24.2	27.4
Average heights attained by living trees (ft.)	27.5	27.3	29.2	34.7	28.0	33.0	33.1	32.9	28.7	31.3	32.0
Per cent. of pines dead (%)	33	57	14	33	38	60	31	38	33	40	37
Mean D.B.H. of pines living and dead (in.)	3.7	3.2	3.9	4.2	2.9	3.0	4.0	3.4	3.1	3.4	3.2
Mean D.B.H. of living pines (in.)	3.8	4.1	4.3	5.3	3.5	5.2	5.1	5.0	3.6	5.1	3.9
Form coefficient for living trees $\left(\frac{\text{Height}}{\text{D.B.H.}}\right)$ *	868	801	822	786	960	761	779	790	957	736	985

* Higher form coefficients indicate thrift and favorable growing conditions. The average coefficient for pines within ten feet radius and in direct contact with the hardwood trees is 847, while for the pines beyond ten feet radius the average is 834.

TABLE IV

GROWTH MADE BY WHITE PINE IN ASSOCIATION WITH BLACK WALNUT

Captions	Distances to nearest walnut trees (ft.)							
	Less than 3	3 and 4	5 and 6	7 and 8	9 and 10	11 and 12	13 and 14	15 and 16
Number of pines measured	11	20	20	1	3	2	2	1
Average heights attained by living and dead pines (ft.)*	15.2	19.1	22.6	26.0	29.7	27.0	29.5	24.0
Average heights attained by living pines (ft.)	15.9	19.7	24.1	26.0	29.7	27.0	29.5	24.0
Per cent. of pines dead (%)	27	30	30	0	0	0	0	0
Mean D.B.H. of pines living and dead (in.)	2.5	3.2	4.5	5.3	6.5	3.4	6.2	3.1
Mean D.B.H. of living pines (in.)	2.7	3.4	4.9	5.3	6.5	3.4	6.2	3.1
Form coefficient for living trees $\left(\frac{\text{Height}}{\text{D.B.H.}}\right)$ **	707	695	590	588	548	953	571	929

* A large number of short and very stocky dead pines were recently cut out of this stand. Most of them stood near walnuts, and would have strongly emphasized the toxic effect.

** Higher form coefficients indicate thrifty and favorable growing conditions. The average form coefficient for pines within ten feet radius of the walnut trees is 626, while for those further away it is 818.

SPECIALIZATION HAZARDS

BY MAX TRUMPER, Ph.D.

Consulting Medical Chemist, Philadelphia, Pa.

In approaching the subject of the hazards of specialization I feel it not only fitting but obligatory to pay tribute to the Pennsylvania Academy of Science which presents to its audience of specialists a program so varied in scope as those we have heard and which are still before us. The subjects cover the fields of botany, zoology, physics, astronomy, chemistry, pathology, medicine, physical geography, forestry, physiology, geology, toxicology, mathematics, education and still other branches of science. Our Chairman has expressed the hope that the list be extended to include the social sciences. The value to one specialist of hearing from the specialist in some neighboring science is great indeed and will help to overcome the scientific isolation which, as I shall try to show, becomes a real hazard of specialization.

Specialization assumes that knowledge is divisible. It goes further and so walls up the divisions which it has created, that few who have entered the precincts of a specialty can climb or even see over the dividing walls into the grounds of a neighboring specialty. As a result we often have scientific isolation—with an accumulated mass of unused information, and a viewpoint distorted because it has not been correlated with adjacent knowledge.

With the rapid growth of scientific knowledge, more and more specialties have been created. Think of the world which knew but two sciences—physics and metaphysics. How infinitely simple it seems now in comparison with the science of to-day which has become divided into a multitude of sciences, each one of which has its many specialties. It has been stated that we now need abstractors of abstracts and reviewers of reviews. During the past five years our National Research Council has published a bibliography of biblographies on chemistry and chemical technology. A recent bibliographical survey of vitamins contained approximately 12,000 references. This flood of researches has brought with it intense specialization within specialties and consequent greater isolation.

Let us take up the subject of chemistry. The advances in the manufacture of synthetic chemicals on a commercial scale have been rapid and spectacular. This continuing creation of new organic compounds, some of which are promptly used as industrial chemicals, exposes the chemist in the laboratory and the factory to hazards the nature of which we do not understand. Before the World War we depended on research in Germany for toxicological data in industry. Now that the universities in that country can no longer afford to continue their thorough and elaborate animal experiments on the new industrial poisons, these data are no longer available. In this country, instruction on the fundamentals of toxicology is seldom given to students of chemistry. We have been too busy with the more immediate problems of manufacture, of making the new products commercially profitable. In the meantime our chemists are being exposed to fumes and vapors of unknown or uncertain toxicity. Thus the chemist who contributes materially towards the advances in modern civilization may also be the first to suffer from the harmful effects born of the progress which he has made possible.

One of the gas hazards to which many industrial chemists will find themselves exposed is that of synthetical methanol. Owing to its low cost, many industries will use this methanol for the first time. Other industries, whose chemists have been familiar with the danger of crude methanol may now welcome synthetic methanol because it has no impurities. But herein lies a new danger—synthetic methanol cannot be readily identified by its odor. Crude wood alcohol contains much acetone, some ethyl methyl ketone, methyl and dimethyl acetate, furfural, allyl alcohol and other substances which give it a very disagreeable odor, which acts as a warning agent. Such a warning is absent in the synthetic product, making it all the more insidious. The chemists in industry should be on guard and scrutinize these synthetic chemicals used in large quantities to ascertain their possible toxicity before many of their fellow workers shall have been exposed. This is of especial concern to industrial chemists in this State. Pennsylvania which ranks high in the number of industrial chemists employed, has no legislation for compensation in the case of occupational disease or industrial poisoning. Workers in Pennsylvania are without the legal protection afforded to our fellow citizens in Massachusetts, Connecticut, Wisconsin, North Dakota, California, New York, New Jersey, Ohio, Illinois and Minnesota. When a new chemical of possible toxicity is introduced in industry, we have to learn its effects by the trial and error method and often at the sacrifice of life. It is therefore important for the chemist to go beyond his specialty and obtain a knowledge of the fundamentals of toxicology.

Let us now consider a problem being investigated by the specialists in engineering. The United Gas Improvement Co., of Philadelphia, is studying the use of natural gas with the view to mixing it with manufactured gas. The engineers are primarily concerned with reducing the costs of manufacturing gas to the lowest possible level. But they must look beyond their own specialty. An important feature of the problem of manufactured gas is the carbon monoxide content. Manufactured gas on the average contains from 15 to 30 percent of carbon monoxide. It costs more to manufacture gas with low than with high carbon monoxide content. In large cities the public has accepted as inevitable the almost daily fatalities from carbon monoxide in the escaping gas. We have grown callous to this hazard. It is interesting to recall that when it was first proposed to supply gas in Philadelphia about 100 years ago, a number of the leading citizens protested because of the danger involved. It is rather curious to note that one of the signers of this protest afterwards became the Chief Engineer of the Gas Works. Illuminating gas containing more than 14 percent of carbon monoxide is prohibited in many cities of England. Natural gas contains practically no carbon monoxide. Therefore its admixture to manufactured gas would decrease the carbon monoxide content. Should not this fact, so important to the public health, weigh heavily in favor of natural gas to be used in as high a percentage as present installations will permit? (Incidentally, Philadelphia statistics concerning deaths from manufactured or illuminating gas are difficult to obtain because they are not distinguished from deaths from carbon monoxide poisoning or from other sources such as automobile exhausts). This problem is becoming increasingly important with the use of gas heaters in private homes. I use this subject to illustrate again the hazards involved when specialists in only one field—in this case engineering—handle a given problem.

The previous illustrations demonstrate the hazards of specialization. But expanding knowledge often extends the borders of a specialty until they include the territory of a neighboring specialty. An example is the case of bacteriology; Until within recent years bacteriology was decidedly orthodox in following the teachings of Pasteur. Now we realize that bacteriology must concern itself with the environment as well as with the host. Research in bacteriology has shifted definitely to the biochemical field. In the past few decades the potability of water was determined largely by bacteriological examinations. To-day it is almost impossible to determine where bacteriology ends and chemistry begins. The bacteriologist now determines the hydrogen-ion concentration of water as well as of the media on which the bacteria are grown. In my studies of Schuylkill water, I was interested to find that when the bacterial count was lowest the chemical pollution was greatest. In other words the chemical pollution was sufficient to interfere with the growth of the bacteria in our river water. For this reason studies limited entirely to bacterial counts are misleading. The healthfulness of the water may be affected by its inorganic as well as by its organic constituents. Thus chemical analysis of water has largely supplemented bacteriological studies. At the University of Arizona, for instance, recent investigations on the local supplies of water report abnormally high amounts of fluorine, that is, from five to twenty times the amount ordinarily found in the potable water of that region. This excess of fluorine causes a so-called mottling of teeth in which the surface of the enamel is corroded and secondarily stained yellow, brown or black. The teeth lose their normal translucency and are structurally weak. I have not seen any bacteriological reports on this water but I am inclined to believe that its bacterial content would be exceedingly low, for the reason that fluorine is an excellent bactericide. In fact the chemist uses fluorine whenever possible for preserving liquids in the laboratory from bacterial contamination. Thus from the old orthodox point of view, the potability of this water would have been accepted without question, but now that the chemical constituents in our water supplies are re-

ceiving serious consideration, this water, because of its high fluorine content is no longer considered potable.

Water potability problems are shifting in the East to a control of the industrial trade wastes, while in the irrigated areas of the West, attention is being centered on the chemicals which may be leached from the soil during the long passage of water through the canals and ditches. Such soil chemicals may accumulate in the food grown in that region and may result in harm to man. (Schofield and Willcox, Science, 71, 542, 1930) found a definite relationship between the boron content of oranges and the boron content of the drinking water. The potential danger of boric acid as a food preservative has long been recognized in this country as well as in the leading nations of Europe. The fact that boric acid is used as an eye lotion has helped to create an impression of harmlessness. Boric acid is largely eliminated by the kidneys and its action is more harmful to individuals having renal or kidney impairment. When a small quantity of boric acid is absorbed there is no immediate toxic effect but when taken for a long time the accumulative effects become apparent in the deranged digestion, loss of weight and damage to the kidneys. Here again in the problem of water pollution we see how closely interwoven are the facts of toxicology with those of geology and agriculture.

In concluding, I hope that I have not given the impression that I would belittle in any sense the orthodox specialist in any science. Without him we should not have reached the present state of human knowledge and to him we must look for future progress. But my aim has been to point out some of the hazards of specialization with the view of emphasizing the essential unity of science. A knowledge of the fundamentals of a neighboring science gives one perspective and it prevents lopsidedness. We have had to divide science into branches in order to bring them within the possibilities of individual human endeavor but such divisions should not be permanent. This specialized knowledge needs to be reassembled and integrated—we must reconstruct the whole from its parts.

THE DEVELOPMENT OF A TECHNIQUE FOR BRAIN AND SKULL OPERATIONS UPON YOUNG RATS

Marcus H. Green
University of Pittsburgh

In undertaking a study of the rôle of bones of the skull in determining the size and form of the brain, the young rat was selected as experimental material. The first problem was that of developing a technique for removal of rather large parts of the skull in such a manner as to make possible rearing the operated young to maturity.

The craniectomy performed involves the removal, in one piece, of a part of the temporal, parietal, and a small caudad piece of the frontal bone. Only the right-hand side is operated upon; the left-hand side serves as a control.

All instruments and apparatus that will eventually come into contact with the rat during the operation should be sterilized for twenty minutes in a hot water or steam sterilizer.

Anesthetization of very young rats is quite difficult, for the eye reflex cannot be employed and cardiac and respiratory rates are hard to determine. The young rat is placed beneath a bell jar with a wad of cotton soaked with ether. It is left there until insensible to agitation. This period of anesthesia lasts until the sutures are ready to be placed.

Immediately succeeding anesthetization, the animal is bathed with 95 per cent. alcohol. If depilitation is necessary, an equal mixture by weight of barium sulphide and white flour with enough water added to make it into a thick paste is smeared over the skin and scraped off with a scalpel. The paste should not be left to dry on the epidermis because the epidermis becomes highly irritated when the depilator is scraped off.

The animal is grasped from beneath by the left hand and oriented from that position. The one blade of a fine pair of scissors is inserted between the skin and skull, in the middorsal line in the region of the axis. It is pushed craniad until the tip of the blade reaches a limit described by a line drawn between the two eyes. One continuous cut then lays open the skin. A series of small cuts frequently cause ragged wounds. Since the skin is very loose it can be easily retracted until the parietals, upper part of the temporals and frontal bones appear. An incision is made with a sharp needle in the parietal bone at the juncture of the longitudinal and occipito-parietal sutures. The one blade of the scissors is inserted through this opening, and is pushed craniad and parallel with the longitudinal suture between the skull and

meninges of the brain to the afordescribed boundary. The next incision is made with the same technique but at a right angle, to the right-hand side of the former incision, starting where the first incision was made with the needle. This second incision extends ventrally along the side to the upper part of the temporal bone.

If a portion of the cortex of the cerebral hemisphere is to be extirpated, the meninges are incised along the lines of the bone incisions, and raised along with the bone by tweezers. The cortex is then removed by a very narrow scalpel.

If the piece of bone mentioned in the introduction is to be removed, another incision is made connecting the most craniad end of the longitudinal incision and the most ventral end of the lateral incision. Removing the meninges along the lines of the bone incisions will produce a well-pronounced craniocele. In case of a craniocele, great care must be taken to prevent any mechanical injury to the distended brain.

A second dose of anesthesia is now administered with an ether cone.

The edges of the incised skin are now pulled together and sutured with black or white silk thread. An interrupted, straight-across stitch is employed so that if one strand should be severed it will not loosen the others. The stitches should not be pulled too tightly or a protruding scar will result.

The sutured wound is washed with 95 per cent. alcohol and swabbed with a tincture of iodine solution. The animal is never bandaged since this would interfere with attempts to suckle, and is not necessary to prevent infection, for I never had any rats become infected through the wound. Never place the operated young upon cotton, for the strands of cotton frequently become entangled with the wound and pull it open. The operated young are placed upon paper in their cage and kept warm by heating the cage with an electric light. Never place the rats with their mother immediately following the operation.

Great difficulty is attendant upon raising the young due to cannibalism in the mother. Various, highly-odiferous chemicals were at first used to try to dispel the odor of blood, but to no avail. F. V. L. Turner thinks that in fowls cannibalism is due to the appearance of blood rather than the odor, and suggests the use of ruby-colored illumination. I shall try this method in the near future. A muzzle has been devised by me for the mother rat which is only removed when she is placed in another cage for feeding. It is composed of the tip of a finger of a glove with the upper and lower halves extended caudad over the head to a region behind the shoulders and below caudad to the region immediately behind the forelimbs. A strap which passes through a loop in the top and one in the bottom of the extended muzzle is pulled tight behind the forelimbs, and the same immediately behind the head. The mother rat is unable to remove this and soon becomes adapted to it and feeds her young. The buckles have been fashioned from wire since I could find none small enough to suit the purpose.

THE DIGESTIVE EPITHELIUM OF THE APHID, *MACROSIPHUM SANBORNII*

Forrest W. Miller

Zoological Laboratories, University of Pittsburgh

The stomach or mid-intestine of *Macrosiphum sanbornii* is located in the anterior region of the abdomen extending from about the first to the fourth segment. It is bulbous in nature becoming abruptly wide in the anterior end and slowly tapering into the hind-intestine at the posterior end. In the anterior end, where the oesophagus joins the mid-intestine, is located the cardiac valve. This valve is a projection of the oesophagus into the lumen of the mid-intestine. This projection extends inward for about one third the length of the lumen and then folds back upon itself and becomes continuous with the wall of the mid-intestine. The cardiac valve prevents the back flow of juices into the oesophagus and also aids in forcing the contents of the mid-intestine into the hind-intestine (Weber, 1930).[1]

The digestive epithelial cells form the inner cellular lining of the mid-intestine and the cardiac valve. In the mid-intestine, these cells are oblong in the anterior and posterior ends, and more rounded toward the middle region. They contain large deeply staining nuclei. These epithelial cells, however, do not come into direct contact with the juices of the lumen, but are separated from it by the intima, a non-cellular layer. This layer, in the region of the cardiac valve, is often pushed away considerably from the epithelial cells, thus forming a reservoir for the secretion. The secretion from the epithelial cells in the region of the cardiac valve is stored here for a time and slowly fuses through the intimal wall into the lumen of the mid-intestine. Underlying these epithelial cells is the basement membrane. This is a non-cellular layer and contains the trachea and nerves. Immediately outside of the basement membrane are located the muscle fibers. These are very few in the region of the mid-intestine. (Figure 19, A.)

[1] Weber, H. *Biologie der Hemipteren.* J. Springer, Berlin. 1930.

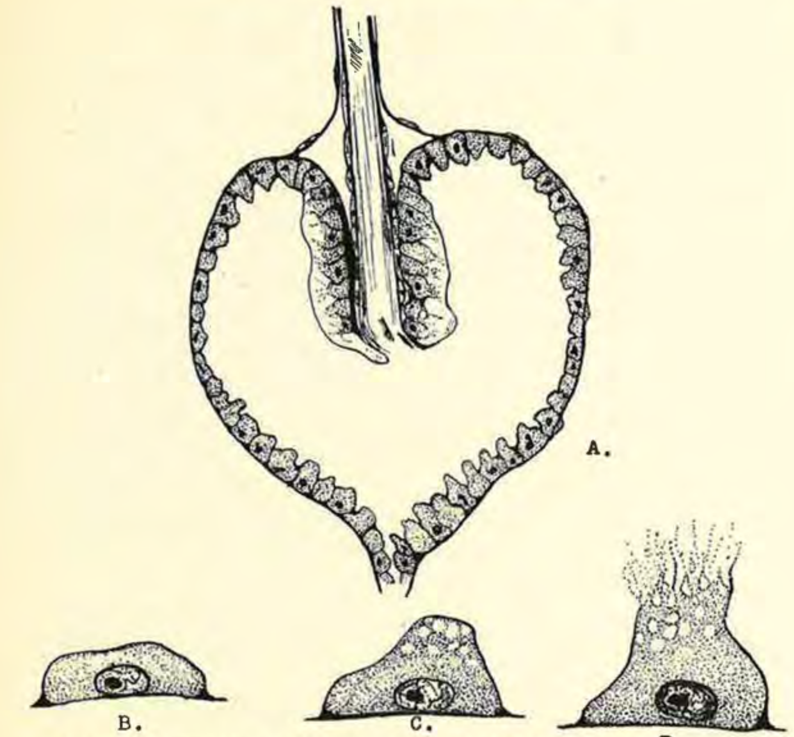

FIG. 19. Digestive epithelial cells of aphid, Macrosiphum Sanbornii.

As mentioned above, the digestive epithelial cells are large and contain deeply staining nuclei. The cytoplasm also takes a deep stain although somewhat lighter than that of the nucleus. The stages of activity of each individual cell may be described as follows:

1. The cell stains uniformly in color, the blue staining granules being equally distributed throughout the cell. The nucleus is dark, deeply stained, and fills a large part of the cell. At the apex of the cell there may appear a few very light areas, the secretion vacuoles. (Figure 19, C.)

2. The cell becomes oblong in shape and the apex becomes more pronounced. The nucleus, however, remains the same size. The number of clear secretion vacuoles at the apex of the cell has become more numerous.

3. The cell reaches its maximum volume, cell wall at the apex ruptures, and the secretion flows into the lumen of the mid-intestine. Figure D.)

4. The cell in the resting stage. (Figure 19, B.)[2]

[2] Hereafter these stages of cell activity will be referred to by the numbers given above.

If one examines a longitudinal section of a specimen which has been feeding normally, the above mentioned stages may be seen. These cells in the different functional stages will be grouped in a band which covers about one-half of the length of the mid-intestine. The cells not found in this band are in a resting stage. The cells in the most posterior,[3] that is, the nearest to the entrance of the hind-intestine, are in the stage indicated in (1). (Figure 19, C). The cells are filled with granules and few, if any, secretion vacuoles may be found. The cells at the most anterior border of his secretion band are in the stage indicated in (3). (Figure 19, D). The cell wall at the apex of these cells has ruptured and the secretion is expelled into the lumen. The cells between these two extremes are in the stage indicated by (2). These cells at the apex are filled with clear secretion vacuoles.

When several specimens are examined it will be noticed that this band of active cells varies a great deal in its position. At times the entire band of cells may appear at one position and again it may be divided and be confined to the extreme anterior and posterior ends of the mid-intestine. Weber (1930) reports of a similar condition in *Aphis fabae*. Thus it would appear that all the cells of the mid-intestine do not function at the same time, and that there is in addition a non-functional stage during the cycle.

In order to study the nature of the above phenomenon the following experiment was carried out:

Several specimens were removed from the host plant, placed in a moist chamber at about 20° C., and kept there without food for a period of ten hours. The mid-intestine of these specimens when sectioned and stained showed that the lumen was completely empty of food juices and the epithelial cells were in the resting stage. Others of these starved specimens were replaced upon the host plant and allowed to feed for periods of 2, 5, 10, 20, 35, 60, 80, 105, and 120 minutes. These forms were sectioned and showed the following:

2 minutes: The cells of the cardiac valve region have started to function. Most of the cells are in stage No. 2. No secretion has as yet been expelled into the lumen.

5 minutes: The cells in the most anterior wall of the mid-intestine show signs of activity and are in stages one and two. Cells in cardiac valve in stage No. 3.

10 minutes: Cardiac valve epithelial cells throwing off secretion vacuoles. These cells are now entering the resting stage. The cells of about the anterior one third of the mid-intestine are now functioning.

20 minutes: Active cells confined to the central region of the mid-intestine. Cardiac valve cells still in the resting stage.

35 minutes: Cells at the posterior half of the mid-intestine in stages No. 2 and No. 3. Cardiac valve cells in stage No. 1.

At the thirty-eight minute period the cells at the posterior end of the mid-intestine are again in the resting stage. The cells of the cardiac valve region are in the stages No. 2 and No. 3, and the cells of the anterior region of the mid-intestine have started to function for a second time since the starvation period. During the time interval from 35 minutes to 70 minutes, the epithelial cells pass through the several stages mentioned above. Thus in a period of 35 minutes all of the cells will have passed through one complete cycle. As was seen above each individual cell requires about ten minutes in order to pass through the three active stages mentioned above and during the following twenty-five minute period the cell is in a resting stage.

[3] Anterior and posterior are here used in a morphological rather than physiological sense.

Summary

1. There are three stages of activity which are characteristic of the functioning epithelial cell. These stages are followed by a rest period.

2. In a normally feeding individual the period of activity for each cell is about ten minutes. The rest period, which follows, is about twenty-five minutes in length.

3. All the cells do not function at the same time, neither do they function at random as in most insects.

4. This active period for each cell passes rhythmically from the anterior to the posterior region of the mid-intestine.

Technique

All specimens were killed and fixed in formo-aceto-alcohol. Clearing was done in xylol and cedar oil after dehydration. Sections were cut from 8 to 10 microns. Both longitudinal and cross-sections were made of all material. Delafield's haematoxylin and eosin were used for staining.

THE DEMONSTRATION OF MUSCLE CONTRACTION IN INSECTS

B. R. Speicher

Zoological Laboratories, University of Pittsburgh

Muscle contraction among the members of the Arthropoda is regional and linearly progressive along the length of the muscle bundles. Each region of contraction is separated from its fellows by an area of relaxed tissue (Dalgren and Kepner, 1908). Without appropriate staining the alternate banding of contracted and relaxed tissue is difficult to distinguish. The writer, in staining sections of the braconid wasp, *Habrobracon juglandis* Ashmead, has noted that Mallory's triple connective tissue stain is well suitable for the demonstration of this method of muscle contraction.

Wasps, killed in fixative, die with their muscles in a state of contraction. When stained with Mallory's the muscle bundles present alternate bandings of red and blue, corresponding to the contracted and relaxed portions (Figure 20, A). The contraction extends throughout the

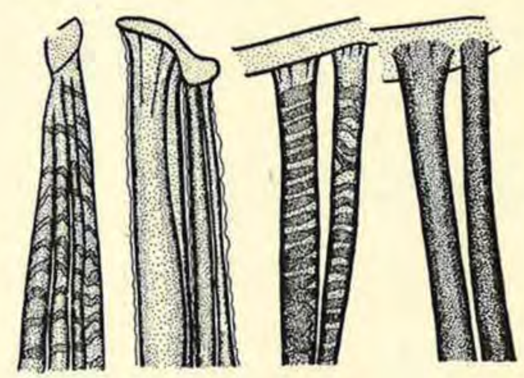

Fig. 20. Insect muscle stained with Mallory's triple connective-tissue stain. Dark areas represent red, light areas blue staining. A, contracting muscle; B, relaxed; C, muscle approaching tetanus; D, muscle in tetanus.

length of the muscle to the tendons of insertion. Muscles presenting the striated appearance include all those activating the ambulatory appendages, the segmental sclerites and the genitalia. Only the large indirect wing muscles remain undifferentiated; these appear uniformly blue in color.

Wasps anesthetized before fixation demonstrate the muscles in a relaxed condition. Such forms when stained show all of the muscles

stained a uniform blue (Figure 20, B). Comparison of these sections with those of contracting muscles indicates that the blue areas of the latter correspond to relaxed and the red areas to contracted portions of muscle tissue.

The areas of muscle contraction are usually confined to even bands crossing the muscle bundle, but in section some may appear cutting across the bundle in a diagonal or otherwise irregular manner. This fact suggests that, although all muscle fibers in a bundle receive the same impulse, in some the reception of the impulse or the reaction to it may be somewhat delayed.

In a few of the wasps sectioned, it was noticed that a number of muscles show the contracted (red) bands much broader than usual; this condition may even grade into large red areas but slightly broken up by blue portions (Figure 20, C). Such a condition is assumed to demonstrate a condition of partial tetanus. Possibly as the contracting muscle, receiving continual stimuli, approaches exhaustion, the red areas widen and eventually merge.

The condition of complete tetanus was observed in a number of forms killed in fixative. Instead of regional differentiation of color, the muscle bundles stain an unbroken red along the entire length. This indicates contraction along the entire length, a characteristic of tetanus.

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A MARVEL IN ARITHMETIC

By R. N. Davis

Director of Everhart Museum, Scranton

The purpose of this paper, aside from a little entertainment, is to show the wonderful conciseness of the exponential system as compared with the common or Arabic notation.

What is the greatest number that can be expressed by three figures? In the common system 999 is the correct answer. If we are allowed to use some of the nines as exponents we get remarkably great values. Let us write it 99^9. It would be possible to raise 99 to the ninth power by actual multiplication but it would be a laborious process. We could approximate the value by means of logarithms but it will be easier and as satisfactory to increase the 99 to 100 and raise this to the ninth power which would be expressed by (1) with eighteen zeros attached or one quintillion. Of course this is greater than 99 to the ninth power but it is an approximation.

If we write our number 9^{99} we get a much greater value. Let us approximate the value as before and we have 10 to the ninety-ninth power which would be expressed in the Arabic system by (1) with ninety-nine zeros attached.

If one of our nines is the exponent of another exponent we get some remarkable results. Let us write $(9^9)^9$. Expanding the part in parenthesis with the nine changed to 10 we have one billion. This one billion raised to the ninth power is expressed by (1) with eighty-one zeros annexed. We could write this number but it defies reading.

Finally let us write $9^{(9^9)}$. To approximate this value we need to make two changes and have $10^{(10^9)}$. The value in this parenthesis is one billion and we might write the number $10^{1,000,000,000}$. If we write this number according to the Arabic system we must write (1) with a billion zeros annexed. To merely write such a number would require a thousand volumes of a thousand pages each, forty figures to a line and twenty-five lines to a page! ! !

MATURATION PHENOMENA IN THE MOUSE

Paul R. Cutright
Department of Zoology, University of Pittsburgh

Sexual reproduction involves the union of two highly specialized cells, a sperm and an egg. In order that these cells may unite at the time of fertilization it is necessary that they undergo certain significant changes in size, shape, and content. Particularly is this true of the sperm. These changes are mainly concerned with a ripening or maturation of the specific gametes and with a reduction of the number of chromosomes to one-half the original number.

The maturation phenomena of the mouse resemble those of many other forms, although, as is usually the case, certain peculiarities present themselves. Some of these peculiarities have not previously been described.

Since the spermatogonial divisions in the mouse are comparable to those of other forms they will be passed over with the single brief statement that forty chromosomes may be counted in the metaphase.

The interphasal nucleus of the primary spermatocyte is characterized by a reticulum similar to that in the spermatogonium and by a large chromosome-nucleolus completely enveloped by a vacuole which was not present in the spermatogonium. This body persists throughout the growth period. As the growth period is initiated the reticulum resolves itself into a number of elongate beaded leptotene threads. That there is not a single attenuated spireme is difficult to establish but a close observation of the nuclear content reveals here and there the free end of a thread. As the prophase continues the leptotene threads become shorter and thicker and during synapsis there is a side-by-side union of the homologous chromosomes to form bivalents. The beads or chromomeres of each member correspond with those of its homologue in size, shape, and position. In two different nuclei at this time a relatively short three-chromomered element was seen paired with a shorter one having only two chromomores, one at each end. In the light of subsequent findings the former is interpreted as having been the X-chromosome and the latter, the Y-chromosome. At this stage the chromosome-nucleolus is still a conspicuous landmark and retains its staining ability.

The chromosomes now condense still further and there is a gradual metamorphosis through a pachytene condition to diakinesis. The transformation has involved a reduction in the number of chromomeres, but in every case the reduction has been the same in each member of the bivalent and has been effected apparently through an actual fusion or coalescence of chromomeres.

By the time diakinesis is reached the bivalents are short and heavy and clearly visible. They tend to take up a peripheral position near the nuclear membrane and assume a great variety of shapes. The most characteristic of these forms are rings, V's, and cross-shaped figures; there are also Y's, hexagonal, and diamond-shaped forms. The nature of the union of the two members of each bivalent would seem to be highly significant. In every observable case the first chromomere is seen to unite with the first chromomere or the second chromomere with the second chromomere. The first chromomere was never seen to unite with the second or the third. This definitely establishes allelomorphism of chromomeres in a mammal.

There was no indication at any time of longitudinal division or splitting of the individual members of the bivalents to form tetrads. In spite of our failure to observe any physical separation cytological evidence at hand indicates that the bivalents are always quadripartite in structure even though the condition is invisible.

The chromosome-nucleolus during diakinesis was as much in evidence as formerly but was seen to divide into equal parts. These parts were of approximately the same size and resembled very much the two largest autosomes seen in the spermatogonial metaphase. After considerable amount of observation of this body in the various stages of its transformation it seems highly probable that the chromosome-nucleolus really consists of the aforementioned autosomes.

During late diakinesis a further concentration of the chromosomal material takes place and there is a gradual transformation into the form of the bivalents as seen in the metaphase.

There are twenty distinct chromosomal elements to be seen in the metaphase. It has been found that the usual technique stains these densely compact bivalents so deeply that their double nature is obscure; in lightly stained preparations, however, this condition is readily demonstrated. One of the twenty members has been formed by a union of the X and Y chromosomes and is readily recognizable due to the disparity of size in the two members. In reduction division the bivalents assume distinctive shapes that soon become recognizable. Some are club-shaped, some diamond-shaped, and several are hat-shaped. The X and Y chromosomes were distinguished in several cells; one large component, the X, is seen pulling away from a smaller component, the Y, as they separate to go to the poles.

The secondary spermatocytes are approximately one-half the size of the primaries. No prophases of this stage were noted due to the difficulties encountered with the material but in the metaphase twenty small ovate chromosomes were counted. An attempt was made to locate the X and Y in separate spermatocytes but the material was not sufficiently favorable for the thorough study of the secondary spermatocytes. Since these two elements have been traced through synapsis and diakinesis and their separation has been witnessed in the first meiotic division it would seem that there is sufficient evidence to warrant the assumption that one-half of the secondary spermatocytes should contain the X chromosome and the other half the Y chromosome.

The spermatids are recognized from the secondary spermatocytes by their smaller size, their lack of stain, and their position nearer the lumen of the tubule. As the spermatid inaugurates its transformation into the gamete it elongates and condenses. This elongation and contraction is continued until the mature gamete, or spermatozoon, is formed.

THE PROPER STUDY OF MANKIND

PAUL R. CUTRIGHT

Department of Zoology, University of Pittsburgh

Almost two centuries ago Alexander Pope said, "The proper study of mankind is man." Considering the wide-spread interest in archeology and anthropology which is attested to by a large number of expeditions annually to all corners of the globe we must conclude that the study of mankind to-day is even more proper than it was in the time of Pope and his contemporaries. So keen is this interest that the newspapers recognize it and the Sunday supplements carry full pages on such subjects as "The Peking Man," "Discoveries in Yucatan," and "Sensational Finds in Mesopotamia." Numerous books have been published which deal with every phase of man's prehistory, both known and problematical. The results of these studies have even been carried into fiction and the moving pictures. The Neanderthaloid type of cave man carrying a wicked cudgel and wearing nothing but a leopard skin and a cruel smile has become a familiar figure.

Anthropological studies have not dealt entirely with the past, however. The races of men as they exist to-day are well known and there are only a few inaccessible peoples who have not been subjected to cranial measurements and linguistic demonstrations. We even know that certain superstitious South Africans kill their babies if the upper teeth appear before the lower and here and there in the world the father, immediately after the arrival of his child, takes to his bed while the mother solicitously cares for him in his great anguish.

In an entirely different way medical scientists have made huge strides in the study of man that have worked a revolution in the conditions of life. The plague and pestilences of the Middle Ages, typhus fever, and cholera have disappeared from civilized countries. Scarlet fever, typhoid, and diphtheria are going the same road. The death rate has decreased to only three-fifths of what it was half a century ago.

It would seem in the face of all these anthropological investigations a gross exaggeration to say that man as a whole is colossally ignorant of himself. It is none the less true that he is miserably informed, as well as misinformed, in regard to his own mechanism. His failure to learn about the functions and behavior of his various organs has not always been prompted by the reticence that characterized the mistress of a ladies' seminary who said that it was, "not quite respectable for persons to know about their insides."

Half a century ago there was a great scarcity of information relative to the action and interaction of our vital structures. To-day there is a wealth of material easily obtainable. The anatomy and physiology of man are well known and we are amassing more and more data in regard to his heredity, the nature of his immunity, and the possible causes of his evolution. Unfortunately the dissemination of this knowledge has proceeded very slowly; in many instances it seems to have proceeded not at all, or to have proceeded only after a certain amount of pressure. It is common knowledge that many people object to vaccinations and antitoxins in spite of the fact that the diseases involved have been practically eliminated by these bacterial agencies. As a matter of fact the only really popular physiological pastimes of our modern era seem to be eighteen-day diets and tropical debates on the moral propriety of contraceptives.

It is my contention that an adequate knowledge of one's own mechanism is as essential to success and happiness, and perhaps more so, than any biological knowledge. Since each individual has to put up with himself, and rub shoulders with many other similar individuals, over a period of three score years and ten, what could be more valuable than a knowledge of what makes the wheels go round? It is a comparatively simple process to secure a divorce from a neurotic spouse, but a divorce from one's self has never been arranged, Dr. Jekyll's experiment to the contrary. And it would be just as much of a problem to divorce entirely a dyspeptic stomach or bilious liver. That being true, the more thoroughly we know ourselves the more amicably should we be able to live with ourselves and with others.

This brings us to the point of this paper. What subject-matter in a general course in zoology is most needed and most desired by college students?

It is no secret that students and professors often get along with the same tender spirit of fellowship that exists between a mongoose and a cobra. This state of affairs is due to a multiplicity of causes not the least of which is the subject material presented. We cannot expect the Cinderella formula to function overnight but there would certainly be an immediate improvement in the teacher-student relations if the former kept before him at all times the question, "What in my field do students most need?" It should be kept in mind too that the majority are satisfying a graduation requirement and do not intend to follow a biological career. The requirement is stipulated in the hope that they will receive a rather broad cultural outlook in this field and that which will best fit

them for sane living. If a biological career is their choice there will be sufficient opportunity in other courses to secure the more detailed information which is all too frequently included in the general course.

It goes without saying that a general acquaintance with the animal kingdom is necessary. A background which includes a study of the major phyla with representative types serves as a skeleton upon which all future studies may be fastened. This material should be given during the first part of the year. The question is, "How can it be most advantageously presented to meet the needs of the majority of the students"? Opinions will vary of course, but it is my belief that the most satisfactory method of presentation should include comparisons of the various forms with man himself and should emphasize the economical aspects of these forms which intimately affect man, either negatively or positively.

In a study of Protozoans it is customary to emphasize the structure and behavior of such forms as Amoeba and Paramecium. By means of these peculiar microscopic forms the students receive an introduction into a world where everything is new and adjustments are not easily made. They find it difficult to incorporate into their vocabularies such foreign terms as fission, cilia, pseudopodia, and protoplasm. These words mean but little to them in the beginning. They take on a real significance however if it is explained that we possess in our bodies certain cells, the white blood cells, that are almost identical with the Amoeba. These policemen of our bodies divide by fission just like an Amoeba and on occasion they can be seen throwing off pseudopodia just like an Amoeba. In our nasal passages and in our windpipe are many cilia very similar to, if not identical, with those on Paramecium, that are constantly in motion sweeping out the dirt and dust that would otherwise accumulate. And it may be pointed out that the protoplasm they have observed in these unicellular forms is practically identical with that in any cell of our bodies.

The real interest in Protozoans is manifested, however, when the pathogenic forms are discussed. Malaria, sleeping sickness, and other diseases that attack man hold their attention and they are intensely interested in the effects of the malarial parasites, their transmission by the Anopheles mosquito, and the prevention and treatment by quinine.

The subject of worms never seems to hold an appeal and when Maggie rather vehemently classifies Jiggs as a worm she unintentionally reflects the prevalent attitude toward these lowly creatures. A prolonged discussion of reproduction, excretion, and axial gradients of the worms before a class does but little to raise their prestige. The students react to this in a manner that could best be described as submissive. How different is the response, however, when the discussion changes to tapeworms, hookworms, Trichinella, and other parasitic worms that are so inimical to man. Their interest is not due to the fact that these forms are worms, far from it, nor from the fact that they are parasites. Their interest is aroused because these parasites are human enemies. A tapeworm is one of the most repulsive members of the animal kingdom we are likely to encounter but students are eager to know how we get them, what they do to us, and how we may get rid of them.

The earthworm is always dissected in a general course in zoology and its anatomy studied in detail due to the fact that it is a typical invertebrate and most of its systems are in an early stage of evolution. The students accept the early assignments on the earthworm as necessary evils and comply with as much grace as their individual natures possess. As the work proceeds and comparisons with man are introduced the angleworm is viewed in an entirely different light. Students can be made to see that the digestive tract is made up of somewhat the same parts and performs the same functions as our alimentary tracts; that the nephridia, or kidneys, are practically identical with the tubules that go to make up our much more highly complex and compact kidneys; that the mode of respiration is like ours with the exception that the moist membrane necessary is on the outside of their bodies instead of being internally located as is the case with our lungs; and that the blood and circulatory organs have many points in common both anatomically and physiologically. It is a far cry from a segmented Annelid to a highly-specialized Primate but by means of a vivid comparison the earthworm can be transformed from a creature devoid of all attractiveness into one which possesses at least a singular significance.

Practically any phase of invertebrate or vertebrate zoology can thus be brought home to the students in a fashion that will hold and stimulate their interest.

As the second half of the year's work is initiated we propound again the question as to the student's greatest need. We are more than ever convinced now that his greatest need consists in a knowledge of his own mechanism; his own insides respectable or otherwise. Isn't it rather paradoxical that college graduates should be able to talk French fluently, recite the poetry of Swinburne at length, work highly complex chemical formulae, and at the same time be totally ignorant of the mechanism of heredity in their own bodies and the action of enzymes upon food in their alimentary canals. As a matter of fact some college graduates do

not know there is a mechanism of heredity and to them the word enzyme is a term far removed like relativity or cosmogony.

In a test given recently to a large group of entering freshmen it was discovered that at least a third of the class had no idea whatsoever as to the functions of the liver and to the remainder it was only an organ that aids in digestion. One youngster replied that the liver, "is part of the excretory system which secreted bowel." Not a single member of the group was able to define a hormone and only a few knew that chromosomes are associated with heredity. Many were unable to cope with such every-day words as vitamins, vaccination, and calorie and surprising as it may seem at least a fourth of the group could not give an intelligent answer to such questions as, "Why do we eat?" "Why do we breathe air?" and "What are our kidneys for?"

Would these students be better served if we insisted that they learn the phylogeny of the vertebrates, the classification of the insects, and the anatomy of some typical mammal or would they be better prepared to face the issues of life if they were able to discuss intelligently some of the physiological questions just advanced.

In regard to the subject of sex there is perhaps more need for education than in regard to any question which is intimately concerned with ourselves. At the present time we are limited by modern conventions and prejudices so that our college instruction in this case is only a veneer and a very thin one at that. A great need exists and it is only a matter of time until the instruction will be a part of the regular curriculum of most colleges and universities.

It is our sincere belief that college students need sound scientific direction in many of the ways already indicated, and in many others of a like nature, and that it is the duty of the zoologist to give them this direction. With changing conditions it is time that a permanent moratorium be declared upon some of the time-aged zoological procedures.

DAVID RITTENHOUSE

M. J. Babb

Professor of Mathematics, University of Pennsylvania

[Abstract]

The two hundredth anniversary of the birth of David Rittenhouse, April 8, 1732, will be celebrated this year by an exhibit of Rittenhouse material, including the famous orrery, a large number of his surveying

compasses, transits, zenith sectors, etc. made by his own hand, together with portraits by Peale and Trumbull and others at the Pennsylvania Historical Society, April 4th to the 23rd. A subscription dinner will be given on Friday evening, April 8th. A large public meeting will be held on Saturday afternoon and a long list of papers will be read in the evening at a public meeting of the Rittenhouse Astronomical Society. Rittenhouse was a member, officer, and later succeeded Franklin as president of the American Philosophical Society, was a fellow of the Boston Society of Arts and Letters, and also of the Virginia Society of Arts and Letters, and a foreign member of the Royal Society of London. He had the degrees of M.A. from Pennsylvania, 1767, Princeton, 1782, William and Mary, 1784, and Doctor of Laws, Princeton, 1789. He was from 1780 to 1782 Professor of Astronomy and Vice Provost of the University of Pennsylvania. It was he who first put spider threads in telescopes and invented the collimating telescope in 1785. He served as member of the legislature, as a member of the Constitutional Convention, State Treasurer, First director of the Mint, as well as a member of the Committee of Safety, the Council of Safety, and the Board of War during the revolution. He was recognized as after Franklin the most able man Pennsylvania had produced, and it is to be noted that Pennsylvania did not produce Franklin.

VARIATIONS IN COLOR PATTERN IN THE AMPHIBIAN, *TRITURUS VIRIDESCENS*

H. H. Collins

Zoological Laboratories, University of Pittsburgh

The normal color pattern has been described by Collins and Adolph[1] as follows:

"The adult Diemyctylus (Triturus) viridescens Rafinesque is ordinarily described as the 'vermilion-spotted newt.' A number of small but brilliant spots are arranged linearly along each side of the dorsum. The dorsum is greenish gray, while the ventrum is predominantly yellow (fig. 1). This contrast between dorsum and ventrum is the most conspicuous feature of the skin-pattern; such a difference is usual in vertebrates of all groups, and seems to be fundamental in animal coloration.

"The ventral surface of the body is uniformly and continuously colored lemon-yellow. Scattered throughout are numerous discrete black spots, which may be round, oval, or elongate in outline. The transition between the yellow ground color and each black spot is sharp and never gradual.

"The dorsal surface of the body is pigmented like the ventral surface, except that in addition a uniformly distributed but discontinuous black pigment covers the entire area. Instead of yellow, therefore, the prevailing hue varies between olive-gray and reddish brown. The combination of the continuous yellow and the minutely discontinuous black gives the olive effect, but the color of the blood in the skin may show sufficiently to modify this to brownish or reddish. Spots of dense black are nearly always present in about the same distribution as on the ventrum. In addition to this, the vermilion spots are present on the dorsum. Each of these is surrounded by a conspicuous ring of black, which has a thickness of about one-third the total diameter. The vermilion or red pigment is very similar to the yellow pigment in its minute appearance and continuity. Only the black pigment is obviously discontinuous, each unit being a single cell or melanophore."

In the course of collecting several thousand specimens during the past few years, the writer has had an unusual opportunity to observe variations from the normal pattern as above described. The variations observed in a collection of 2400 specimens taken at Seaton's Lake in February 1932 may be taken as fairly typical.

A few individuals were observed in which the red pigment, normally in the form of large spots, occurred as numerous small points scattered irregularly over the whole dorsal surface. The spots which happened to be in the normal position although exceedingly small, were surrounded by diffuse black rings. This would seem to indicate that the formation of the marginal black rings is not wholly due to the presence of red pigment, since red spots in abnormal positions on the dorsum have marginal rings either imperfectly developed or usually absent. Red spots, out of normal position are, as a rule, in contact with a mass of black, but not in the center of the mass as are the normal red spots.

In the lot of 2400 specimens, four were found devoid of red spots. In other words these four animals were lacking one of the chief diagnostic characters included in the description of the species. The closely related southern species, *Triturus meridionalis*, is normally without red spots.

In one case the pigment in one red spot on each side of the body was drawn out in a broken line similar to the normal arrangement of the red pigment in another closely related species, *Triturus dorsalis*.

[1] Collins, Henry Homer, and Edward Frederick Adolph. The regulation of skin pattern in an amphibian, Diemyctylus. *Jour. Morph. and Physiol.*, Vol. 42, No. 2, 1926.

OBSERVATIONS ON THE LIFE HISTORY OF THE AMPHIBIAN, *TRITURUS VIRIDESCENS*, IN WESTERN PENNSYLVANIA

BY H. H. COLLINS

Zoological Laboratories, University of Pittsburgh

In the region of Western Pennsylvania the vermilion-spotted newt is aquatic in habit in the adult stage.

The young hatch out from eggs laid during the spring breeding season. They remain in the water during the spring and summer but leave the water in the fall following the loss of gills which occurs at the time of metamorphosis. The young immediately following metamorphosis are very markedly negatively geotropic. This negative geotropism is probably the the major factor involved in their leaving the water and migrating upward and away from the ponds in which they pass their larval stage.

After living for a period of from three to four years on land, the animals return to water where they remain for the rest of their lives. This sequence of terrestrial and aquatic stages is characteristic of mountainous regions within the range of the species. However, Noble has found that in ponds on Long Island the land phase is omitted and the entire life cycle is passed through in the water.

In all the regions in Western Pennsylvania ranging from Erie as far south as Seaton's Lake near Uniontown, a distance of about 220 miles, the aquatic populations studied were without exception composed entirely of adults, and during the spring and summer of pre-metamorphic larvae as well. There was no evidence to indicate that in this region, in sporadic cases, the entire life cycle might be passed through in the water.

The populations studied on Presque Isle were of especial interest in this connection, because here we do not have the typical mountain habitat and environmental conditions are in some respects comparable with those on Long Island. Here as in the more mountainous regions the aquatic population is composed of adults and of pre-metamorphic larvae. Conditions may be sufficiently unlike those on Long Island to account for the marked dissimilarity in the life cycle, as regards habitat preferences. On the other hand, it may well be that this habitat preference has become hereditary in the typical mountain forms and persistent in their descendants, occurring at the present time on Presque Isle.

One of the most puzzling features of the life cycle of Triturus is the great scarcity of land forms in the immediate vicinity of ponds where the adult populations are very dense. The writer's observations on this point are in accordance with those of various investigators who have studied this genus. The great rarity of land forms suggests the possibility that the entire life cycle is confined to the aquatic habitat. However, intensive studies of aquatic populations indicate that such is not the case. This land phase of the life cycle present a problem well worth investigation. It may be added that on Presque Isle where conditions are most atypical for the mountain form of Triturus, land animals are very abundant at certain times of the year. This may be due to the restricted land area, resulting in a concentration of the land population which otherwise might become scattered over a much larger region.

MORPHOLOGICAL ANOMALIES IN THE AMPHIBIAN, *TRITURUS VIRIDESCENS*

BY H. H. COLLINS

Zoological Laboratory, University of Pittsburgh

For the past several years the vermilion-spotted newt has been collected in large numbers for use as research material in experimental morphology. During this time, several thousand specimens have come under the observation of the writer and a number of interesting morphological anomalies have been recorded. The variations found in a collection of 2400 specimens taken at Seaton's Lake, near Uniontown, Pa., in February, 1932, may be taken as fairly typical of the population as a whole.

In this collection the following anomalies were observed:

1. A female in which the second digit of the right hand was bifurcated (incomplete reduplication). The second and third digits, normally long and slender were short and blunt. The other appendages were normal.

2. A female, with a partial fusion of digits three and four of the right foot. The digits of the left foot which are normally long and slender were short and blunt.

3. A female exhibiting a complete fusion (with the exception of a slightly bifid end) of the second and third digits of the left hand. All other appendages normal.

4. A female with a regenerating tail. The tail had been removed 1 mm. caudal to the cloacal opening. The regenerated portion was normal in form and 1.5 cm. in length. Pigmentation of the regenerated portion was a blackish-gray, much denser at the level of the spinal column, than along the dorsal, ventral, and terminal margins.

5. A female with a pronounced bifurcation of the third digit of the right foot.

6. A male with an irregularly bifid tail.

7. A male with right forearm about twice the diameter of the left. The hands were approximately the same size.

8. A male with a supernumerary digit, arising from the right arm, near the elbow. The hand was much distorted. This same specimen had a complete duplication of the foot on the same side.

9. A male with a regenerating tail. Had been removed about midway and had regenerated about 7 mm.

10. A male with marked lateral undulatory twists in the tail. The fixed form of the tail was much like that assumed when using the tail in swimming.

11. A male with third and fourth digits fused almost their entire length, slightly separated at the tips.

12. A male with a markedly irregularly malformed right hand.

13. A male with digits three and four (normally long and slender) represented by first joints only.

14. A male with the third digit of the right hand bifurcated and with a much deformed, shortened, and twisted right foot.

15. A male with tail amputated about midway. About 5 mm. of regenerated tissue.

16. A male with left hand deformed. The two normally long slender digits, much shortened.

Two anomalies in addition to the foregoing have been observed by the writer in previous collections:

First, the presence of large lumps variously located on the dorsal aspect of the body. These lumps have a rough surface and may have a diameter as great as half or more of that of the body. They give the animal a much distorted misshapen body form, suggestive of rickets or acromegaly in man. Under the skin, the lumps are made up of dense masses of rounded bodies, having somewhat the appearance under low magnification of a mass of amphibian eggs. The nature of this tissue is now being studied.

A second malformation is seen in the fixed lateral flexures in the spinal column. Specimens may be bent almost double with three or more major flexures along the length of the body. This condition appears to be correlated with a heavy infestation of parasitic trematodes within the brain cavity.

There is a marked contrast in the frequency of occurrence of morphological anomalies between this species of Amphibian and mammalian forms. In the course of his work on deer mice of the genus Peromyscus some years ago, the writer had the opportunity to look over several thousand living specimens of this small mammal. Most of the types of malformation described for Triturus have never been observed by the writer in Peromyscus, and the cases of misshapen hands and feet which did occur were very rare.

The much higher percentage of anomalies may perhaps indicate that the pentadactyl pattern is not as fixed and stable in the amphibian as in the mammalian type. It is to be recalled that the Amphibians were the first vertebrates to develop this type of limb and that Triturus as one of the urodeles is one of the more primitive forms.

One is also reminded in this connection of the fact that the mammalian embryo develops in an environment in which conditions are relatively constant. The amphibian embryo, on the contrary, is exposed to fluctuating temperatures and other changing environmental conditions. Major fluctuations in conditions approaching or transcending the normal limits of toleration on the part of the embryo, may prove to be an important factor in the production of the anomalies observed.

SOME EFFECTS OF X-RADIATION ON THE AMPHIBIAN, *TRITURUS VIRIDESCENS*

Pressley L. Crummy
University of Pittsburgh

The effect of ultra-violet radiation on the pigment pattern of *Triturus viridescens* was studied by Collins and Wolf ('31). They found characteristic changes that were due to ultra-violet radiation. These changes involved, chiefly, a migration of the red pigment which is concentrated in spots on the dorso-lateral surface of the animal. The black pigment cells or melanophores were also caused to undergo a rearrangement. These results suggested a study of the effects of X-radiation on the pigment pattern of the same animal. It was thought that the more rapid vibrations of the X-rays might cause a greater change in the arrangement of melanophores than did the ultra-violet rays. This hypothesis was supported by the work of Levine ('31) on the larvae of the amphibian, *Rana clamitens.*

A series of experiments was started to test out this idea. As was expected, X-radiation did bring about changes in the pigment pattern. Here, again, the red pigment was most susceptible but contrary to expectations the melanophores showed little response. Those dosages which were most effective in causing pigmentary changes were lethal in their action. Had the irradiated animals lived for a sufficiently long period of time the melanophores might have shown considerable change. The dosage which was most effective was that given when the X-ray tube was operating under a potential of 76,000 volts.

In the experiment to be discussed in this paper a one-half millimeter aluminum filter was used. The above dosage was given in three exposures, of twenty minutes each, at intervals of seven days. Ten experimental animals and ten control animals were used in the experiment. The experimentals were placed at a distance of thirty centimeters from the target during irradiation.

Nineteen days after the first exposure, one of the experimental animals began to show a breaking down or dilution of the red pigment. Within a few days several more began to show the same disintegration of red pigment. Seven days after the first noticed disintegration or dilution of the red, one of the experimental animals died. At that time it showed a marked dilution as well as a migration of the red pigment. Within twenty-one days from the first exposure to the rays all of the experimentals had died. During this time the controls remained healthy and active, with no change in pigment pattern. Sixty per cent. of the animals showed the above mentioned dilution and migration of red pigment at and just before the time of death. The other forty per cent. also showed dilution and migration of red pigment but only to a slight extent as compared with the others.

The red pigment in the normal pattern of the Triturus is concentrated in spots which are lined up in a single row on either side of the mid-dorsal line. These red spots are surrounded by black rings formed by concentration of melanophores. Other melanophores are scattered over the body, some of them being concentrated in black spots. The normal pattern is illustrated by figure 21, A. The manner in which the red pigment begins to break down and scatter is illustrated by figure 21, B. This is the type of dilution shown also by the animals which died before the red pigment became wholly broken down. One of the later stages in the disintegration of the red pigment is shown in figure 21, C. Here migration and scattering of the pigment is to be found. Frequently the red pigment became almost entirely obliterated before the animal finally died. Kelly ('32) describes migration of red pigment due to the abnormal disturbance caused by a wound in the dorso-lateral surface of the animal. This type of migration differs markedly from that due to X-radiation.

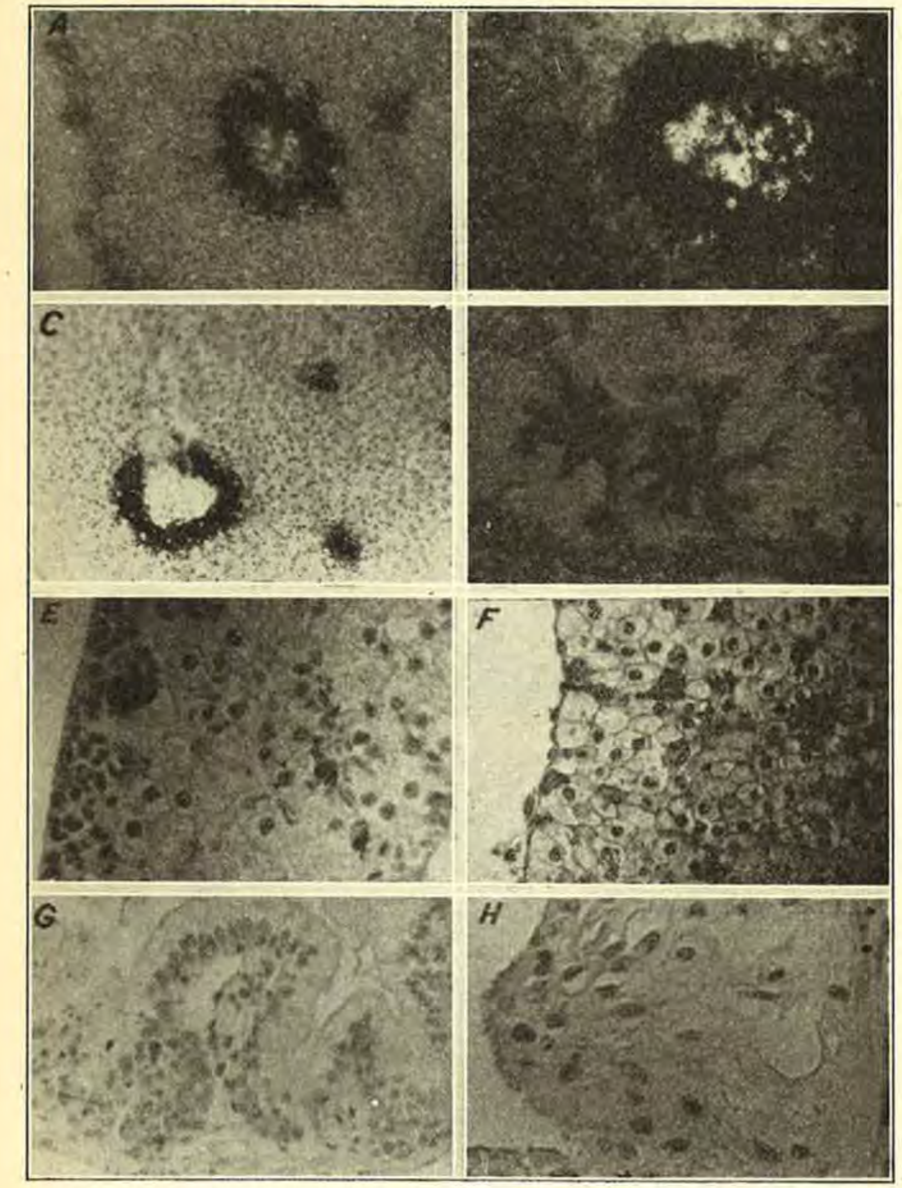

FIG. 21. Photomicrographs of effects of X-radiation on *Triturus viridescens*. A. Normal spot. B. Disintegrate. C. Migration. D. Melanophores. E. Normal liver. F. X-rayed liver. G. Normal intestine. H. Irradiated intestine.

I am at present unable to make a definite statement concerning the final fate of the red pigment after X-radiation. Histological examination of the melanophores shows no definite change in their normally expanded or contracted state. Figure 21, D is a photomicrograph showing melanophores in their normal condition. Present indications seem to be that they make no response to X-radiation. Future work may reveal definite changes from their normal condition.

Post-mortem examinations revealed frequent changes in the appearances of the liver and the intestine. The intestinal wall also seemed to be thinner than normally. Histological examination of the livers and intestines of irradiated animals showed marked degeneration in both cases. A section of a normal liver is shown in figure 21, E. In the normal liver one is able to observe a compact double layer of cells around the outer margin. When examining a section from an X-rayed liver, as illustrated in figure 21, F, one finds that the cortical region has become broken down. A cross-section of the normal intestine shows the usual epithelial lining made up of the ordinary simple columnar epithelial cells. Figure 21, G shows a section of the normal intestine. In figure 21, H one sees that the irradiated intestine shows no epithelial lining. It seems to have been broken down and was probably sheared off from the sub-mucosa. The cell walls of the sub-mucosa seem also to have been broken down. The general appearance of the sub-mucosa in the irradiated intestine is a synctium rather than a tissue made up of distinct cells.

It is well known among X-ray workers that the most active cells are the most susceptible to irradiation. This is well demonstrated by the effect on the epithelium of the intestine which is active in absorption and secretion. The activity of the cells, however, would hardly explain the effect of irradiation on the cortical cells of the liver. Histological examination of other tissues will undoubtedly reveal many remarkable changes.

The few effects of X-radiation on Triturus listed in this paper are indicative of an enormous field of research. A great deal is yet to be learned about the action of X-rays on living tissues. The amphibian, *Triturus viridescens,* proves to be a very convenient and satisfactory source of research material for the study of this action.

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HISTOGENESIS OF BLASTEMA CELLS FOLLOWING AMPUTATION OF THE TAIL OF THE NEWT, *TRITURUS VIRIDESCENS*

Eugene Cutuly

Zoological Laboratories, University of Pittsburgh

Following amputation of the tail of *Triturus viridescens,* sections including normal and regenerating tissues were removed and fixed at intervals of 24 hours; they were cut at from 10–12 micra, mounted, and stained with Mallory's Triple Stain. Studies were made only on tails which had regenerated for from one to seven days.

The lead in active regeneration is assumed by the epidermal cells which surround the wound area. Large mounds of these cells form at the circumference of the wound. Soon after some of these cells are seen coming into the wound area. After two days the wound is completely covered with epidermal cells from normal epidermis. These cells have responded to a disturbance of equilibrium by resuming their natural function of covering surfaces.

Shortly before epidermal cells have completely covered the wound, a mesenchymatous matrix can be seen in regions beneath the epidermal cells. Usually the matrix can be seen first where epidermal cells and connective tissue are in contact. The origin of this matrix has not yet been determined, but its resemblance to the intercellular substance of embryonic connective tissue would lead one to postulate its genesis from connective tissue. This view finds some corroboration in the generally accepted opinion that cells are assimilative and secretory agents concerned in the formation of undifferentiated ground substances. The fenestrated appearance of the matrix, characteristic of embryonic connective tissue, might lead to the assertion that dedifferentiation of normal connective tissue into an irregular network of interlacing fibers having a fenestrated appearance approaches the embryonic condition.

Concomitant with the appearance of the mesenchymatous matrix there is a proliferation of cells whose outlines are indistinct. As stains which would show from what tissues these small cells arise were not used in this study, only a conjecture based on later studies will be made in deriving these cells from connective tissue. Since other workers have found that these small indifferent cells may be the anlagen of many types of tissues, they have been called blastema or formative cells.

After three days the mesenchymatous matrix is well-defined. Wherever connective tissue has been cut, a matrix appears at the cut surface. Delicate focusing on the matrix shows it to contain many of the small blastema cells. It may be said with some degree of assurance that blastema cells probably first arise from connective tissue, and that these, in turn, secrete an intercellular substance, the mesenchymatous matrix. At the end of four days blastema cells can be seen definitely arising from connective tissue. They enter into the formation of a matrix and for a time are lost to view. About this time the matrix becomes filled with many blood cells.

In the three or four day stage the formative cells within the mesenchymatous matrix become differentiated. During the process of differentiation they grow considerably and come to be comparable in size and shape with normal connective tissue cells, rather than blastema cells, although these terms are often used synonymously. Blastema cells continue to differentiate within and to leave the mesenchymatous matrix as embryonic connective tissue cells which migrate to or, in some way not yet observed, arrive at regions just beneath the epidermal cells, forming a layer closely adherent to the regenerated epidermis.

The fate of blastema cells has not yet been determined. Korschelt (1927) believes that they may give rise to many types of tissues, such as: muscular, skeletal, and various supporting tissues, not only of the body, but also of the nervous system. Studies are now in progress to determine experimentally the fate of blastema cells.

EFFECTS OF CAPTIVITY ON THE SALAMANDER, *TRITURUS VIRIDESCENS*

HELEN M. HILSMAN

Department of Zoology, University of Pittsburgh

When *Triturus viridescens* are kept in the laboratory for any length of time, they show certain characteristic modifications which may be regarded as effects of captivity. Very soon after collection the animals lose their secondary sexual characters even during the breeding season, and, as a rule, refuse to breed in captivity. They often crawl out of the water and remain until the skin is dry, a reaction which rarely occurs in nature.

Another change in behavior is the loss of the feeding reflex in some specimens, and this group of animals shows marked effects of inanition. The masculature is so reduced that the salamander is ''bony'' and often has curvatures in the back and tail with a reduction in body length. The skin becomes thin and flaky, tearing easily when the animal is dissected. Even the internal organs show reduction, the spleen, mesonephroi, liver, intestines, and lungs are reduced in the order named. Frequently the organs are covered with minute blood vessels indicating resorption. The gonads remain only as small ridges and the gonoducts as thin threads with few convolutions. No organ, however, is entirely resorbed as there always remains some remnant of it. There is not so much a reduction in the number of cells as in the cell size. These data agree in general with previous work on the effects of starvation.

The secondary sexual characters once lost rarely reappear in the laboratory. This fact may be directly correlated with the changes in the testis. The testis becomes enlarged to at least three times the size of the normal. It loses the bilobed arrangement of anterior spermatogonial and caudal sperm lobes. The gonial material has become displaced over the entire surface of the testis as a cortex and the sperm lobe has been crowded into the center. The characteristic cyst structure is unchanged and the three elements of germinal tissue, nutritive cells, and connective tissue sheath are present in their normal proportions. The spermatogenetic process is unchanged and the sperm are formed normally, but after their formation they undergo degeneration. Degeneration granules may be observed among the central sperm cysts.

The gonoducts are less sensitive to laboratory conditions and only show marked effects after one year's time. They become thread-like with a decrease in length. The lumen is not always evident and there are only a few convolutions. However if the animals are examined after 3–6 months the ducts are normal regardless of the large size of the testis. In other words, the changes in the gonoducts may be a secondary effect due to changes in the testis.

The fat body in this group of salamanders is extremely variable; it may be either large or small. However, in the stock animals the fat body is always pale yellow in color in marked contrast to the bright orange color of that organ in freshly collected specimens.

Some of the factors which may be, in part, the cause of changes in the captive salamanders are:

1. Food, which may be different from the food of the salamander in nature.

2. Chemistry of the water—frequent changes of tap water.

3. Crowding.
4. Temperature—too high in the laboratory. (Fisher, E., 1929.[1])

To summarize:

1. There are marked changes in the salamanders after prolonged captivity.
2. The secondary sexual characters soon disappear.
3. The testis becomes enlarged, accompanied by a concentric arrangement of the tissues.
4. The gonoducts atrophy after the salamanders are kept in the laboratory one year or longer.
5. Some of the salamanders lose the feeding reflex and suffer from the effects of inanition.

SEASONAL CHANGES IN THE GONADS OF THE AMPHIBIAN, *TRITURUS VIRIDESCENS*

HELEN M. HILSMAN

Department of Zoology, University of Pittsburgh

It has long been known that *Triturus viridescens* has both a false breeding season in the fall of the year and a true breeding season in the spring. The normal sexual reactions are present in both seasons but egg laying occurs only in the spring. The question arises whether the false breeding season is interrupted by the winter or if there are two spermatogenetic cycles corresponding in time to the breeding seasons. The present study of the annual germ cell cycle was undertaken in order to throw some light upon the inter-relationship between the true and false breeding season. The present report is confined to a study of the germ cell cycle in the male.

NORMAL STRUCTURE OF THE TESTIS

The testis of *Triturus viridescens* is made up of two lobes. The anterior or spermatogonial lobe contains spermatogonia and stages in spermatogenesis up to the metamorphosis of the sperm. The caudal, or sperm lobe, contains the cysts of ripe spermatozoa. The structural unit of the testis is the cyst, always composed of three parts, the germ cells, the nutritive cells, and the enclosing sheath of connective tissue. These three structures maintain their identity throughout the spermatogenetic process. The cysts are spherical and terminate the numerous divisions of a much branched collecting duct. As the cysts originate with one or two spermatogonia, the succeeding cells are the result of many divisions of the primary spermatogonium. The divisions occur simultaneously so that the cyst contains cells of only one stage in development at a time. However other cysts of the testis may be in more advanced stages so that there exists a succession of developmental stages in a single testis.

[1] Fisher, E. The Effects of Temperature on the Salamander *Triturus viridescens* (Masters Thesis, University of Pittsburgh).

SEASONAL CHANGES

In contrast to the current idea of only one annual sexual cycle, I find two complete spermatogenetic cycles in the observations on the seasonal changes. The first is a short cycle in March and April during the active spring breeding season, and the second cycle begins at the close of the spring season and is not completed until October, the time of the false breeding season. During the false breeding season some of the sperm are deposited in spermatophores and during the winter the remainder of the sperm are stored in the ducts, leaving a large evacuation area and gonial material of only primary and secondary spermatogonia. In February there is an increase in gonial material.

In March and April the testis contains all stages in spermatogenesis from primary spermatogonia to mature spermatozoa. The gonial lobe occupies about half of the testis and the sperm lobe contains loosely packed sperm bundles and a small evacuation area. This cycle is characterized by its gradual metamorphosis of spermatids in only a few cysts at a time. The fact that all stages in spermatogenesis are present in March and only primary and secondary spermatogonia in February proves that this is an independent cycle during the active spring breeding season.

At the close of the spring breeding season all of the sperm that were not discharged undergo degeneration and the testis at this time is made up exclusively of gonial material. In May there are only primary and secondary spermatogonia in the gonial lobe. These proliferate rapidly and in June the testis is much larger and contains a few primary spermatocytes in addition to the primary and secondary spermatogonia.

Beginning in June the whole testis acts as a unit, all the cysts being in about the same stage of development. The testis in July contains an abundance of primary spermatocytes which is one stage in advance over the condition in June. The August testis shows a still greater advance as loose cysts of spermatids and stages in metamorphosis are the most abundant.

Although the entire testis is still composed of gonial tissue, a new gonial lobe of primary and secondary spermatogonia is beginning to form. These cells increase in number gradually but do not enter into a new stage of development until March. Metamorphosis of the entire testis is completed in September but the sperm are not packed into tight bundles until October. Some of the sperm are deposited in spermatophores during the false breeding season, leaving a small evacuation area. From November through February the remainder of the sperm are evacuated and stored in the ducts until spring. The testis at this time is composed of a gonial lobe containing only primary and secondary spermatogonia. The sperm lobe is reduced and there is a large evacuation area.

From this stage we again enter the Spring breeding cycle; and, in conclusion, the spring cycle is characterized by gradual development of sperm in only a part of the testis at one time and the second cycle is characterized in the development of sperm by the metamorphosis of the entire testis which acts as a unit. These two spermatogenetic cycles correspond in time to the fall and spring breeding seasons.

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THE DIFFERENTIAL SUSCEPTIBILITY OF AN AMPHIBIAN HOST TO IMPLANTED MAMMALIAN TISSUES

Henry Idzkowsky

Zoological Laboratories, University of Pittsburgh

Adult albino rat testicular and thyroid tissues and ossifying cartilages of new-born rats were implanted subcutaneously into the lateral body wall, and freely into the peritoneal cavities of *Triturus viridescens*. At intervals, one to three months after implantation, the lateral body walls were removed with the implanted tissues, prepared, and stained with Delafield's Haematoxylin and Eosin. Intraperitoneal thyroid implantations were removed with their host attachments and treated similarly.

The histological structure of implanted testicular tissues could not be studied due to the extremely rapid disintegration of these tissues after they were implanted. The implanted tissues become a mucous-like mass. The area of implantation was continually filled with liquid disintegration products until the hosts died 24 to 100 hours after the implantations were made.

Thyroid tissues when implanted had no apparent injurious effects on the hosts. Implantations did, however, effect an irritability when the hosts were exposed to bright light after having been kept in darkness. There were no other changes, *e.g.*, changes of pigmentation.

The liver of the host showed a marked affinity toward intra-peritoneally implanted thyroid tissue. There was always an attachment of the implant either directly with the liver or by a microscopically small mesentery to the liver epithelium. Histological sections show that where the connection is a direct one with the liver, the hepatic cells adjacent to the thyroid appear to have been broken down and to have dedifferentiated. In some cases the implant was also attached to the serosa of the stomach by a short mesentery.

Histologically the implanted thyroid tissue structures were somewhat altered. The implants are characterized by a hypertrophy of connective tissue which encroaches upon the follicles. There is a reduced amount of colloid present in the follicles remaining. The implants are also characterized by aggregations of amphibian erythrocytes within their blood vessels. These changes occur during a post-operative period of two months. The histological study of this implanted tissue seems to warrant the conclusion that it is alive.

Objective examinations show that when humeri or femurs of new-born rats are implanted the hosts suffer no detrimental changes.

Internally the host reacts to subcutaneous implantations by completely encapsulating the foreign tissues with connective tissue sheaths which originate in the intra-muscular connective tissue of the hosts. The sheaths are fused with the perichondrial connective tissue of the implants. In some cases, where perhaps the epidermis has been doubled under itself at the incision, the epidermal cells proliferate inwardly and attempt to surround the encapsulated tissue. This invading cell mass, which is 3–4 cells in thickness in the epidermis, becomes 12–14 cells in thickness at its point of growth through the dermis, and in the region of growth about the implant.

Intra-peritoneal implantations are secured by means of mesenteric attachments to the articular cartilages of the implant. These supporting mesenteries carry with themselves blood vessels which branch and anastomose throughout the perichondria of the articular cartilages and apparently connect with the forming Haversian canals of the implants. The latter statement is suggested by the fact that if the implants with their attachments are fixed in a 10 per cent. formalin solution, the network of blood vessels cannot only be readily demonstrated but also the discolored blood pigment can be seen to extend part way into the shafts of the implanted tissues.

Ossifying cartilage when implanted presents a puzzling problem concerning its viability in this new environment. Tissues implanted for as long a period as four months maintain their normal histological structure which is apparently that of living tissue. It was incidentally noticed that there were no changes of the gross anatomy of the implants nor were there any detectable evidences of growth on the one hand or resorption on the other.

VITAL STAINS IN RELATION TO DIFFERENTIAL SENSITIVITY TO LIGHT N THE AMPHIBIANS, *TRITURUS VIRIDESCENS*

J. Lorain Jones

Zoological Laboratories, University of Pittsburgh

Specimens of *Triturus viridescens* of approximately the same size, same color pattern, and of the same sex were placed in vessels containing various basic dyes of a concentration of 1:500,000. Some of the dyes such as neutral red, methylen blue, and nile blue sulphate which were non-toxic produced very satisfactory results. Within five or six days the animals were very heavily stained. Other dyes such as acridine red, acridine yellow, rhodamin, pyronin 2g, cotton blue, capri blue, and victoria blue proved to be very toxic—death of the animals resulting within two hours.

Animals were also placed in various food dyes. Some of them such as amaranth, ponceau sx, ponceau 3R and erythrosine produced fatal results within a few hours. Specimens did not take up any of the stains. In other food dyes such as brilliant blue, fast green, and light green, animals remained for a period of five or six days; it was observed that only a very slight amount of the dyes were taken up by the animals.

To all of those toxic dyes of the same concentration, except food dyes, a small amount of sodium bicarbonate was added. It was noted that these dyes did not show any toxic effects upon a second series of animals of the same physical characteristics. The staining process was completed within two days. When a small amount of sodium bicarbonate was added to neutral red, methylen blue, and nile blue sulphate which were non-toxic under normal conditions, the staining process was reduced from five or six days to three days. It rendered toxic dyes non-toxic and hastened the staining process for the non-toxic dyes.

Stained individuals were removed from containers and placed in a vessel containing tap water for several days to remove the excess stain. Dyes such as brilliant blue, fast green, and light green did not remain fixed in the specimens after they were placed in water.

The stained animals were next placed in a vessel in which the water was kept at a uniform temperature by adding ice. They were exposed to a very strong artificial light of an intensity of 200 watts for a period of two hours to determine the photo-sensitizing power of the dyes upon them.

The red dyes had the strongest photo-sensitizing effect. Animals died after one hour of exposure. In the various other dyes, animals became less active as compared with unstained controls and returned to normal conditions three hours after exposure. There were no ill effects of dyes upon the individuals that were not exposed to artificial light. The dyes which gave satisfactory results are arranged according to their photo-sensitizing powers as follows: neutral red, acridine red, acridine yellow, rhodamin, pyronin 2g, nile blue sulphate, methylen blue, cotton blue, capri blue, and victoria blue.

Conclusions

1. Some of the food dyes proved to be very unsatisfactory as vital stains because of their acidic property which rendered them toxic; other food dyes which were non-toxic did not remain fixed in the specimens after they were placed in tap water.

2. Dyes which were toxic in a very dilute concentration were rendered non-toxic by the addition of sodium bicarbonate.

3. The time required to complete the staining process in the case of those dyes which were normally non-toxic and to which sodium bicarbonate was added was reduced from five or six days to three days. In the case of other dyes which were rendered non-toxic by the sodium bicarbonate, the time required to complete the staining process was two days.

4. Red dyes such as neutral red and acridine red showed the strongest photo-sensitizing effects.

5. Other dyes reduced the activities of animals.

6. Animals which were not exposed to light showed no ill effects of dyes.

THE PIGMENTARY SYSTEM OF THE AMPHIBIAN, *TRITURUS VIRIDESCENS*

K. L. Kelley

Zoological Laboratories, University of Pittsburgh

Introduction

Much work and more speculation has been done on the pigmentary systems of Amphibia. Most of the work has been limited to Anura and to such urodeles as the Colorado Axolotl and Necturus. With the exception of Rogers (1906) and of Collins and Adolph (1926) apparently little work has been done on the pigment of *Triturus viridescens*. It may be pertinent, therefore, to bring together most of the material bearing on this particular phase of the general problem of pigmentation before elaborating the author's experiments to date.

Hogben (1924) postulated three pigmentary effectors in Amphibia, viz., epidermal melanophores, dermal melanophores, and dermal xantholeucophores or interference cells. In addition he speaks of such deep-seated effectors as the retinal pigment cells and the internal melanophores.

Many theories have been advanced to explain the darkening and lightening of the skin. Two of these seem to have the greatest following. The first dates to v. Wittich (1854) who considered the changes due to amoeboid movements of the melanophores. Consequently these changes have been called "contraction and expansion" of the melanophores. This view has found support in the work of Bimmermann (1878), Carnot (1896), and Hooker (1914).

Opposed to this concept have been the findings of Lester (1858), Muller (1860), Kahn and Leiben (1907) and Dawson (1920). These investigators have postulated rather than amoeboid contraction and expansion of the melanophores, the aggregation and dispersion of melanic granules within the cells themselves. Hogben (1924) while inclining toward this view continues to use the terms "contraction" and "expansion" as did the previous workers.

Collins and Adolph (1926) found that darkness and cold caused an "expansion" of melanophores and pituitrin a "contraction" of melanophores. The effects of light and darkness, of heat and cold, has been substantiated by other workers with amphibian and piscian materials. However, the effect of pituitrin injections and feeding was contradictory to that observed by Allen and Swingle, Krogh, Hogben and Winton, Noble and recently by Lundstrum and Bard.

Yellow pigment is diffuse and does not migrate into a wound area but "appears suddenly in situ." (Collins and Adolph, 1926). This pigment has been analyzed for other amphibian forms and found to contain carotin and xanthophyll (Palmer, 1924).

Red pigment often breaks down into small spots which vary in color from lemon to orange yellow. It also has been described as passing toward wound areas. Collins and Adolph considered this a purely mechanical process of migration and felt that it occurred only in regenerating or pathological conditions.

Methods and Material

In order to check on the effect of darkness and low temperature on the melanophores, the author kept animals in the ice box for periods of from one week to eighty days. All showed increase in melanic pigmentation after a week in the ice box. The animal left for the longest period (eighty days) was at the beginning of the experiment a light olive green hue and the melanophores showed few stellate processes. Observations taken weekly with the binocular microscope showed a gradual darkening of the pigment of the dorsum and an increase in length and density of the dendritic processes of the melanophores. During this treatment the animals remained healthy, although they ate less frequently and smaller quantities of food than controls kept at room temperature in ordinary light.

Many animals kept in the laboratory for experimental work lighten and the author observed that successful pituitary removal resulted in the lightest colored animal in this group. Intraperitoneal injections of anterior pituitary extract resulted in emaciated animals when large doses were given but no effect on the melanophores was observed. Post-pituitary extract injected intraperitoneally, however, caused darkening of the skin within four to twenty-four hours. Examined at this time the animals showed numerous dendritic processes heavily filled with melanin granules. The controls kept under the same conditions showed no darkening and the melanophores were rounded and comparatively small.

Pathological conditions frequently seem to cause a general fading of the pigment. In eight such animals observed during the course of experiments, there appeared to be not only a disappearance of the melanic granules but also a dilution of the yellow and red units.

In large ventral skin removals the wound healed by inpushing of the epidermal layers followed by the dermal growth beneath. Such wounds appeared bluish gray after a week and after four weeks melanophores had begun to establish themselves as definite black masses. Yellow pigment did not appear for some time but later appeared near the margins of the wound and within a few days to a week was spread over the entire regenerating surface.

Wounds of the lateral surface were usually sufficient to cause a streaming of the adjacent red spots toward the denuded area. The black ring surrounding the red spots usually broke down and the red streamed from spots at as great distances from the edges of the wound as 5.5 and 5.9 mm. The red streamed into the wound in many cases while in others it seemed to disappear without reaching the regenerating area.

Grafts often had the same effect but in three cases red spots 1.1 mm. from the edge of the graft remained unaffected by the graft. Restreaming of the red from a graft back into the original spot and the gradual reformation of the spot with its ring was observed in two cases: one when the affected spot was 1.5 mm. from the edge of the graft, the other at a distance of 2.3 mm.

Tissue cultures have so far given very contradictory results as regards the action of melanophores.

Discussion

Noble (1931) believed the color of *Triturus viridescens* is due to a combination of elements; the olive green effect of the dorsum being the result of dermal melanophores showing through overlying guanophores and through the still more superficial chromatophores which contain the yellow and red pigments.

The ventrum appears yellow due to a lack of underlying melanin which appears only in spots on this surface.

The factors which control color change have not been completely determined but the author wishes to suggest a possible metabolic connection since melanin and granin are not end products of excretion but possible products in the chemical steps involved in such reactions.

The red pigment may on further analysis prove to be intensified yellow since chemical analyses have indicated the presence of carotin and xanthrophyll in both. Quantitative analyses remains yet to be accomplished.

Summary

1. Pigment of *Triturus viridescens* consists of three separate units, viz., deep dermal melanophores, crystalline guanophores and outer dermal chromatophores or xantholeucophores.

2. Satisfactory explanation of melanophore changes will include a consideration of metabolic differences.

3. Red pigment spots may be affected by wounds created at relatively great distances from such spots.

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SOME OBSERVATIONS ON THE REGENERATION OF APPENDAGES IN THE AMPHIBIAN, *TRITURUS VIRIDESCENS*

James R. Stiefel

Zoological Laboratories, University of Pittsburgh

During February, 1931, several specimens of *Triturus dorsalis* whose humeri had been bared from the elbow joint to the shoulder, apparently due to the nibbling of other animals, were noted in a tank containing about thirty animals. The forearm was entirely missing and the flesh had been removed from the humerus, leaving it bare from the elbow to the shoulder. These animals were segregated to see what attempt, if any, they would make at a restoration of the missing limb.

At the same time that these animals were noticed, operations were performed on a number of animals of the same species to test the time required for normal regeneration of the limbs to take place. The right fore-limb was amputated at a point midway between the wrist and the elbow. These wounds healed and the "black tip" of regenerating tissue was apparent within two days after the operation. In the case of the animals with the humeri exposed no regeneration was apparent for a period of two weeks, at the end of which time the humeri were extruded. From the time of the extrusion of these bones, regeneration was very rapid. Within four weeks after the start of regeneration, this process had gone on to the point where digits were starting to form, which was a much more advanced state of regeneration than that attained by the animals operated on at the time that these special cases were noted. In considering this time the fact must be noted that these animals with the humeri exposed showed no outward signs of regeneration during the two-week period in which the bones were still in place, while regeneration was steadily progressing in the case of the normal animals. These observations showed the animals with the humeri exposed as having regenerated their fore-limbs from the shoulder to the point where digits were forming within a period of four weeks while those having their limbs amputated at a point midway between the wrist and the elbow had not reached this stage of regeneration after six weeks.

The observations noted on these chance discoveries prompted the planning of a series of experiments to show whether or not this apparently accelerated regeneration was a standard regenerative procedure for this species, and also if it would apply equally as well to *Triturus viridescens.*

With this idea in view a total of six experiments were carried through, one involving *Triturus dorsalis,* and five involving *Triturus viridescens.* The one experiment involving the *Triturus dorsalis* was worked out for the purpose of establishing the reliability of my former observations, and after this point had been cleared up the work was confined exclusively to *Triturus viridescens.* These experiments cover a period of ten months, from June, 1931, to March, 1932.

In preparing the animals used in these experiments, the fore-limb was first amputated at the elbow and the tissue then removed from the humerus from this point to the shoulder joint. Some variations in regeneration were noted at first, which later proved to be due to the fact that the muscular connection between the humerus and the scapula was not completely destroyed. This variation was later eliminated by the expedient of running a hot needle around the bone, thus insuring the severance of all muscular connections between the exposed bone and the body but leaving the joint ligaments in place.

After the performance of this operation the wound areas assumed a characteristic "fuzzy" appearance which was presumably due to the action of the water on the lacerated tissue surrounding the bone. About one week later this appearance was altered, the wounds showing signs of closing up. This process was followed by the appearance of a bulge around the humerus which persisted until the bone was lost. The formation of this bulge has been interpreted as meaning that very likely some regenerative processes were going on within the shoulder of the animals, but no outward signs of regeneration were visible in any case until the time when the humeri were extruded. In contrast to this behavior the controls, whose fore-limbs had been amputated at the level of the body, had completely healed and started to regenerate quite definitely within three to four days after operation.

The bones in the experimental animals were found to be extruded within an average time of twenty days after operation. This twenty day period between the time of the operation and the time when the bones were extruded means, with allowances made for the beginning of the regenerative process in the control animals, that the controls had a start of approximately seventeen days over the experimental animals in their regeneration. Gross observations taken on one hundred eighty animals showed this accelerated growth to continue until the time when the experimental animals had compensated for the time lost while the humeri were still in place. After overtaking the controls the rate of regeneration slowed down until the experimental animals were found to be regenerating on even terms with the controls. From this point on the two sets of animals were found to regenerate at approximately the same rate.

Average measurements taken on forty animals, twenty experimental and twenty control, showed after two weeks from the time of operation no regeneration in the experimental animals but a plainly noticeable amount of regeneration in the control animals. The extrusion of the humeri of the experimental set took place within a period of from two to five weeks after the date of operation. The majority of the humeri were extruded, however, during the early part of this period, only one being lost during the fifth week. At the end of the fifth week measurements were taken which showed the average regeneration of the experimental group to be 1.34 mm. and the average regeneration of the control group to be 1.3 mm. Two weeks later regeneration of the experimental group was 2.34 mm. and that of the control group 2.82 mm.

These measurements substantiate the gross observations previously made. Here we find a group of animals which showed no evidences of regeneration in the first two weeks following operation, practically equalling, at the end of five and seven weeks respectively, the regeneration of a series which had been regenerating for two full weeks before this experimental group showed any signs at all of regeneration; hence, we must admit the existence of an extremely rapid rate of regeneration immediately following the extrusion of the humeri with a subsequent decelleration until we find, at the end of five and again at the end of seven weeks, regeneration proceeding at the same rate in both groups.

No attempt has been made as yet to determine the cause of this acceleration of regeneration following this particular operation. The experiments mentioned in this paper were planned only with the idea of definitely establishing the existence of this difference in rate of regeneration.

TRANSPLANTATION OF HEAD GLANDS IN THE VERMILION-SPOTTED NEWT, *TRITURUS VIRIDESCENS*

Walter G. Urban and H. H. Collins

Zoological Laboratories, University of Pittsburgh

In the vermilion-spotted newt, *Triturus viridescens,* the males are readily distinguished from the females by the presence in the former of dense masses of black pigment, the so-called nuptial pads on the ventral aspect of the hind limbs and by the broad ruffled tail fins. In addition to these temporary secondary sexual characters, the males are further distinguished from the females by their possession of head glands which are permanent structures. These head glands appear as minute pits in the integument, directly caudal to and at the level of the eyes. The number of pits varies from three to four on each side. In the females the glands are rudimentary or absent. The pits are lined with simple saccular glands which open by small ducts. They function during the breeding season by secreting a substance which attracts the female and causes her to collect the spermatophores which are deposited in the water by the male.

Although in vertebrates in general thus far studied, sex is determined, as a rule, at the time of fertilization, the development of the external secondary sexual characters distinguishing males from females has been shown in a large number of cases to be controlled by hormones produced by the germ glands, ovary, and testis. The ovary in some forms appears to exert an inhibiting effect. However, there is some evidence to indicate that secondary sexual characters as, for example, the type of spur in the domestic fowl is determined long before the germ glands became functional, possibly at the time of fertilization.

The ease with which areas of integument may be transplanted from one individual to another in the vermilion-spotted newt suggested this method of studying some of the factors responsible for the development of the head glands in the male and their suppression in the female.

The head glands, together with a small area of surrounding integument, were excised from one side of a male donor and grafted upon a female host in a wound bed made by removal of an area of host integument equal in size to the graft. The grafts were located about midway between the pectoral and pelvic regions, near the dorsal median line. In this position the grafts were less likely to be disturbed by movements of the animal after recovery from the anaesthetic and were in a convenient location for observation. In order to rule out the possibility that any changes observed might be due to shock of operation and transplantation, a control series of operations was included in the study. In the control experiments, the head glands and adjacent integument from the opposite side of the donor were transplanted to male hosts. A total of one hundred and twenty-five animals were used in the course of the experiments.

The head gland grafts on the male hosts persisted without change for a period of about two months. After this time the grafts began to lose their yellow pigment and gradually became grayish white. Following loss of the normal color the pits became closed. When examined histologically, the glands appeared normal four weeks after operation. In the course of three months the glands underwent involution to some extent but appeared functional. Later the grafts were invaded by lymphocytes and connective tissue and the glandular epithelium gradually became atrophied.

The head gland grafts transplanted to female hosts became attached quite as readily as in the males. However, gross changes, including shrinkage in size and loss of pigment, began much sooner than in the males. The grafts gradually disappeared while persisting in the males. Sections of the grafts taken thirty-two days after operation showed advanced stages of degeneration of the glandular epithelium. Most of the head glands had disappeared by this time.

The much more rapid atrophy of the head glands on the female hosts appears to indicate an inhibitory effect of the ovary. The differential rate of resorption of the integument surrounding the glands needs further investigation of the possibility of the existence of "sex antagonism" between the tissues of the male and female.

EFFECTS OF REMOVING THE THYMUS GLAND FROM THE DOMESTIC HEN

Eugene C. Miller

Bucknell University, Lewisburg

It is extremely amazing to observe the products of a domestic hen which has been deprived of only one of her many ductless glands—namely, the thumus. At present, little is known concerning the function of this particular gland. Although it has been previously "hinted" that the gland is essential for the production of calcium, no definite function has been assigned to it. Thus it was the function of this organ in which the writer is particularly interested.

These glands are located in the neck of the fowl, arising from the old gill clefts, and degenerating some three or four centimeters toward the heart, thus appearing as rather long, cylindrical tissues which has in its structure a very distinct cortex and medulla.

The actual experiment was run on two healthy laying White Leghorn hens. The hens at the time of selection were one year old and fully developed. Let us call these hens A and B respectively. From A the glands were removed with a tenique that did not disturb other organs located in this particular region. B was not deprived of any of her native makeup. She served merely as a control.

In approximately a month's time A showed a distinct deviation from the normal hen in several respects. She almost immediately went into a complete molt with her egg production dropping some 75 per cent. from the normal hen B. The first several eggs received were apparently normal; however, from that time until the present date, no normal eggs have been laid by A.

The first egg showed a slight decrease in size together with an irregular distribution of calcium in the texture of the shell, the contents of the egg being apparently normal. Thirteen days after the previously described egg was laid, another specimen was obtained. This egg deviated considerably more than the first one from the normal eggs that were being obtained from B. Although the egg had a volume approximately the same as B's, the shape and shell texture were very different. The egg contained a very small yolk with an increased amount of albumen. This was the first disturbance of the ovary, as shown by the egg produced, that was noted by the writer. The egg had a very definite pointed appearance at its one pole, together with a considerably flattened surface throughout the center of the egg. Both ends of the egg showed evidence of an irregular calcium deposit that was considerably heavier at the poles than throughout the center.

The third egg obtained from A is of particular interest, for it indicated not only a remarkable decrease in size, but likewise a definite disturbance in its ovulation processes. In volume, it had only approximately half that of the normal egg. Upon close examination it was found to be completely deprived of a yolk and contained nothing but albumen. The shape was likewise very amazing. In an analogy it resembled very closely a short "sausage." The diameter of this specimen was approximately the same throughout its length, which had a distinct oval appearance with a definite constriction near each end. Although it had a shell it portrayed an irregular calcium deposit and as a result was very fragile. This was the last egg laid by A that had a firm shell.

The fourth egg, which was laid by A 17 days after the third one, is probably the most abnormal egg received by the writer to date. The volume of the egg was two-thirds that of the normal egg. The unusual feature of this specimen was that it contained what might be termed a "tail" at the smaller end of the egg. It had no definite shell, being merely enveloped in a soft semi-permeable membrane. The "tail" was solid, having a semicircular appearance and a cartilage-like texture. It measured 3.7 cm. in length.

Specimens 5, 6, and 7 were of a similar shape. Each was successively smaller than the previous one. All three contained only albumen.

From these brief observations it can be readily seen that this particular gland has a specific function in the domestic hen. This function is strongly indicated in the marked decrease in egg production, size, and calcium secretion, change in shape, etc., which is immediately detected when the gland is removed.

THE SEASONAL DISTRIBUTION OF BATS IN PENNSYLVANIA

By Charles E. Mohr

Reading Public Museum and Art Gallery

In addition to doing considerable collecting during the summer as a member of collecting parties from the Reading Museum, I have visited between November, 1930, and March, 1931, all of the caves, about eighty, known to the Pennsylvania Topographic and Geologic Survey. These caves are all listed and described in the second edition of a report of that Survey, "Pennsylvania Caves," by Ralph W. Stone. I have found bats in 72 per cent. of the caves of the State, and in the following account I will use the term "bat caves" to describe this group.

The collecting in Berks County was done under the direction and with the active participation of Earl L. Poole, whose forthcoming bulletin, "Mammals of Berks County," contains the most detailed studies found in any Pennsylvania list.

The present account describes the distribution of the thirteen species of bats known from the State, giving special attention to data on migration and sexual segregation.

Published records of careful observations by well-known naturalists have definitely established the fact that some of the tree-dwelling species of bats are migratory. Such species retreat southward to avoid severe climatic conditions, while the cave-inhabiting species hibernate in caverns where there is little fluctuation in temperature.

Formozov, in Russia, has made important observations of the migrations of tree-dwelling bats and notes that the migrations coincide with that of some species of insectivorous birds, and that the speed of their migration, 30–60 kilometers a day, corresponds exactly with that of many of the smaller forest birds.

I have noticed a striking sexual segregation in many species in Pennsylvania, both in summer and during hibernation. Counts of considerable series of specimens of different species have usually shown a preponderance of males ranging from almost 60 to more than 90 per cent. I have not found any groups, of more than a few individuals, composed of one sex only, except breeding colonies of females, which are often found in early summer.

As there is insufficient data on the sex ratio of the young of bats to warrant a conclusion that the ratio is other than 1:1, it is logical to believe that a dissociation of the sexes commonly occurs after the mating season. Such segregation does not seem to indicate simply that the sexes separate but that they fly to different and perhaps quite distant faunal areas. More detailed data are included under the discussion of the different species.

TROUESSART'S BAT: *Myotis keenii septentrionalis* (Trouessart).

During the summer Trouessart's Bat is very nearly as common as the Little Brown Bat in Pennsylvania. Collections in Berks and Centre Counties totalled 159 of the former, and 178 of the latter. A series of 141 specimens of this species taken in Berks County in August and September, 1931, totalled 116 males, or 77 per cent. of that sex.

The bat becomes comparatively rare in winter and I have found it in just ten caves, all in southeastern Pennsylvania except two, Boyer Cave, Snyder County, and Dulany Cave, Fayette County. In no cave were more than half a dozen specimens found.

LITTLE BROWN BAT: *Myotis lucifugus lucifugus* (Le Conte).

The Little Brown Bat seems to be abundant throughout at least the southern half of the State. I have found it in 43 per cent. of the bat caves of the State and have found more than 100 specimens in Dulany and Woodward Caves, and approximately 5000 in Aitkin Cave.

In this last cave a study of the sexual segregation showed among 406 specimens the slight excess of males of 56 per cent. This was the lowest

percentage found in any count. In Woodward Cave a count of 113 bats of this species, all that could be reached, showed a preponderance of males of 68 per cent. A collection of 157 Little Brown Bats made in Berks County during August and September, 1931, showed the remarkable total of 148 males, or 94 per cent. of that sex.

SOCIAL BAT: *Myotis sodalis* Miller and Allen.

The original Pennsylvania specimens of the Social Bat came from Penn's Cave, and Todd took specimens in Bear Cave which he identified as *Myotis lucifugus lucifugus*. These records, in addition to my own, follow. A significant feature of the occurrence of this species is the presence of considerable bodies of water in the caves where it is most abundant. It has not yet been taken in summer in Pennsylvania.

Locality	*Occurrence*	*Observations*
Penn's Cave, Centre County	2000	Hanging over large stream
Bear Cave, Westmoreland County	?	5 specimens in Carnegie Museum; several streams in cave
Aitkin Cave, Mifflin County	500	Considerable water in winter
Hipple Cave, Fayette County	500	Hanging over large stream
Dulany Cave, Fayette County	4	Small streams in cave
Stover Cave, Centre County	3	Small pools of water
Woodward Cave, Centre County	1	Water at a lower level in cave
Historic Indian Cave, Huntingdon Co.	1	Pools of water
New Paris Caves, Bedford County	skulls	Series of underground caverns, many water filled.

A count of 781 specimens of *Myotis sodalis* in Penn's Cave on April 10, 1932, totaled 624 males and 157 females; a preponderance of males of 79 per cent.

LEAST BROWN BAT: *Myotis subulatus leibii* (Audubon and Bachman).

Though described eighty years ago, only eight specimens of this rare bat have been listed by Miller and Allen. I have taken 12 specimens in Pennsylvania, as follows:

Locality	*Specimens*	*Date*
Woodward Cave, Centre County	3 ♀	Jan. 28, 1931; Jan. 31 and March 20, 1932
Aitkin Cave, Mifflin County	2 ♀	Dec. 13, 1931; Jan. 9, 1932
Stover Cave, Centre County	6 (4 ♀, 2 ♂)	Jan. 31, 1932 (4); Feb. 21, 1932 (2)
Dulany Cave, Bedford County	1 ♀	Feb. 14, 1932

This collection of 12 Least Bats reveals a number of interesting facts. In the first place, Woodward and Aitkin caves are just 11 miles apart, across the Seven Mountains, while Stover Cave lies practically on the line between the two but is closer to Woodward. Eleven of the specimens came from these three caves.

These caves are peculiar in that they are located in, or just at the edge of, heavy hemlock woods. They are all at altitudes a little over 1000 feet above sea-level, and quite close to mountains that rise to a height of 2000 feet. The other specimen was taken in Dulany Cave, at an altitude of 2600 feet.

SILVER-HAIRED BAT: *Lasionycteris noctivagans* (Le Conte).

The Silver-haired Bat is known from five counties: Berks, Cumberland, Lebanon, Philadelphia, and Westmoreland. Not more than two specimens are known from any locality except Germantown, Philadelphia, where Witmer Stone and S. N. Rhoads collected ten.

Merriam found the Silver-haired Bat the most abundant species in Lewis County, in northern New York, and with two companions, shot more than 125. He noticed a remarkable dissociation of sexes, for out of 85 adult specimens which he killed during the summer of 1883, all but one were females. Although he visited different localities and hunted in the morning as well as at night, he failed to find any males.

Murphy and Nichols report the finding of Silver-haired Bats "hibernating in sky-scrapers, churches, wharf-houses, and the hulls of ships in New York City and Brooklyn, during the months between December and March." Accordingly, since this species is known to be migratory, they attribute the presence of these bats to the southward movement of individuals from a more northern faunal area.

GEORGIAN BAT: *Pipistrellus subflavus subflavus* (F. Cuvier).

This is the most widely distributed form in the State, being found commonly everywhere in the summer, and hibernating in 83 per cent. of the bat caves. Typical specimens of this sub-species are rather rare, although many specimens approach this form. Intergradations of the two forms are numerous in Pennsylvania and Poole groups the Georgian Bats as follows:

Pipistrellus subflavus subflavus, typical.
Pipistrellus subflavus subflavus, atypical.
Pipistrellus subflavus, atypical.
Pipistrellus subflavus obscurus, atypical.
Pipistrellus subflavus obscurus, typical.

The majority of Pennsylvania specimens fall in the three atypical groups, but there are typical specimens of the southern form from Baker Caverns, Dulany and Woodward caves, and from Hopewell, Berks County.

DUSKY GEORGIAN BAT: *Pipistrellus subflavus obscurus* Miller.

The series of *Pipistrellus* collected by Todd in Beaver County are, with one exception, typical of this form. I have found typical specimens at Woodward Cave and Poole has taken it at Hopewell. The atypical form is the more common, however. Collections are still too small to draw conclusions on the distribution of the Georgian Bats in Pennsylvania.

BIG BROWN BAT: *Eptesicus fuscus fuscus* (Beauvois).

This species is conspicuously absent from caves until late November or even December. I have found the Big Brown Bat hibernating in 52 per cent. of the Pennsylvania bat caves, but only in the Centre County caves have I found them particularly numerous.

RED BAT: *Lasiurus borealis borealis* (Müller).

I can find no indication that the Red Bat is a resident in Pennsylvania, and as I have yet to find it in any of the eighty caves of the State, I am skeptical of cave records not verified by specimens.

In Pennsylvania all the Red Bats, for which there is data, have been taken between April 12 and November 4, 85 per cent. being collected in the period July to October, and 60 per cent. in the two months August and September.

There are specimens from the following counties: Beaver, Berks, Centre, Chester, Clinton, Cumberland, Dauphin, Delaware, Erie, Indiana, Lancaster, Luzerne, Philadelphia, Sullivan, and Westmoreland.

HOARY BAT: *Lasiurus cinereus* (Beauvois).

There are specimens or published records of Hoary Bats from ten localities, in as many counties in Pennsylvania; Centre, Clinton, Dauphin, Delaware, Lancaster, Luzerne, Northampton, Philadelphia, Sullivan, and Tioga. Also there are two unquestioned sight records from Berks County. The data on most of the specimens is so incomplete, however, that we can get little idea of seasonal distribution or sexual association. Single specimens have been taken in March, May, October, and December, and five in August and September.

While it is definitely established that the Hoary Bat is migratory, it seems likely that the lowlands of southeastern Pennsylvania lie within its winter range. One specimen was taken December 5, 1890, at Collingsdale, Delaware County, Pa., another on January 1, 1910, at Cape

May, N. J., and DeKay mentions one taken December 12, 1841, presumably on Long Island.

SEMINOLE BAT: *Lasiurus seminolus* (Rhoads).

On September 12, 1931, Samuel Wishnieski shot a Seminole Bat flying over a dam at Hopewell, Berks County. This was the first record for Pennsylvania and extended the known range of the bat more than five hundred miles, since the previous northern limit had been Plantersville, on the coast of South Carolina. Poole's identification of the specimen was verified by Miller.

The Seminole Bat was one of a series of bats shot by a museum collecting party, eight Red Bats being taken the same evening. The bats began to fly while there was still considerable light but were probably 100 feet high and well out over the dam. Wishnieski rowed out to the middle of the dam and while standing in a rowboat shot three Red Bats and the Seminole Bat, all flying at a considerable height.

EVENING BAT: *Nycticeius humeralis* (Rafinesque).

There are 12 specimens in the National Museum which were collected by Baird and bear only the data "Carlisle, Cumberland Co." On June 21, 1906, H. A. Surface, state zoologist, received a specimen of the Evening Bat from Buckingham, Bucks County. The report on file in the United States Biological Survey states that Surface verified the record, probably at the Survey's request.

I do not see any reason to doubt this record, and I believe that intensive collecting in southeastern Pennsylvania during the summer will reveal more specimens. It has been taken on several occasions in Washington, D. C., and at least four times in Maryland.

BIG-EARED BAT: *Corynorhinus rafinesquii rafinesquii* (Lesson).

Harrison Allen wrote that S. F. Baird received specimens of a Long-eared Bat from Meadville, Crawford County, Pa., but that the specimen later was lost.

Rhoads doubted the record and placed the species on the questionable list. I am inclined to credit the record, since the range of the Rafinesque Lump-nosed Bat, as it is sometimes called, includes western Virginia, Kentucky, southern Indiana, and Illinois. Stragglers may still wander as far east as Pennsylvania, during migrations or as the result of severe storms.