PROCEEDINGS

OF THE

PENNSYLVANIA ACADEMY OF SCIENCE

VOLUME V

1931

HARRISBURG, PENNSYLVANIA
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OFFICERS

1931–32

President ..... E. M. Gress, Harrisburg
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Secretary ..... T. L. Guyton, Harrisburg
Assistant Secretary ..... V. Earl Light, Annville
Treasurer ..... H. W. Thurston, State College
Editor ..... R. W. Stone, Harrisburg

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PENNSYLVANIA ACADEMY OF SCIENCE

MINUTES OF THE SEVENTH ANNUAL SESSION OF THE PENNSYLVANIA ACADEMY OF SCIENCE 1931–32

HARRISBURG, PENNSYLVANIA—APRIL 3–4, 1931

The seventh annual session of the Pennsylvania Academy of Science met at Harrisburg, Pennsylvania, April 3rd and 4th. The meeting was presided over by Professor D S. Hartline, Bloomsburg, Pennsylvania. The following reports were presented:

The sixth annual meeting of the academy was held in Bloomsburg on April 18th and 19th, Dr. Robert T. Hance presiding. The program given on these days is given in full in the fourth volume of the "Proceedings" of the academy which was published in the fall of 1930. Copies of this were distributed to the membership. The academy is indebted to the committee on local arrangements for the excellent care taken in providing adequate and comfortable meeting places, and for the entertainment given by the people of Bloosmburg. At this meeting 69 persons were elected to active membership and five were so elected at the summer session. The total membership of the academy as of January 1, 1931, is 367. Of this number 216 are also members of the American Association for the Advancement of Science. The death of the following members during the past year has come to the attention of your secretary: Bishop James H. Darlington, Dr. B. A. Thomas and Mr. John Wayman. There were six resignations and 36 names were dropped from the roll for non-payment of fees.

The summer meeting was held at Erie on August 1st and 2nd. There was no presentation of papers, the meeting being for field trips. to demonstrate the geology of the district and the biology of Presque Isle. The meeting was highly instructive and much credit is due to the local committee, Dr. O. E. Jennings, Miss Cora A. Smith, Mr. Philip Hartman, Professor Henry Leighton, and Dr. S. H. Williams, for the excellent planning of the trips.

Your secretary represented the academy at the meeting of the American Association for the Advancement of Science at Cleveland, Ohio, in December, 1930. A separate report of this has been prepared and will be presented at the proper time.

T. L. GUYTON, *Secretary*

REPORT OF MEETING OF THE COUNCIL OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE RELATIVE TO THE STATE ACADEMIES OF SCIENCE, CLEVELAND, OHIO, DECEMBER 29, 1930

Various representatives of the State academies of science met with the members of the council of the American Association for the Advancement of Science, and discussed the problems of the academies in relation to the association.

Three papers were presented and followed by a lively general discussion in each instance.

State Academy Libraries and the Interchange of Academy Publications, by Dr. E. C. L. Miller, Virginia Academy.

How can the Work of the various Science Clubs in the State be correlated with that of the State Academy? by Dr. John T. McGill, Tennessee Academy.

The Illinois Junior Academy of Science: Accomplishments and Prospects, by Miss S. Aleta McEvoy, Illinois Academy.

In the paper presented on the libraries, the speaker said that most academies were without libraries but to his mind, libraries or some depository for exchange of publications was necessary. In some states, the state library was chosen as a depository, others the library of the state academy and others maintain their own library. The publications accumulated by academies were: first, the proceedings of other academies; second, copies of books and other publications issued by members of the academy; third, reports of prizes in research; fourth, exchanges; fifth, bequests; and sixth, purchases.

In the Kansas Academy of Science which was organized in 1868, the authors are charged at the rate of $2.00 per page for publications. These are deposited in three state institutions, two-fifths in two institutions, two-fifths in another and one-fifth in the third. The edition also included five hundred copies used in exchange.

The St. Louis Academy of Science which was founded in 1856, has a large exchange list. The academy owns its own building and has accumulated a large number of valuable publications.

In Michigan, the publication is done by the university and the university library is the depository for the academy's library. There are from ten to twelve thousand copies per issue. Seven or eight hundred are used for exchange. The academy has well over one thousand members. Each member pays $1.00 fee and also purchases the proceedings at about the cost of publication. Only papers submitted at the meetings are included in the publication, and only such of these as will pass the editorial board. The publication of the proceedings pays the university very well, and the arrangement is a most happy one. The annual cost is $10,000 to $12,000.

In Ohio, the university also is the depostory for the academy's publications. All volumes received in exchange are bound, catalogued and placed in a separate stack. The academy has about 600 members.

Dr. McGill's discussion of the relation of science clubs pointed out that science clubs all over the state may profitably be affiliated with the state academy of science in much the same relation as the state academies of science are affiliated with the American Association. None in Tennessee, however, are so affiliated, but it seemed to offer a chance for a real service by state academies. It was suggested that committees from the various clubs be appointed to bring about this affiliation. In this paper it was hinted that high school and college scientific clubs might form the best source of material for such affiliation. In other words, if such sources were so affiliated, the members would have some organization to turn to after they leave high school or college. It was further suggested that the state academies of science provide room on their program for the appearance of representatives of these various affiliated sources.

The matter of the establishment of junior academies of science through the various science clubs in the state as worked out in Illinois, was given by Miss McEvoy. Considerable work has been done along this line in Illinois, and the junior academy is quite active. The academy has its own publication and also has its place on the program of the state academy. At present, one day and one night are given over to the activities of the junior academy. Each branch of this academy as represented by high school clubs, publishes news letters or magazines, and at least once each year has some lecturer talk to them on science. It was suggested that this arrangement might well be extended to college groups, and that the usefulness of such organizations could be extended by the assignment of group problems to various clubs.

The treasurer then submitted the following report which was referred to the auditing committee and later approved by them:

TREASURER'S REPORT

April 1, 1931

Receipts

Balance on hand April 16, 1930	$ 569.25
Dues received since last statement	590.00
A. A. A. S. rebates	99.50
	$1,258.75

Disbursements

Proceedings	$ 588.59
Stationery	40.00
Secretary's account	72.19
Treasurer's occount	34.50
Local committee—Last meeting	13.25
Cash in bank	510.22
	$1,258.75

Approved—
E. Alfred Wolf
LeRoy A. Baer
Auditors

H. W. Thurston, Jr.,
Treasurer.

The president then appointed the following committees:

Nominating Committee—L. K. Darbaker, B. F. Cary and J. C. Johnson.

Auditing Committee—E. A. Wolf and L. A. Baer.

Resolutions Committee—R. N. Davis and M. C. Strauser.

Dr. E. M. Gress then briefly welcomed the scientists to the city.

The following program was given:

Friday—April 3rd

A Study of Boxwood Diseases in the Eastern United States. W. G. Hutchinson, Franklin and Marshall College.

A Preliminary List of the Hepatics of Central Pennsylvania. Thomas M. Little, Bucknell University. Lantern.

A Preliminary Report on the Mammals of Pennsylvania. Charles E. Mohr, Bucknell University. Lantern.

Plants New to the Collections of the Carnegie Museum Herbarium from Monroe and Pike Counties, Pennsylvania. LeRoy K. Henry and Edw. H. Graham, Carnegie Museum. (By Title.)

Total Emissivities of Brass, Aluminum, Copper and Steel. E. Raymond Binkley, Lehigh University. Lantern.

Leaf Spot Production upon Tobacco by a Culture Filtrate of Fusarium affine. W. S. Beach, Penn State College Research Laboratory. Lantern.

Further Notes on the Health of Deer. Norman H. Stewart, Bucknell University.

The Chromosomes of the Mouse. Paul R. Cutright, University of Pittsburgh. Lantern.

Is the Flight of the Japanese Beetle Necessarily Restricted to a Few Months of the Year? George B. Stichter, Bureau of Plant Industry.

Studies in the Variation of the Wasp, "*Vespula maculifrons* Buysson." B. W. Kunkel, Lafayette College. Lantern.

Pennsylvania Institutions and the Supply of Graduate and Professional Students. B. W. Kunkel, Lafayette College. Lantern.

Address of the President: Adjustment of Academy Organization to Growth—Grouping into Sections. D. S. Hartline, Bloomsburg State Teachers College.

Nocturnal Adaptations. Stanton C. Crawford, University of Pittsburgh, Johnstown Center.

Fossils and Fossilization. Bradford Willard, Topographic and Geologic Survey.

Lactuca saligna L. in Franklin Co., Pa. E. M. Gress, Pennsylvania Department of Agriculture.

Studies of *Lygodium palmatum*, with Reference to Values, and Measures to Prevent Extinction. D. S. Hartline, Bloomsburg State Teachers College.

Floating Positions of Homogeneous Square Prisms. Joseph B. Reynolds, Lehigh University. Lantern.

Culturing Haematococcus (Sphaerella). V. Earl Light, Lebanon Valley College.

Samia Hybrids. Walter R. Sweadner, University of Pittsburgh. Lantern.

A Study of the Reproductive Systems of the Male and Female (Oviparous) Cocklebur Aphid. Forrest W. Miller, University of Pittsburgh.

X-Ray Experiments Continued. Benj. F. Carey, Tioga Co. General Hospital. Lantern.

Tattooing of New-Born Infants for Permanent Identification. Evan O'Neill Kane, Kane Hospital, Kane, Pa.

The Effects of Dessication upon the Growth and Development of the Mediterranean Flour-moth." B. R. Speicher, University of Pittsburgh.

The Age of the Spawning Groups of the Log-perch, *Percina caprodes semifasciata* (De Kay) from Douglas Lake, Mich. Homer C. Will, University of Pittsburgh. Lantern.

Animal Ecology on Presque Isle, Lake Erie, Pa. Samuel H. Williams, University of Pittsburgh. Lantern.

On Friday evening the academy was entertained by a trip through Indian Echo Cave near Hummelstown and instructed with a dinner lecture by Dr. H. J. Rose, Director, Koppers Research Corporation, Pittsburgh, Pennsylvania. He spoke on "Bituminous Coal, the Cinderella of Chemical Industry."

Saturday—April 4th

Specific Differences in Regenerative Capacity in Urodeles of the Genus Triturus. (To be read in title). H. H. Collins, University of Pittsburgh.

Sex Ratios in Adult Population of *Triturus viridescens*. (To be read in title). H. H. Collins, University of Pittsburgh.

Doctors of Philosophy. The Responsibility of the Graduate School. Robert T. Hance, University of Pittsburgh.

Reducing Costs in Small Colleges. Robert T. Hance, University of Pittsburgh.

Training Graduate Students in Biology. Robert T. Hance, University of Pittsburgh.

Publication. Robert T. Hance, University of Pittsburgh.

Studies on the Ecology and Distribution of Aquatic Beetles. John T. Gamble, Thiel College, Greenville, Pa.

Evidence of Durability of Building Stone. R. W. Stone, Geological Survey.

The Nature of Gravitation. R. N. Davis, Everhard Museum, Scranton.

Changes in the Prostate of Rats Following the X-radiation of the Testes. Ben H. Kettelkamp, University of Pittsburgh. Lantern.

The Effect of Feeding Prostate Substance to Tadpoles. Ben H. Kettelkamp, University of Pittsburgh. Lantern.

Further Studies of the Effects of Ultraviolet Radiation upon the Color Pattern of Triturus. E. Alfred Wolf and H. H. Collins, University of Pittsburgh. Lantern.

Some Physical and Chemical Effects of Forest Fire on Soils. George S. Perry, State Forest Research Institute.

Miasma and Contaminated Water Supply. Major M. J. Blew, Department of Public Works, Philadelphia.

Where Water is a Strong Drink. Max Trumper, Medical Arts Building, Philadelphia.

A Further Report on the Use of Modified Xanthene Compounds in the Diagnosis of Malignant Neoplasms. Donald C. A. Butts, Hahnemann Medical College.

Effects of Ultraviolet Light on the Eggs of the Corn Borer, *Pyrausta nubialis* Hubn. Russell Edward Springer, University of Pittsburgh. Lantern.

A Reading Program for General Zoology. Paul R. Cutright, University of Pittsburgh.

The Effect of Adrenalin Chloride on the Maze Behavior of White Mice. W. L. Wachter, Lafayette College.

Some Observations on Common Snakes. S. Irvine Shortess, State Teachers College, Bloomsburg.

The Food and Economic Value of Pennsylvania Reptiles. H. A. Surface, Sc.D., Susquehanna University. (By Title.)

At the business session, the recommendations given in the president's address relative to dividing the academy into sections, were discussed at some length. It was decided upon motion that the president be empowered to appoint a committee to take this matter under consideration and report to the academy at the next annual meeting.

The president was also empowered to appoint a committee to report back at the next annual meeting relative to the matter of publications, in particular reference to exchanges and the choosing of a place in the state as a depository for exchange publications of the academy. This was a result of the discussion of the academy's representative to the American Association for the Advancement of Science.

The membership committee, of which Dr. E. N. Gress is chairman, presented the following names for active membership in the academy. All of the names presented were unanimously elected.

Ransom P. Allaman, 2321 Green Street, Harrisburg.
John L. Atlee, 37 East Orange Street, Lancaster.
LeRue P. Bensing, 1510 Oak Street, Lebanon.
George B. Biecher, Palmyra, Box 124.
Lester G. Bixler, 636 Hill Street, Lebanon.
M. J. Blew, N. E. Water Works, Richmond Street, Philadelphia.
Charles W. Burr, 1918 Spruce Street, Philadelphia.
Mitchel Carroll, 540 President Avenue, Lancaster.
Stanley H. Cathcart, 1700 High Street, Camp Hill.
George G. Chambers, 251 S. 38th Street, Philadelphia.
Francis R. Cope, Jr., Dimock.
Thomas D. Cope, 239 Lenoir Avenue, Wayne.
Lawrence H. Creasy, Catawissa, R. D. No. 1.
Paul R. Cutright, Zoology Department, University of Pittsburgh, Pittsburgh
John McCrea Dickson, 103 W. Middle Street, Gettysburg.
Sidney K. Eastwood, 301 S. Winebiddle Avenue, Pittsburgh.
John M. Enburg, 5141 Baltimore Avenue, Philadelphia.
Frank N. Fagan, Pennsylvania State College, State College.
Ira O. Fleming, 200 Susquehanna Avenue, Lock Haven.
John T. Gamble, 64 Eagle Street, Greenville.
Marcus H. Green, Albright College, Reading.
Ivor Griffith, "Rhiwals," Elkins Park.
William A. Gruse, Mellon Institute, Pittsburgh.
Florentine Hackbusch, Department of Welfare, Harrisburg.
D. Roberts Harper, 3rd, 222 Gladstone Road, Pittsburgh.
Norman A. Hemperley, 328 South Ninth Street, Lebanon.
Howard K. Henry, 1464 Drayton Lane, Penn Wynne.
John P. Homiller, Hatboro.
John P. Jones, Box C, Ligonier.
Mabel G. Kessler, 637 Church Street, Reading.
B. H. Kettelkamp, University of Pittsburgh, Erie.
Marie B. Knaux, 1217 Trevanion Street, Pittsburgh, 18.
Michael S. Kovalenko, Swarthmore College, Swarthmore.
Mrs. Leslie H. Lanfear, 5255½ Forbes Street, Squirrel Hill, Pittsburgh.
Norman McClintock, c/o Koppers Research Corporation, Ligonier.
Edgar W. Meiser, 611 North 9th Street, Lebanon.
Walter Mendelson, 639 Church Lane, Germantown, Philadelphia.
David R. Meranze, Mt. Sinai Hospital, Philadelphia.
Arthur L. Michael, Berwick, R. D. No. 1.
Forrest W. Miller, 352 N. Craig Street, Pittsburgh.
Forrest T. Moyer, 1512 Palm Street, Reading.
Mrs. Walter M. Newkirk, Radnor.
James A. Newpher, 3024 Sixth Avenue, Beaver Falls.
Karl F. Oberlein, 1246 North 12th Street, Philadelphia.

Marcus C. Old, Ursinus College, Collegeville.
A. B. Van Ormer, 1822 Mifflin Street, Huntingdon.
Paul D. Peterson, Box C, Ligonier.
Ralph V. Robinson, 7018 Jenkins Arcade, Pittsburgh.
Alden F. Roe, Institute of Pathology, West Pennsylvania Hospital, Pittsburgh.
Glenn W. Rush, 205 S. Prospect Street, Connellsville.
Gardner T. Saylor, Annville.
Porter W. Shimer, 94 Pennsylvania Avenue, Easton.
N. Eugene Shoemaker, Muddy Creek Forks.
James Sinden, Department of Botany, State College.
Benjamin R. Speicher, 352 North Craig Street, Pittsburgh.
Walter R. Sweadner, Sharpsburg Station, Pittsburgh, R. D. No. 2.
Carl V. Tower, 32 Sixth Avenue, Collegeville.
Mrs. C. M. Tuft, 1711 Fitzwater Street, Philadelphia.
Virginia Wallis, Johnsonburg.
Dorothy W. Weeks, Wilson College, Chambersburg.
Edgar T. Wherry, Department of Botany, University of Pennsylvania, Philadelphia.
Lawrence Whitcomb, Department of Geology, Lehigh University, Bethlehem.
Homer C. Will, 4360 Center Avenue, Pittsburgh.
Bradford Willard, 2308 Chestnut Street, Harrisburg.
Samuel H. Williams, University of Pittsburgh, Pittsburgh.

The resolutions committee presented the following resolutions:

The members of the Pennsylvania Academy of Science deeply appreciate the cordial welcome they have received to Harrisburg from the local members, and for the delightful outing planned for us at the Indian Echo Cave.

The academy acknowledges its indebtedness to the state officials for the use of the auditorium in which the meeting was held.

We thank all those who contributed to the success of the meeting by taking a part in the program and especially H. J. Rose, who spoke on "Bituminous Coal, the Cinderella of Chemical Industry."

(Signed) R. N. Davis
M. C. Strauser

The nominating committee made the following report and upon motion the secretary was instructed to cast a ballot in favor of each:

Recommended Officers for 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
Assistant 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. Norman Stewart
Dr. E. A. Zeigler

The new president was conducted to the chair and spoke briefly as to his pleasure in being so highly honored by the academy.

Places for the next meeting were then considered. An invitation was given by Dr. John C. Johnson to come to West Chester for the next annual meeting. Dr. R. N. Davis invited the academy to come to Scranton for the summer meeting. An invitation was also received to visit Bar Harbor for the summer session. The time and place of these meetings was upon motion to be decided by the executive committee.

The academy adjourned at 12:30 p. m.

T. L. Guyton,
Secretary

STUDY OF A DISEASE OF BOXWOOD IN THE EASTERN UNITED STATES

By W. G. Hutchinson
Franklin and Marshall College, Lancaster

For more than ten years growers of boxwood in the eastern United States have been troubled by a disease which affects the plants. The symptoms of the disease are: a slight discoloration of the foliage, often simply a mottling or reddening, followed perhaps a year later by a more complete discoloration and the death of one or several branches or of the entire plant. Oftentimes a cankered area may be found at the base of the plant or at the base of a branch. The damage has been especially severe among the old boxwood mazes of Virginia where sometimes large numbers of the valuable plants have had to be removed. Similarly affected plants have been reported from all the Eastern States from Rhode Island to Georgia and westward to Ohio and Tennessee.

A laboratory examination of diseased plants usually reveals the presence of one or more of the following genera of fungi—Macrophoma, Volutella, Phomopsis, and Verticillium. The Macrophoma and Volutella are found on the leaves and twigs, causing black and pink pustules respectively. The Phomopsis and Verticillium have been isolated from the basal cankered areas or sometimes from the dead twigs. The Verticillium causes a green streaking of the wood. Plants may also be found which are not infected with fungi, but which have been injured by insects or are suffering from some adverse environmental conditions.

In collaboration with the Office of Forest Pathology, United States Department of Agriculture, the writer has undertaken a study of the cause of this boxwood disease. Since a rather lengthy series of studies is entailed, only a progress report can be given at the present time.

A study of the Phomopsis and its relation to the disease has been undertaken for the first part of the work. This fungus was first reported in the United States in 1925 on diseased plants from Washington, D. C. It has been found occasionally in various localities since that time. In the spring of 1930 the writer visited several nurseries and estates in Virginia, District of Columbia, and New York. Badly diseased plants were found in all but one location visited. It was found that the slow growing type—variety *suffruticosa*—was more severely attacked than any other variety. Especially on Long Island the disease seemed to have acquired the nature of an epiphytotic. Many specimens of diseased plants from all these localities were obtained.

In the laboratory, cultures were made upon malt, oat, and corn meal agars from these different diseased plants. Phomopsis has developed in culture from over 50 per cent of these plants. This Phomopsis has been compared with all the species of this genus described in the literature. It appears to be identical with *Phomopsis stictica*, reported as of common occurrence in Europe on "dead or dried" boxwood stems.

Three different varieties of Buxus have been inoculated with suspensions of spores from cultures of the Phomopsis. The results of these inoculations cannot be given with any certainty at the present time. The indications are, however, that healthy boxwood plants may be weakened and partially defoliated by inoculation with the Phomopsis.

PRELIMINARY LIST OF THE HEPATICAE OF CENTRAL PENNSYLVANIA

By Thomas M. Little
Bucknell University, Lewisburg

Although fairly complete check-lists of the Hepaticae can be found for nearly all of the Eastern States, there is no such complete list available for Pennsylvania. Porter's "Bryophyta and Pteridophyta of Pennsylvania" deals almost entirely with the eastern and southeastern portion of the State. Various other local check-lists have been compiled in the western part of the State, but no work has been done in central Pennsylvania in the vicinity of the lower North and West branches of the Susquehanna River. Several years ago William C. Barbour, of Sayre, did considerable collecting along the North Branch of the Susquehanna but no check-list was ever published.

The region to which I have confined my studies lies within a radius of 50 miles from the borough of Lewisburg. The area bounded by this circle comprises some of the richest territory in the State for biological collecting, so it is not at all surprising that some rather uncommon finds have been made during this study.

As the title suggests, the list is only a preliminary one, since it represents the results of but a single year of collecting.

The classification of the list follows the system adopted by Engler and Prantl in "Die Naturlischen Planzenfamilien."

MARCHANTIALES

Ricciaceae

Riccia glauca L. Found in the green-house at Bucknell University, March, 1931.

Riccia Sorocarpa Bisch. On an island in Susquehanna River at Lewisburg, October, 1930. (This species is not recorded in Porter's work.)

Marchantiaceae

Reboulia hemisphaerica (L.) Raddi. Abundantly growing on cliffs all through the region.

Conocephalum conicum (L.) Dum. Very profuse in Rickett's Glen and other parts of the North mountain region.

Lunularia cruciata (L.) Dum. In green-house at Milton, April, 1931.

Marchantia polymorpha L. Quite common about this region.

JUNGERMANNIALES

Jungermanniaceae Anacrogynae

Riccardia pinguis (L.) S. F. Gray. At mouth of spring near Picture Rocks, September, 1931.

Riccardia multifida (L.) S. F. Gray. Along Roaring Run, Picture Rocks, September, 1931.

Metzgeria furcata (L.) Dum. On cliff at Picture Rocks, February, 1931. (Not recorded in Porter.)

Pellia epiphylla (L.) Corda. Along lake at Essex Heights, April, 1930.

Blasia pusilla L. Along Laurel Run, near Picture Rocks, September, 1930.

Jungermanniaceae Acrogynae

Aplozia crenulata (Sm.) Dum. Along run at Hairy John's Park, April, 1931. (Not recorded by Porter.)

Aplozia caestipicia (Lindenb.) Dum. On cliff at Picture Rocks, February, 1931. (Not recorded by Porter.)

Aplozia lanceolata (Schrad.) Dum. On rocks by the creek at Muncy Valley, July, 1930. (Not recorded by Porter.)

Lophozia bicrenata (Schmid.) Dum. On cliff at Picture Rocks, February, 1931.

Lophozia attenuata (Mart.) Dum. On cliff at Picture Rocks, February, 1931. (Not recorded by Porter.)

Plagiochila asplenoides (L.) Dum. In deep woods at Woodward, April, 1931.

Lophocolea cuspidata Limpr. In canyon near Danville, March, 1931. (Not recorded by Porter.)

Chiloscyphus pallescens (Ehrh.) Dum. Along run below Lewisburg, March, 1931. (Not recorded by Porter.)

Cephalozia Lammersiana (Hüb.) Spruce. On bare ground in canyon near Danville, March, 1931. (Not recorded by Porter.)

Cephalozia media Lindbg. Quite common all over the region.

Cephalozia curvifolia (Dicks.) Dum. On rotten logs in canyon near Danville, March, 1931.

Cephaloziella bifida (Schreb.) Schiffn. On cliff at Picture Rocks, February, 1931. (Not recorded by Porter.)

Adelanthus decipiens (Hook.) Mitt. On cliff at Picture Rocks, February, 1931. (Not recorded by Porter.)

Calypogeia fissa (L.) Raddi. Dense woods near Picture Rocks, February, 1931. (Not recorded by Porter.)

Calypogeia trichomanis (L.) Corda. Near Glen Mawr along a run, October, 1930.

Bazzania trilobata (L.) S. F. Gray. Very common all over the region.

Bazzania tricrenata (Wahl.) Pears. In canyon near Danville, March, 1931. (Not recorded by Porter.)

Ptilidium pulcherrimum (Web.) Hampe. On white pine tree at Picture Rocks, March, 1931. (Not recorded by Porter.)

Ptilidium ciliare (L.) Hampe. Found at several stations. Very good fruiting bodies found at Hairy John's Park.

Scapania undulata (L.) Dum. Submerged in run at World's End near Forksville, October, 1930.

Scapania nemorosa (L.) Dum. On cliff at Picture Rocks, January, 1931.

Scapania curta (Mart.) Dum. In canyon near Danville, March, 1931. (Not recorded by Porter.)

Radula complanata (L.) Dum. Cliff at Picture Rocks, February, 1931.

Porella platyphylla (L.) Lindb. Along run near Woodward, April, 1931.

Trichocolea tomentella (Ehrh.) Dum. Along run in Hairy John's Park, April, 1931.

Lejeunea cavifolia (Ehrh.) Lindb. On cliffs at Picture Rocks, January, 1931. (Not recorded by Porter.)

Marchesinia Mackaii (Hook.) Gray. Cliff at Picture Rocks, January, 1931. (Not recorded by Porter.)

Frullania eboracensis Gottsche. Quite common everywhere.

Frullania Asagrayana Mont. Cliff near Picture Rocks, November, 1931.

Frullania Nisqualensis Sulliv. On cliff at Picture Rocks, January, 1931. (Not recorded in Porter.)

ANTHOCEROTALES

ANTHOCEROTACEAE

Anthoceros punctatus L. In spring near Selinsgrove, September, 1931.

Notothylas orbicularis (Schwein.) Sull. On an island in Susquehanna River near Lewisburg.

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PRELIMINARY REPORT ON THE MAMMALS OF PENNSYLVANIA

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This report is preliminary in the sense that it represents the first attempt since Rhoads (1903) to give a detailed record of mammalian distribution throughout the State, and in view of the fact that a more ambitious report is anticipated.

Rhoads' "Mammals of Pennsylvania and New Jersey," is, of course, the basis of any mammalogical work in this State. However, since the appearance of that classical volume there has been considerable taxonomic revision, and the known ranges of several forms have been extended to include Pennsylvania. A few collectors have published valuable local lists: Todd (1904) for Beaver County, Beck (1924) for Lancaster County, Stuart (1926) for Delaware County, Sutton (1928) for the Cook Forest, Shoemaker (1929) for Clinton County, and Green (1930) for the North Mountain region. Several other naturalists, chief among them being Doutt, Poole, and Williams, have made important contributions through their field work. Williams has published a popular manual on Pennsylvania mammals (1928). Shoemaker (1917, 1919) has painstakingly recorded the history of our extinct mammals.

In preparing this report the writer was given valuable assistance by members of the U. S. Biological Survey and by officers of the Pennsylvania State Game Commission, who placed their records at his disposal.

The present list names 68 recent land mammals native to this State. Of these, nine are now extinct: marten, fisher, wolverine, wolf, panther, Canada lynx, fox squirrel, elk, and wood bison or buffalo.

The sequence followed is that used by Miller (1924) who in turn followed the main features adopted by Henry Fairfield Osborn in his "Age of Mammals." The list begins with the most primitive forms and ends with the most highly specialized groups.

Didelphis virginiana virginiana Kerr. Opossum.

The opossum is common in the southern valleys; rare in the higher mountains. 127,298 were caught in Pennsylvania during the season of 1929–30.

Parascalops breweri (Bachman). Brewer's Mole.

This hairy-tailed mole is abundant in the Alleghenies and westward; absent to the east.

Scalopus aquaticus aquaticus (Linnaeus). Common Mole.

The naked-tailed mole is found in abundance east of the Alleghenies.

Condylura cristata (Linnaeus). Star-nosed Mole.

This species is rather common, with a statewide distribution. It is probably rare in the southwestern corner of the State although there are records from Somerset and Washington counties.

Sorex cinereus cinereus Kerr. Masked Shrew.

This shrew is found throughout the State, although there are few records of its capture. At present it is recorded from 12 counties; rather wide-spread, but limited exclusively to the mountains.

Sorex dispar Batchelder. Allegheny Long-tailed Shrew.

Jackson (1928) records a specimen from Lake Leigh, Sullivan County; Green took one in northwestern Luzerne County.

Sorex fumeus fumeus Miller. Smoky Shrew.

This species is well distributed throughout the State, having been taken in 19 counties, although always in the mountains.

Sorex palustris albibarbis (Cope). White-lipped Water Shrew.

Green, in southwestern Wyoming County, and Shryock, at Mt. Pocono, Monroe County, have collected the only specimens of record in the State.

Cryptotis parva (Say). Least Shrew.

There are no records except those published by Rhoads: Chester and Cumberland counties.

Blarina brevicauda brevicauda (Say). Common Shrew.

The short-tailed shrew is ubiquitous.

Myotis lucifugus lucifugus (Le Conte). Little Brown Bat.

This bat has been frequently reported in western Pennsylvania and although there are no published records from east of the Alleghenies, it is known to be one of the most abundant found in the Eastern States.

Myotis keenii septentrionalis (Trouessart).

This bat is reported by Miller and Allen (1928) as being taken in Bradford, Centre, Chester, Montgomery and Somerset counties.

Myotis subulatus leibii (Audubon and Bachman).

This species has been taken at Cornwall Cave and White Sulphur Springs, West Virginia, and at Ossining, New York, but not within this State as yet.

Myotis sodalis (Miller and Allen).

The only record of this bat in Pennsylvania was made by Vernon Bailey, who collected twenty-seven specimens in Woodward Cave, Centre County.

Lasionycteris noctivagans (Le Conte). Silver-haired Bat.

There are very few published records of this species although it is likely rather common over the State.

Pipistrellus subflavus subflavus Miller. Georgia Pigmy Bat.

This form is found abundantly in the lowlands of southeastern Pennsylvania, and probably intergrades with the next species to the northward.

Pipistrellus subflavus obscurus Miller. New York Pigmy Bat.

Specimens recorded from Beaver County, by Todd, have been identified by Miller. It is probably common west of the Alleghenies.

Eptesicus fuscus fuscus (Beauvois). Big Brown Bat.

Despite the fact that this form is distributed everywhere, with the possible exception of the highest Alleghenies, there are very few published records concerning its distribution in the State.

Nycteris borealis borealis (Muller). Red Bat.

This bat is everywhere abundant and it is apparently resident.

Nycteris cinerea (Beauvois). Hoary Bat.

The records of this large bat are insufficient to indicate its distribution in the State. It is probably most common in central Pennsylvania.

Nycticeius humeralis (Rafinesque). Rafinesque's Little Brown Bat.

The only record of this southern species is based on twelve specimens in the National Museum, collected by Baird at Carlisle, Cumberland County.

Euarctos americanus americanus (Pallas). Black Bear.

The bear was formerly distributed statewide and is still to be found commonly in the mountainous districts. During the season of 1929–30, 447 bears were killed in this State.

Procyon lotor lotor (Linnaeus). Raccoon.

The raccoon is uniformly distributed in woodland. The fur report for the State, 1929–30, included 29,528 raccoon skins.

Martes americana americana (Turton). Marten.

This species, formerly common in the mountainous portion of the State, has been extinct for more than a decade.

Martes pennati pennati (Erxleben). Fisher.

Seton (1926) reports the fisher as extinct in eastern United States, except Maine. No Pennsylvania specimens have been reported since 1900.

Mustela cicognanii cicognanii Bonaparte. Short-tailed Weasel.

Data kept by the Bureau of Predatory Animals, Harrisburg, contains 28 records of this weasel, taken between October, 1927, and March, 1928, from fourteen counties, chiefly on or near the northern border of the State: Bradford, Cambria, Crawford, Clearfield, Cameron, Erie, McKean, Mercer, Pike, Potter, Susquehanna, Tioga, Venango, and Wayne.

In addition Surface has identified specimens from Beaver and Luzerne counties and Green records a specimen from Sullivan County.

Mustela rixosa allegheniensis (Rhoads). Allegheny Least Weasel.

Sutton (1930) records the examination of 87 pelts, and sight records of two other specimens, of the least weasel between November, 1925, and March, 1929. His 61 records (localities) are from 22 counties, in the western half of the State.

Fourteen additional records in the data at Harrisburg include specimens from four counties not reported by Sutton: Greene, Clinton, Mifflin, and Dauphin.

The total of 75 records shows the least weasel to be most abundant in the counties bordering the Ohio state line, but extending eastward to Bedford, Dauphin, and Tioga counties.

Mustela noveboracensis noveboracensis (Emmons). Common Weasel.

This species is common throughout the State. Game reports show that 84,370 weasels were trapped in the State during the season 1929–1930. The number of the two preceding forms in this total must be negligible.

Mustela vison vison Schreber. Mink.

This animal is still widely distributed in the forested portions of the State. 12,728 furs were sold during the season 1929–30.

Gulo luscus Linnaeus. Wolverine.

Rhoads considered the wolverine the rarest animal in Pennsylvania in the early part of the nineteenth century, being found even in the most boreal localities only as a straggler. Rhoads, and Shoemaker (1919), agree that the last wolverine taken in the State was trapped by Joe Nelson near Great Salt Lick, Potter County, in 1863.

Lutra canadensis canadensis (Schreber). Otter.

The otter is very rare in Pennsylvania and there are few records during the last decade. Green reports it being seen in the North Mountain region in 1927 and in the Pocono Mountains in 1925.

Mephitis nigra (Peale and Beauvois). Skunk.

The skunk is abundant and distributed statewide. 287,758 were killed during the season 1929–30.

Vulpes fulva (Desmarest). Red Fox.

Urocyon cinereoargenteus (Schreber). Gray Fox.

Williams (1930) finds the gray fox confined to the mountainous districts where it outnumbers the red. In the southern counties there is a great preponderance of the red fox. In fact, there is a ratio of eleven red to one gray in Greene County, while in mountainous Fayette County the ratio is eight gray to one red, according to Williams.

Canis lycoon (Schreber). Wolf.

Shoemaker (1917) writes of the last Pennsylvania wolf being killed in McKean County in 1886. Wolves reported since that time have proven to be dogs, coyotes, or escaped wolves.

Felis cougar Kerr. Panther.

Shoemaker writes, "Panther tracks were observed on the (Coudersport) Pike by Dr. Rothrock in 1913, in Detwiler Hollow in the Seven Mountains in the same year, by several hunters."

Seton (1925) says, "Shoemaker writes me that even as recently as 1922, 'a Panther watched the Askey family seated by their open fire-place, at Cold Springs, Centre County. The next morning they followed the tracks in the snow.' "

Regarding its former distribution in Pennsylvania, Shoemaker writes, "The woods teemed with them." They were found in great numbers in Lycoming and Sullivan Counties. During the years 1820 to 1845 it is estimated that 600 panthers were killed in Centre County.

Lynx canadensis canadensis Kerr. Canada Lynx.

The lynx was probably exterminated by the last decade of the nineteenth century. It formerly inhabited the northern counties but occurred as far south, in the higher Alleghenies, as the southern border.

Lynx rufus rufus (Schreber). Bob Cat.

Rhoads, about 1900, found the bob cat inhabiting 54 counties of the State. It is still widely distributed in the wilder regions of the State as shown by fur dealers' records, which include 190 "wild cat" skins for the season of 1929–30.

Marmota monax monax (Linnaeus). Ground Hog.
Marmota monax canadensis (Erxleben). Northern Ground Hog.

The woodchuck is found abundantly throughout the State. The northern form is probably common in the northern tier of counties, although the only published record is that of Sutton, for the Cook forest.

Tamias striatus fisheri (Howell). Southern Chipmunk.

This form is abundant with a statewide distribution, and intergrades with the next sub-species in the higher Alleghenies.

Tamias striatus lysteri (Richardson). Northern Chipmunk.

Howell (1929) records this form from Blair, Bradford, Cambria, Clinton, McKean, Monroe, and Sullivan counties. It is also reported from Clarion County by Sutton.

Sciurus hudsonicus loquax Bangs. Red Squirrel.

This squirrel is common south of the Canadian zone where it approaches the form *Sciurus hudsonicus hudsonicus.* However, none of the latter sub-species has been recorded for the State.

Sciurus carolinensis carolinensis Gmelin. Carolina Gray Squirrel.
Sciurus carolinensis leucotis (Gapper). Northern Gray Squirrel.

The southern form probably occurs throughout the whole lowland region of Pennsylvania. The northern form occurs in the mountains, its distribution being given as "the Alleghenies from West Virginia northward." The exact status of these two forms in this State has not yet been determined.

Sciurus niger neglectus (Gray). Fox Squirrel.

Bangs (1896) writes, "The northern fox squirrel is one that cannot withstand persecution and the clearing and settling of the country. It is already becoming very hard to get specimens of this sub-species. Dr. H. B. Warren, zoologist of the Commonwealth of Pennsylvania, writes me that the fox squirrel is practically extinct in Pennsylvania except in the counties of Dauphin and Cumberland.

This form is extinct now, the fox squirrel that is found in many parts of the State today being *Sciurus niger rufiventer,* the western fox squirrel, which the State Game Commission has used for stocking purposes for many years. It is doubtful whether this form ever extended east to Pennsylvania as authentic records for Ohio are rare.

Glaucomys volans volans (Linnaeus). Flying Squirrel.
Glaucomys sabrinus macrotis (Mearns). Northern Flying Squirrel.

The former species is uniformly distributed throughout the State. Its nocturnal habits probably account for the few published records. The northern species was first recorded by Doutt (1930) from one of the Canadian life zone islands of Potter County and has since been reported by Green from Sullivan County.

Castor canadensis canadensis Kuhl. Beaver.

After a careful study of records of Pennsylvania beaver, Rhoads concluded that this animal was exterminated from the eastern half of the State about 1830, from the headwaters of the West Branch of the Susquehanna about 1840, and "almost the last stragglers of their race were killed in Elk, Clarion, and Centre counties, between the years 1850 and 1865." It is almost certain that records since that time are from animals imported from other parts of the country. Restocking was begun by the Game Commission in 1915.

Peromyscus maniculatus nubiterrae (Rhoads). Cloudland Deer Mouse.

Osgood (1909) places the Pennsylvania mountain race of deer mice as nearer *nubiterrae* than *gracilis.* Osgood records it from Cambria, Clinton, Monroe, Somerset and Sullivan; Green, from Wyoming and Luzerne; and Sutton, from Clarion.

Peromyscus leucopus noveboracensis (Fischer). Deer Mouse.

This species is abundantly distributed throughout the State.

Neotoma pennsylvanica Stone. Allegheny Cave Rat.

The cave rat is more common than was formerly supposed and is found in 17 counties, from Tioga on the northern border, southward to Westmoreland in the west and to Berks in the east. Its total absence from the North Mountain as anticipated by Rhoads, is questionable, since it is abundant in Clinton and Union and in parts of Lycoming County.

Synaptomys cooperi cooperi Baird. Bog Lemming.

Howell (1927) records this rare mouse from Cambria, Clinton, Monroe, and Sullivan counties, but does not include Rhoads' Beaver County specimen. The Pennsylvania specimens are probably intermediate between *cooperi* and *stonei,* but approach the former, although Green believes them nearer to the latter.

Cleithrionomys gapperi gapperi (Vigors). Red-backed Mouse.

This mouse is widely distributed although records are comparatively few. At present it is known from 15 counties, principally in the northern half or the State.

Microtus chrotorrhinus chrotorrhinus (Miller). Rock Vole.

The only records of this rare species are those of Green, from Sullivan and southwestern Wyoming counties.

Microtus pennsylvanicus pennsylvanicus Ord. Meadow Mouse.

This is the most abundant mouse over the whole State.

Pitymys pinetorum scalopsoides (Audubon and Bachman). Pine-woods Mouse.

The pine vole has been recorded most frequently from the eastern and southern counties, although specimens taken from Clinton, Greene, and Warren counties indicate a wide range for this species.

Ondatra zibethica zibethica (Linnaeus). Muskrat.

The muskrat is everywhere abundant.

Mus musculus musculus Linnaeus. House Mouse.

This animal is always abundant near towns. but is often trapped in fields and woodlots. Introduced.

Rattus norvegicus (Erxleben). Norway Rat.
Rattus rattus rattus (Linnaeus). Black Rat.
Rattus rattus alexandrinus (Geoffroy). Roof Rat.

The Norway Rat has a cosmopolitan distribution and has largely driven out the other two introduced rats. Anthony (1928) says, "All three of the introduced rats display in the three rows of tubercles on the molar crowns an unmistakable character of separation from all New World Rats."

Zapus hudsonius hudsonius (Zimmerman). Hudson Bay Zapus.

Sutton mentions taking several specimens of this northern form in

Clarion County, and Green records it from Wyoming County. Preble (1899) cites specimens from Butler County. It is to be expected anywhere in the higher Alleghenies.

Zapus hudsonius americanus (Barton). Meadow Jumping Mouse.

This form is very common in the southern half of the State, somewhat rare to the north, and absent in the mountains where the preceding sub-species replaces it.

Napaeozapus insignis insignis (Miller). Woodland Jumping Mouse.

This inhabitant of the Canadian zone has been reported from only nine counties, from the mountains of northern and western Pennsylvania.

Erethizon dorsatum dorsatum (Linnaeus). Porcupine.

The porcupine is now quite rare in most parts of its range, the mountainous regions of the State, although it is said to be locally common.

Lepus americanus virginianus (Harlan). Varying Hare.

The snoeshoe rabbit is widely distributed in the northern tier of counties and is found in the mountains to the southern border of the State. Nelson (1909) records specimens from nine of the northern counties.

Sylvilagus floridanus mallurus (Thomas). Eastern Cottontail.
Sylvilagus floridanus mearnsii (Allen). Mearn's Cottontail.
Sylvilagus transitionalis (Bangs). New England Cottontail.

These three native rabbits formerly occurred in this State as follows: *mallurus* was the common form of the lowlands; in the mountains, above 1000 feet, *transitionalis* occurred; while west of the Alleghenies, *mearnsii* was found. There has doubtless been considerable mixing of races since the State Game Commission released 80,000 cottontail rabbits for stocking purposes in 1927–28. These rabbits were obtained from dealers in Kansas City and Oklahoma.

Cervus canadensis canadensis (Erxleben). Elk.

Concerning the elk in Pennsylvania, Dr. W. J. Knight writes in Seton (1927): "Elk County, Pa., was erected in 1843, and was so named on account of its wilderness and great droves of elks that formerly and then roamed in those wilds. This new county was composed entirely of the forest portions of Clearfield, Jefferson, Warren, and McKean counties. In this territory were then about all the elk of Pennsylvania; and the slaughter of them commenced in 1843 and continued annually until 1852. There was one elk killed in 1862, one in 1866."

Several writers credit Jim Jacobs, a full-blooded Seneca Indian, with killing the last elk at Flag Swamp, in Elk County in 1867.

Odocoileus virginianus virginianus (Boddaert). Virginia Deer.
Odocoileus virginianus borealis (Miller). Northern White-tailed Deer.

In speaking of the white-tailed deer, Seton says. "The outstanding case of successful restoration is that of Pennsylvania. The first State game refuge was created in Clinton County in 1905. In 1907 only 200 deer were killed in all of Pennsylvania." During the last season 26,099 deer were killed in the State.

The northern white-tailed deer was formerly abundant in the northern mountainous region, the Virginia deer being restricted to the lowlands. Between 1920 and 1925, 85 *borealis* from Michigan were released in Elk County.

Bison bison pennsylvanicus (Shoemaker). Wood Bison.

Seton, referring to a correspondence with Col. Henry W. Shoemaker, says: "He writes me under date of October 27, 1925, as follows: 'As to the last Buffaloes in Pennsylvania, the last one in Somerset County was killed by Joseph Shank in the glades of that county in 1810 according to George W. Grove, a noted local historian of Somerset County; and another was killed in Northumberland County by Frederick Stamm in 1810. . . .

" 'The last Buffalo was driven out of Buffalo Valley, Union County, in the direction of Lewistown by Jacob Weikert in 1808. Col. John Kelley killed a Buffalo at the Buffalo Cross Roads in Buffalo Valley in 1801; and the last herd of Buffaloes was wiped out in the White Mountains of Union County in (December) 1799.' "

Finally, we should be stimulated in our mammalogical purpsuits, knowing, says Seton, that "The Pennsylvania Buffalo is practically unrepresented in any museum. The young naturalist can do good service by watching excavations that are in progress anywhere in Pennsylvania, and especially in bogs. For in these we are likely to find skulls, bones, and even complete skeletons of this most interesting species."

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PLANTS FROM MONROE AND PIKE COUNTIES, PENNSYLVANIA, NEW TO THE COLLECTIONS OF THE CARNEGIE MUSEUM HERBARIUM

By Edw. H. Graham[1] and LeRoy K. Henry[2]

During the summer of 1930 the writers spent July and August as nature study teachers at Buck Hill Falls, in the Pocono Mountains of Monroe County, Pennsylvania. Through the kindness of Mrs. G. W. Strattan, of Buck Hill Falls, who is a competent botanist with an intimate knowledge of the Poconos, it was possible to visit several localities in Monroe and Pike counties on week-end trips and to collect specimens of the flowering plants and ferns for the Carnegie Museum Herbarium at Pittsburgh, Pennsylvania. The number of species which proved to be new to the Herbarium has prompted the following notes. The first part of the present paper, prepared by Edw. H. Graham, lists all the plants collected by the writers in Pike County which were new to the Herbarium. Obviously, not all of them are rare plants, but the common species listed may serve to stress the fact that collectors often ignore the usual, which after all is more typical than the rarer species. In working over the Monroe County specimens, a list of which forms the second part of the present paper, prepared by LeRoy K. Henry, only the less common species have been noted and a collection made by O. E. Jennings, G. K. Jennings and E. M. Gress in Monroe County from late July to early September, 1920, was also studied and the results interpolated. The families and nomenclature are according to Gray's Manual of Botany, seventh edition; the genera and species are arranged alphabetically. The northern counties of Pennsylvania undoubtedly still hold many plants little collected, and further field work can profitably be spent there, particularly in the northeast.

PART I. PLANTS FROM PIKE COUNTY

By Edw. H. Graham

The following list is composed of those plants, collected in Pike County by Edw. H. Graham and LeRoy K. Henry during July and August, 1930, which are new to the collections of the Carnegie Museum Herbarium. A total of 90 new records is listed. *Botrychium ternatum* var. *intermedium* and *B. lanceolatum* var. *angustisegmentatum* provide new State records in the Herbarium collections, and the occurrence of *Clethra alnifolia*, a coastal-plain species, which was found at the edge

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of Porter's Lake, south-central Pike County, is notable. Among the rare species collected may be noted *Aspidium simulatum, Calopogon pulchellum, Rhododendron viscosum,* and *Campanula aparinoides.* The numbers following the names of the plants refer to localities as follows:

7.[3] Roatch Pond, north of Greentown
8. Nineteen-mile Run, South Sterling
9. Lake Wallenpaupac
10. Little Pond Bog, near Greentown
11. South-central Pike County

Polypodiaceae

Aspidium novaboracense (L.) Sw. 8, 10, 11.
A. simulatum Davenp. 10.
A. spinulosum (O. F. Müller) Sw. 8.
A. spinulosum var. *intermedium* (Muhl.) D. C. Eaton. 7, 11.
A. Thelypteris (L.) Sw. 8, 10.
Asplenium Filix-femina (L.) Bernh. 7, 11.
Dicksonia punctilobula (Michx.) Gray. 8.
Onoclea sensibilis L. 10.
Phegopteris Dryopteris (L.) Fee. 10.
P. hexagonoptera (Michx.) Fee. 11.
P. polypodioides Fee. 8, 10.
Polystichum acrostichoides (Michx.) Schott. 8, 11.
Pteris aquilina L. 11.

Osmundaceae

Osmunda cinnamomea L. 10, 11.
O. Claytoniana L. 10, 11.
O. regalis L. 11.

Ophioglossaceae

Botrychium lanceolatum var. *angustisegmentatum* Pease and Moore. 10.
B. obliquum var. *dissectum* (Spreng.) Clute. 9.
B. ramosum (Roth) Aschers. 9.
B. ternatum var. *intermedium* D. C. Eaton. 9, 11.

Equisetaceae

Equisetum sylvaticum L. 7.

Araceae

Orontium aquaticum L. 7.

Lycopodiaceae

Lycopodium clavatum L. 8, 10.
L. complanatum L. 8, 10.
L. lucidulum Michx. 8.
L. obscurum L. 8, 11.

Pinaceae

Larix laricina (Du Roi) Koch. 10.
Picea rubra (Du Roi) Dietr. 10.

Cyperaceae

Carex crinita Lam. 10.
C. retrorsa Schwein. 10.
C. tribuloides Wahlenb. 10.
C. vulpinoidea Michx. 10.

Liliaceae

Medeola virginiana L. 8.
Oakesia sessilifolia (L.) Wats. 11.

Iridaceae

Iris versicolor L. 7, 10.

Orchidaceae

Calopogon pulchellus (Sw.) R. Br. 10.
Corallorhiza maculata Raf. 8.
Habenaria blephariglottis (Willd.) R. Br. 10.
H. lacera (Michx.) R. Br. 7.

[3] Localities 1 to 6, inclusive, are in Monroe County and are listed below in Part II.

BETULACEAE

Carpinus caroliniana Walt. 11.
Ostrya virginiana (Mill.) Koch. 11.

POLYGONACEAE

Polygonum arifolium L. 10.
Rumex acetosella L. 7.

CARYOPHYLLACEAE

Silene stellata (L.) Ait. f. 11.

LAURACEAE

Benzoin aestivale (L.) Nees. 11.

RANUNCULACEAE

Ranunculus acris L. 10.
Thalictrum polygonum Muhl. 11.

FUMARIACEAE

Corydalis sempervirens (L.) Pers. 9.

CRUCIFERAE

Radicula palustris (L.) Moench. 10.

DROSERACEAE

Sarracenia purpurea L. 10.

SARRACENIACEAE

Drosera rotundifolia L. 10.

CRASSULACEAE

Penthorum sedoides L. 10.

SAXIFRAGACEAE

Chrysosplenium americanum Schwein. 8.

ROSACEAE

Prunus pennsylvanica L. f. 11.
Rubus villosus Ait. 9.

LEGUMINOSAE

Apios tuberosa Moench. 7.
Baptisia tinctoria (L.) R. Br. 11.

CALLITRICHACEAE

Callitriche heterophylla Pursh. 11.

ANACARDIACEAE

Rhus copallina L. 7.

ACERACEAE

Acer saccharum Marsh. 10.

BALSAMINACEAE

Impatiens biflora Walt. 11.

HYPERICACEAE

Hypericum virginicum L. 10.

LYTHRACEAE

Decodon verticillata (L.) Ell. 10.

ONAGRACEAE

Circaea lutetiana L. 11.

VERBENACEAE

Lobelia inflata L. 11.

UMBELLIFERAE

Cicuta maculata L. 10.
Hydrocotyle americana L. 7.

ERICACEAE

Chiogonese hispidula (L.) T. and G. 10.
Clethra alnifolia L. 11.
Kalmia angustifolia L. 10, 11.
K. latifolia L. 10, 11.
Rhododendron viscosum (L.) Torr. 10, 11.
Vaccinium corymbosum L. 10.
V. pennsylvanicum Lam. 10, 11.

PRIMULACEAE

Lysimachia terrestris (L.) BSP. 10.
Steironema ciliatum (L.) Raf. 10.
Trientalis americana (Pers.) Pursh. 11.

LABIATAE

Satureja vulgaris (L.) Fritsch. 10.
Scutellaria lateriflora L. 7, 11.
S. parvula Michx. 11.

SCROPHULARIACEAE

Chelone glabra L. 7.
Gratiola virginiana L. 10, 11.
Melampyrum lineare Lam. 7.

RUBIACEAE

Galium palustre L. 7, 10.

CAPRIFOLIACEAE

Viburnum alnifolium Marsh. 8.

CAMPANULACEAE

Campanula aparinoides Pursh. 11.

LOBELIACEAE

Lobelia inflata L. 11.

COMPOSITAE

Achillea Millefolium L. 7.
Anaphalis margaritacea (L.) B. and H. 7, 8, 10.
Sericocarpus asteroides (L.) B. and H. 7.

PART II. PLANTS FROM MONROE COUNTY

BY LEROY K. HENRY

Among the plants collected by O. E. Jennings, G. K. Jennings and E. M. Gress in 1920, 300 species were new to the Carnegie Museum Herbarium, and among those collected by Edw. H. Graham and LeRoy K. Henry in 1930, 85 additional species are new. All of these are not listed here, but an attempt has been made to list the uncommon or otherwise significant species. A total of 106 such new records is listed below. *Cycloloma atriplicifolium* and *Artemisia ludoviciana,* here reported from Tobyhanna, are western species locally naturalized eastward. They were probably brought to the region in feed supplied the army training camp there during the war. It will be interesting to note whether they persist. *Centaurium pulchellum* has only previously been represented in the Herbarium from York and Lancaster counties. Among the rarer species collected may be noted *Cheilanthes lanosa, Microstylis unifolia, Cuscuta arvense, Gentiana linearis, Campanula aparinoides,* and *Solidago puberula.* The numbers following the names of the plants refer to localities as follows:

Collected by Edw. H. Graham and LeRoy K. Henry.

1. Buck Hill Falls and vicinity
2. Four miles west of Bushkill
3. Near Pipher's Airport, East Stroudsburg
4. Near Delaware Water Gap
5. Marshall's Creek
6. Wagner's, near Pocono Lake

Collected by O. E. Jennings, G. K. Jennings, and E. M. Gress.

12.[4] Tobyhanna
13. Pocono Summit
14. Delaware Water Gap and vicinity

POLYPODIACEAE

Cheilanthes lanosa (Michx.) Walt. 14.

EQUISETACEAE

Equisetum hyemale L. 14.

[4] Localities 7 to 11, inclusive, are in Pike County and are listed above in Part I.

OPHIOGLOSSACEAE

Botrychium ramosum (Roth) Aschers. 1.
B. ternatum var. *intermedium* D. C. Eaton. 12.

LYCOPODIACEAE

Lycopodium lucidulum Michx. 1.

NAIADACEAE

Potamogeton americanus C. and S. 1.

PINACEAE

Larix laricina (Du Roi) Koch. 12.
Taxus canadensis Marsh. 1, 2.

ALISMACEAE

Sagittaria Engelmannia J. G. Sm. 12.

LEMNACEAE

Lemna minor L. 5.

HYDROCHARTIACEAE

Elodea canadensis Michx. 1, 2.
Vallisneria spiralis L. 1.

LILIACEAE

Smilax herbacea L. 5.
Streptopus amplexifolius (L.) D.C. 1.
S. roseus Michx. 1.
Veratrum viride Ait. 2.

DIOSCOREACEAE

Dioscorea villosa L. 2, 5.

IRIDACEAE

Iris versicolor L. 12.

ORCHIDACEAE

Cypripedium acaule Ait. 12.
Habenaria clavellata (Michx.) Spreng. 12.
H. psycodes (L.) Sw. 4.
Liparis Loeselii (L.) Richard. 12.
Microstylis unifolia (Michx.) BSP. 12.

MYRICACEAE

Myrica Gale L. 12.

BETULACEAE

Alnus incana (L.) Moench. 1.

FAGACEAE

Quercus ilicifolia Wang. 12.

CHENOPODIACEAE

Cycloloma atriplicifolium (Spreng.) Coult. 12.

URTICACEAE

Boehmeria cylindrica (L.) Sw. 14.
Pilea pumila (L.) Gray. 4.

POLYGONACEAE

Polygonum prolificum (Small) Robinson. 12.
P. tenue Michx. 14.

CARYOPHYLLACEAE

Stellaria graminea var. *latifolia* Peterm. 1.

NYMPHAEACEAE

Nymphaea advena Ait. 12.

RANUNCULACEAE

Ranunculus aquaticus var. *capillaceus* DC. 1.

DROSERACEAE

Drosera rotundifolia L. 12.

CRUCIFERAE

Erysimum cheiranthoides L. 12.
Radicula nasturtium-aquaticum (L.) Br. and Rendle. 14.

ROSACEAE

Prunus virginiana L. 2.
Pyrus americana (Marsh) DC. 12.
P. arbutifolia (L.) L.f. 14.
P. melanocarpa (Michx.) Willd. 12.
Sanguisorba canadensis L. 12.

LEGUMINOSAE

Amphicarpa monoica (L.) Ell. 5.
Apios tuberosa Moench. 1, 3.
Cassia nictitans L. 14.
Desmodium paniculatum (L.) DC. 3.
Vicia angustifolia (L.) Reichard. 1.

EUPHORBIACEAE

Euphorbia hirsuta (Torr.) Wiegand. 1.

AQUIFOLIACEAE

Ilex monticola Gray. 12.

VITACEAE

Vitis aestivalis Michx. 14.
V. bicolor LeConte. 1.

TILIACEAE

Tilia Michauxii Nutt. 14.

MALVACEAE

Malva moschata L. 12.

HYPERICACEAE

Hypericum Ascyron. L. 14.

LYTHRACEAE

Lythrum Salicaria L. 14.

ONAGRACEAE

Circaea Alpina L. 1.
Ludwigia palustris (L.) Ell. 13.
Oenothera fruticosa var. *hirsuta* Nutt. 13.

UMBELLIFERAE

Cicuta bulbifera L. 12.
Hydrocotyle americana L. 14.
Pastinaca sativa L. 1.

ERICACEAE

Chamaedaphne calyculata (L.) Moench. 12.
Chimaphila maculata (L.) Pursh. 14.
C. umbellata (L.) Nutt. 14.
Kalmia angustifolia L. 12.
Lyonia ligustrina (L.) DC. 12.
Rhododendron canescens (Michx.) G. Don. 13.
Vaccinium atrococcum (Gray) Heller. 12.
V. canadense Kalm. 12.
V. ovalifolium Sm. 14.
V. pennsylvanicum L. 12, 13.

PRIMULACEAE

Steironema ciliatum (L.) Raf. 14.

BORAGINACEAE

Lappula echinata Gilibert. 12.

GENTIANACEAE

Bartonia virginica (L.) BSP. 14.
Centaurium pulchellum (Sw.) Druce. 1.
Gentiana linearis Froel. 12.

ASCLEPIADACEAE

Asclepias phytolaccoides Pursh. 1.
A. tuberosa L. 3.

CONVOLVULACEAE

Cuscuta arvense Beyrich. 12.
C. Gronovii Willd. 1.

LABIATAE

Galeopsis tetrahit L. 1.
Lycopus americana Muhl. 14.
L. uniflorus Michx. 13.
L. virginicus L. 14.
Pycnanthemum incanum Michx. 14.
P. pilosum Nutt. 14.
P. virginianum (L.) Durant and Jackson. 14.

SCROPHULARIACEAE

Gratiola virginiana L. 2.
Gerardia setacea Walt. 14.
Chelone glabra L. 1.
Veronica virginiana L. 14.

PLANTAGINACEAE

Plantago aristata L. 12.

RUBIACEAE

Galium lanceolatum Torr. 1, 3.

CAPRIFOLIACEAE

Lonicera canadensis Marsh. 1.
Triosteum perfoliatum L. 14.
Viburnum dentatum L. 12.
V. Lentago L. 12.
V. nudum L. 12.
V. pubescens (Ait.) Pursh. 14.

CAMPANULACEAE

Campanula aparinoides Pursh. 14.

COMPOSITAE

Artemisia ludoviciana Nutt. 12.
Eupatorium aromaticum L. 14.
Gnaphalium uliginosum L. 1.
Helenium autumnale L. 14.
Inula Helenium L. 4, 6.
Mikania scandens (L.) Willd. 5.
Solidago puberula Nutt. 13.

TOTAL EMISSIVITIES OF ALUMINUM, BRASS, COPPER AND STEEL

By E. RAYMOND BINKLEY
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The total relative emissivities of aluminum, brass, copper and steel were measured from 100 to 500° C. To obtain these measurements at such low temperatures required a special type of total radiation pyrometer; shown in Fig. 1.

The pyrometer is of the fixed focus type, consisting of a tube 20 inches long and 4 inches in diameter. The concave mirror has a focal length of 4 inches, the reflecting surface copper gold-plated, gold being used because the reflection coefficient for gold at long wave-lengths is nearly constant, viz., 0.98 and since the radiation at these low temperatures consisted mostly of the long wave lengths.

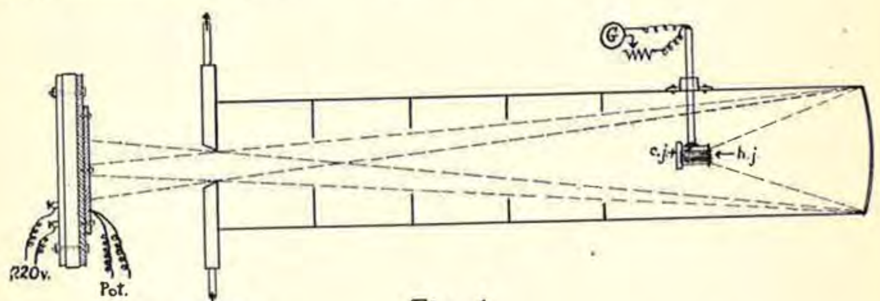

Fig. 1

A water cooled shield was placed at the open end of the pyrometer tube; the opening in it was made one inch in diameter which resulted in a fixed focus pyrometer. Then all the radiation included within the dotted lines as shown in the figure would be converged by the mirror onto the sensitive thermopile.

The thermopile consisted of ten copper-constantan junctions, placed within a circle of ¼ inch in diameter, connected in series with ten similar junctions and separated about one inch from the first group. These latter ten junctions were shielded from all radiation and served as the cold junctions. The hot junctions were coated with camphor black to absorb the total radiation converged by the mirror.

The e.m.f. generated was measured by a sensitive galvanometer. Diaphragms were placed equidistant apart within the tube to prevent the radiation not included within the cone of rays from reaching the thermo element. The pyrometer was calibrated by a camphor blackened surface assumed at 98 per cent. black body.

The surfaces to be measured were placed about 4 inches in front of the pyrometer. These surfaces were 6″ x 4″ x ⅛″ and to obtain uniform heating were fastened upon a copper plate 8″ x 6″ x ½″; this plate in turn was heated by a heating element which consisted of a piece of alundum insulating material wound with Nichrome resistance wire and connected to 220 volts, A. C. A thin sheet of mica insulated the copper plate and the heater. The temperature of the surface was obtained by means of a thermojunction placed on it.

Temperatures indicated by a radiation pyrometer calibrated against a black body are called apparent temperatures (S), and the true temperatures (T) measured by the junction on the metal surfaces. The

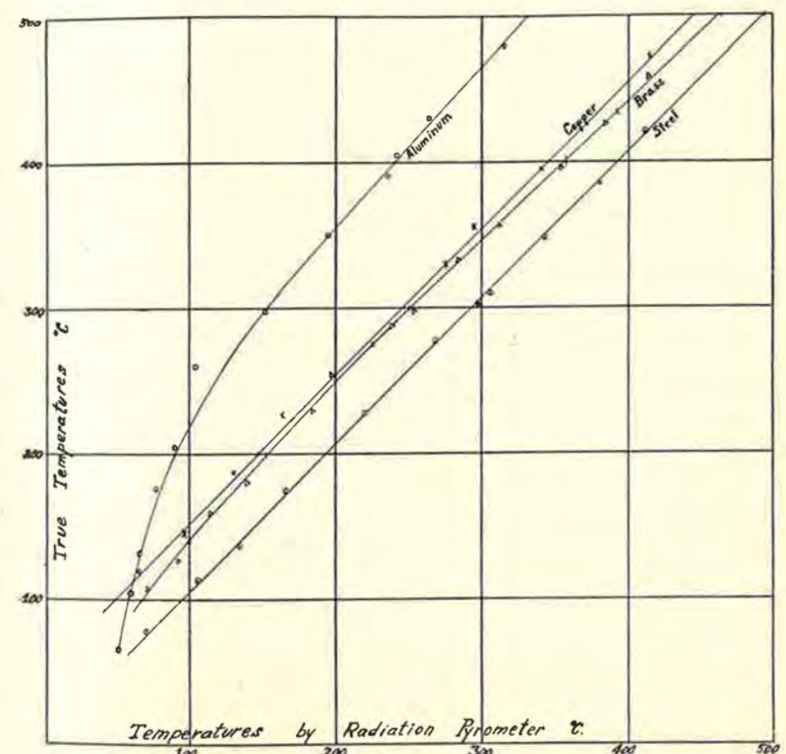

Fig. 2

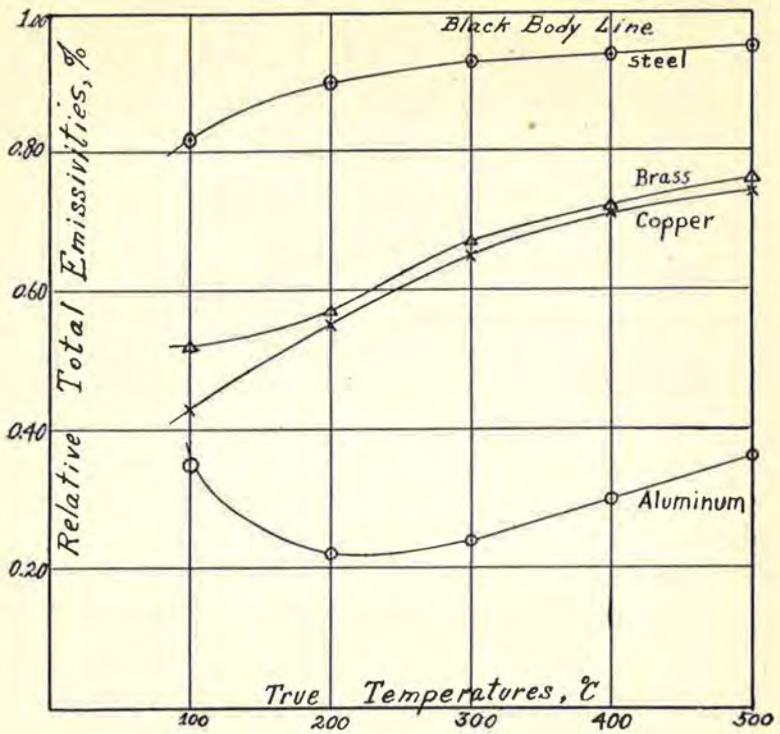

Fig. 3.

relative total emissivity (E) is given by $(S^4 - T_0^4)/(T^4 - T_0^4)$, where T_0 is room temperature.

Figure 2 shows the curves obtained by plotting the true temperatures against the apparent temperatures for each surface, and Fig 3, the results as calculated by the equation: $E = (S^4 - T_0^4)/(T^4 - T_0^4)$.

The steel, copper and brass were oxidized and the emissivities for each remained fairly constant throughout the temperature range, copper varying most. This was probably due to the color of the oxide changing as the temperature decreased. Aluminum, however, varied continuously over the range measured, although its surface was observed to remain unchanged.

LEAF SPOT PRODUCTION UPON TOBACCO BY A CULTURE FILTRATE OF FUSARIUM AFFINE[1]

By W. S. Beach
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In 1921, Slagg (1) described a disease of tobacco characterized by leaf spotting, stem browning and damping-off of young plants. The causal organism was found to resemble closely *Fusarium affine* Faut. & Lamb., and in the present paper this parasite is considered under the same name.

Fusarium affine attacks not uncommonly the seedlings of cigar-filler tobacco, *Nicotiana tabacum* Linn., in Lancaster County, Pa., but is rarely seen on the crop transplanted to the field except occasionally on the lowermost leaves. *Nicotiana rustica,* which is being bred and selected at Lock Haven, Pa., by the United States Department of Agriculture for its high nicotine content, is much more susceptible to *Fusarium affine* than the cigar-filler tobacco. On some plants of *N. rustica* grown in Philadelphia County, Pa., during the dry summer of 1930, new infections continued to develop following each fall of rain and some of the upper leaves of blooming plants became spotted, while adjacent plants of *N. tabacum* showed mere traces of infection near the soil.

On *N. rustica* spot production appears to be the more characteristic disease phenomenon. At first the spots are more or less circular, dusky green or olivaceous blotches appearing on either surface of the leaves; later, as the affected tissues die, the central portion of the spots become tan, or sometimes somewhat ashen, especially on pressed specimens. The epidermal surface on close inspection is seen to be more or less etched and wrinkled, and this aspect is also more conspicuous on pressed specimens. The ashen appearance is probably due to air entering the somewhat disintegrated tissues, Fig. 4 A.

Under very damp seed bed conditions, it has been observed that the wide distribution of the fungus often causes the surface of an extensive part of the foliage to exhibit a slightly etched appearance although the extent of mycelial distribution does not appear to coincide with the affected surface. This observation suggested experimental work to see whether the mycelium produced or excreted any substance which tended to affect the outlying leaf epidermis by being spread about through the medium of rain water or dew. It seemed as if the phenomenon here

[1] Publication authorized by the Director of the Pennsylvania Agricultural Experiment Station as Technical Paper No. 527.

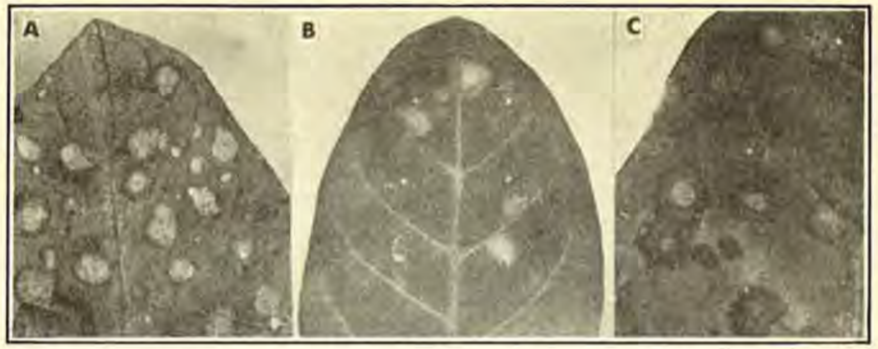

FIG. 4. A. Pressed specimen of a leaf of *Nicotiana rustica* showing natural infection spots of *Fusarium affine*. B. Etched spots on a leaf of *Nicotiana rustica* produced by the action of a culture filtrate of *Fusarium affine*. The two spots with light center exhibit killed leaf areas. In this instance the filtrate was applied to needle wounds but the leaf movements caused the drops to flow aside. C. Infection spots of *Fusarium affine* on a fresh green leaf.

might be similar in action to what Young and Bennett (2) have reported for *Fusarium oxysporium* in the potato plant. These authors found evidence that wilting is not due to a mechanical plugging of the vascular tubes, but is due to certain products of the fungus acting on the host tissue.

Experimental procedure with *Fusarium affine* consisted in growing 21-day-old cultures on test-tube slants of potato-dextrose agar, and then flooding the fungal growth with 5 ml. of sterile water. After the water had been in contact with the growth 24 hours, it was passed through a coarse or V grade Berkefeld filter, sterilized apparatus being utilized. Drops of the filtrate were then placed with a pipette upon series of defined areas of the leaf surface of healthy potted plants of *Nicotiana rustica*. The plants were covered with improvised bell jars consisting of large inverted street lamp globes with plates of glass laid over the upper openings. These inclosures were equivalent to bell jars 10 inches in diameter and 20 inches high and had the distinct advantage of making the experimental plants accessible from the top. If the drops of filtrate dried up, more could be applied to the same areas with very little disturbance. Complete inclosure was continued three days, and then the glass plate was pushed aside a bit at a time making the change from near saturation to room humidity gradual. Complete removal of the glass plate was accomplished on the fifth or sixth day. The lamp globe was left in place to reduce air currents and hence the spread of foreign

organisms, and this was also in part the purpose of the gradual removal of the glass plate.

The drying of the filtrate usually left on the treated leaf areas slight incrustations which in a portion of the cases were removed by swabbing with a dampened piece of absorbent cotton. At the time of the complete removal of the glass plate, it was possible to detect the most of the treated epidermal areas by means of a faint etching even though the filtrate incrustations were swabbed away. In many cases there was no further change discernible, but in a considerable proportion the vividness of the etching increased. Then followed a mild wrinkling of the epidermis and finally after 10 to 18 days it became apparent that the leaf tissue beneath was dead on account of collapse and drying. There was a striking similarity between the dead spots thus produced and those resulting in nature from the infections of *Fusarium affine,* Fig. 4. In testing the power of the culture filtrate to affect the epidermis and the underlying leaf tissues, four series of experiments on different dates were conducted, and in these altogether 84 leaf areas were treated. From this number there resulted 15 killed areas or definite spots, while upon many of the balance more or less discernible etching was present.

As checks, a corresponding number of leaf areas were treated with drops of tap water under similar conditions. On these checks there was no apparent change except for three spots like those produced by direct sun rays through water drops and markedly different in character from those produced by the culture filtrate. It may be added that in the case of the leaves treated with the filtrate there were also two spots apparently produced by sun rays.

Microscopic examination of the tissues affected by the filtrate, not only in the case of the killed areas but also in that of mere etching, showed an absence of *Fusarium affine* and likewise other parasitic fungi and bacteria known to affect tobacco. Elimination of occasional traces of saprophytes was not successful even with an effort at aseptic conditions, but the occurrence of saprophytes was scanty and not indicative of causing the described effects. Failure to exclude all foreign organisms may allow some basis for criticism of the results, but the following points on the other hand give support to the conclusion that the culture filtrate caused the effects: (a) there was a general absence of both parasitic and non-parasitic spotting on the experimental plants except where the filtrate was placed and the few spots apparently caused by sun rays, (b) the spots produced by the filtrate were very similar to those caused by *Fusarium affine*, and (c) there was the absence of those organisms known to parasitize tobacco.

It appears possible that changes and improvements of technique may increase the proportion of treated areas showing definite effects, especially the use of younger cultures or those grown in liquid medium. *Fusarium affine* grows slowly in culture and two to four weeks elapse before a solid medium is overgrown. Precipitation and concentration of the potent substance offers a further line of experiment.

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(2) Young, H. C., and C. W. Bennett: Studies in parasitism in the Fusarium group. Phytopath. 11: 56. 1921. (Abstract.)

IS THE FLIGHT OF THE JAPANESE BEETLE NECESSARILY RESTRICTED TO A FEW MONTHS OF THE YEAR?

By George B. Stichter

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The Japanese beetle (*Popillia japonica* Newm.), a dangerously injurious insect pest new to and not heretofore widely prevalent or distributed within the United States, has now established itself in parts of the States of Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, and the District of Columbia.

Since its first appearance in the United States in 1916, it has multiplied and spread at an astonishing rate steadily in all directions, so that now it infests in greater or less degree the territory just outlined.

As the beetle is now an insect of economic consequence in Pennsylvania, especially in the Philadelphia metropolitan area, and its spread by both natural and artificial means is of vital concern to the uninfested States, the grave question arises: if or when the beetle gains a foothold in our semi-tropical States, such as Florida, whose extreme southern point is almost tropical (latitude 24¾° N.), Texas, whose extreme southern point is 26° N. latitude, or in any other State where there is no winter, will its flight be confined to but four months of the year, as is the case in the Philadelphia area, latitude 40° N.?

The complete seasonal cycle and life-history of the beetle is as follows: The average incubation period of the egg is from two to three weeks, at the end of which time there emerges a small white larva. The larval stage is divided into three substages, the first, second and third instars, each terminating in the moulting of the skin carried through the period just ended. The first two instars extend over a period of approximately three to five weeks, but the third instar period is the usual one for hibernation, which stage usually terminates early in the following June, when the insect pupates. The pupal stage takes from one to three weeks. The total life-cycle of this insect outside is approximately one year in the vicinity of Philadelphia, most of which time is spent in the soil as egg, larva, or pupa, but the life-cycle inside greenhouses is apparently shorter, as adult beetles have been found inside greenhouses early in November.

It is now possible to obtain adult beetles in the vicinity of Philadelphia every month in the year, as follows: outdoors, early June to late October; inside greenhouses, every month. The greatest numbers are found inside greenhouses during the fall, winter and spring, especially from January to April, inclusive. Few are found on cloudy or stormy days. They severely damage leaves, blooms and roots of plants. Some flowers are so badly damaged as to be unmarketable.

If it is possible to find beetles in their four stages throughout the year in the vicinity of Philadelphia, outside and inside greenhouses, and under natural and artificial conditions; what situation will confront us if or when the beetle reaches our extreme Southern States? Will they produce one, two, or even three generations a year, overlapping one another, with both the larvae and the adults feeding at the same time, one below and the other above the ground—on the foliage, blooms, fruit and roots of trees, and on the leaves, vegetables and roots of plants at the same time? If such feeding is continued year after year on trees, death of the trees will unquestionably ensue.

As far as the climate is concerned, the beetle may find in other parts of the United States more favorable conditions than in Pennsylvania or other parts of the presently infested area. No condition of heat has been noted which has been injurious to the eggs or larvae, provided the soil is moist. The hot and dry summer in Pennsylvania in 1930 held in check depredations by certain species of insects, of which the Japanese beetle is conceded to be one.

Beetles were found earlier in the season outdoors in 1930 than ever heretofore, but they did not increase in numbers so rapidly early in the season as in past years, and they were slower in getting on the wing, due no doubt to the prolonged dry spell.

The beetle's flight activity is confined almost entirely to hot and sunny days, although it may, when its numbers are greatest during the season, be found on hot and cloudy days. It is, however, not found on rainy days. Thousands have been found on plants, evidently feeding during and directly after severe storms. Its flights are apparently short and erratic, both with and against the wind that may prevail.

Beetles have emerged from flower pots in private dwellings from early in January to the summer season. The plants had either been purchased from florists who had bought them from infested greenhouses or from greenhouses located in badly infested areas. Again, the plants may have been potted in badly infested localities by the owners.

It is well known that many if not most of our more serious insect pests are not indigenous to this country, but have been introduced through human agencies into this country. The Japanese beetle is an outstanding example of this.

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Pennsylvania Department of Agriculture Bulletins.
New Jersey Department of Agriculture Bulletins.
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THE CHROMOSOMES OF THE MOUSE

Paul R. Cutright
University of Pittsburgh

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

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

After an era of more or less intensive study covering some fifty odd years, what can we say definitely about chromosomes? Practically all of our knowledge is morphological and all else is a matter of deduction. The chromosome number has been reported for a large number of animals and runs all the way from two in one of the round worms up to 208, a questionable count which has been given for a certain species of crayfish. In the house fly the number is 12, in the rat it is 42, and in man 48. The number for all forms, within limits, is constant. We know that the individual chromosomes have a more or less definite size and shape in each species. We know the exactness of division in mitosis and the presence in diploid groups of paternal and maternal homologues in synapsis and we know of their disjunction in reduction division. We are relatively certain that identical twins, which are practically mirror images of each other, owe their great similarities to identical sets of chromosomes. Literally millions of chromosomes have been counted, measured, and drawn. We know the morphology of the chromosomes and from this knowledge we deduce, as did Hertwig, Weismann, and Strasburger in 1885, that they are the vehicles of heredity; at least we know of no other satisfactory vehicle.

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

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

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

Numerous investigators have already worked on the mouse but their efforts have been confined almost entirely to spermatogenesis, although a few have attempted a study of oogenesis. The haploid chromosome number reported has varied all the way from 12 to 20 and no diploid count was made until 1926 when Cox reported the number as 40.

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

I have been able to count forty chromosomes in several spermatagonial cells and this number coincides with that reported by Cox and Painter. These are rather short, heavy rods and in only the longer ones is there any bending or hooking and even in these it is not pronounced. When an alignment was made twenty pairs were distinguishable; in nineteen of these the elements of each were practically identical, but the twentieth consisted of a long rod and a very short one. The long one is evidently the X-chromosome and the short one the Y-chromosome. The forty chromosomes then consist of nineteen plus an X, which came from the female parent, and nineteen plus a Y which came from the male parent. The X–Y combination, in mammals, results in a male. Later on from a study of the ovary we expect to demonstrate the presence of the 2X combination, with the absence of the Y, resulting in a female. It is generally accepted that the X and Y-chromosomes are the main agents in sex determination, although the work of other investigators, particularly that of Riddle, has thrown some physiological monkey wrenches into the machinations of the theory.

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

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

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

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

ADJUSTMENT OF ACADEMY ORGANIZATION TO GROWTH

By D. S. Hartline
Bloomsburg State Teachers College

My Fellow Academicians:

Please let me again express to you my very cordial thanks for the opportunity for study and service you gave in honoring me with the Presidency of this Academy.

The complete surprise, and the happy contacts that I could not otherwise have experienced, are particularly gratifying to me.

As expression of my keen appreciation I would like in this presidential address to share with you some of the results of some of my studies made in the hope of contributing something towards preparing the way for the Academy to take a next step in the course of its normal growth.

You will recall that the medallion stamped on the "Reports of the Smithsonian Institution" bears the motto, "For the Increase and Diffusion of Knowledge among Men."

You will place alongside of this the words from our own Academy Constitution Article 1, Sec. 11, "The object of the Academy shall be scientific research and the diffusion of knowledge concerning the various departments of science."

In furtherance of this diffusion of knowledge, to make sure that this one of its prime objects shall be accomplished, the Academy has made itself peripatetic. And at all the places to which I have gone with the Academy for its meetings, I have seen a nice company of laymen who listened with keen interest, and with enthusiasm expressed satisfaction over having had opportunity to learn of what was being done. Further, in each case the membership from that community was materially increased because the Academy came there. At Bloomsburg, last Easter, ten new members were added to the body. From this point of view then is "diffusion"—by increasing membership to share our findings with us.

That there is "increase in knowledge" is increasingly evident from the number, variety, and quality of papers, always announcing some new findings.

A more detailed consideration of these two phases of our activities may lead us into thinking that will bring us clearly to a next step.

The science of education has long been talked about. We have come along with it at about the same rate and in much the same way we did in the organization of all other branches of science. The digging out of new raw material has gone on apace; its value, and its organization into a scheme embodying other values that will make it a tool, and thence systems of tools, for working out larger values for greater living, has gone about as fast as we go. But for so vast a thing it is only a beginning. All our institutions are outgrowths of it, and therefore, interested in further growth, and in other growths, from it, even before it has become truly a science, and while it is being slowly shaped into a true science. The work of such men as Socrates, Froebel, Herbert Spencer, G. Stanley Hall, and the great host of eager, achieving contemporaries, has only made it evident that here is a vast store of raw material that needs to be worked over for the "increase of learning."

It bothers us whose special business it is to provide for the "diffusion of knowledge" and whatever goes with it—that is, it perplexes us teachers in the schools organized for carrying on the fundamental processes of education, to learn from the laity, our clientele, that we are not doing the thing right! That we are loading down the child with adult knowledge till childhood is at the point of being crushed! That our schools attempt to teach the children everything that the adult knows as fast as he learns it and so are wiping out childhood's dreamy wanderings through the recapitulation of racial experiences, extending to us from the Dawn of Earth life, worked from the same urges, by the same powers and qualities that characterize our present goings, doings and winnings, but of proportions fitting the child. And we are urged to shape-up a school-education program that will give child's education at child's age and a program that will lead rationally into adult learnings, thinkings, knowings and behaviors, in adult life. By trying to do both in the period of childhood we are doing neither well and carrying on hurtful, not helpful processes, and fooling them and ourselves, partly, into thinking they are getting fitting education when they are only doing not-understood stunts, and only getting diplomas and degrees, and education not at all.

Do we teachers know so little about the nature of knowledge, of the process of learning, and of the reaction of the developing the growing mind to these? Shall we have some research into this? Shall we push ahead with new motives, greater powers, finer equipment for further studies into the old inquiry—"What knowledge is of most worth?" When is it? How teach it so that the worth will be evident?

We have just passed through a great World War. Have not we taught for lo! these many years "Peace on Earth, good will to men"?

We are still in a business and industrial depression. Lots to do but willing workers unemployed, bins and granaries filled to bursting, but anxiety, starvation, bread lines, and dole! What is education for?

We are not yet through a period of severe drouth. So are we still destroying forests! Can't we learn and teach the relations between forest and water supply so that learning, knowing, will determine conduct? So that we will quit praying for rain to an offended God who is punishing us by withholding, but appeasing His wrath first by "praising Him"?

Can we handle the teaching-learning process so that the adult will want to continue learning what he couldn't learn in youth, and this without the bribery of degrees?

A prominent and highly successful Nature writer, a prince of story tellers, a teacher, tells this on himself. He had a little niece who pleaded with Uncle to tell her a story. "Yes, Mollie." The little lassie climbed into his lap and he proceeded. The teaching-learning process with adult and child as actors was on. The grip of the story drew in turn a laugh, a shudder, a cry of relief, a sob of pity, a shout of exultation. She sat awhile in thoughtful silence, then jumped from his lap and started to walk away.

"Mollie, didn't you enjoy the story?" "O yes, Uncle! But, Uncle, please don't put the story into your book." "Why not, Mollie?" "If you do we will have to study it in school and that will spoil it all."

Is there something wrong with teachers, teaching school? Might we investigate effects of teacher-learning on the developing mind? Modes of presentation? What's the matter with teachers, schools, school-books? Also with the pupil, and the environment from which he comes, and the heredity with which he comes? What is learning for?

The age-old tendency to humanize animals, plants, stars, things generally, animate and inanimate, brought on, among others, the interesting controversy vigorously waged on the one side by the protestant, John Burroughs, powerfully backed up by our "Teddy" Roosevelt, then President, and others; and on the other side, by the defendants, sinners, Wm. J. Long, E. Thompson-Seton, C. G. D. Roberts, and others. It was brought to high tide in the very interesting and highly useful books by James Harvey Robinson, "Mind in the Making," "Humanizing Knowledge," and it now bears at flood, Wells' "Outline of History," Van Loon's "The Story of Mankind," "The Story of the Bible," Durant's "The Story of Philosophy," Dorsey's "Why We Behave Like Human Beings," and a host of others. And it has gone through the stages, humanizing, popularizing, vulgarizing, and maybe others. Said either way is up or down according to your own outlook upon the matter. You will recall that R. T. Hance in his presidential address last year, in happy vein, and none the less effectively, set before the body the fact that the Academy has some work on its hands if it means certainly to come to complete success in fulfilling its second object, "diffusion of knowledge."

When you see keen, alert men and women drowsing through the reading of one paper, an exceedingly interesting one, and in the very next, mayhap not so interesting, the same people following with absorbing, charmed attention, pleased, active interest, and jumping at the chance for expression when discussion is called for; when you hear Academy members say they lost time sitting through a paper because it was so technical that they could not understand, but did sit through because of waiting for the next, since that was in their field and they knew they could understand; when the lay members and guests say that they were much interested in some paper because they could understand and not in others because the language was beyond them, then it is clear that the "diffusion" is not very thorough, and it may be that the Academy has some work to do in the way of appropriate change.

If this is true of the Academy as an educational institution, it is still more likely to be true of the institutions in the field of public education.

But it is to be said for both the Academy and the school that science has its special language for the very definite purpose of expressing accurately, conveniently, exactly what the terms were made to hold. It may make words that seem long to the workers in another field, but they are very convenient and concise for the specialist of that field. Translation into popular language might not only take work and time from the specialist that he can ill afford to give, but necessitate muddling through a lot of verbosity or chatter that would not in the end make it clear. Physics, mathematics, chemistry, and all other well organized sciences are replete with illustrations. A glance at some well-worn tools, "π," "10^{27}," "Eozoon," "photosynthesis," will make the point clear. Einstein's equation, expressing "the basic law of the universe," brought back to America with loud acclaim from a "4000 mile journey" to the "World's Greatest Thinker," may be a little more dubious to most of us.

For the work of diffustion this may be a fruitful field of study, offering many problems, material for many papers and discussions for some Academy members whose work is especially in the field of public education.

Since every well organized science has its own body of technical terms, such work may well contribute both to bringing education to such scientific organization and to "diffusion of knowledge."

But the most needed work, to get the various phases of science to function in public education as they should in a scientific age, when more and more "science" is "remaking the world," to borrow Slosson's phrase, is the selection of well co-ordinated material for the purposes of education; material that is fundamental, that (1) comes within the category of knowledge possessed by the educated, (2) that lends itself well to the right educational procedure at the various development levels and (3) will be seen and understood as being fit, as having its own place at its right level of educational experience and achievement. This selection of science material for educational service has not very generally, in our set-up for educational functioning, been made by science workers.

Science men and women have not shown sufficient interest or have had no chance. The selection of science subject-matter for educational service has been too frequently made by those whose chief concern was expediency, or collateral interests. The educational needs of the candidates for education and the teaching-learning qualities of the subject-matter have been too much subordinated. In my view the rôle played by science in public education is quite chaotic, quite unscientific, because misplaced in the curriculum and mishandled in the application. This is a fruitful field for study and discussion in such an institution as this. This body cannot determine, but it can study, help furnish the matter, and a group of its members point the way of application to this great opportunity for "diffusion among men."

While this address was in preparation and practically finished, I read my copy of the weekly journal *Science*, the official organ of the A. A. A. S. I came upon the annual address of Vice-President Riley, Chairman of Section F—Zoology, of the Association, and professor of zoology in the University of Minnesota. Its title is "Some Present-Day Problems of Zoology Teaching." Many of you, no doubt heard it. I wish I had been so fortunate. Since I was not, I am glad for the opportunity to read it. In the introductory part of this trenchant survey of the situation Prof. Riley says: "There is another aspect which is a very live problem in educational work, but which we are inclined to give scant attention. I refer to the *ever-growing complaint regarding the teaching of the sciences.*"

This is the triple A of S.! Since the facts are as they are, I am glad it came from there and was encouraged to go on, for I frankly confess that I felt the same temerity about giving this study before this body that he confesses. The weakness is wide-spread—general. It is an encouraging sign to have the thing widely recognized.

Science teaching, rightly done, is necessarily expensive. Wrongly done, as is too often the case, it is yet more expensive because so near a total loss.

Possibilities considered, there is just cause for complaint. There is a large measure of fairness in the feeling of disappointment with our science teaching-learning courses.

We make too few scientists and too few appreciative scientific learners. I do not mean only specialists constantly increasing the vast output of scientific lore. I mean, as well, intelligent users of the output, who can apply it to life appreciatively, with understanding and the saner philosophy and the sheer joy that attends such use.

Our "diffusion" seems faulty, not so thoroughgoing and far-reaching as it should be—may be not so much because the substance wanted is not there as because we do not put it up in available form.

The story of the farmer's experience may make the point clear.

The close of day, the hour of feeding the stock, the time for checking up—

"Rastus, did you feed the horses?" "Yas, Sah!" "What did you feed 'em?" "Hay." "Did you feed the cows?" "Yas, sah!" "What did you feed them?" "Hay." "Did you feed the ducks?" "Yas, sah! O, Yas, sah." "What did you feed them?" "Hay." "Hay! And did they eat it?" "Well, no, sah! Not 'zackly, sah! But dey was talkin' about it when I lef'."

Food stuff all right, but not available.

The causes of non-availability, viz.: non-suitability of substance and incomprehensibility, of form for the duck, of expression for us. No wonder there is quacking!

But, again, there is a happy aspect.

Within the month there was handed to me a quite voluminous paper that came from our State Department of Public Instruction, with the request that I examine and assess from my point of view. It outlines a course in elementary science for the public schools throughout the grades from kindergarten to high school.

It was a thoroughgoing work, superlatively well-done. In each grade the child's background and present level capacities and limitations were carefully considered. The material selected was chosen with instruction for regard to the child's environment, widely differing in so large an area as our State. Seasonal considerations were provided for. Articulation with attainments in previous courses and provision in procedure for the same with work on the next level: Correlations with other activities; meanings, outlooks, reviews and previews; all these and more are carefully planned, and instructions provided so that each teacher who knows, with adequate program opportunity, and an honest determination to be square with her job, can do her part towards getting her grade equipped for the next step in the onward march towards and through the adventurous adolescent high school times. With proper teaching and handling here, there ought to be capacity, and demand for opportunity, for college level work that will make the scientists we have in mind.

And an encouraging feature is the use made by the department, of the scientists, also in State service, and their apt response in right selection and treatment of subject-matter from their fields for this educational purpose. And all those scientists are Academy members—Gress, Ashley, Stone, Illick, McCubbin, Stewart, Surface, and likely others.

The Academy then is already not only set for, but in the process of taking this step. The thing, then, that the Academy needs to provide is adaptation of organization and extension of the work into other fields.

With things moving forward in this way another aspect looms up, which also may have its encouraging features. The New York *Times* magazine for Sunday, September 7, 1930, prints the response of Sir

Arthur Keith to the question put to him by the *Times,* "Should science take a holiday?"

And this is followed in the issue of Sunday, October 5, by a reply to Keith by G. K. Chesterton, which is headed as "A plea that science now halt."

This, of course, comes on the heels of such thinking and talk as is frequently and generally indulged in, when we reflect on the rapidity with which we move from one great achievement to another. Large numbers have not had time to get familiar with this use of a learning, an achievement, a machine, a process, before it is antiquated, scrapped by the faster moving. Slosson, in his inimitable popularizing of science in "Creative Chemistry," pointed out that there is a rapidly accumulating mass of knowledge that we have not yet adjusted to life. We all know better than we do; we all know more than we use.

The bishop who suggested that science take a holiday till the world catches up had, of course, fallen far back in the rear and despaired of catching up, because science was not lingering for the laggard to catch up, but on the contrary, was "speeding up." But we know he had lots of company and he offered it as a joke.

Gentlemen, we are too busy. We have too much to do. We can't afford to take a holiday. We don't want to. Here is our program:

Three fields of endeavor for a group of Academy workers from the Teachers' Colleges and University Schools of Education, interested chiefly in the service to be done by science, through one of its subdivisions, to public education, viz., the school, are suggested:

1. Study of education itself for the sake of making contributions to its development as a science. Its substance; the processes, activities, tools, by which we come to a knowledge of it; the inheritance attitudes involved; the behavior changes and underlying philosophy acquired; the background, the environment, the ability, the development levels with changing tastes, prejudices—these are suggestions of the nature of the subject-matter for study by such a group.

2. Study of the matter to be selected from the science field for contribution to public education; substance at all times of use as educational material, fitted to the development levels, coordinated with the interests and capacities of that level.

3. Study of procedure in teaching-learning with fit treatment of learner and material of learning, so that this material, right, in this sense, shall be well appropriated and play its part with other learnings to make the individual ready for the next step.

To make provision for the functioning of such a group of the Academy membership without meeting-time modifications, or limiting time for reading and discussing the growing number of papers on studies in lines already set, it may be desirable to organize a section and this may lead not so much to reorganization of the set plan of the Academy as

extension of its established form to make necessary adjustment to normal growth. The form of the organization, as it now exists, seems to me singularly direct, simple and efficient. It provides for spontaneity of action that eliminates well nigh altogether the clatter of organization machinery.

It may be that such extension can be brought about by providing for the membership grouping itself into the recognized subdivisions of the subject-matter of our field of work.

Concrete statement may quickly and clearly put the matter before the body.

Keep the object, constitution, officers, meeting-times, set-up as they are now.

To get as directly as possible within time limits, into the studies of each individual's interests, the membership may group itself into sections:

Sec. I. Physical Sciences:

Papers and discussions of this group in the fields:

Physics	Geology	Mathematics
Chemistry	Astronomy	Etc.

Sec. II. Biological Sciences:

Botany	Taxonomy	Ecology
Zoology	Ontogeny	Evolution
Physiology	Phylogeny	Etc.

Sec. III. Sociological Sciences:

Agriculture	Education	Weather
Political	Heredity	Psychology
Geography	Industrial	Child Study
Aviation	Commercial	Conservation
Engineering	Travel & Exploration	Health — Personal and Public

Maybe the first meeting of Easter Assembly should be a General Session, with time sufficiently extended so that the general business can be transacted the sections located, general announcements made, and maybe the annual Presidential address given, especially when it deals with the general welfare of the Academy, so that this will have fair consideration without diverting the thought of the members from the studies for which they especially came together.

Each section may elect its own presiding officer, who shall, by virtue of this office be a Vice President of the Academy.

From this group of officers the President of the Academy may be selected annually, the Academy proceeding by plan now in vogue, giving the usual consideration to geography, institutions and like factors, elements that figure in these proceedings.

The meetings of the several sections may be held concurrently in rooms as compactly grouped as meeting place provides, or in field or museum or laboratory, as nature of study requires, and members at all times feel free to move from any group to another as his selection of studies demands.

These are suggestions. Final determination of Academy's wishes can probably be arrived at by Committee chosen directly by Academy itself.

NOCTURNAL ADAPTATIONS

By Stanton C. Crawford
Johnstown Center of the University of Pittsburgh

This study of adaptations to nocturnal life exhibited by various animal groups is based on field studies made near Kartabo, British Guiana, in the summer of 1924. The region is that of the junction of the Cuyuni and Mazaruni Rivers, 45 miles from the coast. The Mazaruni is a tributary of the Essequibo.

More than twenty trips were made at night to record observations and collect specimens. All of the points visited are in the low tidewater area with the exception of Matope, 17 miles up the Cuyuni in the hills, and Upper Camaria, in rolling country at the head of a four-mile rapids in the same river, and about seven miles from Kartabo. All of the localities are in the rain forest area, but represent variously the conditions of deep jungle, open clearing, tidewater shore, and islands in inland rapids.

The observations were made in June, July and early August. Meteorological data were recorded for each trip. Temperature and humidity were remarkably constant during these months. Light (including moonlight), fog, wind, rain and tide were the chief variables.

Observations were made both by silent and by active hunting methods. Sometimes the observer remained quietly in one spot for several hours, using artificial light only at intervals to identify animals heard. At other times a close-range search of bushes, tree trunks and ground was made with a flashlight for the detection of small forms. Another valuable method was the systematic sweeping of the jungle foliage and forest floor at long range, with the flashlight held above the head, to get reflection from eyes. Regular visits were also made to the beach and other open sandy places, to straight-sided pits dug along the trails, and to fallen logs in the deep jungle. Log landing-places extending into the rivers were very profitable stations for recording the activity of animals with loud calls. These sounds echoed along the rivers for great distances.

The animals observed represent 53 families of arthropods and 32 families of vertebrates. Detailed notes on the nocturnal activity of these groups have been reported elsewhere,* and limitation of time prevents their inclusion here. Many of them will be mentioned as we discuss the general adaptations to nocturnal life which they exhibit, the conditions of life at night, and the possible advantages of the nocturnal habit. The list is of course not complete, and I have ruled out some animals that came to artificial lights and that were accidentally disturbed in other manners, as not being truly nocturnal forms.

A. Possible Advantages of the Nocturnal Habit.

In considering the significance of activity of certain forms at night while the greater part of the animal world sleeps, there are certain probable advantages which may or may not be sufficient reasons for the adoption of the nocturnal habit. It would not be supposed that, except in the higher mammals, the night time is consciously chosen on account of any of these advantages. It might be considered, however, that these benefits associated with nocturnal activity were factors that in some way modified the ancestral stock of the present form, and made these various races nocturnal in habit.

The most evident advantages of nocturnal life are:

1. Avoidance of natural enemies active in daylight.

This seems a probable reason for activity at night in such animals as the harvestmen, spiders, millipedes, centipedes, crickets, roaches, beetles, moths, ants, amphibians, bats, rats and mice, and silky anteaters. It even seems a possible explanation in the case of forms such as walking sticks and mantids, popularly supposed to be safeguarded by protective resemblance but which nevertheless would form part of the diet of diurnal enemies. There is greater safety at night for the feeding of herbivorous animals, such as fruitbats, capybaras, agoutis, sloths, deer and tapir.

2. Easier acquirement of the preferred food at night.

This may be due to the invisibility of the hunter, the plentifulness at night of the form sought as food, or the greater ease of detecting victims or other food by the sense of smell. Odors remain longer in the air at night, due to greater humidity and relative absence of upward air currents.

Forms such as the scorpions, tarantulas, spiders, geckos, sluggish snakes, owls, goatsuckers, opossums, some bats, raccoons, and cats could be thought of as active for these reasons. Also some scavengers, such as

* Crawford, Stanton C., Adaptations to nocturnal life exhibited by various animals of British Guiana, with special reference to the anatomical basis of night vision in the Amphibia and Reptilia. Ph.D. Thesis, University of Pittsburgh, 1926.

beetles and armadillos, may be able to seek food with more ease at night, due to better conditions for the use of the olfactory sense.

3. Avoidance of evaporation from the body surface.

The atmosphere is at night as a rule cooler and damper than in the daytime. Animals that from the nature of their external covering would suffer from excessive evaporation through daytime activity, and would conceivably benefit from the nocturnal habit, are *Peripatus*, Collembola, termites, toads and treefrogs.

4. Easier communication at night.

Sounds produced have less competition, odors travel farther and are apparently stronger in the damp air. Photogenic organs are of value at night, and not at all by day. Here might be mentioned the fireflies, moths, mosquitoes, frogs, treefrogs, caymen, solitary birds, opossums, raccoons and porcupines.

Some forms seem to benefit in two or three of these ways from nocturnal activity; some appear but once in the lists. In any one species, the reasons applicable can only be conjectured. Not all of the animals active at night can be seriously placed under any heading. Thus the fact that the longhorn grasshoppers are in some species nocturnal, in some diurnal, while practically all are apparently protectively colored, and all face the same conditions, is difficult to explain. Along with almost any form active at night for any apparent reason, can be found a closely related form not active at night yet exposed to the same conditions. The problem is hence a very complex one.

B. Adaptations to Nocturnal Life.

When we seek to determine the adaptations exhibited by forms active at night we encounter again much uncertainty. Such differences in sense organs as exist between nocturnal and diurnal forms of close relationship are differences of degree rather than of kind. There are a few definite adaptations in the way of light, sound and scent production. Nevertheless, with the possible exceptions of phosphorescence and some adaptations of vision, there is observed no modification which might not be fully as useful by day as by night. Our feeling is that the extreme development of some of these specializations of form and function is not so necessary by day as by night. The species studied might be capable of successful nocturnal existence without any or all of the unusual modifications which they exhibit. The crucial point of development of each sense necessary for the successful nocturnal activity of each animal would be very difficult to determine, especially since the senses are not employed singly so often as collectively.

It would be difficult to tabulate in exactly certain order the relative usefulness of the various senses at night. The sense of smell is probably of greatest importance, and that of sight might be named last, but this arrangement would be questioned. It must be remembered that our ideas in regard to the sensations of other animals, of invertebrates certainly, are only inferences from our own sensory experiences, and hence doubtless often inadequate and erroneous.

1. The Sense of Smell.

This sense has at least four uses at night:

(a) Congregating of individuals of the same species, and trail following.

Invertebrates employing the sense for these purposes include moths, termites and ants. Vertebrates that could be named in this connection are opossums, raccoons, cats, porcupines, armadillos, deer.

(b) Sex attraction, by means of "alluring glands."

Scorpions, moths, beetles, roaches, walking sticks, and, among the vertebrates, caymen and peccaries would come in this category.

(c) Location of food.

Animals in which this is an important use of the sense are *Peripatus*, millipedes, beetles, moths, mosquitos, ants, bats, armadillos and raccoons.

(d) Detection of enemies and friends.

This is apparently an important use of the sense in such vertebrate forms as deer and tapir, such invertebrate groups as the ants and termites, and doubtless in many other insects.

2. The Sense of Taste (closely associated with the olfactory sense).

Among the invertebrates the organs of taste are difficult to certainly demonstrate. In the Coleoptera, Diptera and Hymenoptera the sense is usually keen. Probably it is very generally developed throughout the groups of non-aquatic invertebrates. No special refinement of this sense would be expected in nocturnal animals beyond the conditions found among their daytime relatives. Perhaps our ideas on this point do not coincide with the actual situation, however, since the sense is so much more highly developed among many invertebrates than in ourselves, and hence perhaps much more significant in their lives than in ours.

Perhaps the only possible distinction between the senses of smell and taste is that if the sensory end organs actually come in contact with the food they are considered gustatory; if they do not, they are considered olfactory. Both of these senses, when resident in antennal structures, are closely associated with that of touch, next to be discussed. There would thus be a contact-odor sense of simple, unified character.

3. The Sense of Touch.

Organs of touch are of value at night in moving about, in inspecting food or other objects encountered, and in perceiving vibrations, this last faculty passing into that of hearing.

In the vertebrates, aside from the general sensitivity of the skin, we find such special developments as the vibrissae of rodents and various other mammals, the delicate muzzle of the deer, and the very delicate organs on the nose and wings of the bat. All of these structures are devices for stimulating nerve terminations. Among the invertebrates many delicate and elaborate devices for stimulating end organs are found.

4. The Sense of Hearing and Sound Production.

The sense of hearing is closely allied to that of touch, particularly among the invertebrates. Sound production and reception is an important means of communication between members of the same species at night, and is important in the detection of approaching enemies or victims, as the case may be. Sound-making serves to frighten away enemies, to warn others of their approach, to attract and woo mates, and to communicate general information.

Kartabo animals apparently depending at least in part on this sense for communication at night include grasshoppers, crickets, cicadas, moths, mosquitoes, mutillids, ants, toads, frogs, treefrogs, caymen, geckos, tinamous, owls, goatsuckers, bats, and red howler monkeys.

It must be remembered that there are many sounds produced and heard by other animals that we cannot hear, because of their being too high or too low in pitch. This is certainly true of the insects. Many interesting devices for both sound production and sound reception are found in the nocturnal animals studied.

5. Light Production and the Sense of Sight.

Among Kartabo forms, light is produced by the fireflies and elaters and their larvae. The light may differ in color and quantity in different species or at different times or on different parts of the same animal. Possibly some animals may produce a form of light not visible to man but capable of stimulating the eyes of some other animals.

Light production has sometimes been considered as simply a by-product of metabolism, but the phenomenon that has been often observed, of the synchronous flashing of the fireflies in a given area, indicates that the light produced by one is perceived by other individuals, and that they are influenced by it. The flashing of fireflies has also been observed to have a part in sex attraction.

The influence of light is apparent in most animal forms. Diurnal insects accustomed to sleep at night are less active or quiescent on cloudy days. Conversely, nocturnal forms shun the light. Moonlight tends to enliven diurnal forms at night to some extent. Thus we have the calling of day birds and the voicing of some primarily daytime mammals at night. The phenomenon of phototropism is quite familiar.

The opportunity for the employment of the sense of sight at night is quite limited compared to its daytime importance. However, some animals can apparently see quite well, even when there is no moon. That eyes are subject to adaptation is eloquently testified by the fact that cave animals have degenerate eyes or are eyeless.

In this discussion we will disregard the possible occurrence in the forms studied of light-sensitive cells other than those in eyes, and will speak only of visual cells that are grouped into eye structures. The several types are as follows:

(a) Ocelli, or similar structures, of invertebrates.

Beneath a simple polished lens is a vitreous body and retina, along with nerve fibers, pigmented hypodermis cells, and accessory cells. The pigment cells here may serve to isolate visual cells in much the same fashion as will be described for the compound eyes. A reflecting tapetum may or may not back up the ocelli. Arthropoda depending on this kind of eye include spiders, millipedes, centipedes and collembola.

(b) Compound eyes, of invertebrates.

Beneath each of the many facets in these eyes is an ommatidium, consisting besides the cornea of lens, rhabdom and retinula, pigment (both iris and retinal), fenestrate membrane, and fibers of the optic nerve. In bright light the pigment cells elongate around the ommatidium and absorb the excess of light. In dim light they shorten, absorbing a minimum amount of light, and permitting a maximum amount of it to reach the retinal cells. On account of the withdrawal of pigment, the image formed by night eyes is probably superimposed to some extent, being reinforced by adjacent ommatidia; that of day eyes is mosaic. Some eyes are fixed as day eyes, with much pigment; some as night eyes, with little pigment; some are capable of the adjustment described.

Comstock has described the divided compound eyes of mayflies as having "two parts; one of which is a day-eye, and the other a night-eye. The two parts of such an eye can be readily distinguished by a difference in the size of the facets, the portion of the eye that functions as a day-eye being composed of much smaller facets . . . the distribution of the pigment in the part composed of smaller facets is that characteristic of day-eyes; while the part of the eye composed of larger facets is fitted to produce a superimposed image."

(c) Vertebrate Eyes.

The well known vertebrate eye needs no description of its general anatomy. Retinal rods, the mechanism of vision in dim light, are the only visual cells found in the eyes of some nocturnal geckos. Cones, the probable structural basis of both bright vision and color reception, are apparently the only visual cells in the eyes of some diurnal lizards. Other forms possess both rods and cones.

The phenomenon of pigment migration in cells of the epithelial layer of the retina occurs commonly in vertebrate eyes. This may be accompanied by complementary changes in length of rods or cones. In darkness the pigment moves back and leaves the spaces between the visual cells clear. Due to refraction and diffusion, the effect of dim light is greater when the visual cells are not covered by pigment.

A reflecting tapetum may or may not back up the retina. When it occurs, the eyes are observed to glow at night, as in spiders, moths, goatsuckers, opossums, kinkajous and the various cats. The supposed function of the tapetum is to increase the effect of faint illumination, the light being caused to pass through the retina a second time in being reflected. The structure of the tapetum varies greatly in different animals.

C. *Summary.*

(1) The adaptations to nocturnal life are chiefly the unusual refinements of one or more of the senses. These are differences of degree rather than of kind and are difficult of analysis.

(2) With the possible exceptions of phosphorescence and some adaptations of vision, there is observed no modification that might not be fully as useful by day as by night.

(3) Eyes present more definite anatomical adaptations for nocturnal use than do any other sense organs. Among invertebrates these include the division of the eye into two parts, each with characteristic structure, one of which is for nocturnal vision; pigment migration; and the presence of a reflecting tapetum.

(4) Keenness of vision at night among the vertebrates depends anatomically on the possession of a rod-rich retina, on pigment withdrawal and rod shortening, and often on the presence of a light-reflecting tapetum, by means of which the rods are doubly stimulated.

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FOSSILS AND FOSSILIZATION

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Abstract

Fossils are of many sorts depending upon the original character of the organisms, postmortem changes, and the type of enclosing medium. This paper tabulates these factors and attempts to classify fossils and methods of fossilization as a guide for the student of paleontology.

Introduction

A fossil is any evidence of past life on the earth. Past life is here interpreted as meaning prehistoric life.[1]

Fossilization takes place according to several processes, involves both plants and animals, and produces various types of fossils according to (1) the original character of the organism, (2) the enclosing medium, and (3) postmortem changes in the remains. Two basic requisites are usual for fossilization of organic remains; first, the presence of hard parts; second, burial in a protective medium soon after death. Rarely, soft parts fossilize, and occasionally there is preservation without burial. Interments occur in sediments accumulating on land and in bodies of fresh or salt water. The degree of excellence of preservation varies according to:

1. The durability of the remains
2. The environment at the time of death
3. Posthumous events

Posthumous changes in the chemical and physical compositions of the remains are common, varying from almost imperceptible alterations to complete destruction. These changes are due to movements in the surrounding medium, the influence of heat and pressure, and solutions. Movements of the enclosing substance distort the shape of the organisms. Heat and pressure may be associated with such movements or be independent of them. The solutions may be cold, percolating water carrying dissolved carbon dioxide or other solvents, or hot solutions. These solutions not only dissolve, but they may also deposit mineral matter in place of the removed remains.

Some fossils are neither parts of the original organisms nor any substitution of material for such parts. They are evidences of the former

[1] Compare Field, R. M.: The use of the term fossil. Science, n. s., vol. LI, no. 1330, pp. 634–635, June 25, 1920.

presence of organic beings which are usually the results of their life processes such as foot tracks, nests and the like. Beside the fossils noted, there are found in the rocks objects called false- or pseudofossils, structures which bear resemblances to organic forms, but have never had any connection with life.

Taxonomic Outline of Fossils and Fossilization

Actual Remains Present

FIRST DIVISION; SOFT PARTS PRESERVED

- I. Kinds: organs, tissues, skin, some vegetation, etc.
- II. Composition: varied and complex compounds, chiefly of the elements carbon, hydrogen, nitrogen, oxygen, phosphorus, and sulphur
- III. Methods of Preservation
  - A. Refrigeration by enclosure in
    - 1. Ice and snow
    - 2. Frozen sediments
  - B. Desiccation, unburied, in dry caves
  - C. Burial in stiff clay
  - D. Immersion in or saturation by fluids
    - 1. Antiseptic media
    - 2. Liquid hydrocarbons
    - 3. Gum and resin; may become amber

SECOND DIVISION; HARD PARTS PRESERVED

- I. Kinds: bones, teeth, tusks, antlers, dermal plates and spines, scales, egg shells, hair, nails, claws, horns, feathers, endoskeletons, exoskeletons, ossicles, shells, zooecia, coralla, rhabdosomes, tests, spicules, secretionary growths, frustrules, wood, bark, leaves, some blossoms, seeds, cones, spores, some fruits, gums, resins, etc.
- II. Composition: calcite, aragonite, magnesium carbonate (in part only), calcium phosphate, magnesium phosphate, keratin, collophane, ganoin, chitin, opal, cellulose, etc.[2]
- III. Methods of Preservation
  - A. Burial in inorganic sediments
    - 1. Clastic materials transported by physical agents
      - a. Gravel; may become conglomerate
      - b. Sand; may become sandstone
      - c. Mud, silt or clay; may become shale
      - d. Calcareous mud or ooze; may become limestone
      - e. Loess and dust
      - f. Pyroclastics

[2] These compositions and those for soft parts also are taken largely from data by E. Blackwelder in "A Treatise on Sedimentation" by W. H. Twenhofel, 1926, and from "The Inorganic Constituents of Marine Invertebrates" by F. W. Clarke and W. C. Wheeler, U. S. Geol. Survey, Prof. Paper 124, 1922.

g. Till and glacio-fluviatile deposits; may become tillite, breccia, conglomerate, "glomerate," etc.
h. Talus, scree, and landslide accumulations; may become breccia, "glomerate," etc.
2. Non-clastic materials transported and deposited by inorganic physical and chemical agents
a. Chemical precipitates; calcareous, siliceous, etc.
b. Physical precipitates produced by cooling or evaporation as stalagmites, tufa, spring deposits
B. Miring in clastic or non-clastic materials into which organisms are often introduced alive
1. Quicksands, bogs, etc.
2. Liquid hydrocarbons, "tar" pits, etc.
3. Gum and resin; may become amber
C. Enclosure by organic substances
1. Organic encrustations; shelly growths, corals, bryozoans, etc.
2. Enclosure of small organisms in cast-off, empty shells
3. Burial in organic precipitates produced by bacteria, algae, etc.
D. Segregations. Accumulations of organic débris with little foreign material
1. Transported deposits formed by moving air, water or ice
a. Bone beds
b. Coquina, some shell limestones, etc.
2. Non-transported except for action of gravity
a. Oozes, some marls, and "earths;" calcareous or siliceous
b. Guano

Actual Remains Partially or Entirely Absent

FIRST DIVISION; STRUCTURES AND TOOLS, NO ACTUAL REMAINS

I. Structures:
A. External
1. Agglutinations; arenaceous tests, etc.
2. Spoors. Dynamic impressions left by living organisms
a. Tracks and trails
b. Burrows and tunnels
c. Root markings and tubes made by plants
3. Nests, graves, dolmens, etc.
4. Imprints. Static impressions left where organisms rested temportarily after death
B. Internal
1. Coprolites
2. Gastroliths
C. Miscellaneous
1. Implements, tools, weapons, webs, etc.

2. Objects of art; drawings, paintings, carvings, moldings, modelings, pottery, etc.
3. Pathological structures; wounds, scars and lesions produced by enemies, parasites and disease

SECOND DIVISION; ACTUAL REMAINS LARGELY ABSENT

I. Changes and Substitutions
A. Alterations. Hard and (or) soft parts more or less completely lost or changed through movement of surrounding medium, heat, pressure, and percolating solutions
1. Chemical alterations. Loss or chemical change of organic constituents
a. Carbonization. Black residue; usually complete loss of minute structure
b. Chalcedonization. Opal altered to chalcedony[3]
c. Calcification. Residue from calcite-bearing, chitinous arthropod exoskeletons after decay of chitin, etc.
2. Physical alterations without loss of constituents
a. Calcitation. Aragonite changed to calcite
B. Pseudomorphs. Original substance and minute structures more or less lost; form preserved. Changes usually due to percolating solutions substituting mineral matter for original remains, or to infiltration of sediments
1. Replacement ("petrification")
a. Silicification, replacement by silica
b. Dolomitization, replacement by dolomite or mixed calcium and magnesium carbonates
c. Ferrization, replacement by iron compounds
d. Miscellaneous, other mineral replacements as malachite, zinc-blende, selenite, beekite, metals, etc.
2. Impressions. No replacement; original substance lost
a. Casts. Internal impressions formed by material infiltrating cavities of original organisms or by filling cavities left in enclosing medium after dissipation of original remains. In either case actual remains lost.
b. Molds. External impressions of organisms retained by enclosing medium after dissipation of organic remains.

APPENDIX; PSEUDOFOSSILS

Pseudofossils are various structures and forms observed in rocks and often mistaken for fossils, but have never had any organic connection. They are classified here according to processes of origin.

[3] Rogers, A. F., Natural history of the silicate minerals. Am. Mineralogist, vol. XIII, p. 85, 1928.

A. Meteorologic or physiographic:
1. Mud, sun, desiccation, shrinkage, or frost cracks
2. Mud chips, edgewise conglomerate
3. Ripple, rill and channel marks
4. Cross- or false-bedding
5. Wave lines and tails
6. Rain, hail, and sleet imprints
7. Gas bubble craters and spatters
8. Glacial striations, chatter marks, etc.
9. Products of differential weathering; "mammal tooth structure," etc.
10. Fulgurites

B. Dynamic, metamorphic, igneous
1. Slickensides, breccia, and other fault-formed structures
2. Feather fracture
3. Cone-in-cone structure and stylolites
4. Flow structure, vessicles, etc.
5. Foliations, crumplings, etc.

C. Mineralogic
1. Concretions, oölite, pisolite
2. Dendrites and moss agate
3. Crystals, mineral aggregates, etc.

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LACTUCA SALIGNA L. IN FRANKLIN COUNTY, PENNSYLVANIA

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Lactuca saligna is commonly known as willow lettuce. This name is due to its leaves which in some plants are slender, entire and resemble the narrow leaves of some of the willows. However, in most plants some of the leaves at least are irregularly runcinately lobed or sparingly toothed.

Lactuca saligna is a European plant which has been reported from only a few places in America. Deam has collected it in Indiana, and it has been found in a few places in Ohio. Previous to 1930, it apparently had not been reported from Pennsylvania.

The plant is quite abundant in several places along the road between Greencastle and Mercersburg in Franklin County, Pennsylvania. A few colonies also were found along the road leading from Mercersburg to the Lincoln Highway near St. Thomas.

Judging from the abundance of plants found and the large areas over which they are distributed, the plant must have been introduced into that locality at least five or six years ago. Furthermore, from its habit of prolific seed production and wind dispersal of seeds, it no doubt will become a serious pest, perhaps as noxious as the prickly lettuce (*Lactuca scariola*) which it resembles in many ways but from which it may easily be distinguished by its nearly or quite smooth stem and by its narrow, smooth, willow-like leaves and longer-beaked seeds.

PRELIMINARY REPORT ON THE RESULTS OBTAINED IN THE CULTURE OF HAEMATOCOCCUS (SPHAERELLA)

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The form of life used in these experiments is described in the literature both as Haematococcus and as Sphaerella. The species has not yet been identified. It is usually classed among the plants, belonging to the subdivision—Algae, of the lowest form of plants. However, because this form also becomes a free motile individual in one stage of its development, it has sometimes been classed as one of the lower types of animals. Since in most respects, it resembles a plant more than an animal, I will call it a plant throughout this discussion.

Haematococcus is usually found in marble urns or marble bird baths that are exposed to falling rain and to sunshine. It has been reported as being found also in exposed depressions in sandstone and limestone outcroppings, where water can gather during rains and gradually dry up. In the "Green Algae of North America," published by Tuft's College Press, Tuft's College, Massachusetts, the distribution is given as "Maine to Texas and Nebraska, California."

The presence of these plants can usually be noticed by a reddish incrustation which appears along the sides and bottom of a marble urn or vessel in which the water containing them has evaporated. In order to obtain them for laboratory use, it is best to place several pieces of white paper in the bottom of the urn or bird bath and wait until the water has evaporated. Gathering the pieces of paper after evaporation, large numbers of encysted plants will be found attached to them, forming a reddish deposit over the exposed portions of the paper.

Such encysted plants can be kept indefinitely in the dry condition. To obtain living forms it is necessary only to place a portion of paper containing encysted individuals in water in the sun for a few hours. This method, however, sometimes fails to produce good results; besides, the sun does not always shine at a time when specimens are to be used.

Encysted individuals are spherical in form, red in color due to the presence of a red pigment called haematochrome, and may pass through one of two so-called life cycles—asexual and sexual. In the asexual cycle a red encysted individual divides twice to form four spores, each of which grows, develops two flagella as locomotory organs, escapes from the cyst wall, and soon assumes the typical adult free living form. In this adult individual photosynthetic processes presumably take place, because the individuals in development and during adult life become green in color, the red haematochrome pigment disappearing except near the center of the plant. A cellulose wall invests each individual loosely, and is held to the plant by protoplasmic strands. Such adults may divide many times, but eventually upon slowly drying, they assume the spherical encysted form.

In the sexual cycle, an encysted individual may divide until 32 or 64 small cells are formed. These small cells develop two flagella each, escape from the cyst wall and are called gametes. Gametes differ in appearance from individuals that develop from spores in being smaller in size and not possessing a loose cellulose wall. They differ in behavior in that they fuse in pairs. This fusion results in the formation of a zygote containing four flagella, which soon forms a cyst wall and assumes the dormant phase.

Since encysted individuals are red, but become green when in the free motile stage it was assumed that carbon dioxide for photosynthesis was obtained by the plants, especially since they are found chiefly in marble urns. An acid of some kind was assumed to be present in order to liberate the carbon dioxide by its action on the marble.

A series of experiments was set up to ascertain, if possible, what conditions are necessary for the culture of Haematococcus in the laboratory. In place of marble urns, finger bowls about five inches in diameter and two inches deep were used. Fifteen grams of pulverized calcium carbonate (marble) was placed in each finger bowl together with 55 c.c. of a solution of known content, and finally a piece of paper about three millimeters square containing encysted Haematococcus.

The first experiment consisted in taking three groups of fingerbowls. Each group was divided into three parts. The solution used in the first part of each group was prepared with tap water and sulphuric acid of the following percentage concentrations: 1, .5, .25, .125, .0625 and .03125. A second part of each group was prepared in the same way, using spring water in place of tap water, and the third part was prepared with distilled water. The first group was placed in direct sunlight. The second in diffused light with no direct sunlight, and the third in a dark closet in a dark room. After three weeks no change was noted in the cultures kept totally in darkness. A few scattered individuals were found in the cultures kept in diffused light, while the cultures exposed to direct sunlight showed the presence of numerous individuals. The best cultures were obtained by using spring water procured near Annville. The middle concentrations of acid produced the best results.

A second series of cultures was set up in the same way, all kept in direct sunlight, but using tap water from three different sources: Jonestown Water Supply; Hammer Creek water from the City of Lebanon; and water obtained from the Annville Water Company. Sulphuric acid was used in this series of experiments.

At the same time, and in the same way, a series of three groups of culture dishes was set up using spring water in place of tap water. In the first group sulphuric acid of the previous concentrations was used; in the second—hydrochloric acid; and in the third—nitric acid. Four additional cultures were set up as a check. In the first, spring water alone was placed; in the second, distilled water alone; and in the third and fourth respectively spring and distilled water with the addition of calcium carbonate, but without any acid. In each culture dish a paper three millimeters square containing encysted plants was placed.

Each week, for a period of five weeks, (to the time of this writing) the hydrogen ion concentration was taken of each culture, and each week, each culture was shaken and a sample placed in a Levy counting chamber to ascertain the number of individual plants in a cubic millimeter of a representative portion of the culture. The following results were obtained:

First: The cultures prepared with nitric acid produced many more individuals than those prepared with any other medium. The best culture was obtained with a concentration of .03125 per cent of acid. These cultures were decidedly green in appearance, and the individuals were active, free-swimming forms.

Second: All other cultures that contained individuals were red in appearance. Most of the individuals were in the encysted form, and where free-swimming individuals were found they contained an abundance of haematochrome.

Third: In cultures prepared with spring water or distilled water alone, although individuals appear in them, they do not multiply very rapidly.

Fourth: In cultures prepared with spring or distilled water and also containing calcium carbonate, but no acid, more individuals develop in the beginning than with water alone, but the number of individuals diminishes after a few weeks.

Fifth: The results obtained up to the present time do not show any consistency between the number of individuals in any series of cultures and their hydrogen ion concentration. The hydrogen ion concentration varied from 7.1 to 8.2. The concentration of the best nitric acid culture was maintained at about 7.9, while the best sulphuric acid culture was found to be 7.7 and the best hydrochloric acid culture was 7.4.

Tests made of the contents of a marble urn on the Mount Annville Cemetery revealed the presence of plants in the free, motile, green stage and the encysted stage, with the hydrogen ion concentration at 7.4.

Haematococcus grew more abundantly in tap water from the Annville Water Supply than in tap water from either the Jonestown or Lebanon Water Supplies. The Annville water is obtained from springs which arise in limestone land and no doubt contain solutes similar to those present in marble urns.

Further investigation must be conducted before the best culture medium can be prepared, but the presence of certain salts with a certain quantity of carbon dioxide seems to be necessary for the continued culturing of this form.

SAMIA HYBRIDS

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Hybridization, as one may gather from a glance through the seed catalogues, has become a fad among florists, but has been more or less neglected by zoologists, especially those chiefly interested in insects. In the latter half of the nineteenth century, when the large silk moths were being studied to determine their life histories, often two closely related species mated in confinement and the offspring were reared, named and described; but the hybrids remained a novelty. Dr. Standfuss, of Vienna, Dr. Rebel and others have made a rather intensive study of hybridization of the European Sphingidae, and to a small extent, of the Saturniidae. Hybrids of American or Asiatic moths have been mainly of the accidentally obtained type. This paper deals with the first few crosses produced in a systematic study of moths of America and the Far East.

A number of methods for securing cross mating were used, the most successful being that of using a female to attract the male of her species to a female of another. This was done by placing the female of the local species, or of the species of which several males were to be had, on the inside of a wire cage, and tying the other female on the outside. The male was attracted to the female of his own species, but inasmuch as she was inaccessible, he eventually mated with the other. Five crosses were obtained by this method. Success depends, in the main, on two factors: (1) on the concurrence of the hours of mating of the two species; (2) on the approximate equality in size of the external genitalia. An example of failure due to the latter cause is a cross mating between a *Philosamia cynthia* female and a *Samia cecropia* male. Although coitus lasted for fifteen hours, there was no insemination, due to the fact that the genitalia of the male *cecropia* were about twice the size of those of the *cynthia*. Other methods used were: holding the selected moths together in the mating position; confining the moths together in a large cage; and two methods for artificially fertilizing the eggs.

It is possible to produce fertile eggs in crosses, even between genera, an extreme case of which is illustrated by a cross between *Graellsia isabellae*, a pine-feeding, luna-like moth, and *Saturnia pavoni*, a brown, tailless moth feeding on a variety of deciduous trees. Mr. Max Standfuss, who produced this cross, was unable to rear the larvae to maturity. There are several other examples of intergeneric hybrids. Since such widely separated species can produce fertile eggs when crossed, and if the obstacle offered by the diverse sizes and shapes of genitalia is overcome, a considerable number of inter-faunal and intra-faunal hybrids should be possible.

The eggs of the Saturniidae are fertilized immediately before being deposited, by sperm that are stored in a bursa copulatrix. Knowing this, two procedures for artificial fertilization present themselves. One, the eggs and sperm may be mixed outside of the body of the female and dependence for fertilization placed on the motility of the sperm. This method, tried with a number of species (not crosses), proved unsuccessful. The method has been incompletely investigated. The other method is that of artificially inseminating the female, which has been done with queen bees by Dr. L. R. Watson with considerable success. Dr. Watson used a modification of the Barber pipette for injecting the sperm. Using an ordinary, finely drawn pipette, attempts were made to inseminate a female of *Tropea luna* with sperm from *Actias selene* and also to obtain the reciprocal cross. The experiment failed, due, probably, to poor technique. There had been no development in the eggs when they were opened at the end of ten days. Further experiments were prevented by lack of material. This method, if it can be perfected, seems to offer the best solution to the problem of securing crosses.

The problem is only partly solved when fertile eggs are obtained. The rearing of the hybrid caterpillars presents many more difficulties than the rearing of a pure species. This is best illustrated in the rearing of three broods of a hybrid between *Samia gloveri* and *Samia cecropia*. The near relationship would seem to indicate that the hybrids would follow rather closely the development of the parent species. A brood of pure *cecropia* was reared along with each hybrid brood as a control. In each of the first two hybrid broods the hatch was about 95 per cent.; in the last, only about half of the eggs hatched. The newly hatched caterpillars were offered a wide variety of leaves and chose the wild cherry (*Prunus serotina*), rejecting the elderberry (*Sambucus canadensis*) which seems to be the best food for the parent species. The *cecropia* were then fed wild cherry also. The first hybrid brood grew nicely until time for the first molt. Some molted with great difficulty, but most of them continued feeding. When they had reached approximately twice the normal size for molting, they stopped feeding and eventually died from desiccation. The ones that molted never resumed feeding. Of the second brood, all except seven were fed on wild cherry, the seven having been offered only the elderberry. The brood showed an extreme variability as to feeding rates and time of ecdysis, there having been at one time, individuals in all five instars, while the *cecropia* all molted within two

days of each other. Another point noted was the delicacy of the skin. Many were lost during ecdysis due to the tearing of the old skin or the rupture of the new. There also resulted from this cause a large number of malformed tubercles which adhered at the next molt and prevented the casting of the skin. Ninety-six reached the last instar and fed for several days. At this time they stopped eating and regurgitated part of their food as a green, watery fluid. They then gradually dried up, and although two were kept in a very humid chamber for a month, they remained alive, but failed to resume feeding. Several local caterpillar breeders of wide experience report that they have never encountered this condition. Four of those reared on elderberry produced healthy pupae. The last brood produced a few weak pupae, but otherwise repeated the history of the second brood.

As far as markings were concerned, the larvae showed their hybrid origin quite distinctly. The first instar was indistinguishable from that of the species of the female parent. The second instar resembled more nearly the male parent; while the third was more like the female. The last two instars seemed to have the color patterns of the two parent species superimposed, the one upon the other. The cocoon, in form, texture and color, is midway between those from which the parents emerged. Two imagos were forced to emerge before their normal time, and, though the wings are somewhat crippled as a result of this forcing, the complete pattern and coloring can be seen. The imago, like the larva, shows an intermingling of the characters of both parents, as would be expected; but taken as a whole, it resembles more closely *Samia nokomis* than either parent. It may be significant that *Samia nokomis*, in distribution, is northwest of *cecropia*, and northeast of *gloveri*.

Although fertile eggs can be obtained from hybrid crosses, caterpillars therefrom are not normal, as indicated by the extremely thin skins and by the faulty feeding and molting instincts. In the case of the ones that stopped feeding in the last larval stage, it is possible that the excretory system was unable to take care of the wastes from the type of food consumed. In each case the *cecropia*, reared as controls, developed normally and produced healthy pupae.

TATTOOING NEW BORN INFANTS FOR PERMANENT IDENTIFICATION

By Evan O'Neill Kane
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In the Journal of the Medical Association there appeared an article by Dr. Delee, of Chicago, entitled "Identification of New Born Babies in Maternities." His method of tagging and bookkeeping, though complicated, was excellent and ingenious. Like many past devices, however, it required considerable clerical departmental work and the technique was so elaborate as to be only applicable in the larger obstetrical institutions. In private practice or in small hospitals such device would be out of the question. No procedure however reliable and satisfactory in the opinion of either the obstetrician or the institution can ever prove to the mind of a suspicious mother that an error may not have occurred however confidently assured to the contrary. Lifelong doubts and fears have been occasioned—possibly not without reason by accusations and suggestions made at later dates, too late for absolute refutation. My simple solution of this difficult problem which it has been my custom to pursue and to which I desire to call your attention is that of tattooing upon some inconspicuous portion of the body of the mother and infant some recording design as one of dots and dashes or some hieroglyphic simple inscription the same in substance on both subjects. This is performed immediately on delivery with sterilized India ink usually in the pubic or axillary region. It is absolutely aseptic and painless being done with a fine needle. Such tatoo recording has been practiced by me for a number of years in my surgical work on completing an operation and has proven most satisfactory. It requires but a few moments in its execution.

Solomon's decision as to the rightfulness to the infant by the contending mothers might have proved unnecessary had the midwife in those days tattooed as suggested. Moses could have proven without difficulty his right to Israelitic parentage and doubtless many instances in history where grave contentions have arisen might easily have been averted. Ever since the dawn of civilization, in all walks of life from the king's palace to the hovels of peasants, changelings have been made the victims of the designing and avaricious. Midwives and obstetricians have alike been baffled to know how to handle this problem, the perfect answer of which I have been laying before this learned society.

I have said nothing in the previous remarks of the well-known methods employed in all commitments in police and other criminal courts on entry or discharge of "victims." I allude to the common custom of foot or finger prints. Incidentally I would here mention the elaborate and cogent article by Harold Cummins, Ph.D., of New Orleans, entitled "The Use of Foot Prints and Finger Prints as Identity Records in the Maternity." In this article which is well worth reading, more elaborately described in detail are the methods well known to police courts as already stated in the admission or discharge of prisoners.

Simple as these methods are, yet they are by no means reliable or as easy of application as of rejection for inaccuracy. I would briefly cite, for instance, I now have a patient who has burned with hot lard while cooking, the finger tips of both hands so that the delicate configuration is quite lost. Again, it is no uncommon matter for washerwomen and others engaged in employment where caustics must constantly be used to have lost entirely, at least for a time, the normal appearance of the finger tips. Again, an attack of long standing and chronic ring worm may entirely change the appearance, whether irrevocably or not, of the contour of the epidermis of the finger tips. I need not dilate upon this subject only to repeat that the finger tips as also the sole and palm of the hand may by disease be altered in the same manner. I would briefly remind you that many infants, if suffering under hereditary syphilis, have such a destruction of the normal aspect of the fingers and toes as to make prints of both absolutely unreliable. I might here mention, not to enter too much into repetition, the complete alteration of both soles of hands and feet of normal infants and children not only by burns and scalds, quite frequent with them, but the results brought about by frosting, heavy scaling of the skin through running barefoot and like abnormalities. But I will not discuss this before the society whose valuable time I have already trespassed upon and merely leave it to them to see how much more simply the union of identity of parent and child may permanently and with the greatest simplicity be performed by every obstetrician.

STUDY OF THE REPRODUCTIVE SYSTEM OF THE MALE AND FEMALE (OVIPAROUS) COCKLEBUR APHID

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Reproduction in the Cocklebur Aphid, during the summer months, takes place parthengenetically. Later, when adverse conditions such as the shortage of food, decrease in the length of day and the lowering of temperature appear, the sexual forms are introduced into the life cycle. Of these true sexual forms, the males are alate and the females are oviparous and apterous.

The reproductive system of the male consists of a pair of testes, a pair of seminal ducts which unite with a common ejaculatory duct, a seminal vesicle and the penis. (Fig. 5, A, C.)

The testes, two in number, are located in the dorsal half of the first and second abdominal segments. They are ovoid in shape. Often the two testes are located so closely that the medial portions overlap.[1] The seminal duct arises from the posterior end of each testis.

Internally, each testis is composed of a number of testicular tubules. Each one of these tubules is lined with an epithelial tissue which is supported by a basement membrane. Surrounding each tubule is a peritoneal envelope. (Fig. 5, B, D.) Within these tubules the different stages of the development of the sperm may be seen.

The seminal ducts are slightly coiled tubes which connect the testes in the anterior part of the abdomen with the seminal vesicle located in the posterior part of the abdomen. These tubes have a very narrow lumen which offers passage for the sperm from the testes to the seminal vesicle. These may be seen in Fig. 5, E.

The ejaculatory duct, during coition, conducts the sperm from the seminal vesicle of the male to the seminal receptacle of the female. The end of this duct is capable of being evaginated due to a stretching of the integumental membrane. The distal end of the duct contains especially strong muscles which serve for its protrusion and withdrawal. These muscles may be seen in a longitudinal section in Fig. 5, F. It will be seen that they extend for the entire length of the ejaculatory duct. Some of these muscles branch into the walls of the seminal vesicle. A thick layer of heavily staining, large nucleated cells covers the muscular layer of this duct. The distal portion of the duct is provided with an inner lining of chitin and forms the intromittant organ or penis. Externally the penis is provided with two fan-shaped chitinous lobes, one on either side. They are heavily chitinized on the outer margins and become more membrane-like in texture toward the middle region. These serve as claspers during coition. The claspers are shown in a dorsal view (C) and a lateral view (A).

At the anterior end of the ejaculatory duct is located the seminal vesicle. The seminal vesicle is used for storing sperm in the male. The vesicle is located ventrally with respect to the proximal end of the ejaculatory duct as may be seen in E. The arrangement of the muscles

[1] Baker, A. C., Woolly Apple Aphid. U. S. Dept. Agr. Rept. No. 101.

in the vesicle would seem to indicate that a contraction would cause a narrowing of the lumen of the vesicle and thus force the contents, the secretion from the accessory glands and the sperm, through the ejaculatory duct.

The accessory glands are two in number and lie between the seminal ducts. (Fig. 5, C.) Externally they appear as slightly bulbed struc-

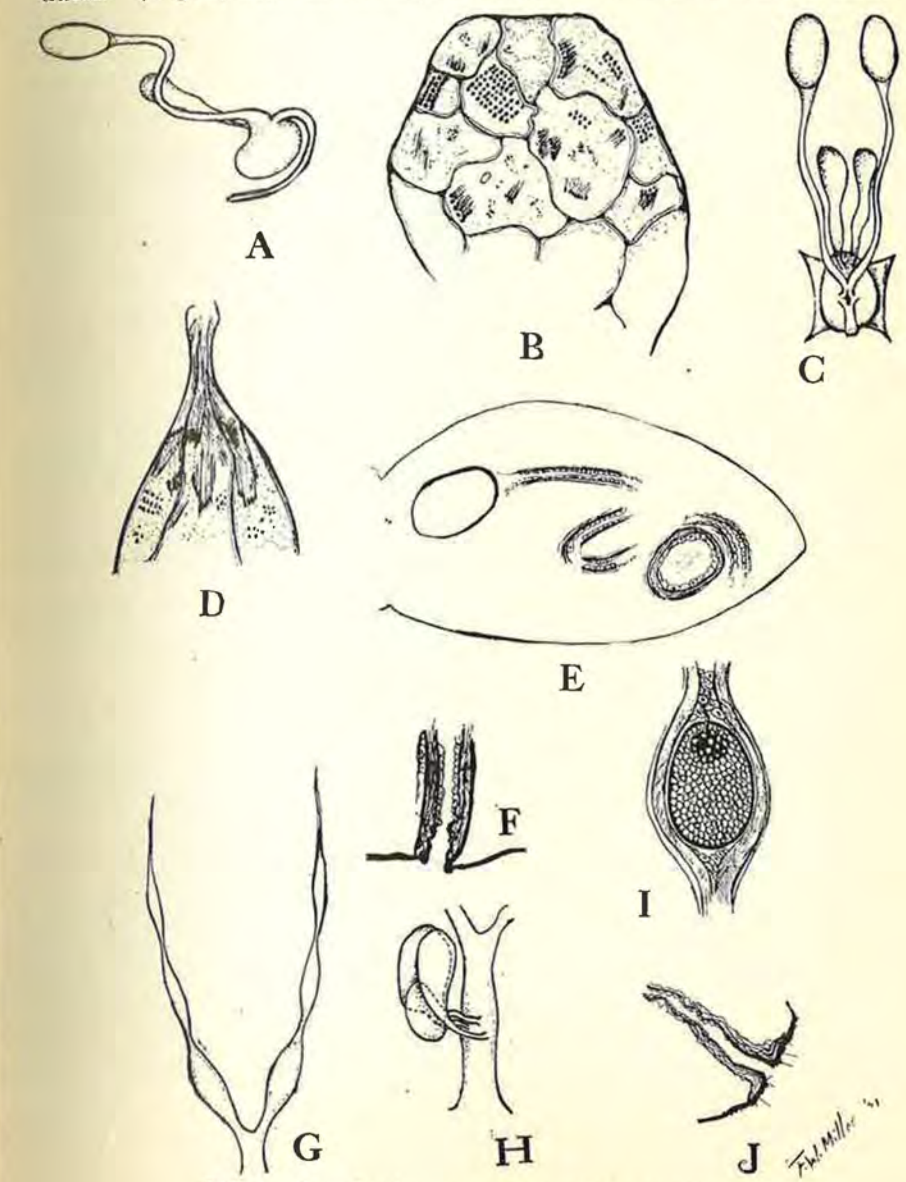

Fig. 5. Reproductive organs of Cocklebur Aphid.

tures. They are about five times as long as wide. Toward the posterior end the two glands unite and enter the anterior end of the seminal vesicle, just ventral to the point of entrance of the two seminal ducts. These glands contain a secretion which mixes with the seminal fluid thus forming a medium in which the sperm may move about more freely. This secretion fills the seminal vesicle and in it may be found the stored sperm. The sperm are usually found clustered into bundles. Occasionally one is found isolated but this seems to be the exception rather than the rule. No sperm were found in the lumen of the accessory glands although the pore which connects the seminal vesicle with the tube leading to the accessory glands is large enough to admit such a passage. The walls of these glands are composed of large cells with deeply staining nuclei.

The reproductive system of the female of this form consists of two mature ovarian tubules. These ovarian tubules are connected with the posteriorly located vagina through the oviducts. In each ovarian tube are located several ova, each of which is in a different stage of development.[2]

The wall of the ovarian tubule consists of a very thin outer peritoneal lining. Directly inside this lining is found a much thicker basement membrane of anastamosing fibrillae. Inside this is a very thin layer of epithelial lining. (Fig. 5, I.)

Three different divisions may be recognized along the length of the ovarian tubule. The portion of the tube which is most anteriorly located is called the terminal filament. Immediately posterior to this filament is a relatively well developed nutritive zone known as the germarium (Fig. 5, I.) The epithelial cells of this division are very large and well developed. It is from this layer that the ova are formed and later pass down the ovarian tubule. After these ova pass into the ovarian tubule they still receive nutriment from the cells of the germarium through a thin connective cord which connects the two. As long as the ova are connected with the germarium through this cord the ova continues to increase in size. This connection remains until the ova has reached the fourth and most posterior position in the ovarian tubule. These positions may be determined very easily. The wall of the ovarian tubule is dilated considerably at the point where an ovum is located and between two ova the tubule is greatly constricted. (Fig. 5, G.)

The ovarian tubules have a common outlet which is known as the oviduct (Fig. 5, G). This tube is relatively short and connects the ovarian tubules and the vagina.

[2] Huxley, T. H., On the Organic Reproduction and Morphology of Aphids. Trans. Linn. Soc., xxii, pp. 193–236.

The vagina (Figure 8) is an invagination of the body wall and is therefore lined with chitin. In addition to this chitinous lining there is also a muscular layer of considerable thickness (Fig. 5, J). The vagina opens as a slit-like orifice between the anal and the genital plate and extends across the ventral side of the abdomen.

Three accessory glands are located dorsal to the vagina (Fig. 5, H). One of these, the spermatotheca, is located medially. Sperm received from the male are stored here until the ova are ready for fertilization. At the time the egg is laid a sperm passes from the spermatotheca into an opening in the shell, the micropyle. Just posterior to the opening of the spermatotheca into the vagina and a little lateral are located the two openings of the colleterial glands (Fig. 5, H). These glands secrete a fluid which is poured over the egg at the time of laying. This affords it an added means of protection and also enables the aphid to attach the egg to the bark or leaf of a tree.

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THE EFFECTS OF DESICCATION UPON THE GROWTH AND DEVELOPMENT OF THE MEDITERRANEAN FLOUR-MOTH

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Desiccation experiments upon living organisms have been somewhat neglected in zoological research. This neglect might indicate to the uninformed bystander that zoologists consider the problem of the effect of humidity to be a relatively unimportant one. But this opinion would be far from correct. Work by Burger ('07)[1] shows that the meal-worm, *Tenebrio molitor*, sacrifices body tissue in order to keep the moisture content of the body at a constant ratio. Others have shown that forms studied exhibit considerable reduction in the rate of metabolism accompanying the increase or decrease of humidity. The influence of moisture upon the development of the organism has scientific interest, and when applied to work in economic zoology, should show also a practical side.

[1] Burger, Bruno (1907), Arch. f. d. Ges. Physiol. Pfluger's Arch.

A more likely reason for the hesitation of the experimenter to conduct work along this line is the fact that to obtain exact mathematical data he must resort to the use of complicated and costly apparatus, something usually far beyond his reach, unless he should be fortunate enough to have affiliations with some rare Utopia of science.

But, although the most exact control of environmental factors is more desirable, it is not strictly necessary. Better one exact experiment than a number less exact, but also better a number of less exact experiments than no experiments at all. The work described in this paper, although admittedly not idealistically exact, nevertheless is sufficiently accurate for interpretation.

Work on such forms as the Mediterranean flour-moth, *Ephestia kuehniella* Zeller, performs the double function of exhibiting evidence of both practical and scientific interest. This particular moth has become, in recent years, a rather serious pest in flour mills through the ravages caused by its larva. The eggs, laid in almost every type of meal, hatch into small white or pinkish caterpillars which not only eat the grain but also have the habit of spinning a web of silk wherever they wander, practically ruining the meal for commercial use.

In the experiment described in this paper the larva was raised under dry conditions with the aim of determining the effect of low humidity on the rate of growth, size and the moisture content.

Meal (rolled wheat) was thoroughly dried by heating it in an oven for $2\frac{1}{2}$ hours at a temperature of 103° C. ± 7. The meal when removed from the oven was immediately distributed into three large glass jars, these being dried in the same manner, two of which contained vials of anhydrous calcium chloride. The third jar was to contain the control stock. After the meal had cooled, young larvae of the second or third instar were introduced and the containers tightly sealed with paraffin. The containers were sufficiently large to contain enough oxygen for the larvae. They were kept together at room temperature.

In four weeks a few moths emerged in the control group. The containers were then opened, the pupae collected and their length, weight and water content determined. In the measurements only those pupae appearing alive and uninjured were used.

To obtain the amount of water contained in the pupae they were weighed after removal from the dry containers, heated for one hour at a temperature of 103° C. ± 5 to drive out the moisture, and again weighed. The difference between the two weights was taken as the amount of free water in the body. Further heating of the pupae produced no change in the readings, indicating that all moisture was removed.

In the three containers not all of the caterpillars had pupated, although there was a higher percentage of pupae in the control stock. In one of the experimental jars there was a lethality of over 50 per cent. Only one larva of the control stock was found dead. Those larvae still alive in the desiccated environment were all small, in some cases appearing no larger than they were when introduced into the container. All of the experimental larvae were perceptibly shrunken. They were also less active and had spun very little silk webbing into the meal. Of these experimental forms, the pupae were either lying bare in the meal or had around them only a very thin cocoon, while the pupae of the controls had spun normal cocoons.

In length and weight there was a striking difference between experimental pupae and the controls. The average length of the experimental forms was 7.6 mm.; the average weight was 12.9 mg. In the controls the average length was 9.8 mm., and the average weight, 26.0 mg. Reference to the illustration will give more strikingly the variations caused by dryness.

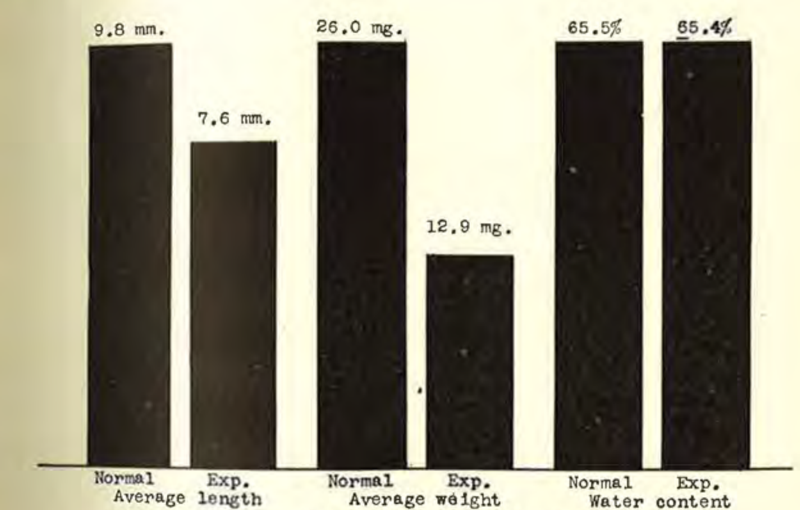

FIG. 6. Effects of desiccation on *Ephestia kuhniella.*

Despite the shrunken appearance of the larvae and the smallness of the cocoons, the percentage of free water contained in the pupae of the desiccated forms was found to be almost exactly that of the control pupae. The percentage of water by weight in the experimental pupae was 65.4; that of the controls was 65.5.

Summary

A dry atmosphere and dry food have an appreciable effect on the Mediterranean flour-moth by diminishing the size and delaying pupation. Larvae so reared in a dry atmosphere are inactive, apparently avoiding all movements involving loss of body moisture. Despite dry atmosphere, the larva and pupae maintain a constant percentage of free water in the body as long as they survive.

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THE AGE OF THE SPAWNING GROUPS OF THE NORTHERN LOG-PERCH *PERCINA CAPRODES SEMIFASCIATA* (DE KAY) OF DOUGLAS LAKE, MICHIGAN, AS REVEALED BY THEIR SCALES

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Introduction

In the summer of 1930 spawning groups of the northern log-perch, *Percina caprodes semifasciata* (De Kay), were found on the barren sandy shoals of South Fishtail Bay, Douglas Lake, Michigan. Representative collections were taken from these groups and preserved in a dilute solution of formaldehyde and later transferred to a 70 per cent solution of alcohol. From each collection fishes of different sizes and sexes were selected for scale study with special reference to the spawning age.

Four scales were used for the age determination of each fish. These were selected as follows: (a) a scale above the lateral line in the middle

region of the body; (b) an anal scale; (c) a caudal scale; (d) a cheek scale. These were mounted on slides, a glycerine-water-glass solution[1] being used as a mounting medium. The following data were obtained and recorded for each fish: (1) the total length of the fish; (2) the standard length; (3) sex; (4) date of collection (Appendix). After setting, the slides were mounted under the microscope and the age of the fish determined from the marks on the scales.

The Scales of the Log-Perch

Circuli or ridges. The ridges or circuli were the most outstanding of the relief features observed on the anterior surface of the scale of the spawning groups of the log-perch. They were developed on the superior layer of the scale and appeared in the form of concentric rings or lines of growth. These rings were entire only in the region of the nuclear area. The formation of spines on the posterior margin of the scale broke the continuity of the circuli as they developed toward the periphery, resulting in discontinuous ridges limited to the anterior and lateral sides of the scale (Fig. 7, A, B, D).

Radii. The scale of the log-perch presented a number of breaks in the anterior field extending from the nuclear area to the periphery (Fig. 7, A, B, D). These breaks across the circuli are known as radii. From seven to ten were commonly found on caudal and median lateral line scales. The number decreased as the center of the scale was approached. New radii appeared at the anterior and lateral edges of the scale and extended toward the nuclear area as the scale increased in size.

Focus and regenerated scales. In the spawning groups of the log-perch a small clear area was found on the posterior region of the scale. This nuclear area termed the focus was bounded by a circulus which was usually unbroken. The small well-defined focus was frequently replaced by an enlarged central area containing no circuli (Fig. 7, E). Scales in this condition have been referred to as "regenerated" since they replace those that are lost (Reighard, 1906). This type of scale was very common in the opercular region of the log-perch. They were discarded in making age determinations and scales formed during normal growth were substituted.

Annuli. Two distinct annuli or year marks were found on the scales of the spawning groups of Percinia (Fig. 7, A, B, D). The first was located midway between the focus and the periphery of the scale. It formed a fairly distinct relief feature on the scale. The distance from

[1] The formula for this mounting medium was prepared by Creaser and Clench (1923).

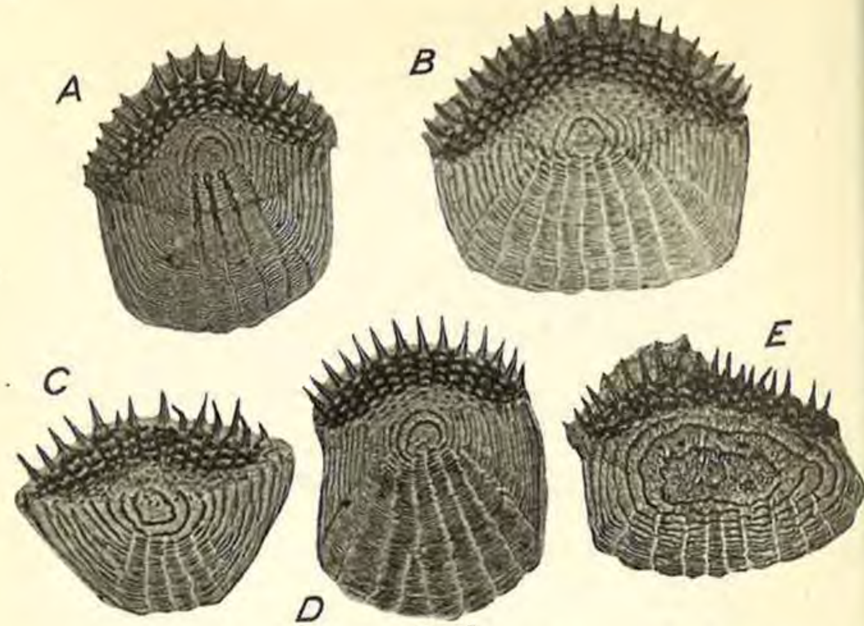

FIG. 7

A. A typical scale of the log-perch from the caudal region of the body.
B. Scale of the log-perch taken from the lateral line region about the middle of the body.
C. A scale from the opercular region of the body.
D. A scale showing two completed annuli and a marginal growth.
E. A regenerated scale found on the log-perch.

the focus to this point was considered to represent the amount of material added to the scale during the first summer after hatching. The second annulus occurred near the periphery of the scale. The ridges or lines of growth developed from the first to the second annulus were laid down during the growth period of the second summer. Only a few ridges were formed between the second annulus and the margin of the scale. Evidently the spawning groups were just beginning their third summer. Evidence from the posterior part of the scale was in complete agreement with the results just indicated.

Ctenii. Ctenii refer to the spines or combs on the posterior field of the scale (Fig. 7). In the log-perch they were formed very early. Near the focus only the base of the ctenii remained embedded in the superior layer of the scale. As the posterior margin of the scale was approached the basal stubs became more distinct. Finally, freshly formed ctenii were found along the margin of the posterior field of the scale.

This differential wearing away of the ctenii in Percina from year to year was used as a supplement for the age determinations. There was a succession of stages of bluntness from the focus to the periphery. Each stage was taken to represent the growth for one year. Three regions were easily differentiated on the scale of the log-perch. The inner region contained the remnant of spines which had been worn down to the superior layer of the scale. A middle area supported the distinct basal portions of spines sharply separated from those of the inner region. Finally, the long and sharply pointed ctenii near the scale margin indicated the beginning of a new growing season.

The evidence from the ctenii as to age agreed with the year marks found on the anterior field. The broken ridges of the annuli coincided with the layers of the ctenii. In summary, two completed annuli and a marginal growth were found on the anterior field, and two ctenoid areas and the freshly formed spines of the third summer were found on the posterior field.

SPAWNING SIZE AND SCALE DATA

In the collections it was noted that males were more numerous than females, there being about three males taken to every female. This difference in number was probably due to the presence of supernumerary males and the tendency of the females to remain on the outer fringe of the spawning field (Reighard, 1913). In determining the age and size of the spawning groups, the same relative numbers were used as were taken in the collections (Appendix).

The total length of spawning females averaged 95.5 mm. The standard length measured to the base of the caudal fin averaged 83.8 mm. The smallest female measured 87 mm. in total length and 77 mm. in standard length while the largest was 104 mm. in total length and 92 mm. in standard length (Appendix).

A typical female from a spawning group collected on July 3, 1930, was photographed (Fig. 8, A). The normal scales of this female showed two annuli and a marginal growth. The evidence from the scales was taken to mean that the spawning age was two years. The standard length of this female was 85 mm.

Spawning males were found to average 97.2 mm. in total length and 85.3 mm. as to standard length. The smallest male in the collections measured 90 mm. in total length and 80 mm. in standard length, while the maximum size was 109 mm. in total length and 98 mm. as to standard length.

Evidence from the scales indicated that the spawning age of the males was two years. The marginal growth added to the scale was considered to represent the beginning of growth of the third summer. A male taken from a spawning group collected on July 10, 1930, was photo-

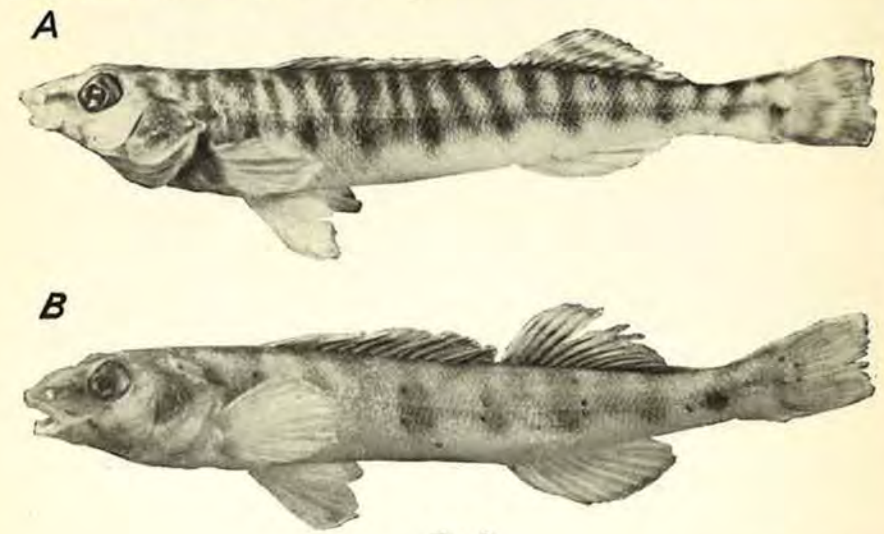

FIG. 8
A. *Percina caprodes semifasciata* (De Kay). Log-perch. A spawning female.
B. A parasitized male from a spawning group.

graphed (Fig. 8, B). This male was parasitized, a similar condition being found in a number of individuals taken in the collections.

CONCLUSIONS

1. Two annuli and a marginal growth were found on the scales of the log-perch, found spawning on the barren sandy shoals of South Fishtail Bay, Douglas Lake, Michigan, in the summer of 1930. This was taken as evidence that the spawning groups were beginning their third summer.

2. The formation of ctenii was used to supplement the evidence from the annuli as to age. Three regions were recognized, (1) an inner, with only the trace of the base of the spines remaining on the superior layer of the scale, (2) a middle, showing the rough basal stubs of the spines projecting above the scale surface, (3) an outer, with long, sharp, freshly formed spines.

3. "Regenerated scales" were very common on the log-perch. They were especially abundant on the opercular region of the body.

4. The standard length of spawning females averaged 83.8 mm.
5. The standard length of spawning males averaged 85.3 mm.

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APPENDIX

The measurements of the log-perch from Douglas Lake, Michigan, listed with the sex, date of collection and the age.

The first value represents the number of annuli on the scale. The second value is the total length in mm. The third value is the standard length in mm. The fourth value is the date of collection. The fifth value is the sex.

II: 103; 91: July 3, 1930 ♂
II: 94; 84: July 10, 1930 ♂
II: 94; 83: July 10, 1930 ♂
II: 96; 85: July 10, 1930 ♀
II: 95; 83: July 5, 1930 ♂
II: 104; 92: July 5, 1930 ♀
II: 94; 83: July 5, 1930 ♂
II: 101; 84: July 10, 1930 ♂
II: 90; 80: July 5, 1930 ♂
II: 87; 77: July 3, 1930 ♀
II: 92; 81: July 3, 1930 ♂
II: 100; 89: July 3, 1930 ♂
II: 97; 86: July 3, 1930 ♂
II: 95; 84: July 5, 1930 ♂
II: 95; 84: July 3, 1930 ♂
II: 92; 81: July 10, 1930 ♂
II: 96; 84: July 3, 1930 ♀
II: 99; 88: July 3, 1930 ♂
II: 96; 84: July 3, 1930 ♀
II: 100; 88: July 3, 1930 ♂
II: 90; 78: July 3, 1930 ♀
II: 103; 91: July 3, 1930 ♀
II: 94; 82: July 3, 1930 ♂
II: 102; 89: July 3, 1930 ♀
II: 92; 81: July 3, 1930 ♀
II: 96; 84: July 3, 1930 ♂
II: 96; 84: July 3, 1930 ♂
II: 93; 81: July 3, 1930 ♂
II: 100; 88: July 3, 1930 ♀
II: 97; 85: July 3, 1930 ♂
II: 96; 85: July 3, 1930 ♀
II: 101; 89: July 3, 1930 ♂
II: 95; 84: July 3, 1930 ♀
II: 103; 90: July 3, 1930 ♂

II: 97; 85: July 3, 1930 ♂	II: 94; 82: July 3, 1930 ♂
II: 100; 86: July 3, 1930 ♂	II: 94; 82: July 3, 1930 ♀
II: 99; 86: July 3, 1930 ♂	II: 96; 84: July 3, 1930 ♀
II: 109; 98: July 3, 1930 ♂	II: 90; 78: July 3, 1930 ♀
II: 97; 84: July 3, 1930 ♂	II: 91; 79: July 3, 1930 ♀
II: 103; 91: July 3, 1930 ♂	

PRELIMINARY REPORT ON THE ANIMAL ECOLOGY OF PRESQUE ISLE, LAKE ERIE, PENNSYLVANIA

By Samuel H. Williams
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Presque Isle, the site of the new University of Pittsburgh Lake Laboratory, is a peninsular, compound, recurved sandspit extending into Lake Erie in a northeasterly direction at Erie, Pa. According to Dr. O. E. Jennings[1] this peninsula was originally attached to the mainland at a point considerably to the west of its present location, and due to incidental movements of the waves it has been steadily moving eastward.

At the present time, Presque Isle is a peninsula more than seven miles long. As the name implies, it is almost insular in its aspects and it has been such in fact at numerous times in its history due to the waves breaking through the narrow neck and completely isolating the land area. The last of these breaks occurred in 1929.

The peninsula is composed mainly of shore sand and gravel that has been transported by the waves and, because of its composition and exposure to southeasterly wave movements from the open lake, pronounced changes are continually taking place. Violent storms effect such remarkable transitions that maps must be corrected from year to year. The waves strike the rounded, convex shore and are deflected along this shore, carrying the loose sand and gravel toward the outer extremity of the peninsula. This results in a continuous destruction of the exposed side. At the other extremity, the transported material is deposited in such a way as to form new sandspits which eventually inclose large rounded ponds, and sandbars which finally isolate longitudinal strips of water from the lake. These frequently become filled with drifting sand but some times they become bordered with vegetation and therefore acquire a degree of permanency.

As has been indicated, the northwestern shore of the peninsula is exposed to the open lake. It is for the most part barren, with a beach of varying width for almost its entire length.

[1] Jennings, O. E.—A Botonical Survey of Presque Isle—Annals Carnegie Museum 1909.

The southeastern shore incloses Presque Isle Bay (Erie Harbor) and is therefore comparatively quiet, being fairly well protected from violent storms. On this shore the vegetation, including the hardwoods, the terrestrial herbaceous plants, and the typical marsh succession of hydrophytes, border the water's edge, thus affording an entirely different set of habitat formations than is to be found on the lake shore. This shore also incloses near its outer extremity a rather large secondary bay (Misery Bay) in which currents are reduced to a minimum. As a consequence, the bottom of the bay is provided with a dense assortment of water plants such as chara, potamogeton, vallesneria, etc.

Due to dredging by the Park and Harbor Commission, lagoons of considerable length have been opened, connecting several of the larger ponds (Long, Big, Niagara, Graveyard) indirectly with the harbor waters.

The ponds formed during the history of the peninsula and in the manner suggested, now constitute a chronological series ranging in age from several hundred years to ponds a few months old. These ponds are separated by ridges, which in the older sections bear large trees; by interdunal swamps, woodlands areas, and sand dunes of varying dimensions.

The transitional character of Presque Isle has resulted in a remarkable assortment of habitats, each with its more or less specific association of plant and animal forms. There are to be found: every type of beach situation; sandy areas; ponds of every age and description; woodland areas of various plant associations; swamps and marshes, and plant successions.

It was because of these interesting features, first revealed by the work of Dr. Jennings, that the University of Pittsburgh transferred its summer biological work to Presque Isle and later established its permanent station there.

The zoological investigations have been directed by the writer and up to the present consist of the studies referred to in this paper, and a few investigations by graduate students.

The zoological program at the present time is chiefly organized for determining the following information: (1) the fauna itself, (2) how it got there, (3) factors effecting its distribution, (4) the conditions governing its survival, (5) the types of animal associations, (6) the kinds of interrelationships involved in these associations, (7) the relationships which exist between the fauna and flora, and (8) the effects of the topographical changes on numbers and distribution.

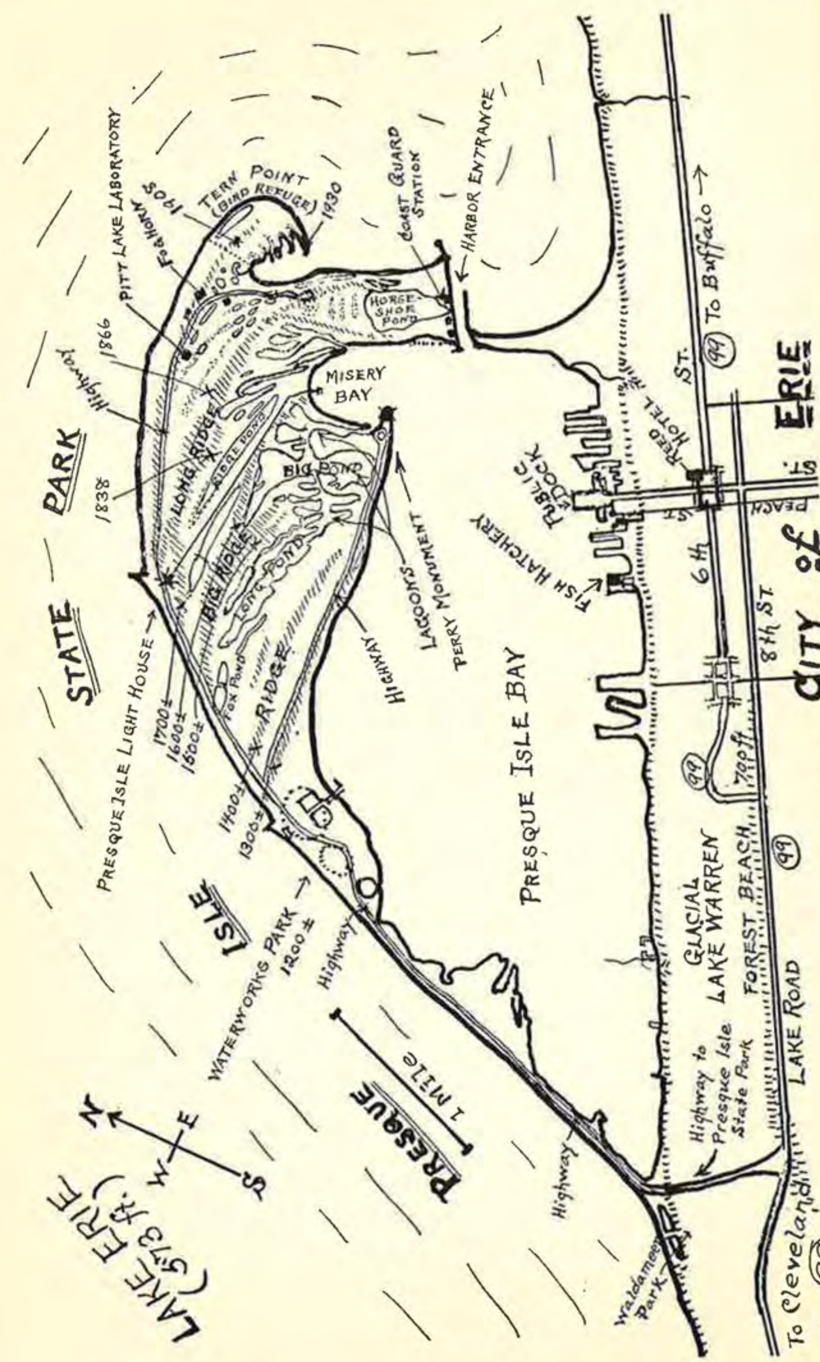

FIG. 9. Map of Presque Isle, Erie, Pa. (Prepared by O. E. Jennings)

It is obvious that the answers to these questions will require a considerable number of detailed investigations. In the first place, a survey of all existing forms and their habitat preferences must be made. This will require years to make and the number of individuals will run into thousands. A complete study will necessarily include food habits, life histories, periodicity, climatic conditions, and seasonal succession. It must also include the measurements of the physical and chemical environmental factors, such as soil, free oxygen, hydrogen-ion concentration, temperature and transparency of water, and the quality, quantity, and intensity of sunlight.

At the present time much data has been recorded and certain phases have been more or less completely studied. The voluminous evidence already acquired through intensive studies is only qualitative and all too inadequate for positive generalizations or specific conclusions. The ultimate determination of all of the factors involved is years in the offing. However, certain of these factors have unmistakably been determined and the purpose of this paper is, chiefly, to present some of the scientific aspects of Presque Isle and to suggest some conclusions which our studies, up to date, warrant.

I shall briefly discuss five of the commanding zoological aspects as follows: (1) the sources of the fauna, (2) the conditions governing its survival, (3) the factors affecting distribution, (4) the responses of the fauna to transitional changes now taking place, and (5) the fauna itself. These will be discussed separately, only in part.

THE SOURCES OF THE FAUNA

The surveys made, although complete in only one or two groups, show that the present fauna has been derived from the following sources:

I. Original fauna.
   (a) Isolated on the land area when contiguity with the mainland was first destroyed.

II. Aerial migrants.
   (a) Voluntary migrants (actively distributed animals).
   (b) Involuntary or wind blown migrants (passively distributed).

III. Animals washed onto the shore of the peninsula from the lake.
   (a) Animals blown into the lake.
   (b) Animals washed into the lake.

IV. Isolated in ponds cut off from the lake.

Original Fauna

Studies of the fauna and the general distribution of the forms involved indicate that a part of the fauna at least dates back to the origin of the peninsula. This conclusion is based on information obtained through studies of the animal life and by comparative studies of similar situations on the mainland, which show that some of the peninsular forms are indigenous to regions farther west.

Many mainland forms are present on Presque Isle, forms typically terrestrial, and therefore descendants of animals which migrated onto the sandspit early in its history. These forms were isolated when the peninsula became separated from the mainland. The isolated native animals continued to survive in their island home but within comparatively narrow limits. Their egress to the mainland was cut off when the peninsula became an island and even after the isthmian channel had been bridged, and after contiguity with the mainland was re-established, the barren sandy connection was, and is still, an effective barrier to reverse migration. This isolated community, or rather association of communities, in their segregation, present and will continue to present, some interesting problems in adjustment, interrelationships, and development.

Aerial Migrants

Flying animals indigenous to both the mainland and to Presque Isle are capable of following the land contour of the peninsula while those with the capability of sustained flight are able to fly across the intermediate half mile expanse of water separating the southeastern shore from the mainland.

The wind blown animals on the peninsula are those which in their migratory flights get caught in lakeward air currents and are carried out to the peninsula or "out to sea." The alternating air currents, although dominantly shoreward, carry thousands of insects from the mainland. Myriads of these, particularly those west of the attachment of the peninsula to the mainland, are directed far out into the lake and are later washed onto the beach where hundreds of specimens including beetles, grasshoppers, bugs, etc., have been taken. Many of the insects are dead when deposited on the sand but many others recover upon exposure to the sun and many of the latter find suitable habitats where they continue their existence, although, as I shall later indicate, the majority of these succumb to other forces in nature.

Combined with that portion of animal life that is deposited on the beach by the waves, must be considered those animals washed into the lake from the creeks to the west of the peninsula. The spring freshets and torrential rains carry numerous animals from these streams and from overflowed ponds, out into the lake where they, too, are caught in the diagonal currents that strike the exposed shore of the peninsula and they are finally deposited on the beach by the surf. Typical stream animals, such as black fly larvae, mayfly nymphs, stonefly nymphs, fresh water flatworms and stream darters have been taken on the beach or in the shallow waters along it. The opportunities for the survival of these forms, accidentally transported, are quite limited. In the first place, very few of these animals are able to negotiate the barriers that exist between the beach and even nearby ponds. Those that do, as a rule, find conditions to which they are unaccustomed. Some of the pond and stream animals transported in this way do, however, occasionally become isolated in newly formed ponds and some of these survive.

Undoubtedly many animals, aquatic, aerial and terrestrial, so unwillingly transported to the peninsula, could survive were other factors excluded. The wide, barren, sandy areas that extend for considerable distances at most places, are barriers which very few forms can negotiate. Thousands of insects, after being washed ashore, start a trek across these sandy spaces, which must seem as great deserts to them, toward the shelter of vegetation beyond the recently formed sand ridges. But, like caravans of the Sahara, the way is fraught with many hardships and dangers. The majority of these fall victims to predaceous insects, spiders, or the birds which patrol the beaches. Many are buried under the shifting sands or succumb to the intense rays of a sun from which there is little or no protection. Each day, in summer, the sand is littered with dead or enfeebled insects, and the dissected remains of numerous others are testimonials of their tragic fate. Most of these insects (June beetles for instance) are poorly adapted to walking over loose sand and their bodies are not fitted to crawling under flattened stones for shelter. A few, however, such as Carabid beetles, will move inland during the night or on cloudy days and take to the shelter of chips, stones and beach débris when threatened by the sun.

Within the past three years a concrete automobile highway has been constructed parallel to the beach. This has proved to be an added peril to those more sturdy individuals which have almost reached their objective. Observations made by the writer during the summer of 1930, showed that hundred of insects which had been washed ashore and which had successfully escaped the dangers of the march across the sands, were killed by automobiles as they attempted to cross the highway.

Similar observations, however, showed that some even escaped this fate and finally reached the friendly shelter of the vegetation zones.

Isolated in Ponds Cut off from the Lake

As the sand shifts eastward along the northwestern shore of the peninsula, as has already been indicated, it is deposited in sandbars parallel to the wave action. In this way, long, narrow strips of water are cut off from the lake and in these ponds numerous lake animals, such as mussels, mayflies, shrimps, and various lake fishes, are unwillingly confined. Many of these are unable to endure the still, shallow, sun-beaten, newly formed ponds and they therefore perish. The absence of wave action, plankton forms and algae, combined with increases in the summer temperatures of the water, the reduction of free-oxygen, lack of protection from the intense light, usually afforded by depth and surface disturbances in the open lake, and the shallowness of the ponds which prevents vertical migration to deeper unfrozen waters in winter, are all contributors to the gradual decrease in number of these unfortunate victims.

The greater limits of adjustment of some of these animals enable them to survive for several years under favorable conditions, but even these eventually succumb to the changes produced by the advent of vegetation, the influx of typical pond forms and by the chemical changes which ordinarily accompany stagnation. This is definitely shown by the absence of the open lake animals in the older, closed ponds. In the ponds connected with lake waters, a number of the open lake animals, especially shrimps, are common.

Distribution on Presque Isle

The distribution of animals on Presque Isle itself is, naturally, largely determined by specific habitats. On the sand dunes ant lions (**Myremelionidae**), robber flies (**Asilidae**), sand colored spiders (**Trochosa cinerea**), mottled grasshoppers (**Sparagemon Wyomingianum**) digger wasps (**Sphecidae**) horse flies (**Tabanidae**) bee flies (**Syrphidae**), turtles and the foraging dragonflies and damselflies, are conspicuous.

On the beach, ground beetles (**Carabidae**), tiger beetles (**Cicindelidae**), carrion beetles (**Staphylinidae, Silphidae, Histeridae**), flesh flies (**Muscidae**), horse flies (**Tabanidae**), digger wasps (**Bembecidae**), plus the great variety of animals washed up and the characteristic birds such as plovers, killdeers, gulls, terns, and sandpipers hold sway.

In the younger ponds catfish, sunfish, white fish and perch combined with mussels (**Unionidae**), shrimps (**Palaemonidae**), mayfly nymphs (**Ephemeridae**), dragonfly nymphs (**Aeschnidae, Libellulidae**), damselfly nymphs (**Agrionidae**) and water beetles (mostly **Haliplidae** and **Hydrophilidae**) are most numerous.

In the older ponds life is abundant from both the standpoint of numbers and individuals. The age, which involves chemical nature, plant associations and isolation, partly determines the fauna. In these ponds Insects (**Chironomidae, Culcidae, Tipulidae, Tabanidae, Libellulidae, Aeschnidae, Agrionidae, Gyrinidae, Haliplidae, Hydrophilidae, Dytiscidae, Gerridae, Veliidae, Nepidae, Notonectidae, Corixidae, Belostomatidae**), Mollusks (**Physidae, Lymnaeidae, Planorbidae, Cyrenidae**), fishes (**Siluridae, Esocidae, Centrarchidae**), annelid worms (**Glossophoniidae, Herpobdellidae**), Crustacea (**Gammaridae, Daphnidae, Cyprinidae, Asellidae, Astacidae**), water mites (**Limnocharidae, Hydrachnidae**), amphibians including salamanders (**Triturus viridescens**) and frogs, and a large variety of turtles may be found in great numbers.

The marshes are inhabited by Tartigrades, marsh striders, (**Hydrometridae**), dragon flies, damselflies, catfish, turtles, snails, frogs, salamanders, snipe, woodcook, killdeer, blue heron, and red winged blackbirds.

The various woodland areas have the characteristic associations of bark beetles, woodborers, phytophagous insects, carabids, ichneumons, tachinids, cicadas, millipedes, centipedes, snails, slugs, tree crickets, assassin bugs (**Reduviidae**), the permanent winter and summer contingent of birds including the American eagle and other forms too numerous to list here.

Except for the fact that few places in the world present such a wide assortment of habitats, the localized distribution on Presque Isle is not spectacular. However, the innumerable variety of situations, each surrounded by such marked barriers, combined with the unique form and location of the peninsula and the continuous changes being effected on it, make the solution of the problems of distribution complicated and at times enigmatical.

It has already been shown that the fauna of Presque Isle is distinctly isolated, the long sandy, open, wind swept (and at times water-swept) neck of the peninsula constituting an effective barrier to mainland migration.

As new ponds and land areas are formed and as woodland areas undergo an age succession of vegetable growth, there is a steady march of inhabitants to populate them. Likewise as old ponds become filled with vegetation, there is also a transformation of the animal populace within them.

The spread of animals is naturally dependent upon (1) adaptability to migration, (2) highways of and barriers to migration, (3) necessary plant associations, (4) food and (5) suitability of habitats. At first thought the distribution within such a limited area would seem to be a matter of comparatively simple studies. But such is not the case. Extensive as they must necessarily be, the measurement of physical and chemical factors and a survey of the existing animal forms, are only indicative of distributional bases.

Perhaps a quantitative determination of distributional factors is not possible. At any rate, certain obvious inclusions in the problem reveal a potential capability of oganisms to live and disseminate.

The newer portion of Presque Isle is the more interesting because of its utter lack of fixity of plant and animal associations. Studies by the writer and Mr. John Gamble, show that newly formed ponds gradually lose their original, isolated, lake fauna and receive typical pond forms. Every bit of evidence indicates that the ultimate fauna of these ponds is received from the more nearly fixed associations of the older ponds.

The sequential arrangement of ponds according to age causes each succeeding pond to eventually become the center of dispersal. Ridge Pond (see map) is now the center of emanation.

As each original pond became surrounded with dense vegetation, the arboreal borders increased in height. The faunal association in the pond became more and more confined because the adult winged aquatic insects such as midge flies, water boatmen, back swimmers, water scorpions, and water beetles, are unable to rise above the heights of a close and elevated border of vegetation. Therefore, the ponds around which the vegetal growth is well started but sufficiently low to permit the egress of animal forms, become the "feeders" of newer ponds.

As additional land areas are developed they receive wind-blown sand, and dunal areas are begun. The primary grasses and low shrubs are the first inhabitants of the sandy areas and with these come ant lions, robber flies, sand spiders, mottled locusts, turtles, and in due time, the other animals typical of such areas. As sand ridges are formed against the cottonwoods, which, as Dr. Jennings has shown, are the marginal trees of newly formed ponds, the beginning of a woodland succession is established. The definite but slow progression of plants from the older

wooded sections to the newer portions of the peninsula, is accompanied by a characteristic progression of animal life.

Thus, the principle of everlasting change, involving only temporary stability, in any situation, combined with physical, chemical, and biotic adjustments, render Presque Isle a veritable complex for the Ecologist and Systematist to untangle.

STUDIES ON THE ECOLOGY AND DISTRIBUTION OF AQUATIC BEETLES OF PRESQUE ISLE, LAKE ERIE, PENN.

By John T. Gamble
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One of the most interesting biological regions in Pennsylvania is Presque Isle at Erie. The Peninsula, as it is commonly known to inhabitants of that region and numerous visitors from other States, is a compound, recurved sand-spit about seven to seven and one-half miles in length and varying in width from a few hundred feet, at its point of attachment to the mainland, to a mile and a half in its widest portion. It encloses Presque Isle Bay (Erie Harbor) and is attached to the mainland about four miles west of Erie. (See Figure 9.)

The peninsula is gradually moving eastward due to the vigorous action of the shore drift and littoral lake currents.[1] Since 1921 Presque Isle has been a State Park and since that time the Pennsylvania Park and Harbor Commission have been waging an earnest battle to make the peninsula a stationary affair and to keep it in the region of Erie. Dr. O. E. Jennings is responsible for the rumor that if the peninsula were allowed to go on unmolested it would continue to travel eastward at the rate of about a mile every 300 years and eventually go over Niagara Falls and disappear. We sincerely hope that the Commission is successful in holding the peninsula to its present moorings.

Prevailing westerly winds build up off-shore bars at the end of the peninsula, and, as the eastern end of the sand-spit is elongated, these sand bars come to enclose beach pools and lagoons. The northeastern storms are mainly responsible for the formation of the recurved part of the sand-spit and the cutting off of series of ponds from the bay region. These ponds and lagoons are arranged in chronological series from the older ponds at the neck of the peninsula to those recently formed at the eastern end of the spit. These ponds of various ages, representing plant successions in different stages of development, show very interesting

[1] Jennings, O. E., Botanical Survey of Presque Isle. Annals Carnegie Museum. Vol. 5 (1909), Nos. 2–3.

associations, distributions and successions of aquatic insects; and it is these ponds that have been chiefly dealt with in this study.

The aquatic Coleoptera, or water beetles, of the families Dytiscidae, Hydrophilidae, Gyrinidae and Haliplidae were chosen as being the most representative group of aquatic insects that would lend themselves to an investigation of this type.

This investigation was carried on during the summers of 1927–1928–1929 and 1930 at the University of Pittsburgh Biological Station at Erie. Occasional trips have been made early in the year and late in the season in order to find out which of the forms studied were active at those times. The periods of activity have not been worked out, but the general statement may be made that the aquatic Coleoptera are most active during the warmer summer months. However some of these forms, except the Gyrinidae (Whirligig beetles) which are restricted to the surface of the water, will be found active at any season of the year, even when the ponds are covered with ice. The bulk of the material used in this study was collected during the summer months of June, July and August when the quantities collected seemed to indicate that they were present in their maximum numbers, and therefore gave better data on the quantitative as well as the qualitative distribution of the beetles.

The area west of Water Works Park (See map of Presque Isle) has been disregarded because it has been interfered with too much by man. Some of the ponds have been made into reservoirs for the storage of water; some have been filled in by the Park Commission in order to do away with the breeding places of the mosquitoes and thus make the area more inviting for the picnickers and bathers; and some of the ponds are being taken care of by the Park Commissioners and certain clubs in Erie. This leaves the area east of Water Works Park as the most desirable for any biological study, and it was in this area that collecting efforts were concentrated and ecological factors considered.

A few of the more prominent features that are outstanding in the present stage of the solution of the problem are:

(1) That Fox Pond does not contain a representative group of beetles because it is subject to frequent floodings on account of its close proximity to the lake front.

(2) That Long Pond, Big Pond and Graveyard Pond would be ideal situations if it were not for the fact that a channel has been cut through to connect these ponds with the bay. This creates an open pathway for some of the larger lake forms that would naturally feed on insects, and thus reduces the numbers of the beetles.

(3) That Ridge Pond represents the richest collecting ground and may therefore be referred to as the center of dispersal of the water beetles, because they do migrate by leaving the water and resorting to flight.

(4) That this so-called "center of dispersal" is a changeable factor that will move eastward with the succeeding plant vegetation and that it will always be found in the zone between the more-or-less open vegetation and the heavily wooded areas.

(5) That the wooded areas act more as barriers to the migration of these insects than do the sand dune areas because the woods are full of insectivorous forms while the sand dunes are represented by a rather specialized group of insectivorous forms like the ant lions, sand spiders, digger wasps and a few birds.

(6) That the new, or beach pools have as their predominating forms, those aquatic beetles that are most common in the mainland streams draining into the lake. This seems to indicate that they receive their beetle population from those streams by directed or accidental migration from the mainland.

(7) That this particular territory is very rich in its insect fauna is evidenced by the following figures:

Comparison of the Coleopterous Fauna of Presque Isle with that of Indiana and New York

	Dytiscidae		Hydrophilidae		Haliplidae		Gyrinidae	
	Gen.	Spec.	Gen.	Spec.	Gen.	Spec.	Gen.	Spec.
Presque Isle[1]	22	53	12	20+	2	6	2	8
Indiana[2]	24	70	20	54	2	10	2	15
New York[3]	26	129	25	88	2	17	2	31

[1] From the present survey.
[2] From Blatchley, Coleoptera of Indiana.
[3] From Leonard, Insects of New York.

In the comparison of the numbers of these beetles on Presque Isle with the numbers given for Indiana and New York, it must be kept in mind that both of the State surveys include all types of Hydrophilidae and Dytiscidae, while the present study is limited to aquatic forms. Considering the small area covered, as compared with the large area and wide range of distribution covered by both State surveys, I hope that you will agree with me when I say that Presque Isle has given a very good account of herself.

Those members of the Pennsylvania Academy of Science who were fortunate enough to be able to attend the field meeting held August 1 and 2, 1930, had a brief glimpse of the peninsula on a rather hasty field trip conducted by Drs. Jennings and Williams of the University of Pittsburgh. They were given a mere glimpse into the future possibilities of scientific study in that spot. The surveys by Jennings in Botany,[1] Tood in Ornithology,[2] Williams in Field Zoology, Ortmann in Conchology, myself and other graduate students in the fields of Zoology and Botany,—have not more than scratched the surface of the possibilities that are still present at Presque Isle.

SPECIFIC DIFFERENCES IN REGENERATIVE CAPACITY IN URODELES OF THE GENUS TRITURUS

By H. H. Collins
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The genus *Triturus,* one of the most widely distributed groups of American urodele amphibia is represented in the eastern United States by the vermilion spotted newt, *Triturus viridescens* and by the much larger brown newt, *Triturus torosus* west of the Rocky Mountains. These two species are being used as experimental material in a study of limb regeneration. It has long been known that *viridescens* possesses the power of replacing lost appendages, but, so far as the writer is aware *torosus* was thought to be one of the number of urodeles incapable of limb regeneration in the adult stage. The writer has found, however, that regeneration of limbs and tail takes place very slowly. In specimens, for example, in which the arm was removed midway between the elbow and wrist, the digits are beginning to differentiate fourteen months after operation. The relative length of the digits approaches that of the normal hand. In adult *viridescens* regeneration occurs much more rapidly. In some instances the differentiation of the hand is much farther advanced two months after operation than in *torosus* at fourteen months.

[1] Jennings, O. E., Botanical Survey of Presque Isle. Annals Carnegie Museum, Vol. V (1909), Nos. 2–3.

[2] Todd, W. E. Clyde, The Birds of Erie and Presque Isle, Erie County, Pennsylvania. Annals Carnegie Museum, Vol. II, 1904.

SEX RATIOS IN ADULT POPULATIONS OF *TRITURUS VIRIDESCENS*

By H. H. Collins
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Jordan, one of the pioneer students of the life history of the vermilion spotted newt, *Triturus viridescens,* reported ('93) observing that in adult aquatic populations the males considerably outnumbered the females. Among 426 specimens, he found 280, or 65 per cent, were males. More recently Pope ('24) found, in the course of his collections involved in his excellent and comprehensive study of the life history of this form, that of a total of 435 specimens, 339, or 78 per cent, were males. He ventured the suggestion that this one sided sex ratio might be apparent rather than real, and that the males might be more easily seen and more readily captured during the breeding season than the females.

The writer's observations on the sex ratio are based upon collections made in western Pennsylvania during the past six years. The collecting stations from which the animals were obtained are all within a radius of 70 miles of Pittsburgh. The collections were made mainly in October and November, and in March and April. The number of animals taken at any one time ranged from 17 to 554. The males were in all cases much more abundant than the females, varying in seven collections in which the exact sex ratios were noted from 68 to 86 per cent. Of a total of 1,452 animals, 1,098, or 76 per cent, were males.

There is not a larger percentage of males in the collections made during the breeding season than at other times of the year. Furthermore, in some instances where small ponds containing large numbers were almost depopulated, the number of females taken was not noticeably greater. These observations would seem to indicate that the excess of males is characteristic of the aquatic population and not due merely to differences in behavior and habitat preference between males and females during the breeding season, making the males more easily captured. Studies are in progress to determine at what time in the life cycle and in what manner this inequality in the sex ratio arises.

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NEGATIVE GEOTROPISM IN POST-METAMORPHIC YOUNG OF *TRITURUS VIRIDESCENS*

By H. H. Collins
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The vermilion-spotted newt, *Triturus viridescens*, is distributed over the eastern portion of the United States, from the Mississippi eastward to the Atlantic coast and from southern Canada to the Gulf of Mexico. In the south Atlantic coast and Gulf regions, the animals make seasonal migrations from the aquatic to the terrestrial environments. In lowland districts, such as Long Island, the terrestrial phase of the life cycle is omitted and the animals are aquatic throughout the entire life cycle. In mountainous districts, within their range there are three definite habitat phases in the life cycle. The larvae hatched from eggs deposited in the water in the spring remain in the water during the summer. In the fall the larvae undergo metamorphosis and leave the water, at the time when the external gills disappear. The post-metamorphic young then enter upon a terrestrial phase which is thought to last for a period of between three and four years. When the animals reach the adult stage, they return to water and remain aquatic during the rest of the life cycle.

The factors involved in the marked changes in habitat preference, characteristic of the life cycle of these animals, are in the main unknown and present an interesting problem. From the writer's observations and experiments, it appears that as regards the migration of the post-metamorphic young from water to land following the loss of their gills, their geotropic reactions are mainly responsible.

The possibility that negative geotropism might be a factor in the landward migration of the post-metamorphic young was suggested to the writer by his observations while collecting the migrating forms in the field. On one occasion in particular, while attempting to find land forms in the vicinity of a large pond (located near Harmarville, Pa.) post-metamorphic young were found in large numbers along the base of a steep cliff on a hillside about 200 feet from the water's edge. About 150 specimens were collected at the time. Many were found along the face of the cliff in as nearly vertical positions as it was possible to assume. The animals were not only almost without exception oriented with heads up, but when watched were found to move as nearly straight upward as the irregularities of the surface would permit.

These field observations suggested laboratory tests of their geotropic reactions. The tests were made by means of a plane, 6 feet in length, 42 inches in width, inclined at different angles.

The animals were placed on a starting line in the middle of the plane and oriented either at right angles to the axis of the plane or with heads downward. While numerous individual variations were observed, a very marked negative geotropism was evident. In some instances, direct upward orientation occurred almost at once, followed by crawling almost directly upward until the top was reached. The upward movement might be continuous or intermittent. Some individuals crawled horizontally for a few minutes, then oriented upward and moved to the top. Some were more erratic in their reactions orienting upward, later moving downward, then reorienting upward and continuing to the top. In successive trials, some became more certain in their reactions, others somewhat more erratic. Some individuals were much frightened by handling, and when placed heads down, would travel rapidly downward, then stop, turn about and crawl more slowly almost in a straight line to the top of the plane.

Care was taken to eliminate differences in illumination as a possible factor in determining the animals' movements. The ends of the plane were reversed frequently during the trials to rule out the possibility that the animals might follow their trails through the sense of smell.

Although there were marked individual differences in the reaction of the fifty individuals studied, the results demonstrate quite conclusively the presence of a very marked negative geotropism in the post-metamorphic young of *Triturus viridescens*. It appears that this tropism is the major factor involved in the migration away from the water, which occurs at the beginning of the terrestrial phase of the life cycle.

DOCTORS OF PHILOSOPHY

The Responsibility of the Graduate School

By Robert T. Hance
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What is it that we expect of the representatives of academic tradition? I believe that we all have very high, perhaps impossibly high, ideals of what the professor should be. And I also believe that a conscious or subconscious realization that personally we fall far short of our standard, leads many of us into much strutting and no little academic bickering—smoke screens as it were, to cover our professional short-comings. It is perhaps needless to point out that this is just so much waste effort since everyone else is already painfully aware of our deficiencies.

However this may set the theme of our first requisite. We should expect to see in our graduate students the basic elements of gentleness.

This would seem to be inherent although many of the externals that serve to tag the individuals concerned as gentlemen are acquired through associations of the right sort. To provide such associations and experiences is the duty of the Graduate School. To try to veneer these qualities onto students lacking in the inherent gentleness is to create more social misfits.

Since the professor is guide and directs his students into fields of far greater immediate prestige than that which he himself occupies in this country, he must teach by example as well as by word of mouth. His dress must be at least in good taste and his social actions at least natural and reasonably graceful. For a teacher to fall short of this minimum would seem to place him beyond the pale of our ideal.

It goes without saying that we expect our professor to exhibit soundness of scholarship. Soundness of scholarship is not to be confused with the mere knowledge of one's subject, important though that is. When all is said and done, almost any one of good memory can acquire a mastery of the minutiae of almost any field of thought. But the translation of these details (that are so impressive to many who possess them) into living, related and correlated facts for the inspiration and use of others is something else again. This something else is without much doubt again basically an inherent rather than an acquired art.

I cannot feel that this inspired scholarship, inherent though I have persistently insisted it to be, can be divorced from the environmental influences of the spirit of research and from its prerequisite, time for reflection. To see a few graduate students each year suddenly catch fire with the enthusiasm of a new idea and in the draft of this conflagration be lifted to a new level of forceful work, is to be reconfirmed in the essential wisdom of old methods of apprenticeship. The man who has found something never before found by any one else is never quite the same again. In his private opinion, he has won his academic spurs and the right to fall in behind the masterly cavalcade that has ridden on before, making history. I know of no other way to achieve the same results.

The other elements that we should like to see in this ideal academic man will follow more or less automatically. Breadth of information, a lack of narrowness, cooperativeness, enthusiasm, courage, all seem to me to be largely subdivisions of the qualities already listed.

Research may indeed lead to specialization and specialization to narrowness but it may be added, this narrowness will only occur in that certain type of individual who is already so proportioned and who perhaps has no place in the university. While a research institution may absorb him, it is an open question whether such an individual is the best sort of an acquisition for even such an establishment. Breadth of interests, providing that such breadth is not without reasonable limits, would seem to be an aid rather than a drawback to the imagination that is the soul behind creative work. From this point of view it is hard to see how an investigator of such stamp could fail as an inspiring teacher.

If it is true that many of these desirable qualities are inherent, then the duty of the Graduate School is to select those that possess them and then to make almighty sure that the environmental background, so necessary to bring these traits into flower, is provided. If the Graduate School has the courage and kindness to sidetrack the obviously unfit, there should be less question in the future of the adequacy of collegiate pedagogy. The difficulty (and it does exist in products of our Graduate Schools as well as in those of the commercial world) of our doctors of philosophy lies not so much with the virility of their training as in those qualities in them that hitched up for better or for worse at the time of gametic union. To divert such gametic mishaps into their proper sphere of activity should be the work of the College, but should it fall to the lot of the Graduate School, this body should not shirk its duty. If this is done as well as any group of properly qualified men can pass judgment upon any particular individual then, I think, we shall find little reason to say that the specialist is narrow, lacking in enthusiasm, and without power to inspire intellectual enthusiasm in others. Rather out of his specialization should come the feeling of the mastery of some one field and an enthusiasm that is contagious. The Graduate School has produced such beings before and will continue to do so. No biologist would advocate the die casting of an academic ideal for he has seen too frequently the successful results of biological variability. Let us have each doctor of philosophy a gentleman, a scholar but a personality as well, a teacher who believes that he is teaching the most important thing in the curriculum and can prove it, and lastly and importantly, an investigator. Such a man may be a specialist but he can seldom be narrow.

Having thus proclaimed my reactionariness it suddenly dawns on me that I had better fold my own Ph.D. and silently slip away before someone who knows, proclaims too loudly that it is without the support of a single listed attribute, genetic or acquired.

FLOATING POSITIONS OF HOMOGENEOUS SQUARE PRISMS

By Joseph B. Reynolds
Lehigh University

It is the purpose of this paper to discuss positions of equilibrium of homogeneous prisms of square cross section and differing specific gravities[1] when floating in a quiescent liquid of uniform density. We shall treat only cases where the length of the prism is sufficiently greater than its width to prevent any tipping of the geometric axis.

The locus of the center of gravity of the liquid displaced by a floating body, for different positions of the body, referred to axes in the body is called the curve of buoyancy. It is shown in hydrostatics that:

(a) the tangent to the curve of buoyancy is, at any point, parallel to the surface of the liquid in the position determining that point;
(b) positions of equilibrium are those in which the normal to the curve of buoyancy passes through the center of gravity of the body;
(c) positions of equilibrium are stable provided the center of gravity of the body lies below the center of curvature of the curve of buoyancy;
(d) the radius of curvature of the curve of buoyancy is the quotient of the moment of inertia of the surface section of the body by the volume of the body; and
(e) for each position of equilibrium for a body of specific gravity s there is a corresponding inverted position for the same shaped body of specific gravity $s' = 1 - s$.

Let ABCD, Fig. 10, be a square plane section of the floating prism through its center of gravity with B the lowest corner. Let the prism be rotated about a horizontal line by a couple causing the line AB to make an angle θ with the horizontal. We shall have all possible positions of the prism or their equivalents by letting θ vary from 0° to 45°. Let P (x, y), the center of buoyancy, move along the curve of buoyancy, c. The submerged portion of ABCD will vary from a rectangle for $\theta = 0$ through a trapezoid to a right triangle which becomes isosceles for $\theta = 45°$, for values of $s < \frac{1}{2}$. Successive positions are the first three shown in Fig. 11.

[1] Specific gravity is used in this paper to mean the ratio of the weight of the volume of the prism to that of an equal volume of the liquid.

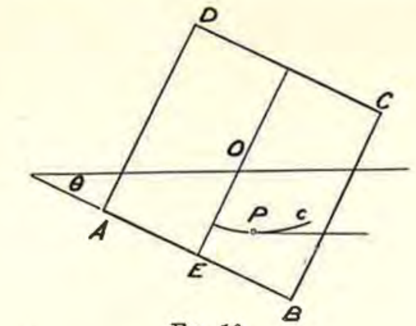

Fig. 10

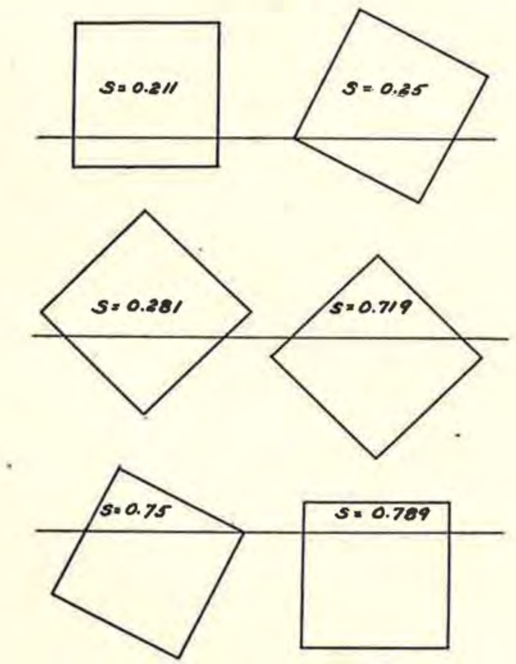

Fig. 11

Using AB as x_1-axis and a line, EO, the midpoint of AB parallel to BC as y_1-axis, we have for the curve of buoyancy, while the submerged section is a trapezoid

$$(1) \qquad x_1 = a \tan \theta / 12s; \qquad y_1 = \tfrac{1}{2} a \, (s + \tan^2\theta / 12s),$$

in which a is the length of a side of the square. For this curve $dy/dx = \tan \theta$, showing that the tangent to the curve is parallel to the surface of the liquid as stated in (a). By (d) the radius of curvature is $R_1 = a\ (a \sec\theta)^3/12V = a \sec^3\theta/12s$. The submerged section is trapezoidal for $0 < \tan\theta < 2s$.

When the submerged section becomes triangular, using BA and BC as x_2-axis and y_2-axis, respectively, we have for the curve of buoyancy

$$(2) \qquad x_2 = (a/3)\ (2s \cot\theta)^{\frac{1}{2}}; \qquad y_2 = (a/3)\ (2s \tan\theta)^{\frac{1}{2}}.$$

For this curve $dy/dx = -\tan\theta$. It is parallel to the surface of the liquid. The radius of curvature is

$$R_2 = (2a\, s^{\frac{1}{2}}/3)\ (\csc 2\theta)^{3/2}.$$

The submerged section is triangular for $2s < \tan\theta < 1$.

The parabola (1) joins the hyperbola (2) at the point N, Fig. 12, where $\tan\theta = 2s$. At this point these curves have a common tan-

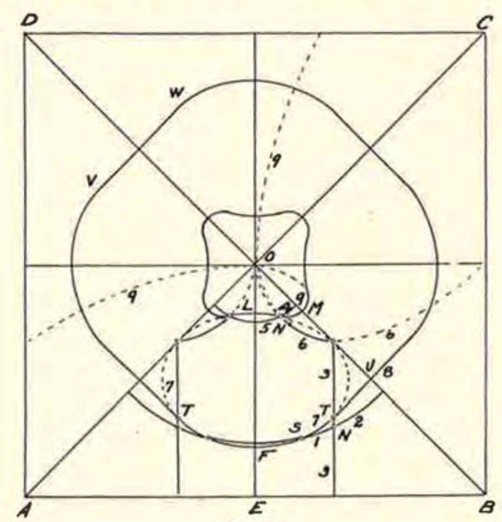

Fig. 12

gent line and equal radii of curvature, since for $\tan\theta = 2s$, $R_1 = a(1 + 4s^2)^{3/2}/12s = R_2$. That is, at this point, the parabola and hyperbola have contact of the second order. Thus, for a given prism, the curve of buoyancy for all positions is made up of four equal arcs of parabolas joining four equal arcs of hyperbolas. It is a closed curve symmetrical with respect to the center of the square with eight, and for some specific gravities, sixteen, apses.

By equations (1) it is seen that the locus of the point, N, where the parabolas for the different values of s join the corresponding hyperbolas (where $\tan\theta = 2s$), is the straight line

$$(3) \qquad x_1 = a/6.$$

This line parallel to BC trisects the side of the square BA and the diagonal BD.

For specific gravity $s' = 1 - s$ the square section is more than half submerged since s' varies from $\frac{1}{2}$ to 1. The submerged section varies from a pentagon with two pairs of equal angles for $\theta = 45°$ through other pentagonal shapes to a trapezoid which finally becomes a rectangle for $\theta = 0°$. Successive positions are the last three shown on Fig. 11. The inclination of the side AB is the same for specific gravity s as for $s' = 1 - s$ by (e). Different positions of the prism for variations in θ due to variations in s are illustrated on Fig. 11.

The curve of buoyancy (4), for positions in which the submerged section is pentagonal, has the equations

$$(4) \qquad x'_2 = (2s' - 1)\ a/2s' + (1 - s')^{3/2}\ (2 \cot\theta)^{\frac{1}{2}}\ a/3s';$$
$$y'_2 = (2s' - 1)\ a/2s' + (1 - s')^{3/2}\ (2 \tan\theta)^{\frac{1}{2}}\ a/3s'.$$

The radius of curvature of this hyperbola is

$$R'_2 = 2[(1 - s') \csc 2\theta]^{3/2}\ a/3s'.$$

In positions in which the submerged section is trapezoidal the curve of buoyancy is

$$(5) \qquad x'_1 = a \tan\theta/12s'; \qquad y'_1 = \tfrac{1}{2} a\ [s' + \tan^2\theta/12s'].$$

The hyperbola (4) makes contact of the second order with the parabola (5) at the point N′ where $\tan\theta = 2\ (1 - s')$; that is, for the position at which the pentagon passes into the trapezoid. The hyperbolas (4) and (2) are identical for $s = s' = \frac{1}{2}$.

By (5), the position of N′ is where $x_1 = a(1 - s')/6s'$ and $y_1 = a(4s'^2 - 2s' + 1)/6s'$. The locus of N′ for different values of s′ is the hyperbola

$$(6) \qquad 12x^2_1 - 12x_1y_1 - 2ay_1 + a^2 = 0.$$

This curve cuts (3), the locus of N, at the limiting point where $x_1 = a/6$, $y_1 = a/3$ which trisects the diagonal, BD, of the square.

By (b) we have for positions of equilibrium for trapezoidal sections $\tan\theta = 2x_1/(a - 2y_1)$. This relation with (1) gives as coordinates of S, a center of equilibrium

$$x_1 = a\ [12s\ (1 - s) - 2]^{\frac{1}{2}}/12s; \quad 12y_1 = a\ (6 - 1/s)$$

and for all values of s the locus of S is the ellipse

$$(7) \qquad x^2_1 + 2\ (y_1 - a/4)^2 = a^2/24.$$

The locus is the same for s as for $s' = 1 - s$. Centers of equilibrium on this curve are confined to that part of it for which x_1 is real and will exist only if $6s^2 - 6s + 1 > 0$. This corresponds to $s > \frac{1}{2} - \sqrt{3}/6 = 0.211$ or $s' < \frac{1}{2} + \sqrt{3}/6 = 0.789$. Since points on this locus must not lie to the right of (3), $x_1 = a/6$, we find that to meet this condition $s < 1/4$. Hence, centers of equilibrium can lie on the lower half of the ellipse between and including the points, T ($\pm a/6$, $a/6$), only. (See Fig. 12.)

Centers of equilibrium on the upper half of the ellipse cannot lie to the right of the locus of N′ given by (6). This shows that $s' > 3/4$ and that these centers can lie between and including the points ($\pm a/18$, $7a/18$) only. Hence the locus of centers of equilibrium for values of s between 0.211 and 0.25 and of s′ between 0.75 and 0.789 and including these limiting values lie upon that part of the ellipse (7) which is included on and between the lines $2y_1 \pm 4x_1 = a$.

For a center of equilibrium to lie upon curve (2) or (4) we must have $(a - 2x_2)/(a - 2y_2) = \tan\theta$. This relation with equations (2) gives as locus of centers of equilibrium,

$$x + y = \tfrac{1}{2}a, \tag{8}$$

a straight line bisecting OB perpendicularly at U($a/4$, $a/4$) and tangent to (7) at T. For U to lie upon (2) we find $s = 9/32 = 0.281$. Thus, for an increase of the specific gravity, from 0.211 to 0.281, the angle of inclination increases from 0° to 45° and the center of equilibrium moves from F on Fig. 3 through S and T to U.

For a center of equilibrium to lie upon curve (4) we find

$$x_2 = a(8 + 15\tan\theta + 6\tan^2\theta + 8\tan^3\theta)/2(1 + \tan\theta)(8 + 7\tan\theta + 8\tan^2\theta);$$

$$y_2 = a(8 + 6\tan\theta + 15\tan^2\theta + 8\tan^3\theta)/2(1 + \tan\theta)(8 + 7\tan\theta + 8\tan^2\theta).$$

Referred to OB and OC as x_3-axis and y_3-axis this locus has the equation

$$(46\sqrt{2}x_3 - 9a)x^2_3 + (18\sqrt{2}x_3 + 9a)y^2_3 = 0. \tag{9}$$

This curve is a strophoid with $x_3 = -a/2\sqrt{2}$ (the line VW, Fig. 10) as asymptote. It cuts OB at M where $x_2 = 37a/92$ and $y_2 = 37a/92$. These coordinates satisfy (4) if $s' = 23/32 = 0.719$. Thus, for an increase in specific gravity from 0.719 to 0.789 the angle of inclination decreases from 45° to 0° and the center of equilibrium moves from M through the intersection of (6) and (7) to L.

If P is any point on the locus of centers of equilibrium and O the center of the square we have by (c) that the equilibrium is stable if the radius of curvature, R, of the curve of buoyancy for the point P satisfies the inequality $OP < R$.

At the vertices of the parabolas (1) or (5) $y_1 = as/2$ and $R_1 = a/12s$; hence the position in when $\theta = 0$, that is, AB horizontal, is stable if $\frac{1}{2}a - y_1 < R_1$ or $6s^2 - 6s + 1 > 0$. This condition is met if $s < 0.211$ or $s' > 0.789$. At the vertex of the hyperbola (2) where $\theta = 45°$ $x_2 = a\,2s/3$, $y_2 = a\sqrt{2s}/3$ and $R_2 = 2a\sqrt{s}/3$. Hence, positions for $\theta = 45°$ or BD vertical are stable if $a/\sqrt{2} - \sqrt{x^2_2 + y^2_2} < R_2$; that is, if $s > 9/32$. For the upper limit in this position we must refer to curve (4) which takes the place of (2) for $s' > \frac{1}{2}$. At the vertex of (4) where $\theta = 45°$ $x'_2 = \frac{1}{2}a(2 - 1/s') + a(1 - s')^{3/2}2/3s' = y'_2$. For stable equilibrium in this position we must have $a/\sqrt{2} - \sqrt{x'^2_2 + y'^2_2} < R'_2$. This requires that $s' < 23/32$.

If $6s^2 - 6s + 1 < 0$ the cusp of the evolute of the parabola (1) lies on EO above O; hence, for such points as S, $R > OS$ and the equilibrium is stable. For an hyperbola of the type (2) cutting TU the cusp of the evolute lies on OD above O and, therefore, TU is a locus of stable equilibrium. In similar manner it can be shown that points on ML are centers of stable equilibrium.

Fig. 13 shows the locus of centers of equilibrium for values of s between 0 and 1.

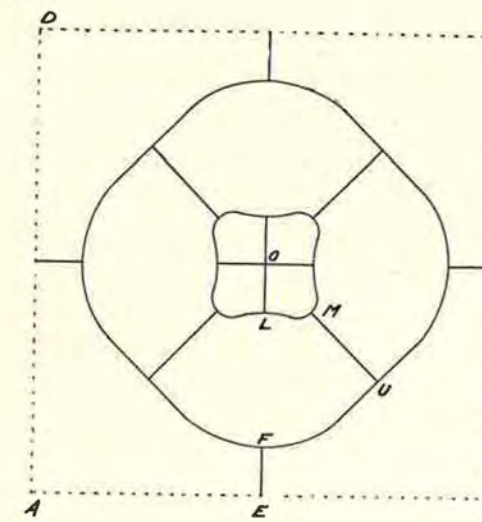

FIG. 13

For $0 < s < 0.211$, $\theta = 0°$ and EF is the locus;
for $0.211 < s < 0.281$, $0° < \theta < 45°$ and FU is the locus;

for $0.281 < s < 0.719$, $\theta = 45°$ and UM is the locus;
for $0.719 < s < 0.789$, $45° > \theta > 0°$ and ML is the locus;
for $0.789 < s < 1$, $\theta = 0°$ and LO is the locus.

It will be seen from the figure that for all possible positions of equilibrium the locus of centers of equilibrium consists of two closed curves symmetrical with respect to the center of the square section each having eight apses; along with ten radial straight lines meeting the closed curves at their apses. The outer closed curve consists of four elliptic arcs joined by four straight lines. The inner closed curve consists of four elliptic arcs joined by four strophoidal arcs. Four straight lines from the midpoints of the sides of the square meet the outer curve at right angles. Four others on the diagonals of the square join each an apse of the outer curve to one of the inner. Finally two straight lines through the center of the square parallel to its sides join opposite apses of the inner closed curve.

This figure shows that any line through the center, O, of the square section in that section can be vertical under stable equilibrium for at least two different values of the specific gravity other than unity but for only one corresponding angle of inclination and four possible positions of the prism. For eight particular positions of the prism—four with an edge vertical, four with a diagonal vertical—there correspond an unlimited number of values of the specific gravity.

The results of the analysis in this article can be verified by floating prisms of differing specific gravities in water or other liquids.

EVIDENCE OF DURABILITY OF BUILDING STONE

By R. W. Stone
Pennsylvania Geological Survey, Harrisburg

In the report of the Tenth Census of the United States[1] an estimate was made on the "life" of different types of stone, based on observations on buildings in New York City. The "life" represents the period the stone will endure until disintegration renders it so unsightly that its repair or replacement is necessary.

The estimates in which we are interested are

	Years
Coarse brownstone	5– 15
Laminated fine brownstone	20– 50
Compact fine brownstone	100–200
Gneiss	50–to many centuries

[1] Julien, Alexis A., Tenth Census of U. S., vol. 10, pp. 364–393. Durability of various types of stone in New York City.

It is possible that building stone of the same character will endure longer in the country or in a city like Harrisburg than it does in New York City, and a comparison with buildings in or near this city may illustrate that point.

The Berst house at Waltonville, which is the site of the well known Hummelstown brownstone quarries, was built of medium-grained brownstone in 1800 and a barn on the same property in 1809. The stone in this house after 130 years shows no sign of deterioration. In an adjoining cemetery are tombstones made of the same material which date back to 1725 or more than 200 years. On some of these the carving has become very indistinct and weathering is readily noticeable, but a tombstone in which the original bedding is parallel with the carved face exposes the edges of the beds on three sides and disintegrates faster than a stone built into the wall of a house and laid with the bedding horizontal.

Other evidences of the long "life" of the local brownstone are Sant Peters Kierch, Middletown, erected in 1767 and the Frey mansion house on the Lancaster Pike in Middletown built in 1768. In these structures which have stood for more than 160 years the only conspicuous disintegration of the brownstone is in the foundation of the Frey house where the spatter from a rain spout has caused spalling.

Brownstone containing quartz pebbles up to the size of a hickory nut has been used in local buildings, as in the foundation of Market Square Presbyterian Church, Harrisburg, which was erected about sixty years ago. This variety of stone shows occasional pitting where the pebbles have weathered out. However, it is only a surface feature and not sufficiently detrimental to require replacement from an asthenic viewpoint nor from structural weakening.

On this evidence it would seem that the normal run of medium-grained brownstone quarried in Dauphin County has a "life" measured by centuries, rather than by decades, and that 500 years or more would be a reasonable estimate for its durability.

Some conspicuous instances of brownstone ashlar having spalled might lead to the conclusion that this is a common habit, but from my observation of many brownstone buildings it seems to be demonstrated that when the ashlar is finished with a rock face, spalling does not occur and only rarely when finished with a sawed face. It is my impression that spalling develops more frequently on those blocks which have been dressed to a smooth face by hand or machine tooling, the impact of the tool having loosened the grains of the dressed surface so much that moisture penetrates and causes the face to scale off.

Evidences of the durability of the local limestone when used as building stone can be seen in the Paxtang Presbyterian Church which was built in 1740, the John Harris mansion house at 219 S. Front Street which is the oldest residence in the city and was built in 1766, the Bailey house at 401 N. Front Street, 1791. Less ancient but still of mature years are the Pine Street Presbyterian Church, built in 1859, and Grace Methodist Episcopal Church in 1871. In all of these buildings the limestone is in perfect condition, a fact which would indicate that the "life" of this stone can be measured by centuries.

The Tenth Census report referred to gneiss as being very durable. The fact that mica schist or Wissahickon gneiss from the Philadelphia district has been used in Harrisburg recently in the construction of residences on the River Drive just above Division Street, and a church at Third and Woodbine streets makes it fitting that evidences of the durability of this stone be presented. Similar stone was used in the construction of St. Davids Church (1715) and of Friends Meeting House (1718), both at Radnor, Pennsylvania. These buildings are still in regular use for religious services and after 200 years of exposure to the elements no sign of deterioration is apparent in this stone.

TRAINING GRADUATE STUDENTS

By Robert T. Hance
Department of Zoology—University of Pittsburgh

Those students who set their cap for the goal of professionalism in the sciences either because their straining eyes seemed to discern a call, or because some medical school failed to call, have much to learn concerning their trade that is not included among the academic impediments of those who profess the so-called humanities. There is much connected with the techniques of the various sciences that might be termed manual training and that seldom finds a place in any course. Not only is a knowledge of standard equipment desirable but even more so is an appreciation of the principles behind such apparatus so that in event of its absence similar tools may be improvised. I shall never forget my disgust with an army company doctor in the last war who felt called upon to make a 60 mile trip to our base-hospital laboratory to sterilize some petri dishes. We had a regular sterilizer, so called and pictured in the catalogue. The fact that there was a cook's oven in his outfit meant nothing to him. It was for beans and not for sterilizing despite the fact that it could be fired quite as hot as our laboratory product. This non-adaptability was not infrequently exhibited by other members of the medical

staff of the army although it is but fair to say that it was perhaps more than adequately compensated for by the ingenuity of others. We see it too frequently for comfort among our graduate students, who feel that they must have an elaborate piece of apparatus to initiate their research. They forget that some graduate students, in all likelihood, originally devised this catalogue equipment that is now so bravely tricked out in shining mahogany and bakelite. Perhaps they are not to be too much condemned for their apparent lack of originality, and the condemnation should be laid rather at the door of those whose duty it is to lead these noviates out of Egypt to the promised land.

Feeling that the responsibility was theirs the staff of the Department of Zoology at the University of Pittsburgh have outlined a series of demonstrations with opportunities for putting the new acquisitions into practice, of techniques in which they felt themselves reasonably proficient. The meetings are held in the evening to avoid interruption and attendance is entirely voluntary. Some of the subjects that are being presented are:

Preparing a scientific paper for publication.
Sharpening microtome knives.
Use and structure of the microscope.
Preparation of entomological material.
Preparation of anatomical material.
Caring for genetic material.
Hydrogen-ion equipment—its value and methods of use.
Preparation of a bibliography.
Illustration.
Photography—Drawings—Painting.

The plan has been heralded with surprising enthusiasm by our graduate students. We expected and indeed had equipment for but five or six and so were quite unprepared for the attendance of almost the entire group. It is obvious that we cannot hope to produce experts in these various techniques within the limits of the time allowed for the present course. We do hope, however, that the present method of exposure will at least draw the attention of our students to the possibilities and to the existence of these techniques. They may not need skill in these professional mechanics at once, but if and when they do, we feel that it may be of some value to them. The course, if such it is, is being tried out for the first time and the results are on the knees of the gods. We trust that these anatomical supports prove stable.

THE NATURE OF GRAVITATION

By R. N. Davis
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At a previous meeting of the Academy I attempted to outline a theory of the real nature of gravitation. In the discussion that followed two objections were raised. At the time I did not feel that I could meet these objections with the conciseness that their importance demanded. I wish now to discuss them.

Let us briefly restate the theory. It is founded upon the acknowledged fact that every mass of matter is surrounded by a gravitational field varying in strength with the magnitude of the mass and the kind of material of which it is composed. It assumes that all space is occupied by an ether composed of particles of infinitesimal size moving in all kinds of directions at enormous velocities. These particles are so minute and they move at such great velocities that they pass through molecules and atoms and even through great masses of matter like the earth without encountering much obstruction. There is some obstruction, however, and it is this obstruction that produces the gravitational field.

Let us apply this theory to the earth and an object near its surface, say, an apple on a tree. This apple, like all other masses, is bombarded by the ether particles from all directions. There is no tendency for the apple to move laterally since the pressure is equal on opposite sides. This is not true of the pressures from above and below. The ether particles coming from below have been slightly obstructed in their passage through the earth and so do not exert the same pressure upon the apple as comes from the opposite direction. This unbalanced pressure is the force of gravity. As the cohesion of the apple stem diminishes it finally becomes less than the push of gravity and the apple separates from the twig and is pushed with a constant pressure towards the ground. Gravitation is really a push instead of a pull. Of course the earth is pushed toward the apple just as truly as the apple is pushed toward the earth but on account of the disparity in the masses only the movement of the apple is apparent.

The first objection to this theory was, in substance, "The weight of similar masses varies as the cubes of the like dimensions while the theory would imply a variation according to the squares of the like dimensions." This objection is due to my failure to make clear the theory. The objector was evidently thinking of the pressure of steam upon the piston of a steam engine. The action of the ether is very different as these particles are conceived to pass through the mass of matter giving up energy all the

time. The result depends upon the number of ether particles traversing the body and the average distance they traverse the mass.

Suppose we have a sphere of lead that weighs one pound. Now take another lead sphere of just twice the diameter. The cube of two is eight and so we know the volume of the second sphere is eight times the first and it must weigh eight pounds. The scales would agree with this result. A cross-section of the second sphere would be four times the area of the first and so would intercept four times as many ether particles and each of these particles would traverse twice the distance in passing so the final gravitation result would be eight times as much for the second sphere as for the smaller one. If we enlarged our sphere by any scale whatever the gravitational effect will increase in accordance with this theory just as we know it does in actual practice.

The second objection was that as the ether particles are assumed to be stopped to a certain extent in their passage through matter they would be entirely consumed and gravitation would come to an end. This idea suggests the most fundamental questions. Is all matter "coagulated ether"? We know that a gas gives up energy as it condenses into a liquid and the liquid also gives up energy as it solidifies. May not the ether be a fourth state of matter which gives up infinitely greater energy as it condenses into ordinary matter? This might help to explain the "endless fires" of the stars and sun.

In Webster's International Dictionary we find this definition of Gravitation:—"That species of attraction by which all particles of matter tend toward each other—Its nature is unknown, but Sir Isaac Newton established the law that its force as exerted between two bodies is proportional to the product of the masses of the bodies, and inversely proportional to the square of their distance apart.

It will be noticed that the dictionary says "Its nature is unknown." Newton himself said "The cause of gravity is what I do not pretend to know." It could hardly be claimed that any one now knows the real nature of Gravitation. The discoveries of the past half century, however, enable one to visualize the action of Gravitation and make a plausible explanation of its nature. It is the purpose of this paper to make such an explanation. To understand this theory requires no extensive knowledge of higher mathematics. Any one with a good training in high school physics and mathematics can work out the theory for himself. He will need to watch his steps, however. There are many ways by which he may be shunted from the correct path. He will have to think of gravitation as a push rather than a pull. The great difficulty is to think of the minuteness of the ether particles and their enormous velocity. It may help some to bear in mind that the earth's gravitational field is much weaker than the electro-magnetic fields used in modern mechanics.

Newton's Law may be expressed as an equation $F = \frac{mM}{d^2}G$ in which F is the force of gravitation between any two bodies, m and M are the two masses under consideration, d is the distance between them and G is the unit of gravitation.

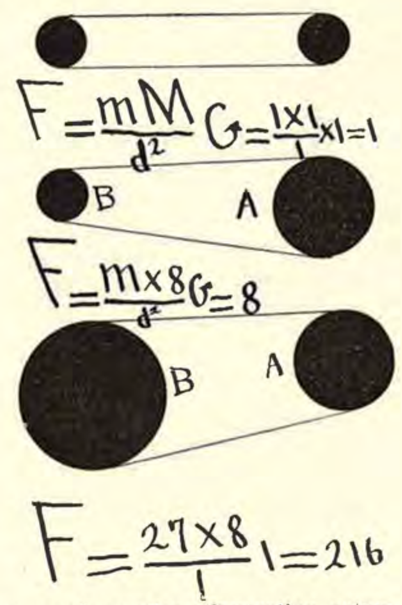

FIG. 14. Diagram and equations illustrating nature of gravitation.

If we start with two unit spheres, A and B, a unit distance apart the gravitational force between them would be unity. Now suppose the diameter of sphere A to be doubled. There will now be four times as many ether particles pushing A towards B. Each particle traverses twice the distance in passing through A so the force will now be eight times as great as at the beginning.

Now let us replace B with a sphere three times as great in diameter. There will now be nine times as many particles suffering retardation as they move through B toward A and each particle will be retarded three times as much or 27 times as much in all. As the ether push from A toward B is eight times the original push and the resistance is 27 times less the total increase of gravitation on account of the increase of both spheres is 8 times 27 or 216.

Now let us vary the distance between the masses. Suppose it is increased to four times its original length. Under this condition the apparent diameter of each sphere when viewed from the other is one fourth as great as before and the area one sixteenth as great as before. Evidently the number of ether particles concerned will be one sixteenth as many and as changing the distance between the masses does not affect the result of each particle we divide the product of 8 times 27 by 16 and find the result is $13\frac{1}{2}$. If we had substituted the values in the formula we would have arrived at the same result we have reached by this analysis.

No one has regarded Newton's Law of Gravitation as anything more than an empirical law so far as I know. An analysis of what takes place with varying masses and varying distances in accordance with our view of the nature of gravitation shows that the law is founded upon reason as well as experience. To be sure we must accept the law with the mental reservation that gravitation is a push rather than a pull. When men regarded the earth as the center of the solar system and insisted that the sun and planets circled around it they were bothered by many contradictions which disappeared when they accepted the sun as the central body. There is little prospect of solving the mystery of gravitation until we conceive it to be a push rather than a pull. We may speak of the attraction of gravitation just as we speak of the rising of the sun although we know better.

Both astronomers and physicists are satisfied of the correctness of Newton's Law. The astronomers have applied it to the moon, the planets and the double stars. Perhaps more conclusive is the work of the physicists. Cavendish found when he suspended leaden spheres near together that they attracted one another. More astonishing still, he could measure the attraction and could actually weigh the earth. Many others have weighed the earth by the same method. The most elaborate experiment of this kind was recently finished by the United States Bureau of Standards. Considering the great opportunities for error the results are remarkably uniform and give the value of the earth's specific gravity as between 5 and 6. Other methods give nearly the same results.

Nearly a century ago a man named Le Page announced a theory of gravitation which seems to have been something like the theory I have been discussing although I have seen only scanty references to it. His theory was examined by the great physicist, James Clerk Maxwell, and pronounced inadequate. We should bear in mind that many discoveries have been made since the death of Maxwell, a half century ago. If Maxwell were living now I fancy he would not only realize that gravitation is due to unbalanced ether pressure but he would be developing a kinetic theory of the ether to correspond to his universally accepted kinetic theory of gases.

The ether, the Cinderella of the Universe, is now coming into her own. For a long time the scientists courted her big sisters, the solids, liquids and gases, scarcely recognizing the existence of the ether. Now she must be considered a member of the family and the most attractive of all its members.

Our knowledge of the ether's composition is now about in the stage of knowledge of the atmosphere two or three centuries ago. It was then known that water vapor was mixed with the air but a number of other gases have since been found in it. In regard to the ether we have enticed one constituent to separate from the others and to move in eddies or vortices where it has a wonderful effect upon certain substances, notably iron. If the ether, like the atmosphere, has several constituents they must be very uniformly mixed for gravitation is always the same on the earth's surface. Such variations as do occur are readily accounted for by the altitude or latitude.

While we know so little about the ether our conception of it now is very different from what it was assumed to be when it was first conceived as the medium for conveying radiant energy from the sun and stars. Then it was supposed to be inert and capable only of vibratory movement something like the movements of a bowl of jelly. Now we think of it as something like a glorified gas with infinitesimal particles moving in all kinds of directions like the molecules of air, and at such velocity as to possess great kinetic energy. Air, steam or other gas may be confined and its pressure may be applied so as to operate on one side of a piston and then on the other to give us mechanical energy. Ether cannot be confined on account of the minuteness of its particles and their immense velocity but it causes gravitation by the unequal ether pressure when two bodies are near together.

A gas may be set into vibrations which we perceive as sound. Ether vibrations of short length convey energy which we recognize as heat, light or chemical action. The long ether waves operate our radios. The air may move bodily as wind. The disturbances in the sun's atmosphere which accompany the aurora seem perfectly analogous to the cyclones, tornadoes and hurricanes of the earth's atmosphere.

In conclusion, the theory that unbalanced ether pressure is the cause of gravitation seems fairly well proved since it so perfectly agrees with the Law of Gravitation. The speculations about the ether, however, must be regarded as mere speculations at present. Probably some of them will prove to be true and others false. At any rate the ether offers a wonderful field for investigation by scientists and philosophers.

THE EFFECTS OF FEEDING PROSTATE SUBSTANCE TO TADPOLES

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The effects of thyroid feeding on the metamorphosis of larval amphibia are well established. Macht (1919) fed tadpoles with prostate gland substance, and recorded an acceleration of metamorphosis. There was little shrinkage in the size of the tadpoles; so he concluded that the effects in general of prostate feeding were comparable to those which follow thyroid feeding and that the effects of prostate substance are less toxic than those of thyroid substances. Hegner (1922) fed tadpoles with dried flour paste to which dried prostate substance had been added. Controls received only dried flour paste. After a few weeks the length of the intestine of the experimental animals had been reduced to one-half that of the controls. Rogoff and Rosenberg (1922) in similar experiments concluded that increased growth and metamorphosis caused by feeding prostate and other substances are not comparable with the effects caused by thyroid feeding.

An experiment was recently repeated in the hope that an analysis of the gland substance might indicate the cause of the accelerated growth. A gland preparation was used in which all fat and all but a few complex proteins had been removed by successive treatment with ether, acetone, and alcohol. Tadpoles of the common bull-frog, *Rana catesbiana,* were fed with 112 parts dried flour paste to which three parts of prostate gland material had been added. The animals were fed daily over a period of eight weeks with as much material as they would eat. At the end of that time, the body length of the prostate-fed animals was increased almost 5 millimeters over that of the controls. Half of each group was killed and their intestines were measured. The average gut length of the experimentals animals was 230 millimeters and that of the controls was 264 millimeters. The results of this experiment differ from those of Hegner and Macht in that they show only a slight acceleration of growth and a doubtful acceleration of metamorphosis.

The analysis of the gland material suggests the cause of these changes. Reducing sugars were not present. Positive tests were obtained, however, for halides, nitrogen, and sulphur. Of these, in all probability, only the halides could influence growth. When a quantitative determination was made for iodine, it was found to be present in

[1] I am indebted to my friend and colleague, Dr. L. A. Goldblatt, for the chemical analysis of the gland substance.

the proportion of .05 per cent. Although this is only about one-fifth the amount found in the commercial thyroid preparations, we feel justified in attributing any acceleration of growth and metamorphosis directly to the iodine content of the prostate substance.

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THE EFFECT OF ULTRA-VIOLET RADIATION UPON THE COLOR PATTERN OF TRITURUS

BY E. ALFRED WOLF AND H. H. COLLINS
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In a previous paper (1930) the authors have reported that ultra-violet radiation with the Hanovia quartz-mercury vapor lamp applied to the dorsal surface of Triturus at a distance of 19 inches for twenty minutes and repeated at intervals of three days would, after from three to five applications, cause a striking migration of red pigment from its normal location toward the middorsal line, uncovering hereby a white surface at the original seat of the red. In crossing the black margin of the spots, the red would temporarily cover the black. Microscopical examination of frozen sections had shown that the red is located in the epidermis whereas the black is found mainly in the dermis, although black chromatophore-like patterns, as a rule, can be seen also in the epidermis. The red color is due to a pigment of the carotin group dissolved in oil droplets.

The present paper reports observations on animals five months after the cessation of the treatment. It was found that the red pigment persists in its new location. In the same time a gradual redistribution of the black pigment took place in the old spots as well as in the neighborhood of the new red markings. In the old spots the marginal black gradually diffused into the central white field previously occupied by the red, giving it a dark gray appearance. The new red spots, on the other hand, acted as forces of attraction for the dispersed black pigment cells which are normally characteristic of the dorsal surface; gradually

around each red spot a new black margin began to form giving to the displaced spots an approach toward the appearance of normal red spots. As a result of this concentration of black around the red, the dorsal surface of the animal assumed a much lighter general background coloration than that present at the beginning of the treatment.

This was an unexpected confirmation of the discovery made by Collins and Adolph (1926), of the attractive force apparently exerted by the red pigment over isolated black pigment cells. These writers observed the restoration of the heavy marginal black ring following its excision, through the migration of isolated melanophores in the surrounding skin toward the red spot.

In a new series of experiments animals were radiated for the same length of time on their ventral surface. Here also a migration of the red was observed in the direction of the mid-ventral line. This result was surprising since the radiation did not reach the red spots directly, the latter being normally located so close to the dorsal median line as not to be exposed when the animals were placed ventral surface uppermost.

It is obvious, therefore, that ultra-violet radiation not only causes the migration of the red but also determines its direction.

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SOME CHEMICAL AND PHYSICAL EFFECTS OF FOREST FIRES ON SOIL

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The plateau summit of Snowy Mountain near Mont Alto, Franklin County, Pa., with an elevation of about 1,900 feet above tide was the scene of a severe and stubborn forest fire which raged August 13, 1930. Although the forest was in full leaf at that time, the soil and litter had been very dry for weeks, and the foliage of many trees and lower plants was clinging parched and dry on the parent stems. For this reason the fire in many places burned tree stumps and roots that were underground, and consumed the forest humus or peat layer completely. In other places the destruction was of a normal type for forest fires generally.

The writer started a comparative investigation to get some light on the changes wrought in the soil by this fire. Three locations were chosen (numbered 1, 2 and 3) for collection of soil samples for study. Location 1 was a rather stony site with a sandy-gravelly soil where the fire burned with moderate intensity. Location 2 was an area where the fire raged furiously. Location 3 was a site with fine loam soil where the fire burned with moderate intensity. For each location two soil sampling stations were marked with locust posts, one being on the burnt-over area (B) and the other about 100 feet distant on ground (G) not burnt over at this time and where the forest growth is still green. Station 1-G is on a site where fire has probably not occurred for 20 years or longer. Station 2-G is on an area burnt over in 1926. Station 3-G is on a site last burnt in 1917. There is a good accumulation of humus and litter on soil at all the unburnt (G) stations, since because of the elevation, and character of the soil, litter decomposition is normally slow.

The first samples of soil and litter were collected September 20, 1930, and the second set February 4, 1931. Two samples were taken at each station. (1) Top soil (T) consisted of the upper three inches of peat or humus and more or less mineral soil, after undecomposed or unburned material was brushed away. (2) Mineral soil (M) was sampled from a depth of three to six inches. Each sample was brought to an air-dry condition, thoroughly mixed, and screened through a 3-mesh per inch sieve to remove coarser gravel, charcoal and bits of wood.

Data on the samples are given in the table. They need no special explanation, beyond the statements that acidity was determined colorimetrically, and other tests were made carefully and uniformly by generally accepted standard methods. Percolations were made with tap water through 7½ inches of soil shaken down gently in cylinders of 1.9 inches diameter. After water had passed steadily through the soils for two hours and ten minutes, this test was ended, and the acidity of the leached soils was determined for comparison with values before leaching. The water percolation rates of the soils are denoted by figures in cubic centimeters for water passed through the cylinders during ten minute periods at the start of the test and after intervals of 30 minutes and two hours, respectively.

While it is unsafe in drawing conclusions to rely on averages of the sort appended to the table, yet it is believed that these, as well as the individual data, permit certain deductions of a tentative character.

By liberation of electrolytic elements, forest fires temporarily decrease the acidity of the soil. This effect is probably quite transitory and superficial, as will be seen from inspection and comparison of data for September and February. Between August 13 and September 20

Data for Burnt-over and Green Forest Soils

(Laboratory Work by C. A. Coover and Geo. S. Perry)

Designation of sample	Acidity (pH)		Soil Fines passing thru a 100-mesh per inch sieve (%)	Hygroscopic moisture (%)	Loss on ignition %	Water Percolation Results			
						Penetration time (Min.)	Seepage in 10 Min.		
	Dry	After Leaching					At start (c.c.)	After ½ hour (c.c.)	After 2 hours (c.c.)
Samples of Sept. 20, 1930.									
1–G–T	3.4	3.8	21.7	1.72	18.4	2.4	393	278	214
1–B–T	4.5	4.4	11.1	.70	23.6	3.0	465	290	198
1–G–M	3.8	4.6	20.2	1.40	7.6	38.0	36	31	32
1–B–M	3.9	4.3	10.8	1.14	6.4	19.0	54	47	42
2–G–T	3.6	4.2	30.4	3.61	44.3	3.8	351	241	176
2–B–T	6.2	5.7	9.7	1.70	11.2	6.5	167	172	153
2–G–M	4.2	4.4	19.1	.78	4.0	21.0	30	24	22
2–B–M	4.3	4.7	17.9	.60	4.6	20.3	40	36	33
3–G–T	3.5	4.1	27.9	1.33	14.6	3.3	172	122	85
3–B–T	4.	4.4	23.2	1.96	16.8	1.7	311	204	158
3–G–M	4.7	5.1	34.4	1.19	6.4	30.5	38	29	22
3–B–M	4.5	4.5	26.6	1.15	5.8	9.0	172	122	85
Samples of Feb. 4, 1931									
1–G–T	3.8	4.5	28.8	2.27	22.3	.9	1145	982	763
1–B–T	4.7	4.7	25.1	3.51	35.2	.8	1105	790	564
1–G–M	4.2		33.2	.99	6.4				
1–B–M	4.2		29.7	.53	3.9				
2–G–T	3.9	4.3	30.7	3.48	29.3	1.3	598	431	317
2–B–T	6.2	6.5	32.1	1.56	9.6	31.3	30	33	32
2–G–M	3.7		26.1	.93	6.8				
2–B–M	4.2	4.5	29.4	1.17	5.7	7.5	152	171	132
3–G–T	3.6	3.9	28.5	2.22	15.4	1.7	828	662	593
3–B–T	3.9	4.3	34.5	2.86	17.1	.8	1251	927	780
3–G–M	4.2	4.6	32.1	1.57	5.2	2.2	345	251	198
3–B–M	4.3	4.7	22.9	.93	3.7	2.5	352	242	231
Mean Values for All Samples									
Green Top	3.6	4.1	28.0	2.44	24.0	2.23	581	453	358
Burnt Top	4.9	5.	22.6	1.88	18.9	7.30	555	403	314
Green Mineral	4.1	4.7	27.5	1.14	6.1	22.90	112	84	68
Burnt Mineral	4.2	4.5	22.9	.92	5.0	11.65	154	124	105

the weather station of the Forest Research Institute recorded 2.65 inches of rainfall, of which half fell on September 16 and 17, yet the pH of the upper mineral soil was apparently little altered.

When soil acidity before and after percolation is compared there is definite verification that organic acids from incomplete decomposition of forest litter are the primary factors of soil reaction on this site in general. At station 2-B, for the top soil sample, free alkaline compounds may account for a change in pH value contrary to the usual course.

Contrary to expectation of the author, fire does not seem to make the soil finer when tested in a dry state by shaking through sieves after careful crushing with a wooden pestle. In 11 instances out of 12 the unburned soils showed the highest per cent of fines. This feature is verified by the data on hygroscopic moisture, where 8 out of 12 comparisons show the unburned soils to be more hygroscopic, and hence more favorable to desirable soil flora and fauna. Hygroscopicity of soils is practically in direct proportion to their colloidal content, and their productivity where drainage conditions are good.

Loss on ignition shows results that are to be expected, and explains why the burnt-over soils decreased in hygroscopicity, since humus is a soil fraction most notable for this characteristic. It is also to be noted that even a very severe forest fire, such as raged at station 2-B, does not burn near all the organic matter from the soil, or even from the upper peaty layer. In fact, most of the organic matter loss on many sites is not actually caused at the instant of the fire, but results during the summer seasons that follow when the soil is more or less unprotected by vegetation, and the direct rays of the sun, in conjunction with decreased acidity conditions, stimulate rapid and complete disintegration of many organic residues.

The organic matter content of soils, as indicated by ignition loss, explains in a general way the water penetration rates and percolation values found in the cylinders. But before considering this subject, it should be noted again that the soils from unburned (G) stations were naturally finer than those from the burnt (B) ones. This would make penetration easier and percolation more rapid for the soil samples from burnt-over stations, other things being equal. Indeed, this was exactly the case with tests made on samples from the mineral soil layer which was but slightly reduced in organic content by the fire. For these mineral soils on the average, the water penetrated to the bottom of the cylinders of burnt-over soil in half the time required for unburnt soil, and

the percolation rate was about 50 per cent more rapid. Yet for top soils results were diametrically opposite. The water penetrated the cylinders of unburned soils (G-T) in less than one-third of the time required for burned samples (B-T) and it also percolated more rapidly.

An interesting and important feature of the percolation data is the quite constant and uniform decrease in the permeability of the soil. On the average, the mineral and unburned top (G-T) soil samples permitted percolation at the end of two hours at a rate only 61 to 68 per cent as fast as during the first ten minutes. The burned top soil samples (B-T) showed percolation rates of but 56.6 per cent of their original rates. The decreased permeability of the soil as regards water is caused by settling together of the soil constituents and consequent clogging of the pores and channels in the soil. These phenomena have been observed before under other conditions, and are referred by Lowdermilk[1] to the effect of the litter cover on the surface openings of the soil pores. This study demonstrates that they are a concomitant of organic content also.

None of the effects of forest fires above discussed can be considered beneficial or desirable, from the view-points of water and soil fertility conservation. In fact, surface run-off and erosion are bound to be greatly increased on most areas where fires burn the litter and decrease the organic matter content of the soil. The present study deals only with a secondary phase of the problem, as all loose litter was first removed from the soils, but it shows how a soil may "tire" as to the percolation of water in times of heavy rain. Those soils with greater organic matter content, other things equal, seem to show greater endurance in permitting the passage of water.

MIASMA AND CONTAMINATED WATER SUPPLIES

By Michael J. Blew

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Water plays an important part in all of the processes of life. It is present in all of the tissues and fluids of the animal body and also in the structure of everything in the plant kingdom. It is likewise present in all of our foods and all of our waste materials. An adequate supply of pure water is therefore necessary to the well-being of the human race.

The chief purpose of water in vital processes is as a circulating medium. Water is the vehicle that carries food through the processes of digestion and assimilation to the point of utilization in the tissues,

[1] Lowdermilk, W. C. 1930. Journal of Forestry, April, Vol. XXVIII, No. 4.

and also the waste products of metabolism from the tissues through the processes of elimination. A very small fraction of ingested water enters into the body substance and remains there—most of it keeping on its way and being eliminated from the body.

The circulation taking place in the body takes place on a larger scale in the outside world. Raindrops form rivulets: rivulets form brooklets: brooklets form rivers; and rivers unite to form the seas. Just as the blood washes the tissues to remove the waste products of metabolism, so do the streams wash the land to remove the waste products of life from its surface. The more complex life becomes on the surface of the earth, the more difficult becomes the task of keeping waste products washed away and purified. The real problem commenced about 100 years ago with the advent of our modern factory system.

All sanitarians and water works engineers are proud of the part they have played in the elimination of intestinal diseases through the adoption of filters and chlorinators. Cases of typhoid have become so scarce in some sections that young physicians have had no opportunity for clinical experience with the disease.

The reduction in these diseases has been so remarkable that there is danger of relying too much on present methods of treating water. Research and experimentation should be constantly kept abreast of developments in other fields of human activity, so that future stores of water will be safeguarded.

In speaking of a contaminated water, it is almost always rated on its bacteriological characteristics, and it is passed as being satisfactory when the total bacteria are low in number and *B. coli* are scarce or absent. No one has ever explained to what extent waste waters can be purified so that they pass requirements for good drinking water. There are plants in this country today that are returning their sewage effluents to their water supply, not figuratively, but actually.

Good water must be colorless, odorless, and not unpleasant to taste. Water that has a taste forces the consumer to drink from unauthorized springs and wells or to consume too much bottled goods for his health's sake.

Chemical wastes, wood distillation and gas house waste, or any material carrying compounds that produce taste directly or when chlorinated are generally of a phenolic nature. This does not mean that they are carbolic acid, but that they are of the same general chemical nature. Probably the worst thing that these compounds do is to drive consumers away, but there may be additional effects that should be studied thoroughly by medically trained investigators. In cases of poisoning of the

animal organism by compounds of the phenol group, we find a coagulation and hardening of the protein. It has never been demonstrated whether or not there is a selective action in the tubules of the kidneys that picks out these substances and holds them until real damage has been done to the cell structure. In other cases of poisoning by some of the heavy metals, such an action does take place. There is a possibility that the damage wrought by these compounds might become apparent only after long continued use.

It is a significant fact that the development of city life during the past 10 to 15 years is coincident with the development of stream pollution and likewise with the increase in the mortality and morbidity rates for the degenerative diseases. The sanitarian has effectively combated every disease except the degenerative diseases, and he is engaged in searching for the causes for this increase.

There are many other substances to be considered as well as those producing taste. Many industrial wastes produce soluble constituents that are not necessarily simple in nature. They are such things as the soluble extractives from wool washing, dyeing, and cloth washing, and may be complex in character. The effect of using these compounds for long periods has never been demonstrated.

This is an age of micro-reactions in chemistry and biology. We are still learning in amazement of the marvelous reactions carried on by the enzymes, the vitamines, the bacteriophages, the lytic agent and the catalysts. All of these substances are able to act in very minute amounts, and yet the results of their activity are very apparent.

The exact function of the inorganic electrolytes in drinking water is little understood, but it is probable that they play an important and too little studied role in human metabolism. It has been shown that distilled water played no detrimental part in metabolism, but this may be due to the presence of the necessary salts in the food. It was believed for a long time that water laden with magnesium salts was conducive to goitre, and the beneficial effect of certain mineral constituents of mineral spring water is fairly well understood.

More study should be given to the mineral examination of drinking water to determine the function of the salts in metabolism and disease. In our zeal at finding means of decreasing the morbidity rate to almost nothing, we have rested secure and neglected to develop the chemical study of waters. It is important that we as sanitarians and pure scientists about-face and reconsider some of the things we have been neglecting, especially those substances that are soluble in water and pass through our filters unchanged. There may be more relationship between surface washings and good health than is ordinarily considered.

WHERE WATER IS A STRONG DRINK

By Max Trumper, Ph.D.
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The Greeks used to say "The best thing is water." They said it however in the days before acid mine drainage, phenol wastes and chlorination made water a strong drink.

After the basic requirement of quantity has been met in a city's water supply, attention must be given to the quality of that water which is used for human consumption. Until recently the various methods of purification have been directed almost exclusively to the removal of the pathogenic organisms and the organic matter upon which these bacteria live. Public health authorities have been primarily interested in the elimination from the water supplies of disease producing bacteria. Such efforts have brought about a distinct advance in public health. We have virtually eliminated the ravages of typhoid. In the meantime, there has arisen a different kind of health problem, namely, the chemical pollution of our waters by trade wastes. The problem which we will have to solve is what are the cumulative effects of these waste laden waters on the human machine. And what methods of prevention are to be followed to combat and eliminate the increasing number of water-soluble trade waste chemicals that find their way into streams supplying drinking water to our communities.

The continuous introduction of new chemicals and processes in our industries has resulted in the introduction of new trade wastes into our streams. To secure the complete elimination of a given waste may require several years, during which time new trade wastes may make their appearance. For example: since the world war the old beehive ovens for burning coke have been largely replaced by the modern by-product plants from which valuable substances are recovered. But the residues from these new processes contain tar, cresols, phenols and creosotes; which when present in drinking water cause a medicinal taste and odor which becomes intensified on chlorination. But it has taken twelve years to combat this pollution. This kind of pollution has at least one distinct advantage—the public is warned by its specific chlor-phenol taste and odor. But many of our water-soluble trade wastes have no warning taste or odor and their possibly harmful effects upon the human system call for intensive laboratory study.

The problem of toxic trade wastes in drinking waters is simplified in those States having occupational disease compensation laws, for industries in these States yield valuable information as to the frequency and kinds of noxious chemicals which one may expect to find in the trade

wastes. Our own State of Pennsylvania has no legislation providing for compensation in cases of industrial poisoning. We are without the legal protection accorded to our fellow citizens in Massachusetts, Connecticut, Wisconsin, North Dakota, California, New York, New Jersey, Ohio and Minnesota. Thus the problem of combating the trade waste pollution of our water supplies is all the more difficult.

Classified according to origin, there are three types of industrial wastes: 1. Wastes of animal origin such as those from packing plants, tanneries, woolen industries. 2. Wastes of vegetable origin such as those from cotton and paper mills, also rubber factories. 3. Wastes of mineral origin such as those from dye and gas plants, coal mines, chemical plants, bleacheries, etc. The raw water of the Schuylkill River at Philadelphia is polluted by all three types of industrial wastes. This in my opinion gives one the right to call the raw water of Philadelphia a strong drink.

What effort is made to convert this strong drink into a potable water? The Sanitary Water Board of this State is charged with the administration of laws relating to sewerage and pollution of water and with the investigation and recording of the ways and means of preventing and eliminating such pollution. This Board has accomplished good work in this field during the six years of its existence. It has collaborated with some 730 industries with the view of improving the quality of the heavily polluted waters. It has secured active cooperation from the pulp and paper mills and especially from the tanneries and gas plants, industries which are responsible for much pollution. At frequent intervals, this Board has announced that progress has been made by agreements with industrial establishments. Last Fall the Board estimated the improvements as a 70 per cent reduction in the load of organic industrial wastes and a 60 per cent reduction in the acid wastes reaching the waters of the Schuylkill. Recently there appeared in the newspapers throughout the State a statement attributed to the Board that "the waters of the Schuylkill are only one-fifth as bad as they were four years ago." This is indeed welcome news but in these statements it will be noted that figures on the chemical and bacterial analyses are conspicuous by their absence. In the conclusions drawn the authors of the report do not take into consideration that owing to the present economic depression many industries are closed or are working on a part time basis. Thus the quantity of industrial trade wastes may have been reduced chiefly because of industrial inactivity. Mention should be made also of the drought of the past year which has aided in the natural sedimentation of industrial wastes. Is this reported improvement in the water due partly to the temporary effect of these economic and physical forces?

In order to measure correctly the actual decrease or increase in the industrial pollution of our water some standard of comparison such as the quantity of water used in our industries must be obtained. Otherwise we shall continue to flounder on this problem as we have in the past.

Finally, there is too much secrecy as to the data on our water supplies in the files of the State Sanitary Water Board as well as those in the water bureau in Philadelphia. Many investigations and tests have been made from which general conclusions have been presented to the public. The actual data of these findings however are not submitted to the public nor are they even accessible to the qualified chemist, physician or engineer who may wish to study them. In my own endeavor to obtain specific data on the accomplishments of the Sanitary Water Board and of the Philadelphia water bureau I found a maximum of general statements with a minimum of laboratory data. They invariably report continuing progress. They are no doubt making progress in clearing up some of the industrial pollution and have done excellent work in the problem of sewage disposal. But more preventive work should be done; for instance: those industries which are known to pollute the streams should be required to install the most modern equipment so that a minimum of trade wastes will be discharged into our waters. If the Board does not possess such power then its power should be extended to include a certain amount of police duty along the river in order to prevent the introduction by industries of various noxious substances which are used because of the economy of manufacture without regard to the hazards to the public health. To neglect the problem at its source means to protract endlessly the work, somewhat like the man in a leaky boat who is continually bailing out the water but makes no attempt to plug the leak.

The information gathered by departments vested with the responsibility of securing and maintaining pure drinking water should be available to individuals and organizations interested in these findings and able to arouse public opinion sufficiently to enact measures making sure of a wholesome water supply.

A READING PROGRAM FOR GENERAL ZOOLOGY

By Paul R. Cutright
University of Pittsburgh

It is common knowledge to a zoologist that the lobster has an exoskeleton of chitin and five pairs of walking legs and that the sartorius muscle in the leg of the frog is next door to the triceps extensor femoris We, of course, regularly present these facts to the students and, just as

regularly, raise a pedagogical eyebrow if the information has not been incorporated. It seems to me, however, that this type of knowledge is not the ultimate goal of a general course in zoology and efforts should be made at all times to introduce new features that will alleviate in the present stock of students some of the ills that were steadfastly and courageously borne by former aspirants of zoological knowledge.

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

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

I learned ornithology and valuable ecological lessons from Hudson's boyhood experiences in Argentina; I learned much of entomology from Bates and Wallace, I learned evolution from Darwin, and I learned geographical distribution from all.

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

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

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

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

To be as brief as possible I have included books from all the zoological fields, namely, genetics, physiology, evolution, ecology, and entomology. There are only a few in these fields that would be read easily by a freshman and to offset this, books on scientific travel, biological essays, semipopular treatises of scientific interest along many lines, and even one book of fiction have been added. There is so much to choose from that I saw no reason for including any book that might be termed dull or difficult. To make my point clear, if a student should wish to read about heredity, why subject him to Babcock and Clausen's Genetics In Relation To Agriculture, which is a highly valuable text-book but extremely

laborious, when he can read and absorb with little difficulty such works as Altenburg's How We Inherit and Jenning's The Biological Basis of Human Nature.

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

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

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

THE READING LIST

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

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

THE EFFECT OF ADRENALIN CHLORIDE ON THE MAZE BEHAVIOR OF MICE

By W. L. Wachter
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Fifty mice ranging from 3–9 months of age were given initial training for 10–30 consecutive days, each day's work consisting of 5–10 runs through a simple maze. Then followed a period of three days when each animal was given 0.1 c.c. adrenalin chloride by mouth and put through the maze as soon as it began to take effect (about 35 minutes).

The administration of adrenalin chloride increased the speed of the animal which always ran excitedly about and gave no evidence of caution or curiosity characteristic of the initial training period. The distance traversed and the time required to run through the maze were always less than in the training period, showing positive effects of the initial training. The number of errors, however, was always greater.

A further comparison of the maze scores for the three days when they ran under the influence of adrenalin chloride and the last three days of the initial training period allow of the following conclusions: (1) The distance traversed in the maze varies inversely with the age of the mouse (−11 to −38 per cent) and the amount of training (−5 to −31 per cent). (2) The time decreases with training (−25 to −37 per cent) and is constant for all ages up to 5 months (−30 per cent) when a decrease to −52 per cent is obtained for 13 older animals. (3) The errors increase with age (−4 to +13 per cent) and with training (+12 to +38 per cent). This increase in errors may be due in part to increased speed and momentum of the animals which would rush into a wrong alley, regardless of the associated electric shock, and unable to stop themselves at the "error line" as was their custom in the initial training period, or the adrenalin chloride may have disturbed the mechanism of the conditioned reflex other than that of the musculature itself since the number of errors varies directly with the training, whereas time and distance vary inversely with the training.

THE EFFECTS OF X-RAYS ON THE DEVELOPMENT OF THE PROSTATE GLAND

By B. H. Kettelkamp
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It has been demonstrated repeatedly, both in man and in many other mammals, that the development of the prostate gland is dependent upon normal testicular function. The gland does not develop until sexual maturity is reached. Moreover, if the animal is castrated prepubertally the prostate does not fully develop. These facts show very conclusively that there is an intimate relationship between the prostate and the testes. The question naturally arises whether normal spermatogenic function is necessary for prostate development or whether the prostate belongs to that vast group of organs the development of which is dependent upon the internal secretion of the interstitial tissue of the testes.

In those mammals which experience cyclical breeding seasons, such as the mole and hedge-hog, the prostate undergoes definite changes in size and activity as the spermatogenic activity of the testes varies. If the animals are castrated during the period of testicular quiescence, the prostate does not hypertrophy with the return of the breeding season.

These phenomena would seem to indicate that the functional state of the prostate was directly dependent upon the reproductive function of the testes. Experiments recently performed demonstrate that testicular function is not necessary for prostate development.

Sexually immature rats, 36 days of age, were subjected to varying dosages of x-rays. The animals were securely tied in a heavy lead box so constructed that only the scrotum and the testes were exposed. After ninety days breeding tests demonstrated that the animals had not attained fertility. At 101 days they were killed, the testes and prostates removed, and fixed in Bouin's fluid (Allen's modification B15).

The sectioned material showed seminiferous tubules in various stages, ranging from those which were apparently normal size and with active spermatogenesis to those which were only about half-normal and in which there was no sign of spermatogenesis. The condition of the tubules was directly proportionate to the severity and length of the exposure. In those animals in which there was a complete cessation of spermatogenesis there was a marked shrinkage of the tubules. They were reduced to about one-half the size of those in which there was active spermatogenesis.

Associated with the degeneration of the seminiferous tubules was a great hypertrophy of interstitial tissue. By actual measurement the area presented by the tubules was reduced to half while the interstitial tissue was increased by ten. This is, then, an actual increase and not an apparent one as has been previously suggested.

Gross observation showed the prostate gland slightly hypertrophied while sections showed the lumen of the tubules completely filled with secretion and the secretory epithelium in a very active state. The general hypertrophy of the gland is undoubtedly due to the increase of the epithelium.

These results are not at variance with those obtained in the mole and hedge-hog previously mentioned. In these two animals the hypertrophy of the prostate is undoubtedly caused by the increase of interstitial tissue coincident with the return of the sexual cycle. In the case of the x-rayed testes we conclude that the hypertrophy of the prostate is likewise caused by the hypertrophy of the interstitial tissue and is in no way dependent upon the generative function of the testes.

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MODIFIED XANTHENE COMPOUNDS IN THE DIAGNOSIS OF MALIGNANT NEOPLASMS

By Donald C. A. Butts[1]

Since the presentation of the first report on "The Use of Certain Modified Xanthene Compounds in the Diagnosis of Malignant Neoplasms" before the sixth annual meeting of the Pennsylvania Academy of Science,[2] many angles of study and research have been investigated on these compounds by the Emery Laboratory. These findings offer promise of possessing scientific and practical value and application, and will be presented briefly.

Within the past year it has become necessary for the Emery Laboratory to increase its technical staff to meet the demand of problems offered by this research. Two tissue culture technicians, one chemist, a biologist, and an additional curator have been added.

In closing the discussion on the previous report, reference was made to the observation that unstained paraffin sections of tumors prepared from rats which had previously been injected intravenously with a modified xanthene compound, known in the Laboratory as "E-47," demonstrated an accumulation of the dye in the nuclei of the tumor cells.

Since that time this phenomenon has received intensive study. Results to date, based on the examination of 305 stained and un-stained

[1] Director, Emery Laboratory of Experimental Radiology, Roentgenology & Cancer Research, Philadelphia.

[2] Butts, D. C. A., The Use of Certain Modified Xanthene Compounds in the Diagnosis of Malignant Neoplasms, Proc. Penna. Acad. Sci., Vol. IV, 1930, pp. 117–121.

sections, tend strongly to establish the observation that within thirty minutes following the intravenous administration of his compound, the nuclei of the active tumor cells are so densely "packed" with a granular material as to nearly absorb all light, making the nuclei appear as almost black areas in the field. This "packing-effect" we believe to be due to the deposition of the dye in the nuclei, or the precipitation of certain nuclear elements, directly brought about by absorption of the dye.

Normal cellular structures run as controls, failed to reveal any such phenomenon, nor did the cells of other parts of the body removed from the tumor-bearing rats.

Degenerated and necrotic portions of the tumors apparently did not absorb, or very sparingly, took up the dye.

To eliminate the possibility of these granular inclusions as being due to actions other than that of a specific absorption by tumor cell nuclei, series of rats bearing tumors inoculated at the same time and with fragments of the same tumor, were injected intravenously with hypotonic, isotonic and hypertonic saline solutions, while others of the same series remained uninjected. In no case was there demonstrated any such phenomenon from such treatment as that observed following the intravenous administration of the dye solutions.

As the interval between injection of the dye and the excision of the tumor increases, the picture undergoes considerable variation, demonstrated by an increasing disintegration of the previously "packed" nuclei with the subsequent liberation of the nuclear contents. This picture only applies for the higher concentrations of the dye, 1: 10 and 1: 20. Low concentrations, that is, 1: 50 and below, show a steady increasing absorption or precipitation of the material, with time.

In order that the studied areas may be definitely identified, alternate sections from the same paraffin block are cut, and stained in the regular manner with haematoxlyn and eosin.

Although our researches to date will not allow me to state definitely that the absorption of the compounds with which we are working is entirely limited to malignant cells, I do feel that sufficient evidence has been accumulated to allow us to make this prediction.

Other interesting researches being conducted to expand our present knowledge of these compounds are those upon various forms of bacteria, and upon embryonic structures. Although offering results of collaborative nature and of definite scientific interest, this phase of our work has not progressed far enough to warrant reporting, except to say that in vitro, the growth of streptococcus hemolyticus and certain bacilli of the

colon-typhoid-dysentery group is retarded or completely inhibited by the incorporation of the dye in the media in concentrations above 1: 100.

Continuation of researches reported in our former communication on the apparent local temperature rise produced in the malignant areas following the absorption of the dye, tend to indicate that in some instances there resulted from the treatment of malignant and normal tissues simultaneously with the dye solution, an elevation in temperature of approximately 0.5° C. in the tumor tissues, in excess to any temperature rise produced in the normal tissues. In other cases however, the increase in the tumor tissues, over and above that produced in the normal was slight (.01–0.1° C.). In a few experiments, the rise produced in the normal tissues was in excess to that in the tumor tissues. However, this investigation presents many technical difficulties which are prohibitive to continuous work, and for the present this research is put aside for more pertinent problems.

Extensive work in the field of haematology has conclusively demonstrated that the introduction of these compounds into the blood stream produces no noticeable effect on the red or white cells of the blood.

Work in our recently organized tissue culture laboratory is now actively under way. Here it is hoped that the modus operandi of the compounds under study may be explained, and permanent micro cinema records prepared.

At the time of the previous communication, it was realized that the diagnostic agent then employed could, in all probability, be further altered to render greater selective opacity to malignant areas. During the months which have followed, our chemists have been able to produce, in very small amounts, the planned new compound. In concentrations of 1: 10, this compound is, in vitro, considerably more opaque to x-rays than any material used in radiography. Tests have proven it less toxic than former compounds, and as far as our investigations will merit reporting, is selectively absorbed by malignant cells, as demonstrated by roentgenograms and micro sections.

Another very promising research of this Laboratory is a study of the chemistry involved in malignant cell transformation, and the alterations produced by radiations and by the compounds under study. This research is a continuation of an investigation reported by two of my associates and myself in 1927,[3] and deals entirely with the sodium content of

[3] Butts, D. C. A.; Huff, T. E.; Palmer, F., Jr., A preliminary report on the Study of the Emission Spectra and Surface Tension Alteration in Experimental Animal Tumors, Science, Vol. LXV, No. 1682, March, 1927, pp. 304–306.

the cells. The result of 103 analyses substantiates earlier finding, that malignant cell transformation is associated in some way with an increased sodium content of the cells. Other angles of this investigation are offering very interesting results, too early to report. However, it is our hope that continued research in this field will help to unfold the true action of certain xanthene compounds in cancer.