PROCEEDINGS

OF THE

PENNSYLVANIA ACADEMY OF SCIENCE

VOLUME VII

1 9 3 3

HARRISBURG, PENNSYLVANIA
1933

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OFFICERS

1933–34

President .... John C. Johnson, West Chester
Vice-President .... S. H. Derickson, Annville
Secretary .... T. L. Guyton, Harrisburg
Assistant Secretary .... V. Earl Light, Annville
Treasurer .... H. W. Thurston, Jr., State College
Editor .... R. W. Stone, Harrisburg

Editor's Note. Customarily an author's paper is limited to five pages. Several of the papers in this volume exceed that length, but in each case the author has agreed to pay the Treasurer the cost of composition and printing of all pages in excess of five.

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ILLUSTRATIONS

PENNSYLVANIA ACADEMY OF SCIENCE

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

JUNIATA COLLEGE, HUNTINGDON, PENNSYLVANIA

APRIL 14–15, 1933

The ninth annual meeting of the Pennsylvania Academy of Science convened at Juniata College, Huntingdon, Pennsylvania, Friday morning, April 14, 1933. The meeting was presided over by Dr. S. H. Williams, University of Pittsburgh.

The following report of the secretary was read, and was approved by the society:

The eighth annual meeting convened in West Chester, March 25 and 26, 1932, Dr. E. M. Gress presiding. Reports of the editor, treasurer and secretary were adopted.

Sixty-seven papers were presented. These either in their entirety or in abstract were printed in Volume VI of the PROCEEDINGS of the Academy, which was mailed to the membership on September 22, 1932.

A field trip was made to the conservatories of the Pierre du Pont Estate. Plants typical of all the earth's plant zones were growing in the gardens.

The evening lecture was given by Dr. Elmer O. Kraemer, of the E. I. du Pont Company, on "Present Trends in Colloidal Science." In a popular way he explained something of the relation of colloidal chemistry and industry.

Professor M. J. Babb, of the University of Pennsylvania, gave a talk on "David Rittenhouse," which was particularly interesting at the time and place.

At the closing business session 54 persons were elected to active membership.

During the year 1932 twenty members resigned and six were dropped for non-payment of fees. Dr. Adolph Koenig, University of Pittsburgh, a charter member, died October 8, 1932. A total of 246 of our members are also members of the American Association for the Advancement of Science. The membership as of April 1, 1933, in 388 compared with 367 for April, 1930.

The summer meeting was held at Slippery Rock, July 23, 1932. Dr. Waldron was chairman of local arrangements. Places of interest to naturalists were visited. The thanks of the academy were extended to Dr. Waldron and the president of the State Teachers College for the splendid entertainment. Two persons were elected to active membership.

Respectfully submitted,
T. L. GUYTON, *Secretary*

The following treasurer's report was submitted and later approved by an auditing committee:

April 13, 1933

Receipts:		Disbursements:	
Balance on hand March 24, 1932	$ 388.80	Proceedings, Vol. VI	$ 622.74
		Programs and stationery	41.75

Dues received since last meeting	584.00	Treasurer's account	52.00
A. A. A. S. rebates	120.50	Secretary's account	11.24
Miscellaneous sales	8.50	Editor's account	1.40
		Local committee (1932 meeting)	12.75
	$ 1,101.80	Checks returned	10.00
		Check tax	.12
		Cash in bank (this date)	349.80
			$ 1,101.80

H. W. THURSTON, *Treasurer*

Approved by Auditing Committee,
P. W. WHITING, *Chairman*

Papers as appearing later in this volume were read in full or by title.

At the final business session the previously appointed committees made their reports.

REPORT OF THE COMMITTEE ON JUNIOR ACADEMY

During the year the committee sent out approximately 60 questionnaires requesting the information concerning science clubs. A sample of the questionnaires is attached. Nineteen replies were received to date. Several replies expressed enthusiastic interest in the idea. The membership of the nineteen clubs responding to the questionnaire is 827.

During the year an announcement about the junior academy appeared in the February issue of the Pennsylvania State Educational Association *Journal.*

Mr. William Bristow, deputy superintendent in charge of secondary education, Harrisburg, is interested in the movement and has assured the academy of his cooperation. Mr. W. E. Hess, supervisor in secondary education, has been in attendance at these sessions and is present this morning from the State Department of Public Instruction at the request of Mr. Bristow. The curriculum bureau will have available for classroom use courses of study in science for grades one to twelve. One of the points stressed in the course of study is club activities.

The committee on junior academy has tentatively set up the following plans for the coming year:

1. Distribute from time to time to interested high-school clubs during the coming year a mimeographed bulletin setting forth the aims and purposes of the junior academy.

2. Interesting and timely science news items and suggested club activity will be included to make the bulletin appeal to the high-school groups. Several senior members of the academy have already signified their willingness to contribute from their special field material suitable for this purpose.

3. A joint meeting of the junior academy to be arranged along with the senior academy at its annual Easter meeting.

The committee recommends that an active working committee be appointed and authorized to carry out the plans. It is suggested that this committee consist of five members, two from the senior academy, two active sponsors of high-school science clubs and a representative from the State Department of Public Instruction. It is further recommended that one of the senior and one of the sponsors be chosen from the locality where the next meeting is to be held.

Respectfully submitted,
The Committee—
K. F. OERLEIN, *Chairman*
H. W. THURSTON
M. J. PHILLIPS
CORA SMITH
DOROTHY SCHMUCKER

The membership committee presented the names of the following persons all of whom were elected to active membership in the ACADEMY:

Edward P. Claus, 133 Claus Ave., Pittsburgh (10)
Arthur B. Cleaves, Lafayette College, Easton
K. D. Doak, University of Pennsylvania, Botanical Laboratory, Philadelphia
Noah G. Good, Morgantown
Lyle W. R. Jackson, University of Pennslyvania, Botanical Laboratory, Philadelphia
Paul Douglas Keener, Box 515, State College
Thomas H. Knepp, 120 N. Main Street, Yeagertown
John H. Lowe, P. O. Box 275, Allentown
Elizabeth E. McKinniss, State Hospital, Torrance
D. M. Rockwell, Juniata College, Huntingdon
A. E. Ruark, University of Pittsburgh, Pittsburgh
C. S. Shively, Juniata College, Huntingdon
J. Clyde Stayer, 310 Seventeenth Street, Huntingdon
J. Hershel Stone, 2709 Tilbury Street, Pittsburgh (17)
Anna Rachel Whiting, Pennsylvania College for Women, Pittsburgh

The resolutions committee offered the following resolutions which were adopted by the ACADEMY:

1. *Resolved*, That we express our sincere thinks to President Ellis and the officials of Juniata College for their invitation to hold our annual meeting at Juniata College and for the use of their buildings and facilities during this meeting.

2. *Resolved*, That we express our thanks to Dr. Will, Professor Engle, Dr. Yoder, Dr. Brumbaugh and Dr. Rockwell, the local committee, for the pleasurable arrangements which they have provided for the members of the ACADEMY during this meeting.

3. *Resolved*, That we express our thanks and appreciation to the officials of the Pennsylvania Industrial School for the privilege of observing the school in action and the facilities provided for the betterment of the sociological conditions in our Commonwealth.

5. *Resolved*, That we express our profound sorrow to Dr. John C. Johnson because of the death of his beloved wife and extend to him our sympathy in this hour of bereavement.

S. H. DERICKSON
K. F. ORLINE
J. R. CARTLEDGE

The committee on nominations, E. M. Gress, *Chairman*, F. D. Kern and Homer C. Will, named the following persons and they were unanimously elected for the year 1933–34:

President—John C. Johnson
Vice-President—S. H. Derickson
Secretary—T. L. Guyton
Assistant Secretary—V. Earl Light
Treasurer—H. W. Thurston
Editor—R. W. Stone

Sixty-six persons registered for the meeting. The ACADEMY was adjourned Saturday at noon. The next session of the ACADEMY will be held at Ohiopyle, Friday and Saturday, August 4 and 5, 1933, the time and place having been fixed by the action of the executive committee.

Respectfully submitted,
T. L. GUYTON, *Secretary*

Harrisburg, May 19, 1933.

PRELIMINARY BIOLOGICAL SURVEY OF LAKE CONEWAGO, MOUNT GRETNA, PENNSYLVANIA

D. RALPH HOSTETTER AND S. HOFFMAN DERICKSON
Lebanon Valley College

This paper is an abstract by the senior author of a more detailed compilation of data assembled during the summer of 1931 by the junior author and by him collaborated into a dissertation of 107 pages and 21 plates and submitted by him in partial fulfilment of the requirements for the degree of Master of Science in Lebanon Valley College. The more detailed statistical data, omitted here, is available to any one interested in the library at the college. The work already done is but the beginning of more detailed work planned for the future.

To make a scientifically useful biological survey requires careful observation over a considerable period of time and necessitates the accumulation of much and varied data. Collecting and identifying the organisms is but one phase of the work. In order to account for the presence or absence of certain forms, the limited or general distribution of some species, and the abundance or rarity of others, a study of all possible ecological factors must be made.

Such factors include location, size and history of lake, source and depth of water, temperature of water at various depths, light intensity, circulation of water as caused by winds and entering streams, hydrogen-ion concentration of water and soil at various parts of the lake, frequency of rains and turbidity of water, kinds of organisms both in the water and on the shore, and the condition of the lake prior to the survey.

In this brief survey an attempt was made to collect data on nearly all of the above factors.

HISTORY OF LAKE CONEWAGO

The lake was built as an ice dam in 1882 by the Cornwall and Lebanon Railroad Company. At the time of its construction the land now occupied by the lake was a grassy meadow surrounded by woodland on the south, east and west. A few years later a boat-house and landing were constructed at the northeast end and it was used for this recreation for about forty years, when the boat-house was removed. A bathing beach which has been in use for many years is located at the northwestern shore. About 1920 a similar beach was developed on the southeastern shore but was abandoned a few years later.

The lake was covered with ice during the greater part of the winter preceding this survey. In the early part of April the lake was drained except that portion at the southwestern end which is more than ten feet deep. At this time some of the sediment was dredged from the vicinity of the bathing beach and hauled to the eastern end where it was used to separate the waters of a swampy zone polluted by decaying vegetation from the main body of the lake. After the greater part of the lake bottom had been exposed to the air and sun for 65 days the drainage outlet was closed and after 27 days the lake was again filled with water. Examination during this period revealed that sedimentary deposits had accumulated at some parts of the lake bottom to a depth of three feet. Portions of the lake floor consist of clay but this clay is largely covered by clay, sand, and humus from the surrounding slopes.

Although the margin of the lake on all sides is shallow there has not been extensive invasion of vegetation accompanied by transition from aquatic to terrestrial habitat except at the eastern end where the main stream enters. Here a considerable area, formerly lake bottom, now supports a colony of black willow and smaller vegetation. The willows are the largest of their kind in the vicinity and probably grew from seeds carried by migrating shore birds.

DESCRIPTION OF LAKE

Lake Conewago is located at Mount Gretna, Lebanon County, Pennsylvania, just north of South Mountain. It is 610 feet above sea-level. It is bordered on the north by sparsely wooded grass lands rising 65 feet above the lake. To the west is an abrupt wooded elevation to the height of 140 feet. The heavily timbered hills on the south rise to 265 feet above the lake. To the east is a wooded valley about one mile wide and rising gently to a watershed 1.5 miles east of the lake. It is the drainage from this eastern end of the valley that enters the lake. The lake is roughly triangular in outline, its greater length being in a northeast-southwest direction. It is about 1450 feet long, the western shore measures 750 feet. The area is about 543,750 square feet. (See figure 1.)

The main source of water is derived from 17 springs which unite to form the stream that flows into the lake at the eastern end. In addition there are several springs in the lake bottom. The greatest depth is 13 feet, near the southwestern corner. The water is in constant motion. The main current is from the entrance of the stream at the east to the

FIG. 1. Photograph of Lake Conewago looking eastward and including the oak-maple forest covering the slopes that drain into the lake. Chestnut formerly was an important element in the composition of the forest. It has been replaced largely by black birch.

overflow somewhat south of the middle of the western side. There is a cross current from a spring at the northwestern corner to the outlet. The surrounding woodlands protect the lake from violent agitation from the wind.

METHODS OF STUDY

For convenience of preliminary study the lake was divided into arbitrary sections. It was first bisected by a median line. Nine cross lines were then run at right angles to the first, dividing the lake into 20 sections. Each section was designated by a letter. In the eastern portion

of the lake the lines were placed at the limits of apparent natural plant habitats. The distribution of certain plants, as Sparganium, Typha, Echinochloa, etc., largely determined the size of sections. West of the center natural plant habitats were less apparent and the sections were made arbitrarily of more nearly equal size. Figure 2 shows sections described above as well as depth, which is indicated by contour lines.

STUDY OF ORGANISMS

In addition to records made of all organisms found in each section in the lake a record was also made of all trees growing within 25 feet, of all shrubs growing within ten feet and of all herbaceous plants growing within three feet of the lake. The plant life on the shore was considered

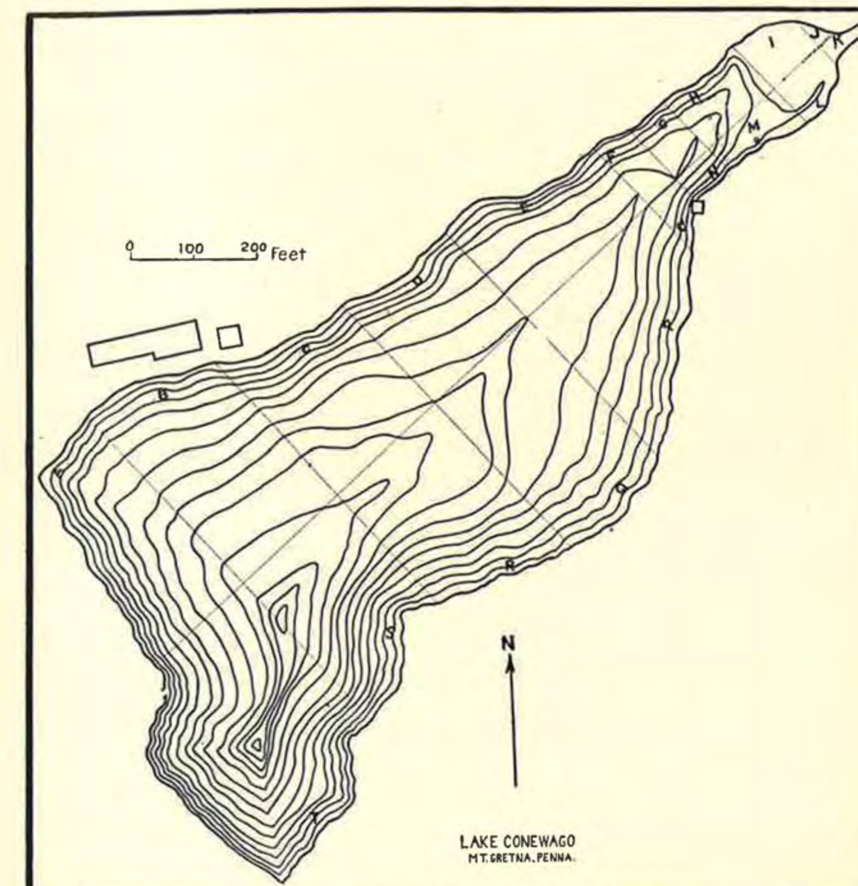

FIG. 2. Map of Lake Conewago showing depth and arbitrary zones referred to in text. Each contour represents 1 foot in depth.

a possible factor in influencing the distribution of organisms in the lake proper.

Each section was studied separately. Collections of both microscopic and macroscopic material were made from many places in each section. Plankton forms were collected either by hand-net along shore or tow-net from a boat. Benthos or bottom living forms were gathered along shore by hand with pipettes or from mud samples taken by uprooting plants, and in deeper parts with large-mouthed bottle attached to a pole with stopper operated by wire cable. This ingenious device was also used in obtaining samples at varying depth.

All organisms were identified when obtained and questionable identifications were verified through the Plant and Animal Identification Service of the General Biological Supply House. Dr. E. M. Gress identified the grasses and sedges.

Study of Ecological Factors

Besides the determination of organisms as ecological factors, several other factors were recorded. Surface and bottom temperature was recorded for each foot of water depth. These readings were taken on section boundary lines by attaching a soil thermometer to a long pole graduated in inches. Temperature of the air was also recorded as well as that of the sand on shore. Depth measurements were also made with the graduated pole which was weighted at the end and moved along on the bottom and record made of each foot of rise or fall and location indicated on sectional lines.

Two tests were made of the hydrogen-ion concentration of the water and soil in each section and at several points in some of the sections. A La Motte-Morgan set and indicators was used. During the period of the survey there were many showers and nine heavy rains. At no time did much muddy water flow into the lake. No effort was made to measure the turbidity or the rate of precipitation.

Classification of Data

PLANTS FOUND IN THE LAKE AND THEIR SECTIONAL DISTRIBUTION

(In the following list the letters following the name of the plant indicate the section of the lake shown on Figure 2 where that species of plant occurs. Bt = Benthos; Pt = Plankton.)

NAME OF PLANT	SECTIONAL DISTRIBUTION
BLUE-GREEN ALGAE	
Coelosphaerium Kutzingianum	H
Aphanocapsa sp.	B:L
Rivularia dura	C
Lyngbia inundata	B
Phormidium sp.	H:L:O

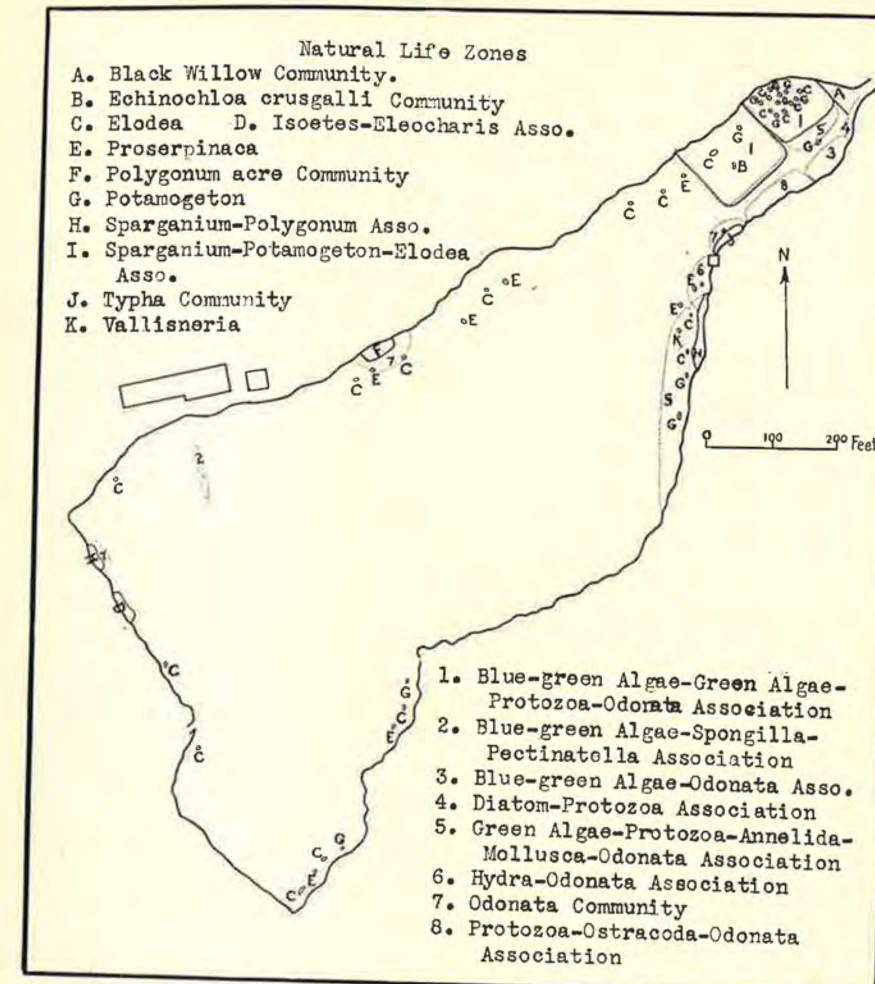

Fig. 3. Map of Lake Conewago showing natural life zones indicated by an analysis of the data obtained by a study of their distribution. July, 1931.

NAME OF PLANT	SECTIONAL DISTRIBUTION
Oscillatoria sp.	B:I:L:M:O:P
Oscillatoria nigra	I
Anabaena sp.	A:H:L:M
Anabaena variabilis	P
GREEN ALGAE	
Gleocystis sp.	H
Actinastrum hantzschii	P
Actinastrum sp.	H
Selenastrum gracile	S
Scenedesmus acutus	H
Ankistrodesmus sp.	B:I:O:P
Pediastrum pertusum	A:P:T
Pediastrum Ehrenbergii	A:T:Bt

Hydrodictyon reticulatum	D:E:F:G:I
Pleurococcus sp.	F:H:I
Characium ambiguum	H
Gonium pectorale	A
Chaetophora elegans	A:P
Ulothrix sp.	A:D:E:P:Pt
Oedogonium sp.	C:D:E:H:K:L:M:O:P:Pt
Vaucheria sp.	K:L:P
Zygnema sp.	M
Spirogyra sp.	A:H:M:S:Pt
Spirogyra crassa	C:H:T
Mougeotia sp.	A:H:M:P
Nitella sp.	I:M
DESMIDS	
Closterium sp.	A:C:H:I:M:P:Pt:Bt
Closterium acuminatum	I
Closterium lanceolatum	K:O
Closterium dionae	I
Closterium parvulum	A:O
Closterium moniliferum	O
Closterium moniliferum concavum	F:G:H:I
Staurastrum sp.	F:G:H:K:T
Staurastrum brevispinum	D:E
Staurastrum odonatum	D:E
Staurastrum dejectum	Pt
Staurastrum crenulatum	H:I:L:O:P
Staurastrum iotanum	H
Staurastrum gracile	H:Pt
Staurastrum luteolum	I
Micrasterias rotata	H
Micrasterias furcata	I:P:T
Cosmarium sp.	H:S:Bt
Cosmarium botrytis	C:F:G
Cosmarium suborbiculare	P
Cosmarium tumidum	A:Pt
Cosmarium undulatum	I
Cosmarium pyramidatum	I
Cosmarium perforatum	A:B:H
Cosmarium intermedium	B:K:T:Pt
Cosmarium Portianum	D:E:Pt
Cosmarium tetrophthalmum	D:E:K
Cosmarium Nordstedtii	P
Cosmarium pardalis	S
Cosmarium quinarium	H
Sphaerozosma sp.	K
Sphaerozosma filiforme	P
DIATOMS	
Melosira sp.	L
Pinnularia sp.	C:I:K:T:Pt:Bt
Pinnularia viridis	F:G:P
Navicula sp.	A:B:C:D:E:F:G:H:I:K:M: P:Q:R:S:T:Pt:Bt
Navicula nobilis	A
Navicula viridis	A:O
Navicula sillimanorum	H
Navicula parva	I
Navicula solaris	I
Navicula rhyncocephala	L
Navicula decephala	L
Navicula decurrens	L

Navicula fusidum	O:P
Navicula gracilis	O:P
Navicula Borealis	O
Navicula tenella	O
Navicula major	P
Stauroneus anceps	A:F:G:H
Cymbella sp.	A:L:P
Cymbella parva	O
Gomphonema sp.	K:L:O:P
Gomphonema dichtomum	L
Gomphonema constrictum	T
Surirella sp.	H:K:O:T:Bt
Diatoma sp.	D:E:S:T
Synedra sp.	O
Synedra superba	A:P
Synedra pulchella	H:I
Synedra ulna	P
Fragilaria sp.	A:P
Fragilaria virescens	D:E
Epithemia sp.	A:L:T:Bt
Epithemia gibba	H
Epithemia turgida	P
Eunotia sp.	T
Frustulia sp.	A:H:K
Triceratium solinoceros	F:G
Triceratium antillarium	H
QUILLWORT	
Isoetes macrospora	A
FLOWERING PLANTS	
Typha latifolia	A:I:M:N:O:P
Sparganum americanum androcladum	I
Potamogeton natans	H:I:M:P:S:T
Potamogeton crispus	H:I:T
Sagitaria latifolia	A:C:D:E:F:G:H:I:N:O:P:S:T
Elodea canadensis	P
Vallisneria spiralis	H:M
Echinocloa crusgalli	A
Elocharis palustris	A
Elocharis obtusa	I:M
Scripus validus	A:C:D:E:H:M:N:O:P:S:T
Polygonum acre	A
Polygonum sagittatum	C:D:E:O:P:S:T:
Proserpinaca palustris	

ANIMALS FOUND IN THE LAKE AND THEIR SECTIONAL DISTRIBUTION

NAME OF ANIMAL	SECTIONAL DISTRIBUTION
PROTOZOA	
Amoeba proteus	K
Amoeba verrucosa	K:Pt
Amoeba guttula	N
Arcella sp.	A:C:D:E:P:S:T:Pt
Arcella vulgaris	H:T
Arcella dentata	P
Centropysix arculeata	D:E:H
Difflugia sp.	I:O:P:Pt
Difflugia lebes	A:M:T

Difflugia corona	H:O
Difflugia lobostomum	B:I:T
Difflugia globostoma	B:D:E:H:I:K:M:Q:R:S:T:Pt:Bt
Difflugia pyriformis	T:Pt:Bt
Difflugia acuminata	D:E:Bt
Actynophrys sp.	K:S
Acanthocystis chaetophora	I

MASTIGOPHORA

Anthophysa vegetans	Bt
Heteromita ovata	A
Euglena sp.	B:O:Bt
Euglena viridis	F:G:H:I:K:Pt:Bt
Euglena deses	I:P
Euglena gracilis	K
Euglena oxyurus	Pt
Euglena spirogyra	Bt
Euglena cysts	B:D:E
Trachelomonas hispida	B:I:M:T:Pt:Bt
Trachelomonas volvocina	M:O:Bt:Pt
Phacus sp.	H:Bt:Pt
Phacus pleuronectes	Bt
Asterias sp.	Pt
Atractonema tortuosa	Bt
Chilomonas sp.	S:T:Pt
Chilomonas paramecium	D:E:H:I:K:M:O:P:Q:R:Pt:Bt
Trentonia flagellata	I
Chlamydomonas sp.	K
Chlamydomonas pulvisculus	L
Goniodoma sp.	B:H:O:P:T:Bt

INFUSORIA

Coleps hirtus	I:M:Bt
Didinium sp.	H
Holophyra sp.	Q:R
Chaenia sp.	H
Enchelys sp.	K:Bt
Prorodon armatus	L
Dipletus gigas	I
Lionotopsis anser	H
Lionotus sp.	Q:R
Chilodon cucullulus	H
Chilodon caudatus	K:Bt
Urocentrum turbo	H:Q:R:Pt
Leucophrys patula	H
Colpoda sp.	H
Colpoda campyla	K
Trichoda pura	H
Paramecium sp.	Pt:Bt
Paramecium caudatum	A:H:K
Lembadium bullinum	L
Pleuronema sp.	L
Cyrtolophosis mucicola	A
Microthorax sulcatus	Bt
Spirostomum ambiguum	H
Stentor polymorphus	K
Halteria grandinella	H:M:O:Q:R:S:T:Bt
Stichotrichia secunda	M
Holosticha sp.	H
Holosticha vernalis	I:L
Holostichia setigera	K

Stylonychia sp.	H:Pt
Stylonychia putrina	C:D:E:K:Q:R:S:T
Euplotes charon	H:S
Vorticella campanula	F:G:H:I:L:M:Q:R:Pt
Spirostoma sp.	M

PORIFERA

Spongilla sp.	P
Spongilla fragilis	A:B:M:O:T

HYDROZOA

Hydra vulgaris	(A:T)O

PLATYHELMINTHES

Dendrocoelom graffi	A:H
Planaria maculata	A:I
Planaria gonocephala	P:S:T
? ? (A Ciliated Flatworm)	B:H
Platyhelminthes? sp.	Pt:Bt

NEMATHELMINTHES

Nematodes? sp.	D:E:H:Q:R

ROTIFERA

Diglena sp.	S
Salpina sp.	H:L
Salpina spinigera	O
Enchlanis sp.	Bt
Colorus sp.	Bt
Anuraea sp.	Pt
Anuraea cochlearis	B
Notholca longispina	Bt
Noteus quadricornis	Q:R
Microcodides robustus	H
Pterodina sp.	P
Melicerta ringens	M:P
Rotifera? sp.	A:F:G:Pt
Rotifera citrinus	B
Philodina sp.	H:I

GASTROTRICHA

Gastrotricha sp.	T
Chaetonotus sp.	L:Bt
Chaetonotus similis	H:O

BRYOZOA

Bryozoan sp.	H
Plumatella princeps	A:M:P:T
Pectinatella magnifica	A:B:M:P:T
Pectinatella statoblasts	I

ANNELIDA

Nais sp.	I
Stylaria fossularis	D:E:M:P:T
Dero sp.	H:I:T:Pt
Glossiphonia parasitica	N
Glossiphonia rugosa	I
Glossiphonia stagnalis	I

MOLLUSCA	
Lymnaea columella	H:I:P
Lymnaea humilis	I
Physa sp.	M
Physa heterostropha	H:P:T
Planorbis sp.	I:L
Planorbis trivolvis	I
Planorbis bicarinatus	H:P:T
Planorbis parvus	D:E:I
Ancylus rivularis	I:P:T
Sphaerium sp.	I
Pisidium abditum	M:P
CLADOCERA	
Daphnia sp.	Bt
Daphnia pulex var.?	O:P
Simocephalus vetulus	A:I
Scapholeberis mucronata	I
Ophryoxus gracilis	M
Eurycercus lamellatus	F:G
Alona affinis	A:M
Pleuroxus denticulatus	D:E
Chydorus sp.	P
Chydorus sphaericus	B
OSTRACODA	
Limnicythere reticulata	M
Cypridopsis sp.	H:I:S:T
Cypridopsis vidua	C:H:M:S:T
Cypris americanus	M
Cypris virens	I
Cypris fuscata	A:B:M:O:P
Cypris reticulata	B
Cypris postulosa	M
COPEPODA	
Cyclops viridis	
INSECTA	
Ephemerida	
Heptagenia sp.	L
Odonata	
Odonata sp.	A:F:G:H:I:L:S:T
Anax sp.	A:P
Anax junius	A:M:O
Perithemis domitia	A:H:I:N:O:P
Libellula pulchella	A:H:O:S:T
Libellula lactuosa	H:I:L:M:N:O:P
Plathemis sp.	H:I
Plathemys lydia	H:I:L:M:N:O:P
Aeschna sp.	M
Argia violacea	L:M:N:O:P
Ischnura sp.	M
Ischnura verticalis	H:I:M:N:O:P
Hemiptera	
Hydrometea martini	M:P:S:T
Mesovelia mulsanti	D:E

Gerris remigis	H:M:P:T
Gerris marginatus	I:L
Belostoma flumineum	A:M:P:Q:R
Nepa apiculata	P:Q:R:S
Ranatra fusca	P:S:T
Notonecta undulata	H:I:L
Callicorixa praeusta	A:H:I
Aphis sp.	I
Trichoptera	
Molanna sp.	A:S:T
Psilotreta sp.	H:M
Limnophilis sp.	A:M:P:T
Platycentropus macculipennis	L
Platyphylax sp.	T
Diptera	
Diptera sp.	A:B:H:I:P:S:T
Pedicia sp.	H
Tipula abdominalis	H
Chironomous sp.	A:H:I:L:M:P
Tanypus sp.	F:G
Tanytarus sp.	I
Culex sp.	H:I
Chrysops niger	I
Dolichopodid sp.	A:H:I:L:M:N:O:P
Coleoptera	
Haliplus sp.	L
Haliplus ruficollis	F:G:I
Dytiscus sp.	H:I:N
Dineutes assimilis	I
Dineutes discolor	A
Dineutes emarginatus	Q:R
Hydrophilus sp.	H
Berosus sp.	L
Tropisternus sp.	A:F:G:I:M:N:P
Tropisternus lateralis	H:P
Dascyllid sp.	N
ARACHNIDA	
Water-mites	
Eylais extendens	C:N
Diplodontus sp.	D:E
Diplodontus despiciens	C:S:T
Arrhenurus globator	I
Limnesia histrionica	A
Piona sp.	H
Piona rufa	A:P
Atractides spinipes	P
Hygrobates lingipalpis	M
Spiders	
Dolomedes sp.	M
PISCES	
Anguilla chrisypa	C:D:E:P:Q:R
Catastomus commersoni	C:D:E:F:G:M:N:O:P:Q:R
Notropis whipplii	A:B:P:Q:R
Ameiurus nebulosus	P:Q:R

Helioperca incisor	A:B:D:E:F:G:H:M:N:O:P:Q:R:T
Huro salmoides	A:D:E:F:G:P:Q:R:S:T
Perca flavescens	O:P

AMPHIBIA

Triturus viridescens	I:L
Bufo americanus	A:D:E:F:G:H:I:L:M:N
Rana palustris	H:I
Rana clamitans	F:G:H:I:L:M:N
Rana catesbeiana	A:F:G:H:I:M:N:O

REPTILIA

Natrix sipedon	A.B
Chelydra serpentina	H:I:L:P
Chrysemis picta	H

AVES

Ceryle alcyon	H
Chaetura pelagica	C:D:E:F:G:H:M:N:O:P:Q:R:S
Hirundo erythrogaster	C:D:E:F:G:P:Q:R:S

MAMMALIA

Homo sapiens	A:B:C:D:E:Q:R:S:T

HERBACEOUS PLANTS ON 3 FT. MARGIN OF LAKE SHORE AND THEIR SECTIONAL DISTRIBUTION

MOSSES AND FERNS

Sphagnum sp.	Q:R
Asplenium filix-femina	A:F
Aspidium Thelypteris	A:M:N:O:P
Aspidium novoboracense	A:P
Onoclea sensibilis	D:F:J:M:Q:R:S:T
Osmunda regalis	O
Osmunda cinnamomae	O
Equisetum arvense	S

GRASSES, SEDGES AND RUSHES

Andropogon furcatus	
Digitaria sanguinalis	Q:R:S
Panicum stipatum	B
Panicum anceps	H
Panicum clandestinum	E
Echinochloa crus-galli	A:H:L:M:T
Setaria glauca	B
Leersia virginica	
Phalaris arundinaceae	G
Agrostis palustris	C:D
Cinna arundinacea	
Dactylis glomerata	
Poa compresina	R:S
Glyceria nervata	L
Festuca elatior	
Cyperus flavescens	A
Cyperus strigosus	O:P
Eleocharis obtusa	A
Eleocharis palustris	A
Scripus validus	I:M
Scripus atrovirens	L:S
Scripus cyperinus	M:O:T

Scripus Eriophorum	L:M:R:S:T
Carex scoparia	R:S
Carex culpinoidea	R:S:T
Carex crinita	L:Q:T
Carex stricta	O:P:Q:R:S:T
Carex hystericina	R:S:T
Carex lurida	L:M
Juncus tenuis	S:T
Juncus effusus	H:M
Juncus acuminatus	M

OTHER HERBACEOUS SEED PLANTS

Sagittaria latifolia	H:K:L:R
Symplocarpus foetidus	A:E:H:L:N:P:R:S
Commelina virginica	L
Maianthemum canadense	H
Urtica dioica	A:D:F:H:I:K:L:M:N:O:P:Q:R:S:T
Pilea pumila	K
Rumex obtusifolius	I:K:S
Rumex acetusella	F:H
Polygonum acre	A:T
Polygonum Persicaria	I:K:L:M
Polygonum arifolium	M:S
Polygonum sagittatum	C:D:E:F:G:H:L:M:P:R:T
Cerastium viscosum	S
Ranunculus sp.?	L.P.
Ranunculus hispidus	L
Thalictrum polyganum	A:D:F:G:H:J:K:M:N:P:Q:R:S
Penthorum sedoides	L
Heuchera americana	F:H:
Fragaria virginiana	A:F:G:H:I:P:S
Potentilla sp.	H:L:P:S:T
Agrimony sp.?	D:H:I:S:T
Agrimony gryposepala	K
Cassia nictitans	A.H:S
Trifolium pratense	S
Trifolium agrarium	S
Melilotus alba	A:L:P
Desmodium sp.?	H:T
Phaseolus polystachyus	R
Amphicarpa monoica	F:L:P
Oxalis corniculata	A:F:H:P
Geranium robertianum	Q
Acalypha virginica	H:I
Impatens biflora	A:E:F:H:J:K:L:M:N:O:P:R:S:T
Hypericum sp.?	M
Hypericum perforatum	A
Hypericum virginicum	A:G:I:N:O:Q:S
Lechea sp.?	A
Lythrum Salicaria	M
Cuphea petiolata	H
Ludvigia alternifolia	D:G:I:M:N:O:R:T
Epilobium coloratum	G:L
Oenothera biennis	B:D:L
Hydrocotyle americana	A:K:P:Q
Cicuta maculata	G
Thaspium sp.?	H:P
Daucus Carota	A:H:F:L:M:S:T
Samolus floribundus	M

Lysimachia nummularia	K
Asclepias incarnata	A:D:E:M:Q:T
Asclepias syriaca	H:I:T
Cuscuta Gronovii	A:D:H:J:K:L:S:T
Myosotis palustris	A:L
Verbena urticaefolia	D:I:T
Verbena hastata	I
Scutellaria lateriflora	F:H:O:S
Nepeta hederacea	K
Prunella vulgaris	A:H:K:P
Salvia lyrata	B
Pycanthemum flexuosum	A:D:F
Lycopus sp.?	A:C:E:F:H:N:P:R:S:T
Mint? sp.?	A:D:L:M:T
Linaria vulgaris	F
Chelone glabra	D:P:Q:R
Mimulus ringens	K:L:M
Veronica americana	L:M
Veronica officinalis	A:P:S
Plantago major	H:L:P:S
Plantago lanceolata	H:L:S
Galium sp.?	A:F:G:H:I:P:R:S:T
Houstonia caurelia	H
Dipsacus sylvestris	I
Lobelia inflata	L:M:S
Eupatorium purpureum	B:H:I:Q
Eupatorium perfoliatum	H:N:P:R
Aster sp.?	A:B:D:G:H:I:K:M:P:S
Erigeron ramosus	A:H:J:K:S
Ambrosia trifida	A:F:G:H:I:S
Ambrosia artemisiifolia	F:H:L:S:T
Bidens frondosa	K
Bidens bipinnata	I
Achillea Millefolium	A:D:F:I:L:M:P:S:T
Chrysanthemum Leucanthemum pinnatifidum	L:S
Arctium sp.?	K
Cirsium sp.?	A:H:T
Taraxacum officinale	H:L
Lactuca canadensis	F

SHRUBS ON 10 FT. MARGIN OF LAKE SHORE AND THEIR SECTIONAL DISTRIBUTION

Smilax rotundifolia	H:J:
Alnus rugosa	A:D:E:F:G:H:I:L:M:N:O:P:Q:R:S:T
Quercus ilicifolia	H
Physocarpus opulifolius	A
Pyrus arbutifolia	A:S:T
Amelanchier canadensis	A
Crataegus coccinea	A
Rubus sp.?	A:P:R:
Rubus hispidus	P:Q:
Rosa rubignosa	D
Rosa Carolina	A:E
Rhus glabra	A
Rhus toxicodendron	A:G:R:T
Ilex verticillata	G
Psedera quinquefolia	A
Vitis labrusca	A:E:F:S
Vitis aestivalis	A:E:F:R:S

Cornus paniculata	D:E:G
Rhododendron arborescens	P
Rhododendron viscosum	O
Leucothe sp.?	A
Gaylussacia baccata	T
Vaccinum sp.?	Q:R:T
Vaccinum pennsylvanicum	E:H:R:S
Vaccinum atroccum	A:E:F:H:R:S:T
Viburnum dentatum	A:E:H:N:O:Q:S:T
Sambucus canadensis	H:M:P:T

TREES ON 25 FT. MARGIN OF LAKE SHORE AND THEIR SECTIONAL DISTRIBUTION

Pinus strobus	T
Salix sp.?	K
Salix nigra	A:J
Populus tremuloides	A:M:N:J:L
Juglans nigra	A
Carya glabra	I:Q
Carpinus caroliniana	H
Betula lenta	R
Castanea dentata	R:T
Quercus alba	A:D:H:L:Q:R:S:T
Quercus prinus	M:Q
Quercus palustris	T
Quercus velutina	H:L:Q:R:S
Liriodendron tulipifera	A:D:F:G:H:L
Sassafras variifolia	A:H:J:Q:R:S:T
Pyrus communis	A
Prunus serotina	A:H
Prunus persica	A
Robinia Pseudo-Acacia	J
Acer rubrum	A:I:J:K:L:M:N:O:P:Q:R:S:T
Cornus florida	H:T
Nyssa sylvatica	G:H:M

SUMMARY OF PLANTS AND ANIMALS INCLUDED IN THE SURVEY

In the lake	Genera	Species
Plants	56	115
Animals	163	221
Total organisms	219	336
On 3-foot margin		
Grasses and sedges	19	33
Other herbaceous plants	76	94
Total herbaceous plants	95	127
Shrubs on 10-foot margin	20	27
Trees on 25-foot margin	17	22
Total organisms identified	351	512

SUMMARY OF HYDROGEN-ION CONCENTRATION

The hydrogen-ion concentration of the water of the lake ranged from 6.8 to 7.12, that of the mud and ooze at the bottom from 5.4 to 6.5.

SUMMARY OF TEMPERATURE-DEPTH VARIATION

The temperature remained fairly constant to a depth of two feet. Below that, a steadily decreasing temperature was noted with increasing depth. At a depth of three feet the surface water was about one degree warmer than that at the bottom. At a depth of 13 feet the surface was 12 degrees warmer than the bottom. The surface temperature over the deeper area and near the north shore was about one degree warmer than over the rest of the lake.

PRELIMINARY LIST OF HEPATICS OF WESTERN PENNSYLVANIA

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The list of hepatics given at the close of this paper is the result of collections and study (carried on from 1928 to the present) of specimens from 32 counties of Western Pennsylvania as follows:

Allegheny, Armstrong, Beaver, Bedford, Blair, Butler, Cambria, Cameron, Centre, Clarion, Clearfield, Clinton, Crawford, Elk, Erie, Fayette, Forest, Fulton, Greene, Huntingdon, Indiana, Jefferson, Lawrence, McKean, Mercer, Mifflin, Potter, Somerset, Venango, Warren, Washington, Westmoreland.

About twenty-five collecting trips consisting of two to five days have been made, in addition to a number of single day trips, during which collections have been made in approximately 200 localities. A number of specimens have also been kindly contributed by members of the faculty and students of the University of Pittsburgh. About 1,000 specimens have been identified, a complete set of which is to be found in the herbarium of the Carnegie Museum in Pittsburgh, Pennsylvania, and one specimen of each species will be sent to the hepatic herbarium of the Sullivant Moss Society. Three species in the list given are not included in the collection, but are simply listed as to be expected in Western Pennsylvania, since one of them is included in Miss Greenwood's[1] list for Centre County, and two are listed as occurring in counties of Western Pennsylvania in Porter's[5] Catalogue. These species are so indicated on the list. There still remain a number of specimens as yet unidentified as to species, which may add to the following list. Distribution maps have also been made for each species and family.

[1] All footnote references are given at the close of the article under the heading of Literature Cited.

A record has been kept, for the most part, of the time of fruiting of the various species collected. Since the fruit or location of sexual organs is often quite necessary in identifying specimens, the best collections for study were obtained in the early spring or in the fall, as the majority of forms are found fruiting at such times, although there is no time of year at which some species may not be found in fruit or with perianths. Some forms continue fruiting for several months. To obtain the best specimens in the summer, it is necessary to collect around springs, streams, bogs, or on decayed logs, as forms growing on the soil are usually hidden by other vegetation.

The most widely distributed and common liverworts found in Western Pennsylvania are *Pellia epiphylla, Scapanias, Calypogeia Trichomanis, Lophocolea heterophylla, Conocephalum conicum, Cephalozias, Marchantia polymorpha* and *Ptilidium pulcherrimum.*

Liverworts grow best in moist, cool, shady habitats where transpiration is not excessive, and hence are most numerous in mountainous regions in virgin forests or forest reservations, but scarce in regions of cultivation and along main highways where trees have been cleared away. Many places in Pennsylvania which once formed excellent habitats for liverworts are now destitute of them due to the encroachment of civilization. Therefore, it is all the more important that these forms be studied and recorded before they disappear, due to proper conditions for growth being eliminated. Much better collections are usually made, therefore, by leaving main highways and following dirt roads which lead along small mountain streams, or where springs occur, etc. Some of the counties and places where the largest collections of liverworts have been made are: Potter, McKean, Cameron, Warren, Elk, Westmoreland (Nawakwa in Forbes Forest, and Hillside), Forest (Cook Forest), Fayette (Ohiopyle), Crawford (Pymatuning Swamp), Clarion (vicinity of Foxburg and Clarion), Lawrence (McConnells Mills), Butler (along Slippery Rock Creek), and Indiana.

The following classification might be made of the types of habitats in which liverworts are to be found in Western Pennsylvania, together with a few examples of genera and species found in such places:

1. Water habitats
   a. Free-floating: *Riccia fluitans, Ricciocarpus natans.*
   b. Submerged in deep, swift, clear water: *Scapania undulata.*
   c. Wet rocks submerged or sticking out of water in spring streams: *Chiloscyphus rivularis, C. fragilis, Riccardia multifida, Jubula pennsylvanica, Porella pinnata* and *Scapanias.*
   d. On wet rocks beside springs or where water drips over them:

Marchantia polymorpha, Reboulia hemisphaerica, Pellia epiphylla, Conocephalum conicum, Anthoceros, etc.

e. Near waterfalls: *Diplophyllum apiculatum, Scapania.*

f. Sphagnum bogs: *Pallavicinia Lyellii, Riccardia pinguis, Riccardia latifrons, Riccardia palmata, Marchantia polymorpha, Cephalozia connivens, Mylia anomala.*

2. On wood

a. Decaying logs: *Lophocolea heterophylla, Ptilidium pulcherrimum, Jamesoniella autumnalis, Odontoschisma denudatum, Cephalozias, Riccardia palmata.*

b. Base or trunks of live trees: *Lejeunea cavifolia, Frullania eboracensis, F. Asagrayana, Porella platyphylla* and *P. platyphylloidea.*

3. Burned-over areas: *Marchantia polymorpha.*

4. Moist soil

a. Clay banks, or shale: *Blasia pusilla, Anthoceros laevis.*

b. Sand: *Nardia crenulata, N. hyalina.*

c. Stubble fields: *Riccias.*

d. Humus soil: *Bazzania trilobata, Lepidozia reptans, Calypogeia Trichomanis, Fossombronia Wondraczeki, Conocephalum conicum, Pellia epiphylla.*

5. Greenhouses: *Lunularia cruciata.*

For the following list, the synonymy used, classification as to families, etc., is according to that found in the North American Check List.[2] The writer is very grateful to Dr. Evans, of Yale University, for the determination and verification of more difficult or doubtful specimens.

It may be interesting to note that 31 genera and 38 species of the following list also occur on Little's[3,4] lists for Central Pennsylvania.

The following preliminary list for Western Pennsylvania adds 20 genera and 51 species to the Western Pennsylvania Hepatic collection in the herbarium of the Carnegie Museum. Twenty-five species on the list are not recorded by Porter.[5]

I. MARCHANTIALES

A. Ricciaceae

1. *Riccia fluitans* L.
2. *Riccia Sullivantii* Aust.
3. *Ricciocarpus natans* (L.) Corda

B. Rebouliaceae

4. *Reboulia hemisphaerica* (L.) Raddi

C. Marchantiaceae

5. *Lunularia cruciata* (L.) Dumort.
6. *Conocephalum conicum* (L.) Dumort.
7. *Preissia quadrata* (Scop.) Nees
8. *Marchantia polymorpha* L.

II. JUNGERMANNIALES

Anacrogynae

A. Riccardiaceae

9. *Metzgeria conjugata* Lindb.
10. *Pallavicinia Lyellii* (Hook.) S. F. Gray
11. *Riccardia latifrons* Lindb.
12. *Riccardia multifida* (L.) S. F. Gray
13. *Riccardia palmata* (Hedw.) Carruth.
14. *Riccardia pinguis* (L.) S. F. Gray

B. Pelliaceae

15. *Blasia pusilla* L.
16. *Fossombronia Wondraczeki* (Corda) Dumort.
17. *Pellia epiphylla* (L.) Corda
18. *Pellia Neesiana* (Gottsche) Limpr.

Acrogynae

A. Lophoziaceae

19. *Chiloscyphus fragilis* (Roth) Schiffn.
20. *Chiloscyphus pallescens* (Ehrh.) Dumort.
21. *Chiloscyphus polyanthus* (L.) Corda
22. *Chiloscyphus rivularis* (Schrad.) Loeske
23. *Geocalyx graveolens* (Schrad.) Nees
24. *Harpanthus scutatus* (Web. & Mohr) Spruce
25. *Jamesoniella autumnalis* (DC.) Steph.
26. *Jungermannia lanceolata* L.
27. *Jungermannia pumila* With.
28. *Jungermannia Schiffneri* (Loitles.) Evans (?) Only a very small specimen of this was found with the fruits quite immature. Dr. Evans thought the fruits represented this species, but more material is necessary before identification can be positive. If correct, it is the first time the species has been reported in the Eastern United States. It is not found in very many localities.
29. *Lophocolea alata* Mitt.
30. *Lophocolea bidentata* (L.) Dumort.
31. *Lophocolea heterophylla* (Schrad.) Dumort.
32. *Lophocolea minor* Nees
33. *Lophozia attenuata* (Mart.) Dumort.
34. *Lophozia bicrenata* (Schmid.) Dumort.
35. *Lophozia incisa* (Schrad.) Dumort.
36. *Lophozia ventricosa* (Dicks.) Dumort.
37. *Marsupella emarginata* (Ehrh.) Dumort.
38. *Mylia anomala* (Hook.) S. F. Gray
39. *Nardia crenulata* (Smith) Lindb.
40. *Nardia crenuliformis* (Aust.) Lindb.
41. *Nardia Geoscyphus* (De Not.) Lindb.
42. *Nardia hyalina* (Lyell) Carringt.
43. *Plagiochila asplenioides* (L.) Dumort.

B. Cephaloziellaceae

44. *Cephaloziella byssacea* (Roth) Warnst.

C. Cephaloziaceae

45. *Bazzania trilobata* (L.) S. F. Gray
46. *Calypogeia Neesiana* (Massal. & Carest.) K. Müll.
47. *Calypogeia Trichomanis* (L.) Corda
48. *Cephalozia bicuspidata* (L.) Dumort.
49. *Cephalozia catenulata* (Hüben.) Spruce
50. *Cephalozia connivens* (Dicks.) Lindb.
51. *Cephalozia curvifolia* (Dicks.) Dumort.
52. *Cephalozia media* Lindb. (from Helen Greenwood's[1] list)
53. *Lepidozia reptans* (L.) Dumort.
54. *Lepidozia sylvatica* Evans
55. *Odontoschisma denudatum* (Mart.) Dumort.

D. Ptilidiaceae

56. *Blepharostoma trichophyllum* (L.) Dumort.
57. *Ptilidium ciliare* (L.) Nees (from Porter's[5] Catalogue)
58. *Ptilidium pulcherrimum* (Web.) Hampe
59. *Trichocolea tomentella* (Ehrh.) Dumort.

E. Scapaniaceae

60. *Diplophyllum apiculatum* (Evans) Steph.
61. *Scapania nemorosa* (L.) Dumort.
62. *Scapania undulata* (L.) Dumort. (including also what was formerly considered a separate species, namely, *S. dentata*)

F. Radulaceae

63. *Radula complanata* (L.) Dumort.

G. Porellaceae

64. *Porella pinnata* L.
65. *Porella platyphylla* (L.) Lindb.

66. *Porella platyphylloidea* (Schwein.) Lindb.

II. Lejeuneaceae

67. *Cololejeunea Biddlecomiae* (Aust.) Evans
68. *Frullania Asagrayana* Mont.
69. *Frullania eboracensis* Gottsche
70. *Frullania riparia* Hampe
71. *Jubula pennsylvanica* (Steph.) Evans
72. *Lejeunea cavifolia* (Ehrh.) Lindb.
73. *Leucolejeunea clypeata* (Schwein.) Evans (from Porter's[5] Catalogue)

III. ANTHOCEROTALES

Anthocerotaceae

74. *Notothylas orbicularis* (Schwein.) Sulliv.
75. *Anthoceros crispulus* (Mont.) Douin
76. *Anthoceros laevis* L.
77. *Anthoceros punctatus* L.

It is to be hoped that this will stimulate an interest in the collection and study of hepatics and that others will report any additional species collected or criticisms of the present list, in order that a more complete and correct list may be compiled.

Literature Cited

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3. Little, Thomas M., Preliminary list of the Hepaticae of Central Pennsylvania. Proc. of Penna. Acad. of Sci., V, 14. 1931.
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5. Porter, T. C., Catalogue of the Bryophyta and Pteridophyta found in Pennsylvania. 1904.

No attempt is made here to list books and articles used in identification work as space would not permit.

UNUSUAL SPROUT DEVELOPMENT IN *MAGNOLIA ACUMINATA* L.

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Practically no information concerning natural vegetative reproduction in *Magnolia acuminata* L. appears to be available in the literature. In view of this fact the following observations are presented.

In northwestern Pennsylvania the species frequently sprouts from stumps, the sprouts apparently developing from dormant or adventitious buds. In the southern Appalachian region, where the tree probably reaches its best development, sprouting capacity appears to be more pro-

nounced than in the northern portions of its range. Occurrence of root suckers is unknown to the writer.

In 1931 an example of unusual sprout development, shown in the accompanying figure, was encountered in Sheffield Township, Warren County, Pennsylvania. The parent tree evidently was large. The stump had disappeared but judging by appearances it had a basal diameter of about 45 inches. The bole is badly decayed but its remains may be traced for a distance of 65 feet from the sprout group. Twelve

Fig. 4. *Magnolia acuminata* L. sprout group in northwestern Pennsylvania.

sprout stems (eleven alive, one dead) form a complete circle about the depression left after the stump decayed. The sprouts were 44 years old and their average height was about 40 feet. Their diameters at breast height varied from 4.3 to 9.8 inches and averaged about 7 inches. Externally the trees all appeared vigorous but basal increment borings showed the heartwood of most of them to be slightly decayed.

This unusual sprout development is of particular interest in view of the large size and probable advanced age of the parent tree. The generally accepted view is that the sprouting capacity of a species decreases with advanced age. The reason for decreased formation of sprouts appears to be due in part to hardening of the bark which makes it difficult for dormant buds to break through and also to the fact that with advancing age the connection of the xylem of the stem with that of the buds is more likely to be destroyed. In the example cited the sprouts appear to have developed from dormant rather than adventitious buds. This is indicated by the fact that the sprouts arose from the root collar; the tree was not cut, so it is unlikely that any wound tissue developed. On the basis of the number and development of the sprouts it may be suggested that the tree was in a vigorous vegetative condition at the time of its death. Following death the bole remained standing as a snag for several years after the sprouts originated. This is indicated by the deformation of two of the stems which apparently were injured when the snag fell.

WING-VENATION VARIATIONS IN THE ROSE SAW-FLY, *EMPHYTUS CINCTIPES* NORTON (TENTHREDINIDAE: HYMENOPTERA)[1]

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In June, 1931, the late Mr. William D. McIlroy, Jr., of the Carnegie Institute, Pittsburgh, collected the rare rose sawfly, *Emphytus cinctipes* Norton, in considerable numbers at his home at Ingram, a suburb of Pittsburgh, Pennsylvania. A study of this collection revealed a number of variations in the wing-venation of the males. These tracheal aberrations include the addition of veins which are common to closely related genera and supernumerary veins which are not represented in the Chalastogastra.

The genus Emphytus has the radio-medial cross-vein missing in the front wing, so that the cells R and R_5 are combined (Figure 5, A). As a result three submarginal cells are present. Some of the males of *Emphytus cinctipes,* however, were found with the radio-medial cross-vein present and the cells R and R_5 separated (Figure 5, B). No cases of a similar condition were found in the females, although they occurred in equal numbers in the collection. The presence of this cross-vein

[1] Classification according to MacGillivray, Hymenoptera of Connecticut: Conn. Geol. Nat. Hist. Survey, Bull. No. 22 (1916), pp. 56–57.

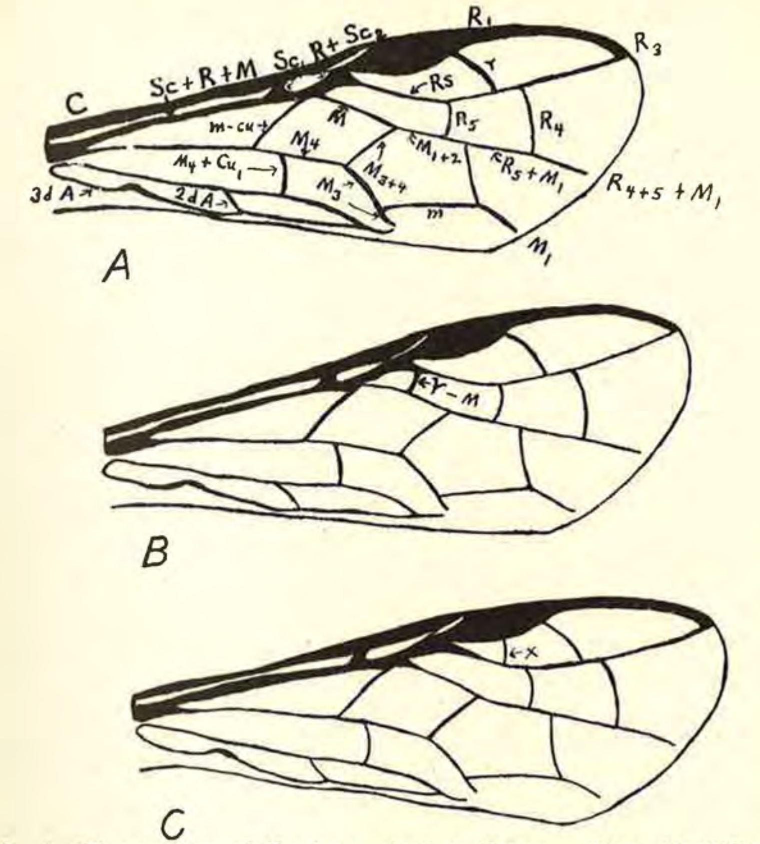

FIG. 5. A. Wing-venation of *Emphytus cinctipes* Norton. (After MacGillivray.) B. Radio-medial cross-vein in males. C. Supernumerary vein.

would indicate that in the genus Emphytus reduction has resulted from atrophy of the radio-medial cross-vein and not to anastomosis of veins.

A striking aberration was found in the venation of other males of this rare sawfly of the cultivated rose. In this case a supernumerary vein joining the stigma with R_3 in the region of the radial sector occurred. This vein was anterior to the radial cross-vein and roughly parallel to it (Figure 5, C). The supernumerary vein joined R_3 in cell $R + R_5$ while the radial cross-vein joined R_3 in cell R_4.

Tracheal aberrations have been frequently noted in the Tenthredinoidea. The presence of supernumerary veins may have an explanation in regarding the modern hymenopterous tracheation as a result of coalescence and atrophy, with the more generalized condition indicated by these extra veins.

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THE GENUS TENTHREDOPSIS OF AMERICA, NORTH OF MEXICO (TENTHREDINIDAE: HYMENOPTERA)

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Rev. F. W. Konow in the Genera Insectorum listed eight species of sawflies under the genus Tenthredopsis from North America. Dalla Torre in an earlier list had placed additional species and varieties in this genus. Apparently the group is not a compact one, for an examination of the literature has shown that later workers have referred the eight species listed by Konow to six different genera. In one case, a species was transferred to another subfamily of sawflies.

In some instances these rapid changes have been confusing, particularly when made in check-lists without additional data. Other changes have been made and indicated in unpublished notes. The bibliographical study of the literature has revealed these features and the data respecting the present disposition of Tenthredopsis has been compiled in this paper. Apparently, at present, there are no North American representatives in O. Costa's genus.

TAXONOMY AND NOMENCLATURE

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[1] Mr. Rohwer kindly permitted the writer to use and study the notes on the genus Tenthredopsis.

SOME RECENT CURRICULAR DEVELOPMENTS IN SECONDARY SCHOOL PHYSICS

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The course of study for science in the secondary schools has been going through a process of evolution ever since the beginning of our American high schools in 1825. Many sciences have been included in the curriculum during that time and the variety ran the gamut from agriculture to astronomy. Since 1890, however, the number of different sciences in our high schools has been decreasing. By the turn of the century, the science courses had been pretty well crystallized into the present standardized four years consisting of general science in the freshman, biology in the sophomore, chemistry in the junior, and physics in the senior year. Within the last decade this arrangement has so entrenched itself in our schools that it has been accepted without comment and became the stereotyped pattern for new schools when they were organized. Indeed, the four types of science fitted in so well with our standard four year high schools that curriculum builders rejoiced at the very beauty of the fit.

I sometimes think a curriculum maker finds much in common with the theory builder who constructs a theory to explain all facts so plausibly and so inclusively that it almost reaches divine sanction. Then some new situations arise. The theory fails to explain the new facts and because of this incompatibility the validity of the facts is questioned. But more facts are discovered and still more. A time comes when they can no longer be denied. A last attempt is made to adjust the theory to accommodate the new situations—But alas! we suddenly realize that our beautiful theory so well constructed, so meticulously built up is doomed. Our tranquility is upset and we are obliged to build anew.

In much the same way the present accepted courses of study in science for our American high school may have to be blasted. Especially is this true in physics, to which subject I shall confine my remarks.

At the present time, a year, usually the senior, although occasionally the junior, year is given to the study of physics, five hours per week or approximately 180 hours of class time. About 25 to 35 experiments are performed by the students, taking an hour each and reducing the instructional periods to about 150 hours; actually the time is even less because of examinations, holidays, tests, etc.

What, then, has happened to disturb our accepted one year's course of study in physics? Because the subject-matter has enlarged beyond proportions, and because universities and colleges insist on the mathematical aspect of physics, it becomes exceedingly difficult in the space of a year's course to drill sufficiently to meet the rigid requirements of the colleges, and at the same time to realize those unique values of which the subject is inherently capable and to present those broader aspects of physics that touch life in so many ways.

Considering only the past two decades, the developments in physics which touch every-day life have been enormous. While the content of most subjects in the high school has remained relatively constant, physics has grown beyond all anticipation. For example, here are just a few of the additions that have been made during this time to each of the five major divisions into which physics is normally divided:

Mechanics: The automobile with its many physical accessories, pneumatic tools, dirigibles, airplanes, rotor ships.

Heat: Household mechanical refrigeration, both electric and gas, mechanical ventilation.

Electricity and *Magnetism:* Radio, television, photoelectric cells, and the induction compass.

Light: Motion pictures, neon signs, artificial sunlight, color photography.

Sound: (a topic, by the way, frequently treated as a physics step-child) Talking pictures, acoustical information on public address systems, studios, theaters, etc.

All this means that physics has simply outgrown its quarters. The study has become entirely too "heavy" for a year's course.

But even more pressing than this expansion of subject-matter are two other problems. The first problem concerns those students planning to go on to college. Universities, colleges, and examination boards are constantly insisting on a thorough mastery of fundamentals, besides a broad knowledge of the general field of physics. Since these authorities hold the whip in the form of a rigid examination for admission their demand must be taken seriously. For these students it becomes necessary, therefore, to emphasize a mastery of the principles, laws, and rules. This requires a rather mathematical treatment of the subject with considerable drill to insure retention for examination purposes. Time spent on this phase of physics may be justified because the students will in all probability take additional physics in college, perhaps even specializing in it. The broader field of applications to every-day life may be restricted to the time remaining or even omitted entirely.

The second problem concerns those students whose formal education ends with the high school course. An increasing number of high school

graduates are not going on to college. It is for this group of students that the problem becomes especially urgent. The purposes of modern high school education have changed considerably in the last twenty years. Whereas a generation ago most graduates planned and actually went to college, now there is an increasing number not even planning to go. Indeed, there is a growing attitude that some of the students now going to college should not go at all. It would be granted, I believe, that science has a proper place in the education of this group. Modern life pretty nearly demands familiarity with the principles and applications of physics, in the home, garage, shop, farm, etc. It would seem rather wasteful to attempt to present physics as a step toward higher specialization or to emphasize the mathematical phase to the exclusion of other more immediately useful material. To prepare this group for an examination which they will never take, is not only inefficient educational practice, but it is also undemocratic.

Recently two proposals for reorganizing the physics course have been made. The first proposal comes from the Association of Science Teachers of the Middle Atlantic States and Maryland. "Their suggestion is that some of the topics be omitted in a one year course and that the course consist of one of the following groups:

Group I	Group II
Mechanics (a)	Mechanics (a)
Electricity (a)	Electricity (b)
	Heat or light

Group III	Group IV
Mechanics (b)	Mechanics (b)
Electricity (a)	Heat
Heat or light	Light
	Sound

Note: Mechanics and Electricity (a) to constitute complete and more technical courses with problems and applications.

Mechanics and Electricity (b) to cover fundamentals only and to be less technical in character."[1]

The second proposal grew out of the first and comes from the Eastern Association of Physics Teachers, a New England organization.

This group opposed the omission of topics on the ground that "to sanction the omission of two of the five major topics of the subject would

[1] School Science and Mathematics, vol. XXXIII, No. 2, p. 199.

be to admit that these topics at least, if not the whole subject, were not important." They suggested the following:

"That there be two different courses in physics:

(a) A one year course of six periods per week, of a more qualitative nature with considerably less mathematical work than is now required by the College Entrance Examination Board, and (b) a two year course of five or six periods per week, with the same mathematical requirement as at present."[2]

Whether we agree with the suggested proposals or not, coming from such representative bodies, they must be considered. The fact that these large groups have deliberated on the problem indicates its importance. That the more formal phase of the work must be permitted to crowd out the practical every-day applications because of time is to be regretted. That this is true for the non-college group is still more regrettable. Since this group must receive the maximum educational value from its studies because of their shorter schooling, it is important that specially designed courses be prepared for them. It is very doubtful if the college and the non-college groups should receive the same type of material or even the same kind of instruction. With the increase of leisure time, training in the proper use of it becomes a worthy educational objective. Helping students develop hobbies is justifiable and the broad field of physics furnishes an abundant source for selecting such hobbies.

That our present course in secondary school physics needs reorganization is quite obvious. Science courses are the most expensive formal courses in our high schools. If we allow laymen to assume charge of this reorganization we are apt to find both the time and the equipment reduced. This would be little short of a tragedy.

The State Academy through its affiliation with the American Association for the Advancement of Science and because of its strategic position in the State would be a proper body to initiate reorganization of science education. Indeed this idea is not new, for several State Academies have already done this very thing. The Texas Academy was instrumental through its committee in reorganizing the science in the junior high schools of the State.

In closing, therefore, I should like to suggest that we, too, consider this a proper activity for our State Academy.

[2] *Ibid.*

PENNSYLVANIA BATS OF THE GENUS MYOTIS

By Charles E. Mohr

Reading Public Museum and Art Gallery

Six bats of the genus *Myotis* occur east of the Mississippi River: *Myotis austroriparius, M. grisescens, M. keenii septentrionalis, M. lucifugus lucifugus, M. sodalis,* and *M. subulatus leibii.* All except the first two have been taken in Pennsylvania.

M. austroriparius occurs rather commonly around Gainesville, Florida, and doubtless in other parts of that State. Strangely enough the only other region from which this species is reported is Indiana, where W. L. Hahn collected a specimen in a cave near Mitchell in December, 1906, and four specimens in August, 1917. They were recognized by Miller and Allen as belonging to this species. With the range of this bat so incompletely known, it should be watched for throughout the East. It seems likely that if the species is found in this region, it will be as a summer visitant.

M. grisescens has a rather wide distribution, but records indicate that it is restricted to caves along tributaries of the Mississippi River, from eastern Tennessee to Missouri. Throughout its range it is common only in summer; in fact, its winter range is at present unknown. The absence of caves along the Ohio River or its tributaries, in Pennsylvania, makes it unlikely that this species will be found here. It should occur in neighboring States to the southwest, however.

I have taken the four Pennsylvania representatives of the genus in considerable number during the past two years, the following notes being supplementary, on the most part, to previously published articles. The summer observations were limited almost entirely to the region around Reading, in southeastern Pennsylvania. All caves mentioned, unless specifically located, are described and located in "Pennsylvania Caves" by R. W. Stone, published by the Pennsylvania Topographic and Geologic Survey.

Myotis keenii septentrionalis—While this species is one of the most common bats in this region, remarkably little is known about its habits. It is very rarely found here in winter, and in those caves where it does occur only a few individuals have been taken. In May and June, 1932, I netted Shofer Cave, where during the night of August 15, 1931, we captured 149 bats entering the cave, 65 of them being of this species. During April and May, however, not more than a dozen bats were taken at any time. Not until August did the bats occur in large numbers. At that time this was the most numerous species at the entrances of the caves near Reading. I have never learned of the discovery of a roost of these bats, and nothing is known concerning their breeding habits.

Myotis lucifugus lucifugus—A colony of about 500 of these bats found in the walls of a frame house near Kempton, 30 miles north of Reading, included young born as early as June 17, and as late as July 5.[1] The young bats were taken on the wing three or four weeks after birth.

As in the previous year, collections made during late summer showed striking sexual segregation. On September 6 and 7, 1932, at Hopewell, in southern Berks County, 30 bats of this species were shot, all of them males. Twenty more, shot a week later, also were all males. These bats were feeding over the water. Possibly the females feed on types of insects that do not ordinarily occur over water, or perhaps they have migrated to other regions. Several deserted bat roosts were discovered near caves in Berks and Centre counties early in the fall of 1932. By means of tagging I hope to discover whether the bats which occupy these roosts simply move into nearby caves during the winter or have an extended migration. It is certain that these bats, whether their migration is lengthy or simply a movement to nearby caves, do spend several weeks away from their roosts before they settle in caves for the winter. For instance, in September, in Centre County, roosts were deserted but no bats had yet entered the caves for the winter.

Myotis sodalis—Observations during the past winter strengthened my belief that the distribution of this species is largely determined by the presence of water in caves. As pointed out last year[2] the four caves in which it occurs abundantly: Penn's Cave, Centre County; Bear Cave, Westmoreland County; Aitkin Cave, Mifflin County, and Hipple Cave, Bedford County, all have streams of water flowing through them. Another colony, numbering 150 individuals, was located on April 2, 1933, in a newly-found cave on the Jacob Shalter farm, two miles east of Centre Hall, Centre County, and just about three miles from Penn's Cave. A stream of water flows into the entrance of this cave and the bats hang within 60 feet of the entrance.

Throughout its range from Alabama to Vermont, this species is found in caves in the Allegheny Mountains, or to the westward. I have been in scores of caves east of the mountains but have never found *M. sodalis* in any of them. All attempts to locate it in summer in Pennsylvania have failed. I have netted the entrance of Aitkin Cave during early summer

[1] Observations on the young of cave-dwelling bats. Jour. Mamm. Vol. 14, No. 1, pp. 49–53.

[2] The seasonal distribution of bats in Pennsylvania, Proc. Pa. Acad. of Science. Vol. 6, pp. 100–105, 1932.

without taking a single bat. The absence of summer records throughout the range indicates that there is a general migration away from the winter haunts. I have found no evidence that this species is active during winter in Pennsylvania, and even early in April the colonies were quite torpid, in many cases heavily covered with moisture that must have been accumulating for months. On April 16, this species was beginning to show signs of activity but the clusters had not visibly diminished in size.

Myotis subulatus leibii—The discovery of a single specimen of this bat in Woodward Cave, in January, 1931, was followed during the next winter by the finding of eleven additional specimens; two more in Woodward Cave, two in Aitkin Cave, six in Stover Cave, and one in Dulany Cave. During the past season I was unable to revisit these caves until February, but since that time I have found 38 bats of this species, nine of which were collected and made into scientific study skins, the remaining 29 being tagged or banded and released. The data on these bats follows:

Date	*Locality*	*Number Collected or Marked*
Feb. 4, 1933	Stover Cave	2 specimens (♂, ♀)
		10 bats tagged (5 ♂, 5 ♀) (278, 279; 281–285; 287–289)
Feb. 4, 1933	Aitkin Cave	2 bats tagged (♂, ♀) (276–277)
Mar. 19, 1933	Aitkin Cave	1 specimen (♂)
		4 bats tagged (3 ♀, ♂) (290–293)
		1 recovery (277)
Mar. 19, 1933	Little Aitkin Cave	3 specimens (2 ♂, ♀)
		3 specimens (2 ♂, ♀)
Mar. 19, 1933	Stover Cave	1 recovery (287)
Apr. 1, 1933	Stover Cave	2 bats tagged (♂, ♀) (210–280)
Apr. 2, 1933	Stover Cave	3 " banded (2 ♂, ♀) (198–200)
Apr. 2, 1933	Aitkin Cave	4 " " (3 ♂, ♀) (194–197)
Apr. 2, 1933	Little Aitkin Cave	4 " " (3 ♂, ♀) (190–193)

Forty-nine of the fifty bats that have been collected or marked during the last three years have been taken in four caves which are located within a few miles of each other in Centre and Mifflin counties. In fact, if a circle with a radius of 5½ miles were drawn on the map it would include the four caves. Last year I took this species in Aitkin, Stover, and Woodward caves; this year Aitkin, Little Aitkin (a small cave one-quarter mile farther north), and Stover caves. The abundance of these bats in such a limited area is very remarkable in view of the fact that only 18 other specimens are believed to be in existence, the type, collected somewhere in Erie County, Ohio, being missing. I know of the following specimens:

United States Biological Survey—National Museum Collection

No.		Locality	Date	Collector
71926	♂	Sing Sing, New York	June 9, 1884	A. K. Fisher
187853	♂	" " " "	June 29, 1881	A. K. Fisher
150274	♂	Plummer Island, Md.	Aug. 24, 1907	A. K. Fisher
150275	♂	" " "	Aug. 31, 1907	A. K. Fisher
202783	♀	Chittenden Cave, Vt.	Apr. 10, 1913	Geo. L. Kirk
224614	♀	"Near Bat Cave," Vt. (Chittenden?)	Apr. 7, 1917	D. R. Mahaffy
248210	—	Cornwall Cave, W. Va.	Mar. 16, 1928	A. B. Brooks
249138	♂	Near Crystal Cave, Ky.	Aug. 22, 1929	L. Giovannoli
249139	♂	Near Mammoth Cave, Ky.	Aug. 22, 1929	L. Giovannoli

Museum of Comparative Zoology Collection

No.		Locality	Date	Collector
1285	♂	Hickman's Cave, Ky.	"1860–64"	Alpheus Hyatt
6921	♂	White Sulphur Springs, W. Va.	Apr. 16, 1897	Thaddeus Surber

Private Collections

	Locality	Date	Collector
3 ♂, 1 ♀	Chittenden Cave, Proctor, Vt.	Jan. 11, 1914	Duane E. Kent, Rutland, Vt.
1 ♀	Chittenden Cave, Proctor, Vt.	Jan. 11, 1914	Geo. L. Kirk, Rutland, Vt.
1 ♀	Chittenden Cave, Proctor, Vt.	Nov. 22, 1914	Geo. L. Kirk, Rutland, Vt.
1 ♀	Mt. Brydges, near London, Ontario	May 9, 1929	Eli Davis London, Ontario

Observations on the habits of this bat reveal several interesting facts. In the first place, my belief that this species will be found only in very definite ecologic situations seems to have been further confirmed. The area in central Pennsylvania is wild and mountainous, the Seven Mountains which separate Woodward and Stover caves from Aitkin and Little Aitkin caves being heavily wooded and rising to 2000-foot altitudes. The caves themselves are in unusual situations, three of them being located in hemlock forests, the fourth near-by. Likewise Dulany Cave is in a heavily forested location on the top of Chestnut Ridge in western Pennsylvania. The only other cave in this region from which the bat has been taken is Cornwall Cave, in West Virginia, about 30 miles south of Dulany Cave. Cornwall Cave is located on a steep mountainside overlooking the Cheat River, a remote and wild situation, practically inaccessible in winter.

Another observation on the habits of this bat that seems significant is that it is not only comparatively abundant but also very active in late winter and deserts the caves long before the other hibernating bats. I

believe that this indicates a migratory movement in late winter. With scarcely an exception the least bats taken responded quickly when touched, and a number which were seen escaped before they could be caught. Indeed, during the past few months we saw at least a dozen of these bats which could not be reached with the fishing pole which we used, or which flew as we attempted to catch them. The attitude of the bat as it hangs on the walls or ceilings of the caves is so characteristic that it offers a very definite means of identification at a distance. The arms instead of hanging practically parallel are extended about 30° from the vertical, and almost every least bat was found in this position, other bats seldom. The last least bats were taken this year on April 2. No caves were visited the following week but visits to Dulany Cave on April 15, Cornwall Cave on April 16, and Aitkin, Little Aitkin, and Stover Caves on April 17, failed to show a single bat of this species although the other hibernating bats were still inactive.

Apparently, then, the least bat may hibernate in caves in the Allegheny Mountains from Vermont to West Virginia, migrating southward during February and March, and possibly earlier; and stopping over for short periods in remote caves in heavily forested sections of the mountains. That it may remain near the caves after it leaves them early in April is indicated by Giovannoli's shooting of two specimens in August, one on the hotel grounds at Mammoth Cave, and another at Crystal Cave, about four miles farther west.

The tagging and banding of 29 least bats offers hope for learning more about the unusual habits of this little known species. Continued search for these and other specimens in Pennsylvania and in other known haunts is planned for the coming winter.

SOME EFFECTS OF FIRE ON FOREST SOILS OF SNOWY MOUNTAIN, MONT ALTO STATE FOREST, PENNSYLVANIA

By Geo. S. Perry and C. A. Coover

In the summer of 1930 a forest road was constructed diagonally up the west face of Snowy Mountain, exposing the soil profile practically everywhere along its course. Samples of soil were carefully collected from these profiles and other data secured as shown in the tabulations. The field work was done in September and the laboratory work during the succeeding winter. All work was executed uniformly and in accord with an outline drawn up in advance. Stations for sampling were located every 200 paces (about 550 feet) apart along the road. Four stations at the lower end were in forest growth that showed no traces of fire injury. The first three of these were in soil partly or largely derived from a red igneous rock (rhyolite). All the other stations were in soils of Weverton sandstone origin. Four stations were on sites where fire burnt last about 1902. Four were on sites burnt over in 1902, 1917 and probably earlier. Three stations were on a typical scrub oak area where fires have probably been frequent for decades and are of record for 1902, 1917, and 1926. Difference in elevation is the chief factor of error in making comparisons of the data given, but since the trees now present are those typical of the sprout hardwoods, it is very probable that all the areas were originally so much alike in soil composition, moisture, and physical structure, that the habitats were closely comparable and better suited to the mixed oaks, chestnut, red maple, pignut hickory, etc., than any other species. The changes now noted in soil conditions and shown in the tables are chiefly attributable to forest fire. Clear-cutting of the forest growth for charcoal once or twice also reacted on the sites in somewhat the same way as fire, and naturally the more elevated and exposed parts of the area have been slower to recover from denudation whether by axe or fire. All the areas have a western exposure and vary but slightly in gradient. The bearing of elevation on the comparisons here made is considered nearly negligible, because at the same elevation on near-by mountains where fires have not burnt, there are good forest stands and soils similar to those of areas 1 and 2 (Table I).

As to the fine fractions of the soil from which trees derive nearly all their mineral nourishment (Table I, column "a"), the two upper mineral layers have lost heavily because of rapid water percolation. Figures for the humus layer are not significant in this connection. But protected sites show an average of 29.6 per cent fine soil in the leached and enriched layers, as against 18.8 per cent in those layers on burnt-over sites.

The podsol type of soil is rarely met on the protected sites but its horizons are very pronounced where fires have been frequent (Column "b"). The absolute loss to a forest soil because of podsolization and the physical transportation of fine mineral soil fractions by downward moving water is not significant. The enriched layer retains much of the soluble humus compounds and some of the mineral particles, while the unaltered subsoil catches most of the rest. However, the rearrangement of these soil fractions on the burnt sites is far less favorable to tree growth than their original distribution, which can be surmised from the values for protected sites. Any one who has studied or noted the root-

Data from soil profiles along Snowy Mountain road, Mont Alto State Forest

Soil profile horizon	Fraction of soil passing through 80-mesh sieve	Thickness of soil horizon	Reaction or acidity of soil	Loss on ignition	Coefficient of organic matter in three upper horizons (b × d)	Organic matter content per acre—three upper horizons (*)	Hygroscopic moisture content
	(a) Per cent	(b) Inches	(c) pH	(d) Per cent	(e) Coeff.	(f) Lbs.	(g) Per cent
			1. *Protected forest area*				
Humus or peat	(20–42) 31.5	(0.5–1.4) 1.00	(3.8–4.6) 4.1	(21.0–55.0) 38.0	38.0	29,399	(2.3–5.9) 3.80
Leached layer	(10–49) 29.4	(0.0–2.0) .68	(3.8–4.3) 4.1	(4.8–12.7) 7.7	5.3	15,708	(.6–1.4) .96
Enriched layer	(10–43) 29.8	(0.0–2.2) .50	(4.1–4.2) 4.1	(4.1– 9.9) 6.3	3.1	9,450	(.6–2.3) 1.25
Unaltered mineral**	(7.5–30) 18.3	....	(4.2–4.3) 4.3	(3.9– 5.0) 4.5	.....	....	(.7– .9) .81
			2. *Area burnt over last in 1902 and rarely before*				
Humus or peat	(27–30) 28.5	(0.8–2.0) 1.40	.... 4.1	(18.0–32.0) 25.0	35.0	16,018	.... 2.42
Leached layer	.... 13.2	(2.0–2.8) 2.40	(4.0–4.3) 4.2	(2.7– 5.4) 4.0	9.7	29,016	(.6– .7) .64
Enriched layer	(13–28) 20.5	(0.0–3.0) 1.50	(4.2–4.3) 4.2	(2.7–11.8) 7.2	10.8	32,490	(.7– .94) .81
Unaltered mineral**	(23–24) 23.5	....	.... 4.3	.... 3.2	.....	....	.... .88
			3. *Area burnt over in 1902, 1917 and occasionally before*				
Humus or peat	(15–31) 23.2	(1.4–4.2) 1.98	(3.8–4.1) 3.9	(35.0–68.0) 47.0	93.0	42,590	(2.8–6.7) 4.96
Leached layer	(4–29) 16.2	(1.4–10.0) 5.32	(3.8–4.1) 4.0	(.6– 6.1) 2.4	12.6	37,825	(.1–1.9) .55
Enriched layer	(10–30) 21.0	(1.2–4.0) 2.62	(4.1–4.2) 4.2	(.5–13.1) 6.6	17.2	51,640	(.7–2.2) 1.48
Unaltered mineral**	(7.6–47) 25.3	....	(4.2–4.4) 4.3	(1.9– 3.3) 2.6	.....	....	(.7– .9) .79
			4. *Area burnt over in 1902, 1917, 1926, and frequently before*				
Humus or peat	(21–36) 28.2	(1.6–2.3) 1.90	(3.8–4.1) 3.9	(13.0–45.0) 29.0	55.0	25,217	(1.0–5.6) 3.01
Leached layer	(17–22) 18.8	(2.3–5.0) 3.63	(3.8–4.0) 3.9	(1.3– 1.6) 1.5	5.5	16,444	(.2– .3) .24
Enriched layer	(21–24) 22.3	(2.5–4.5) 3.50	(4.1–4.5) 4.3	(5.6– 6.3) 6.0	20.9	63,000	(1.3–1.6) 1.45
Unaltered mineral**	(17–20) 18.8	....	(4.3–5.1) 4.7	(2.1– 3.1) 2.7	.....	....	(.9–1.5) 1.13

Data in parentheses show the range in values from the several stations whenever it was considerable. Other data are simple averages.

* For purposes of comparison, mineral soil has been considered as weighing 300,000 pounds per acre inch when air dry and free of stones.

** Unaltered mineral layer differentiated by color. It really possesses organic matter as shown in (d). Samples include material down to one-foot depth.

ing of trees in the forest, will recall how great a proportion of the fine feeding roots are found in the upper soil. A few large roots for anchorage and to get water in times of drought are all that usually occur at lower levels.

While forest fires apparently have but little altered the chemical reaction of the soil layers, yet the slight changes indicated are logical, since calcium and other basic minerals are an important part of the downward transported material. The enriched layer and subsoil below are less acid because of such leaching (Column "c"), and subsequent deposition.

Hygroscopic moisture in sandy loam soils is primarily a function of humus content (Columns "d" and "g"), and varies more or less proportionately thereto where other factors are the same. Except for fire causing the development of a rather sterile leached horizon of slowly increasing thickness, no other important effects are apparent in the distribution of organic matter in the burnt-over soils. In course of time, however, the leached soil layer tends to cut off or separate more and more widely the rich stores of organic plant food in the humus and litter from the deposited compounds and the very important and inexhaustible mineral nourishment below. The roots of many trees and plants seem to shy at this sterile zone. This is the most probable reason why podsol soils are characterized by a meager flora, since inability to secure needed mineral food elements, and dry weather effects soon eliminate the ill-adapted species; naturally tending to favor forms with strong tap roots, or those with very extensive and efficient shallow roots or some protective adaption against drought.

The organic matter content per acre (Column "f") can easily be misinterpreted, as it therein refers to soil and humus layers of variable thickness. The true status of this soil feature is seen in Table II where values are given for the upper foot of soil and the humus layer. The total weight of vegetable matter is 10 tons for the protected area, as compared to 7½ tons per acre on the burnt sites. The effect of fire seems to be a concentration of organic matter in the peaty layer and the enriched or deposition horizon of the mineral soil (Table I, columns "b" and "d"). Where the forest is protected there is a far more desirable and even distribution of the decomposition products derived from the litter. This may be in part due to physical action of insects, earthworms, and rodents, but is more likely caused by greater biochemical activity in the protected soil. Many organisms of decay are unable to exist where they are subject to extreme diurnal and seasonal fluctuations as to temperature and moisture. The area burnt last in 1902 shows rapid and complete decomposition of the litter. The area burnt in 1917 has not yet shown accelerated activity in this way, and is characterized by a very heavy layer of peat (Columns "b" and "f") and a strongly developed deposition layer. Probably the annual fall of litter is slightly heavier on this area than on the others, but it is the general assumption that this factor is about the same on all the areas as an average, since dense fully stocked stands occupy the whole mountain slope. Of course, in case of area 4, the cover is mostly a dense growth of scrub oak. It is a matter of surprise to find that the organic matter on sites frequently burnt over should total so high as compared to a somewhat more fertile and moist protected area near-by. But the slowing up of decomposition processes in a forest soil for a decade or so following a severe fire, is a most fortunate circumstance, since loss by erosion and leaching might otherwise be far greater than it is.

TABLE II

Content of organic matter in upper mineral soil and humus layer for protected and burnt-over sites

Designation of area	Average amount of slope	Weight of organic matter in humus and upper foot of mineral soil
	Per cent	Lbs. per acre
1. Protected area	4.5	200,627
2. Area burnt last in 1902, etc.	7.0	141,844
3. Area burnt last in 1917, etc.	13.5	148,279
4. Area burnt last in 1926, etc.	2.8	128,718

A parallel study on soils of another portion of Snowy Mountain, including all organic matter down to five inches deep in the mineral soil, gave figures that check fairly well against those in Tables I and II. In this series the best protected area had 62,570 pounds of organic matter per acre in the humus layer and upper mineral soil, while the worst and most frequently burned had 76,108 pounds. For areas where protection has been intermediate in effectiveness the organic matter varied between 89,180 and 178,498 pounds, with an average of 135,200 pounds.

The final test for results in terms of forest growth is seen in Table III. The good height and cross-section increment on the protected area, as well as that burnt last in 1902, demonstrates most emphatically the advantages of thorough forest fire protection.

When average height growth is multiplied by sectional area increment for the three areas with older stands, it gives a factor that illus-

TABLE III

Growth rates of dominant trees on protected and burnt-over sites

Designation of area with respect to past forest fires	AVERAGE GROWTH DATA FOR DOMINANT TREES TO 1930					
	Mean height	Mean DBH	Mean height growth to 1930	Breast high cross-sectional area increment		
				During 1930	For period ending with 1930: 5 years	For period ending with 1930: 10 years
	(*ft.*)	(*in.*)	(*ft.*)	(*sq. ft.*)	(*sq. ft.*)	(*sq. ft.*)
1. Protected area	57	8.0	1.42	.0113	.0766	.1400
2. Area burnt over last in 1902, etc.	50	9.0	1.18	.0140	.0828	.1560
3. Area burnt over last in 1902, 1917, etc.	26	4.9	1.02	.0057	.0316	.0551
4. Area burnt over in 1902, 1917, 1926, etc.	6	.....	1.15	No data as trees are only five years old		

Note: On areas 1, 2, and 3, the dominant trees average respectively 43, 45, and 30 years old.
DBH means "diameter breast high" (4½ feet above the ground).

trates very closely the proportionate wood volume growth per tree. For areas 1, 2, and 3, the volume growth factors would be respectively: 1,088, 977, 325 for the last five years. Which shows that the growth made by trees not killed by recent fires, on areas frequently burnt over (3), averages less than a third of the volume put on by similar dominant trees on the fully and well protected sites (1 and 2).

The study as a whole indicates:

(1) Forest fires, at their worst, permit flood waters to carry away much fine material by surface washing. But they always destroy the productive possibilities of forest soils by permitting percolating water to carry downward the finest and most valuable fraction of the soil, so it is deposited in the subsoil where the feeding roots of most trees derive little benefit therefrom, and some soluble matter is lost in the drainage water.

(2) Forest fires are a contributing cause of primary importance in Pennsylvania for that type of forest soil degeneration known as podsolization, which is distinguished by the presence of a zone or horizon of ashy gray and relatively sterile coarse soil just below the dark peat or humus layer, formed by decomposition of the litter.

Other conditions the same, the thickness of the leached horizon is a good index to the progress of soil deterioration in the forest, whether it be caused by fire, improper forest management, or some natural feature of topography or constitution. Of course, red shale soils, for example, do not develop typical podsol profiles, but it is also probable that they do not degenerate from a forestry standpoint to the same degree that sandy soils do.

(3) Fires tend to destroy the normal and fairly uniform gradation of organic content in forest soils. On sites frequently burnt over, the organic matter gradually seems to become more concentrated in the humus and enriched layers, lying respectively just above and below the ashy gray leached layer, which with the lower mineral subsoil tends to decrease in content of vegetable fertility and is therefore less suitable as a substratum for root development.

(4) While fire naturally somewhat reduces the organic matter store of forest soils, it does not, however, make such a great difference in the total content of the true soil layers, since the sterilizing effect of denudation caused by fire tends to slow up decomposition for a good many years thereafter.

(5) The forest stands investigated showed a reduction of 60 to 70 per cent in the volume growth of trees on frequently burnt sites as contrasted with similar trees on protected sites, despite wider crowns and more growing space where fires occurred.

CONCERNING THE EFFECTS OF EQUAL PRACTICE ON INDIVIDUAL DIFFERENCES

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One of the unsettled problems of educational psychology concerns the question whether differences in ability which exist before practice tend to increase, to decrease, or to remain the same if the members of a group receive the same training.

The hypothesis of the equalizing effects of equal opportunity is superficially supported by the fact that the same kind of training brings about a greater qualitative similarity, such as the fact that practically all people of our country learn to read and write and to perform the elementary operations of arithmetic. In studying the effects of practice on individual differences, however, the psychologist is not so much interested in qualitative similarities. It is possible for people to become qualitatively more like each other, yet within the system of qualitative similarity to become increasingly different in a much more important quantitative sense. It is with such quantitative differences that psychologists are concerned.

Critical Summary of Experiments

Five reasons may be enumerated in support of our contention that the problem under consideration is still unsettled:

(1) The results of different experiments appear to be contradictory.

(2) The interpretations of the same results by different workers conflict.

(3) Experimental conditions have been inadequately controlled.

(4) The statistical devices used for analyzing and interpreting the findings are equivocal.

(5) The units of measurement to show ability are equivocal.

The literature on the subject was summarized by Margaret Kincaid in 1925 and again in 1931 by Homer B. Reed. We shall in the following briefly present Reed's criticism and elaborate somewhat more fully our own.

Contradictory and conflicting results. A tally of the conclusions reported in the original papers reveals that most of the earlier studies favor the hypothesis that equal practice increases the differences between subjects, while those appearing since 1920 favor the contradictory hypothesis. One worker finds no change in variability and another arrives at no definite conclusions. Several workers (*cf. especially* Reed, *op. cit.*) have reanalyzed the data of others and have often reached opposing conclusions. It becomes evident, therefore, that the statistical analysis followed by the various experimenters is in need of examination and that an unqualified solution of the problem depends upon our finding an unequivocal method of measurement.

Experimental conditions. Reed lists three desiderata of experimental conditions relative to equality of practice. Practice, he says, should be the same in kind of material, the same in difficulty, and the same in amount. He points out that these conditions are only approximated in the experiments which he reviewed. He also shows that in some experiments the attempt is made to keep amount of training constant in terms of work performed; in others in terms of the time spent in practice. Often these conditions are only approximated. Let us note that the time constant method gives an advantage to the faster subjects because they do more work during the time allotted than the slower ones. On the other hand the work constant method gives an advantage to the poorer subjects because they spend more time at practice.

In many of the experiments, furthermore, too few subjects were used to give statistical reliability. Finally, it is inconsistent with the aim of the present type of investigation to use in the same group subjects who have had considerable experience in the performance studied together with subjects who have had no experience, as some have done. The problem is not to discover the effects of practice on individual differences that are, to start with, produced by varying previous training, but to discover the effects of equal practice on individual differences that are present prior to any practice. These considerations cast doubt upon the meaning of any correlations and other statistical constants used to analyze the data.

Equivocality of statistical devices. Nine different measures, with variations of these, have been used for interpreting the experimental data. In some cases a combination of several measures was used and the conclusion based on a count of those measures which support one hypothesis as over against those which support the other. (*Cf.* Kincaid, *op. cit.*) We question whether valid conclusions may be drawn from a summation of measures of doubtful validity. Let us, therefore, examine the measures from the point of view of their utility for the present purpose.

Ratios, relative gain, correlation of initial performance and relative gain. Most equivocal are devices involving ratios based on the raw scores. Thorndike's earlier study was based upon the ratios of best to worst, next best to next worst, and so on, before and after practice. This device is also found in variations in which two points of a distribution are compared.

Reed criticizes Thorndike's ratios on the basis that they compare only the extremes of a group and reveal nothing concerning the middle. A more fundamental objection than Reed's to the use of any kind of ratio based on the original scores is the fact that the scores themselves are equivocal. A comparison of two ratios is only valid when the scores are measured from a true zero, and when the units of measurement at different parts of a scale are equal and comparable. Neither of these conditions obtain in the experiments under review, as will be brought out later.

Much use has been made of the relative gain of subjects as a measure indicating convergence or divergence of abilities, and Reed considers the correlation of initial performance with relative gain as the most valid measure of the trend in question. However, since relative gains are ratios, our criticisms of ratios with unknown zero and unknown true score value at various parts of a scale obtain. Nor does subjecting them to a correlation procedure by some Pythagorean magic make them valid measures.

Absolute gains and correlations with initial performance. Most of the studies are based on a comparison of absolute gains of the better and poorer subjects. Chapman says relative to this device, "The only assumption that this method makes is that the units at different points of the scale are equal." We have already indicated and will later show that this assumption is untenable. Correlation of initial performance with gross gain, of course, depends upon the unequivocality of the gross scores.

Comparison of curves. One or two experimenters have compared the practice curves of their subjects by plotting them on the same coordinates. However, the meaning of a separation of two curves at any point cannot be determined by mere inspection, but must be interpreted relative to the value of the point intermediate between the curves compared.

Standard deviation. Reed has shown that the standard deviation cannot be used as a measure of variation since it depends upon its relation to the average from which it is computed.

Correlation of initial and final performance. The correlation of initial and final performance merely indicates the degree to which the members of a group tend to retain their original rank positions after practice. It tells us nothing concerning increase or decrease in the differences of ability.

Coefficient of variability. Reed considers the coefficient of variability, *i.e.*, the ratio of the standard deviation to the mean, as a reliable measure of the effect of practice on individual differences. This is usually indicated by the symbol V. The one objection that Reed makes to these devices is that they compare only certain points of the distribution.

The writer agrees with Reed that if the scores are measured in equal units from a true zero, and we compare two parts of a practice curve in terms of the coefficient of variability, an increased V would unequivocally indicate increased variability, and a decreased V would be strong evidence for decreased variability, at least for the two points of the curve compared. As already indicated, however, the former condition does not exist in our present method of measurement.

Equivocal measures. The crux of our criticism is the fact that our measures of learning have no precise meaning. This is due to two considerations which must not be taken into account, viz., that the measures are taken from an arbitrary zero and that the values of the raw scores at different parts of the scale are not comparable.

We have seen that statistical devices which make use of ratios depend upon scores measured arithmetically from an absolute zero. Whether for learning data in the form of raw scores such a zero may be statistically approximated, I am not at present in a position to say. The writer believes that a scale such as will be described below may give a rational series taken from an approximately absolute zero. That, however, will have to be decided by experiment.

Our other point is that as learning has been measured the values at different parts of the scale are not comparable. The assumption that the units at different parts of the scale are equal is not tenable. The learning curve, plotted in terms of work done per unit of time, is a curve of negative acceleration. It rises rapidly at first, then more and more slowly. Increments of achievement, therefore, become increasingly difficult as practice continues and as the limits of improvement are approximated. It is, therefore, also possible for the absolute and relative difference between two subjects in terms of the raw accomplishment scores to be less at the end of practice than at the beginning, and yet for this difference to be actually greater.

A Psychophysical Scale for Measuring Learning Achievement

Having criticized the work done in this field and shown it to be equivocal, we ought at least try to suggest a way out of the dilemma. Let us start with the assumption that the scale of measurement should be weighted in terms of the difficulty of adding an increment of achievement from one part of the scale to another. We may, then, define difficulty in terms of the amount of practice required to achieve successive degrees of accomplishment. If we grant that equal amounts of practice are equal, we can devise a psychological unit for measuring learning accomplishment in which the units are equal and comparable. This would be done by projecting the physical achievement scale in terms of work or time upon a psychological scale of difficulty, *i.e.*, amount of practice required to reach each successive degree of proficiency on the original scale.

One method for doing this is in terms of average amount of practice required by a group to reach each successive point on the accomplishment scale. The effects of practice would be measured at a large number of equally spaced intervals. For each of the original score values we would determine the average amount of practice required to reach it and substitute this value for the original scale value. Such a method would give us a scale in equal and comparable units measured from a true zero.

It would not, however, take into account the fact that plateaus do not occur for all individuals in the same part of the learning curve. Our results would necessarily be the values obtained from a smoothed curve. The writer believes that the advantages of the method would outweigh its disadvantages.

Another possibility is to make use of a practice quotient, *i.e.*, a subject's difficulty score divided by the actual amount of practice he required to achieve the degree of proficiency which it signifies. Change or constancy of this quotient would give conclusive evidence of the true effect of equal practice on individual differences.

As a final point, it is the writer's opinion that a generalization regarding the problem in question should not be arrived at by a comparison of initial performance with a single end performance, but on the basis of a trend obtained from a comparison of the initial performance and a sufficiently large number of subsequent performances, and also of adjacent performance levels within the series. The conclusions of the experiments thus far reported, if valid at all, are valid only for a very specific amount of practice. It may well be that variability is increased or decreased for any given amount of training, while at the same time the true trend is in an opposite direction. The problem, as stated, demands a general statement of the effects of equal practice on individual differences rather than the effects of a specific amount of practice. It may also well be true that such effects are different for different types of performance and for different ages of the subjects. This should also be investigated.

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DINOSAUR FOOT TRACKS NEAR YOCUMTOWN, YORK COUNTY, PENNSYLVANIA[1]

By Wm. O. Hickok, 4th, and Bradford Willard
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Three- and four-toed foot tracks were discovered many years ago in the Triassic sedimentary rocks of the Connecticut Valley. At first, they were considered to be bird tracks because of their similarity with the tracks of modern birds. Eventually, however, dinosaur skeletons were found associated with the tracks and it was concluded that the tracks were made by dinosaurs. Dinosaur tracks are abundant in the Triassic rocks of Connecticut and Massachusetts, and common in New Jersey. They have been found at few localities in Pennsylvania.

The tracks which are described below were found in the summer of 1932 by J. Carroll Hayes who informed Dr. Geo. H. Ashley, State Geologist, of their occurrence near Yocumtown, York County. Hickok, who was investigating the Triassic rocks of the New Cumberland quadrangle, independently discovered them several weeks later in the course of his investigation. Later, the tracks discovered by Hickok were found to be those previously found by Hayes.

Several blocks of sandstone with footprints on them were collected by Hickok, F. T. Moyer and M. N. Shaffner, of the Survey. Subsequently, Bradford Willard visited the locality with Shaffner and additional specimens were brought in. The better specimens were mounted and displayed at the Pennsylvania State Farm Show held at Harrisburg in January, 1933. Some of them have been loaned by the Geological Survey to the Century of Progress exposition in Chicago, where they are on display in the Hall of Science; others have been turned over to the State Museum in Harrisburg.

The greater part of the foot tracks may be classified in two genera and species, *Grallator tenuis* E. Hitchcock and *Anchisauripus sillimani* (E. Hitchcock); the former being more abundant than the latter.

Measurements on *Grallator tenuis* are as follows: Pes, length of digit II, 39 mm; III, 55 mm; IV, 45 mm; entire foot, 79 mm; distance between lateral claws, 48 mm; divarication of digits II and III, 19°; III and IV, 22°. The length of stride is 190 mm; the width of the trackway was not determined.

The measurements on *Anchisauripus sillimani* are as follows: Pes, length of digit I, 32 mm; II, 56 mm; III, 82 mm; IV, 62 mm; entire foot not including hallux, 112 mm; with hallux, 130 mm; distance between

[1] Published with permission of Geo. H. Ashley, Pennsylvania State Geologist.

lateral tips 55 mm; divarication of digits I and II, 135°; II and III, 13°; III and IV, 20°. The length of stride and width of trackway are unknown.

Occasional footprints, which appear to belong to species other than those mentioned above, were found, but they are too poorly preserved to be identified.

C. H. Hitchcock and A. Wanner (see bibliography) have reported previous finds of dinosaur footprints from this area, but neither has given specific identification of them. A. Wanner, however, has reported the finding of a bone fragment of Belodon (Rutiodon) along the banks of Little Conewago Creek near its junction with Big Conewago Creek. The fragments came from a sandstone bed lying far below the zone at which the dinosaur footprints occur.

A rough correlation between the Triassic of the Connecticut Valley with that of southern Pennsylvania can be drawn from these meagre data. In Connecticut the Triassic (Newark series) is divided as follows:

	Feet
Upper series—sandstone and shale with some conglomerate	3,500
Posterior trap sheets	100– 150
Posterior shales	1,200
Main trap sheet	400– 500
Anterior shales	300–1,000
Anterior trap sheet	0– 250
Lower series—sandstone, shale and conglomerate	5,000–6,500

In the New Cumberland quadrangle the Newark series is divided as follows:

	Feet
Gettysburg formation	15,000 +
New Oxford formation	8,000

The foot tracks of *Grallator tenuis* and *Anchisauripus sillimani* occur at an horizon near the middle of the Gettysburg formation and lie about 6,000 feet above its base and 14,000 feet above the base of the Newark series. The Belodon (Rutiodon) remains, on the other hand, were found above the middle of the New Oxford formation and lie barely 4,500–5,000 feet above the base of the Newark series.

In the Connecticut Valley *Grallator tenuis* and *Anchisauripus sillimani* occur only above the posterior trap sheet in the upper series. This indicates the contemporaneity of the upper series of the Connecticut

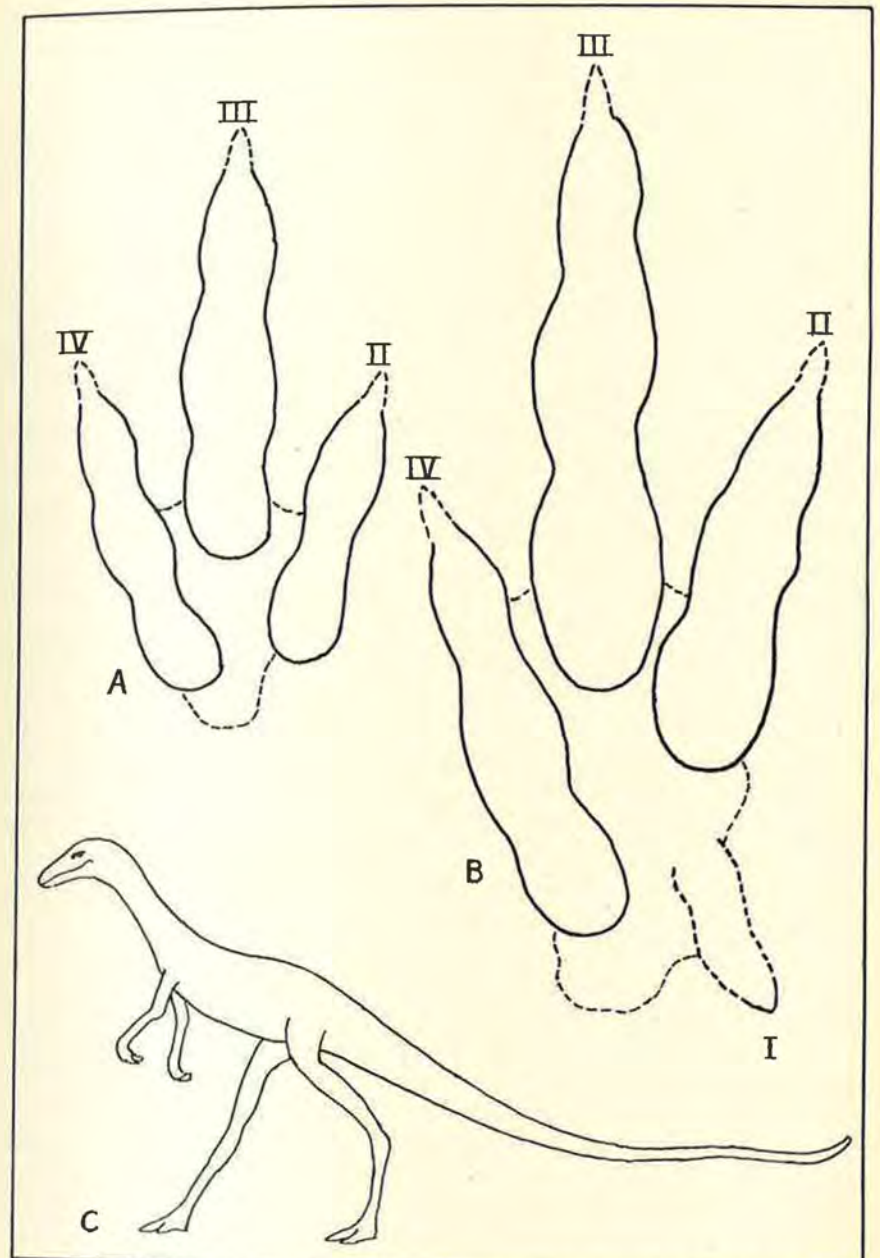

FIG. 6. A. Foot track of *Grallator tenuis*, natural size. B. Foot tracks of *Anchiosauripus sillimani*, natural size. C. Restoration of *Podokesausus holyokensis*, thought to have made the *Grallator tenuis* tracks (after Lull), $\frac{1}{10}$ natural size.

Valley Triassic with the middle of the Gettysburg formation of southern Pennsylvania. On the other hand, the Belodon (Rutiodon) remains indicate the contemporaneity of the upper half of the New Oxford formation with the Connecticut Valley lower series where they have also been found. The three trap sheets which lie between these two zones in the Connecticut Valley are lacking from the Newark series of southern Pennsylvania.

In the Connecticut Valley the Newark series measures 12,000 feet, whereas in the New Cumberland area it measures 23,000 feet, which is almost twice the thickness attained in New England. Although the thickness below the footprint horizons is only slightly greater in southern Pennsylvania than in the Connecticut Valley, the Newark series extends many thousand feet farther above this zone in Pennsylvania than in the Massachusetts-Connecticut area, thus indicating that Triassic sedimentation continued in southern Pennsylvania after it had ceased in the Connecticut trough.

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NEW CRITERIA FOR THE TAXONOMIST

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The taxonomist's chief aid in determining species has always been morphology. It is true that the modern taxonomist is growingly conscious of the broadened view which ecology and genetics have given, but their help has been in elaborations of old ideas or systematically impractical. What is needed to revitalize taxonomy perhaps more than anything else are new criteria for the identification of those forms we refer to as species in nature. Many of these criteria appear on the horizon.

There is, for example, the study of behavior or habit. G. K. Noble, of the American Museum of Natural History, has done considerable to enlarge the significance of this criterion in his experimental studies of amphibians and reptiles. In a recent paper[1] he states: "Habits are more stable than adult characters. . . . The phylogenetic position of an amphibian is best determined by comparison of its habits and life history, as well as its structure, with those of its relatives." As an example of this in the field, *Hyla rosenbergi*, a frog of Panama, is known to make a nest pool in the mud, in the water of which the eggs are laid. Morphologically this species has shown a close relationship to *Hyla maxima* of South America and Mr. M. Graham Netting, Curator of Herpetology at the Carnegie Museum, informs the writer that in 1929 he found *Hyla maxima* in Trinidad making the same unique type of nest pool in gravelly soil, thus corroborating its relation to *Hyla rosenbergi* with habit evidence.

A second new criterion of aid to the systematist is that involving a time element, and one so far little appreciated. The time-lapse movie mechanism, which permits us to see what our ordinary perception denies us, may be of considerable aid, particularly to the botanist. Clements and Clements[2] have made careful observations on time and arrangement of the vernation or opening of flower buds in relation to pollination and its taxonomic significance. Alfred Gunderson[3] has studied the flower before it opens, a kind of floral embryology, and has verified many of our generic and family conceptions and given us some new information, the value of which cannot be questioned. Such studies might be enhanced by time-lapse moving pictures like those of Norman McClintock and Arthur C. Pillsbury and one cannot help but wonder what a complete series of such pictures of opening flower buds in a chosen family or group of related families would teach us of natural relationships, for the manner of bud unfolding has always been of taxonomic significance. With the new lighting arrangement invented by Edgerton and Germeshausen, which permits a photograph in 1/100,000th of a second, still further possibilities are hinted.

Another criterion which may be of definite assistance to the taxonomist is that of serum diagnosis. The work of Carl Mez and Ziegenspeck[4] has resulted in the development of the extensive Koenigsberger phylogenetic tree.

Still another method has recently been advanced by Werner and used successfully by a Japanese, Kiichi Ohki. We find a review of his work[5] in *Nature* as follows: "A New Method in Plant Taxonomy.—Kiichi Ohki

[1] Annals of the New York Academy of Science 30: 119. 1927.
[2] Flower Families and Ancestors. New York, 1928.
[3] Flower buds and the directions of floral evolution. Torreya 32: 154–158. 1932.
[4] Proc. Intern. Congr. 2: 1402. 1929.
[5] Nature, November 26, 1932. (No. 3291, 130: 816.)

appears to have given the 'spodogram' method of distinguishing species a very thorough examination in connection with his studies of the Japanese Bambusaceae, and does not appear dissatisfied with the method. The spodogram is obtained by taking a small piece of the leaf from the middle region and incinerating it carefully, using a special apparatus first suggested by Werner (Biologia Generalis **4**: 1928). The ash when cool is mounted on a slide, with xylol and Canada balsam. In this way the outlines in particular of the epidermal cells are retained because of the silica contained in their walls. At first sight it would appear more reasonable, if such microscopic characters are to be used in taxonomy, to examine the full leaf tissue without resort to incineration, when the same characters together with others will be available for study, but the method of incineration certainly reduces the salient microscopic characters to a limited group, recognizable after incineration, which may be more simply treated in systematic study. Ohki's paper will be found in the *Journal of Science* (Tokyo, Section 3, Botany, vol. 4, part I)."

Dr. Mildred Mathias, working with the Umbelliferae or Carrot Family of plants, assures the writer that it is possible to identify many of the Umbelliferae by odor alone, and that it may be quite possible to distinguish all of the species in the family by the essential oils which they contain. Since the chemist has been of little aid in helping us to identify highly complex protein molecules we turn to the physicist. Perhaps it is in physics that we may find some of the most strikingly new tools for the taxonomist's use. For example, each of the essential oils possesses a distinctive surface tension, and methods for determining the changes in surface tension are already available. If this, or some similar physical method, will work for the Umbelliferae, it will work for other fomilies possessing unique essential oils, such as the Ericaceae, Cruciferae, Labiatae and many others.

Not only may the physicist prove to be of practical help to the taxonomist, but his caution and tolerance of new ideas, if not his exacting technique, are already winning the taxonomist's attention.

These aids, and many others, the taxonomist must learn to recognize and to use, and his keeping alert to such new criteria as appear on the horizon, may cause his science to gain new vigor and reach a fuller significance.

FROM H_2O TO 3.2

By Max Trumper

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Having addressed the Academy twice on the subject of water and last year on the subject of specialization hazards, I feel that I should practise my own preaching and change the subject.

In these times from H_2O one goes to 3.2. Alcoholism in this country is one of those subjects on which many people feel so strongly that they cannot think. For this reason it becomes all the more necessary for the scientist to do careful thinking unbiased by prejudice for or against existing legislation. Legislation concerns itself with the liquor traffic while education concerns itself with the liquor habit. My paper will concern itself with the toxicological aspects and with the physiologic processes which underlie them.

People will drink more beer than they did before prohibition. The enthusiasm accompanying the revival has given the initial impetus. The fact that the stronger beverages are still withheld from legal public sale will give beer its chance to make stable its present popularity. But also the fact of the poor quality of the drinking water in so many of our cities will cause many to choose beer as a less dangerous drink since its ingredients are more carefully determined than are those of the water admitted to homes as potable. The breweries usually secure the water content of their beer from artesian wells. The drinking water sources are rivers and lakes much more subject to both trade waste and bacterial pollution. The alcoholic content of beer is measured, its other ingredients are based on definite recipes and no chemicals are added. The inorganic chemical contents of drinking water are unmeasured and further chemicals are introduced to rid the water of disease-producing bacteria. In so doing we may merely be replacing a certain evil by an uncertain one. It was in the brewing industry that the science of bacteriology found its beginnings. I refer to the researches of Pasteur on fermentation in brewing. Bacteriology in turn has taught us how to free our drinking water from disease-producing bacteria, but we know little as yet concerning the effect on the human body of the chemical contents of water when consumed daily over a long period of time. All the stages of the various processes of brewing are usually subject to careful supervision in order to maintain a fixed quality for the beer. Until equal care is given to the quality of our drinking water, it will require scientific investigation to determine whether the water of a given community or its beer is to be recommended.

Now that the controversies on the 18th amendment are on the wane, the public is once again interested in fundamental facts of physiology. Alcohol is one of the few substances that may be absorbed directly from the stomach. Like water and glucose, alcohol is absorbed within a few minutes and undergoes no change during digestion. While the rate of absorption is rapid, it varies with the motor activity of the individual's stomach and intestines. Absorption also depends on the concentration of the alcohol ingested, whether taken on an empty or full stomach and also upon the kind of food in the stomach. For instance, fat foods retard absorption. In drinking 3.2% beer even on an empty stomach, the quantity of alcohol is not sufficient to produce intoxication. Though an individual have a rapidly emptying stomach, a glass or two of beer requires a period of one and one-half to two hours before all the liquid contents leave the stomach. It is this time factor of a few hours in the absorption of the beer plus the so-called tolerance or rate of oxidation which practically precludes the possibility of beer intoxication. While it is true that an ounce of concentrated alcohol to exceptionally few people might be considered excessive, to the vast majority of individuals this amount would not have any intoxicating effect. To-day we know that the effect of alcohol does not depend on the amount consumed but on the amount of alcohol that reaches the brain or the spinal fluid. In the case of the habitual drinker, less alcohol reaches the brain because his tolerance or metabolic rate of utilization is greater than in the case of the non-drinker. The habitual drinker as a rule oxidizes his alcohol quickly and thus less reaches the brain, but intoxication develops when an excess of alcohol is ingested. The alcohol in the brain and spinal fluid exerts a constant effect on all persons irrespective of their drinking habits.

A question frequently asked is—does the drinking of beer affect the efficiency of the worker? From the standpoint of the industrial toxicologist, I would say that the moderate drinking of 3.2% beer or non-intoxicating beer is harmless, but that when taken in excess it is harmful and reduces the efficiency of the worker. Immoderate beer drinking will in time produce a sluggish mind and body—a sort of lethargic obesity. In some instances it predisposes to accidents. Thus 3.2% beer, like carbohydrate food, becomes harmful only when taken in gluttonous excess over a long period of time.

One progress-born factor brings the alcohol question before us with renewed vigor, namely the automobile. Our courts are glutted with motor accident cases in many of which alcohol plays an important rôle. This is especially so in motor fatalities where the court wishes to know whether the deceased was sober or, if intoxicated, to what degree. In those non-fatal cases of intoxication with symptoms of delirium or coma, spinal puncture is usually done to relieve the pressure on the brain. The spinal fluid obtained in these cases should be analyzed for the percentage content of alcohol. Gettler, who has examined several thousand fatal cases of intoxication and whom I consider to be our foremost authority in this work, reports that "all cases having 0.265 per cent or more of alcohol in the spinal fluid were found to have been in fact intoxicated." Thus this information should be incontrovertible evidence. In the less severe cases of intoxication Bogen contends that the effects of alcohol are in direct ratio to the content of alcohol in the blood stream. Thus in these non-fatal cases, blood specimens should be promptly obtained and if alcohol is found to the extent of 0.2 to 0.5%, this would indicate that the individual was intoxicated. When the blood concentration of alcohol exceeds this figure, the intoxication may prove fatal, in which case a spinal fluid specimen is to be preferred. But the circumstances of most cases of collision make such exact tests difficult to obtain and the officer on the spot usually relies merely on smelling the breath and other superficial tests which prove only that the individual has been drinking. The question as to when drunkenness begins is still legally moot.

In some instances symptoms are incorrectly attributed to alcoholism which may arise from an entirely different cause. For instance the symptoms of drunkenness are sometimes not unlike those of carbon monoxide poisoning, and it may be extremely important to decide which is the case. The diagnosis of alcoholism once made, the individual is very apt to be neglected and given little further consideration, whereas he may in reality be suffering from a condition in which his only hope lies in prompt and effective treatment.

These are all modern phases of the age old question which gave rise to public measures of restriction on the use of alcohol. Since, however, in this motor age even the slightest deviation from normal efficiency may have disastrous effects, it becomes important for the scientist to study even more closely than heretofore the effects of small quantities of alcohol on varying human systems. Until such knowledge is available, it is the part of wisdom for those whose vocation is the operating of vehicles of the road, water, or air to abstain even from beer drinking prior to and during their work.

STUDY OF AN INTRA-MUSCULAR PARASITE IN THE SALAMANDER *TRITURUS VIRIDESCENS*

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Animals with swellings along the tail have from time to time appeared in the laboratory stock of *Triturus viridescens*. The swellings are characteristic; that is, they are fairly smooth with the skin stretched taut, and are usually located at the base of the tail. In a few cases an enlargement has developed on a limb, along the spine in the body region, or even on the head. Otherwise the animal is normal. That this might be a laboratory-induced condition is disproved by finding such individuals in the free population in the lakes where collections are made. The ratio of diseased to normal animals is low, and both sexes are afflicted.

On dissection the swelling appears as a mass of fairly hard cysts in a gelatinous matrix. This replaces the muscular tissue, adhering closely to the skin and bone, both of which are unaffected. Smears made from a fresh wound and stained with methylene blue show bits of muscular and connective tissue, and small capsules containing more deeply staining oval forms. In paraffine section the skin and bone are intact. The space normally occupied by the muscles is filled by the round or oval capsules. Faintly staining connective tissue fibers show up between the capsules in some places, though not filling the entire space. The gelatinous matrix apparently does not stain. A few disconnected muscle fibers have also been found.

The capsules are composed of endothelial tissue. Stained with methylene blue and eosin each shows a deep blue body surrounded by a clear area. This body I believe to be the parasite. Each is criss-crossed by heavier blue threads having a pattern somewhat like that of chromatin threads. Food vacuoles which usually appear in protozoon parasites are not present, but this is not out of the ordinary in the encysted state.

Infestation does not occur through an open wound. I have tried placing whole cysts or minced tissue on open wound beds or under flaps of skin. In both cases the foreign material is sloughed off and the wound heals normally. Once infested the animals do not recover. I have excised small swellings on the tail, but the wounds healed slowly, death intervening before complete recovery. Usually the skin over the swelling splits just before death, thus releasing the encysted parasites, which are probably then picked up by the secondary host if there is one or by another salamander if there is not.

Transmission is undoubtedly through the alimentary canal and the blood stream. As is usual in blood stream diseases, histological changes occur in the liver. The liver of a normal salamander has a fairly definite perihepatic region with the cells oriented to each other, and no mitotic figures present. In the parasitized animals, chromosomes in all phases of mitosis appear in the liver cells and the peripheral arrangement is distorted. Neither the common intestinal parasite, *Trypanosoma deimyctyli*, nor the brain parasite, a flat-worm, which is practically 100 per cent in the salamanders of western Pennsylvania cause such changes. Chances are that our healthy normal salamander contrasted to the diseased one is infested with both. It is quite likely, however, that some stage of this parasite is passed in the intestine.

Morphology alone has led me to believe that this parasite is a protozoon, probably an ameba. Further study will give a more definite diagnosis.

HISTOLOGICAL CHANGES INDUCED BY HEAT AND IN HIGH FREQUENCY FIELDS

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McKinley (1930) found that young albino rats, placed in high frequency electrostatic field, suffered a violent rush of blood to the extremities. These results were seemingly duplicated by subjection to an oven heat of 160° C. or higher. McKinley, Schereschewsky, and others found that animals which were exposed to sub-lethal treatments later developed hemorrhagic areas in the appendages.

It was thought desirable to examine microscopically the principal tissues of these experimental animals to determine the extent and possible differences of the injuries. The animals used were 6-day-old rats all from the same litter. The tissues were fixed in Bouin's fixative, stained in Delafield's Hematoxylin, and counterstained with a mixture of Orange G and Sudan III. The usual histological technique was followed throughout.

The tissues of the animals which had been killed in high frequency fields showed a pronounced increase in the quantity of blood present. In the appendages the blood was not confined to the vessels alone but was scattered between the muscle bundles and throughout the connective tissues. This was obviously due to the rupturing of the capillaries. The same condition existed also in the liver, spleen, and lungs with the congestion of blood in the lungs most nearly corresponding to that in the appendages.

The tissues of the animals killed by heat showed similar changes but in no case was the congestion of blood as pronounced either in the internal organs or in the appendages.

It has previously been reported (by McKinley, 1930, and others) that abdominal temperatures taken on rats killed by external heat were essentially the same as for high frequencies. The variations pointed out in the histological pictures could not then be due to any variation in internal heat but were probably produced by the stimulating effect of the high frequency oscillations on the tissues of the animal entirely independent of the heat factor.

SUMMARY

1. Gross changes produced on young rats by heat and high frequency fields appear somewhat similar.

2. Microscopic examination, however, shows that the tissues of the animals subjected to the high frequency currents were much more congested with blood than the tissues of animals killed by heat.

3. Since there was no demonstrable difference in the internal body heat produced by either treatment the marked difference between the results are probably due to a stimulatory effect, other than heat, that was produced by the electrical field.

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THE MECHANICS OF ANTENNAL MOVEMENT IN HABROBRACON

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The antennae of Habrobracon are capable of considerable movement and assume definite positions under certain conditions. The movements, unlike those of many other insects, originate in all of the segments and are shown to be caused by two types of mechanical force: first, muscle contraction which controls the basal segments and second, internal fluid pressure which controls the distal part.

Observations were made on living wasps under magnification and by the use of both sectioned material and whole mounts. The sectioned material was cut at eight microns and was stained with Mallory's triple stain. Whole mounts, which were unstained and cleared in xylol or Euparal, were used for studying musculature.

The muscles which effect the movement of the antenna are associated with the first two segments, the scape (SC) and the pedicel (PD) respectively (Fig. 7, B). The remainder of the antenna is composed of a varying number of segments which, collectively, are called the flagellum. The flagellum is inclined at an angle of about 23° to the first two segments. The scape is articulated very loosely within the antennal socket so that on depression and elevation of the antenna the scape is rotated within the antennal socket through an arc of about 45°. This rotation of the scape may be observed by an examination of the segment during the raising and lowering of the antenna. The scape has a slight bulge on one side and this raised region may be used as a mark for observations on the rotation of the segment. When the antenna is elevated, this raised portion or bulge is medial in position, but when the antenna is lowered, the bulge is dorsal. Thus, there is a 45° rotation between the "elevated" and the "depressed" positions of the antenna. A small apodeme (x) on the medial rim of the proximal end of the scape (SC) serves as the point of articulation to the head capsule (Fig. 7, C and D). This apodeme moves quite freely within a groove located in the medial circumference of the antennal socket.

There are two sets of muscles located within the head capsule which effect elevation and depression of the antenna. These are as follows:

Elevator of the antenna (el. ant.) (Fig. 7, C and D): This is a double muscle. One point of origin is on the anterior arm of the tentorium (AT), the other on its dorsal arm (DT). Both branches pass directly upward to their point of insertion on the elevator apodeme (m) on the dorsal rim of the proximal end of the scape.

Depressor of the antenna (dep. ant.) (Fig. 7, C and D): This is also a two-branched muscle which has one point of origin on the anterior arm of the tentorium (AT), the other in its dorsal arm. It passes directly upward to the depressor apodeme (n) on the ventral side of the proximal end of the scape. A posterior view of these muscles is shown in Figure C.

Within the scape (SC) are located the extensors and the flexors of the flagellum. These may be described as follows:

Extensor of flagellum (ex. flg.) (Fig. 7, B): Arises dorsally and medially on the base of the scape (SC) and is inserted (p) dorsally and medially on the base of the pedicel.

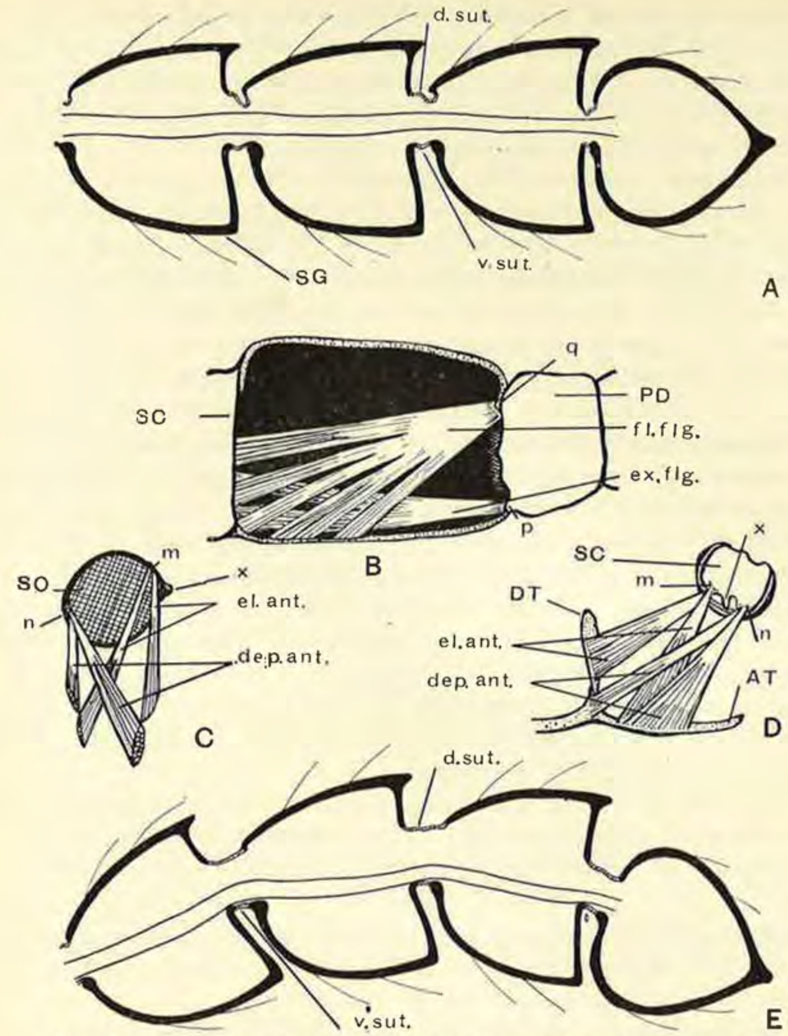

FIG. 7. Section of antennae and antennal muscles in Habrobracon

Flexor of the flagellum (fl. flg.) (Fig. 7, B): This is a larger muscle than the extensor. It arises ventral and medially at the base of the scape (SC) and passes forward, diagonally across the segment, to the insertion (q) on the dorso-lateral rim of the proximal end of the pedicel.

Aside from the separate movements of the scape and the pedicel, the flagellum is capable of independent movement. Somewhat like the action of the pedicel, the movement of the flagellum is limited to one plane, a downward flexing and a return to the extended position. All segments take part in this movement although the distal third are most active. When fully flexed the flagellum is but slightly curved in the basal region,

but the curve becomes more abrupt towards the tip. In males the tip of the flagellum may be so strongly recurved, when the flexing is carried to an extreme condition, that a complete circle is formed.

The independent movement of the flagellum is not due directly to muscular action since no muscles are present in this region. During anatomical observations on the living wasps it was noted that the characteristic flexing of a flagellum could be artificially produced by applying slight pressure to any of the segments composing it. The same reaction could be brought about simultaneously in both antennae by squeezing either the head or the thorax with a pair of forceps. This fact suggests that the action is produced by differences in pressure of the body fluid, an increased pressure causing a downward movement of the flagellum and a release of pressure allowing the flagellum to return to its resting position.

Sagittal sections of antennae (Fig. 7, A) show a series of heavily sclerotized regions (SG) representing the body of the segments. These are connected together by flexible sutures in which regions all movement takes place and which differ in form and extent on the dorsal and ventral sides.

On the dorsal side between any two segments this membranous area (d. sut.) is rather extensive and thrown into wavy folds. Extension of this area allows the sclerotized regions of the segments to separate slightly from each other. But on the ventral side the membranous areas (v. sut.) are less extensive and those regions of the inter-segmental sutures which they bridge are deeper than the corresponding regions on the dorsal side.

It is evident that increased pressure within the flagellum would tend to expand the inter-segmental sutures, spreading the individual segments farther apart and resulting in a lengthened flagellum. But, since the dorsal side (Fig. 7, E, d. sut.) of the flagellum is capable of greater expansion than is the ventral side (Fig. 7, E, v. sut.), each ventral suture pulls the axis of its corresponding segment downward. The sum of these individual curvings is a flexure of the entire flagellum. Upon release of the fluid pressure the flagellum then returns to its relaxed position.

VARIATIONS IN THE WING VENATION OF *APHIS FEMINEA* (HOMOPTERA—APHIDIDAE)

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Certain veins of both the primary and secondary wings of aphids are subject to variation. In this connection Patch[1] has pointed out the

[1] Patch, E. M., Homogogies in wing veins. Ann. Ent. Soc. Amer., 2, p. 101, 1909.

variation of the median vein in several species. Other accounts make mention of the variability of a certain vein with regard to a particular species but no study has been made which takes into account the variations in the wing venation of a large number of individuals belonging to a particular species.

For observations of this nature the red and black cherry aphid, *Aphis feminea* Hottes, was used. This species was very abundant in the region of Woods Hole, Massachusetts, during the summer of 1932. The host plant was *Prunus serotina.* Collections were made at different times between June 15 to September 1. These collections consisted of individuals chosen at random from the colonies inhabiting the host plants. In this manner a total of 756 alate females was collected. These were examined and the state of the primary and secondary wing venation recorded as follows.

The radial sector vein of the primary wing varies as to its length. Normally this vein arises at a median point on the stigma and curves downward and again upward to the apex of the wing. This condition was arbitrarily given the numerical value of four (4). The variation here consists in a shortening of the vein, starting in the distal region. Where the basal three-fourths of the vein remains the condition was tabulated as three (3); where the basal half remains, as two (2); where the basal one-fourth remains, as one (1) and with all traces of the vein gone the condition was tabulated as zero (0).

In this species the median vein of the primary wing is twice branched, ($M_1 - M_2$) and ($M_3 - M_4$). In the individuals examined, the median vein varied in that it consisted of but a single branch. This, according to Patch, is due to a coalescence of M_1 and M_2 forming M_{1-2}. Thus, the remaining two veins are M_{1-2} and M_{3-4}.

In the secondary wing the variation of the median vein was recorded. In the normal wing this vein appears single. The variation here consists of a forked condition. Recordings were made as "normal" and "forked."

It seemed desirable, in the case of the radial sector vein, to determine the degree of correlation between the right and left wings. Accordingly the data recorded as mentioned above were arranged in the form of a correlation table. The coefficient of correlation was found to be .4000 with a probable error of ± .0443.

The median vein of the primary wing was found to consist of a single branch in several cases. In the 756 cases counted, this vein consisted of a single branch 56 times; 12 on the left alone, 24 on the right alone and 20 times on both right and left wings. This vein was effected, therefore,

44 times on the right and 32 times on the left. The difference between the ratio of the two would be .0159 with a probable error of ± .00755. By count, in 20 individuals both the right and the left wings were affected. The expected number may be calculated by obtaining the product of the ratio of the total number of cases on the right (44) and on the left (32) wings). From this the ratio of coincidence may be calculated by a method similar to the one used in genetic work for determining interference in crossing-over; the actual number of cases divided by

Left						
	4	2	1	0	6	128
	3	3	0	1	9	4
	2	2	0	0	0	1
	1	0	1	0	0	2
	0	0	1	0	0	2
Right		0	1	2	3	4

the expected number of cases. For the median vein of the primary wing this ratio was found to be 1.07. There is, therefore, an equal chance that the vein be effected in both the right and left wings at the same time.

The median vein of the secondary wing may be treated similarly. Among the 756 individuals counted, there were 412 normals, 96 with left alone forked, 144 with right alone forked; and 104 with both right and left forked. This median vein was, therefore, effected in 248 cases on the right wing and in 200 cases on the left wing. In this wing the difference between the ratio of the right and left sides was .064 with a probable error of ± .0157. Here the ratio of coincidence is found to be 1.57.

We find, therefore, that there is a correlation between the radial sector vein of the right and left primary wings. There is also a direct correlation between the right and left wings of the median vein.

THE INFLUENCE OF ALCOHOL ON THE PROGENITURE

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The problem of inheritance has presented, from time immemorial, great difficulties for its solution. With the advent of Darwin's laws of natural selection (Origin of Species), in 1859, it received its first scientific orientation.

Among various agents which are capable of deteriorating the germ-cells and thus producing a lasting alteration in the hereditary energies of these cells, which will be manifested in anomalies and defects involving the embryonal development of various organs, syphilis and alcohol occupy a most conspicuous place. We shall be concerned here exclusively with the effect of alcohol on the progeniture.

The three series of pedigrees presented here come from families about whom the most careful investigation with regard to other pathological conditions has been made. The information about the medical histories of several generations was obtained from the near and distant relatives with whom a correspondence was kept up for many months. Diseases, infection, or intoxication, other than alcohol, could not be traced as far as the statements of the members of the families could be relied upon. Every one of the surviving members of the last generation was submitted to a Wasserman test of the blood-serum and spinal fluid, and the results were negative. It appears that alcohol was the sole, or at least the most conspicuous, agent that created the abnormalities in several successive generations.

Case I. In the three generations we find individuals with various degrees of mental deficiency, epilepsy, choreiform movements, tremors, eccentricity and violent temper; we find also miscarriage and dead-born children. There are only two apparently normal children. Alcoholism was present in two generations—namely, in the great grandfather and in one of his sons, who married and brought into the world four living children and two dead-born. The youngest died at four, one developed tuberculosis at twelve, one was feeble-minded, and one was epileptic. A glance at the pedigree will show the remaining ravages. In the entire family tree alcohol seems to be the only pernicious agent.

Case II. Alcoholism was present in the grandfather and one son. The latter had three children, of whom one died at six months from meningitis(?), one is epileptic, and the third is a masturbator. The other children of the grandfather were not alcoholic but abnormal, and two of them were married and gave birth to several defective children.

Case III. The family tree is traced from the grandparents, one of whom was profoundly alcoholic. Out of six children, only one was normal but he never married. Of the others, two married and gave birth to several defective children and one normal child.

The conclusion to which these exceptionally striking pedigrees lead, although small in number, is that alcoholized individuals procreate defective children. These in their turn, if permitted, continue the chain of pathological condition. One such family is capable of throwing into the community dozens of useless or dangerous individuals, who, if capable of multiplying, will produce their like. If by depopulation is meant loss of individuals, not only in a quantitative but also in a qualitative sense, alcoholism is undoubtedly one of its causes.

Heredity consists of the transmission of physical and mental characteristics of parents to the offspring by means of the energy of the nuclear plasm of the characteristics of both cells follows. Should any change occur in the qualities of the plasm of the germ cells, a lasting alteration will develop in the hereditary energies of these cells. Alcohol is one of the agents capable of producing the blastophthoria of Forel or germ deterioration, which, in its turn, causes many anomalies and defects, involving the embryonal development of various organs. Blastophthoria or germ deterioration can be perpetuated for many successive generations through habitual hereditary transmission.

COMPARATIVE RUST RESISTANCE OF SHINGLE NAILS

By J. A. Ferguson

Forestry Department, The Pennsylvania State College

The literature of trade magazines for many years has contained articles on the relative lasting qualities of shingle nails. Especially was this true twenty years or more ago when the modern wire nail began to supplant the old fashioned blue cut or wrought iron nail. It has been held by many that the wire nail is the inferior. In order to attempt to answer this question the Pennsylvania State Agricultural Experiment Station through the Forestry Department of The Pennsylvania State College in 1914 started a test to compare the rust resistance of different kinds of shingle nails by placing the nails on a roof under similar conditions.

The roof selected is on the wing of the Forestry Building at State College, Pennsylvania, with a southeast exposure, covering about 60 by 30 feet. The pitch is slightly steeper than is ordinarily used, being 4 to 9 or about 41° with the horizontal. The base for the shingles consists of 6-inch and some 8-inch boards spaced 4 inches apart, with no roofing paper between the boards and shingles, thus permitting full circulation of air to the under side of the roof. The rainfall at State College, Pennsylvania, averages about 39.1 inches per year. The mean relative humidity during the summer months for the past 10 years averages 77.1. The air is considered remarkably pure. In corrosion tests with metals by the American Society for Testing Materials, State College, Pennsylvania, was selected as a testing locality because of the purity of the air. Examinations have failed to detect the presence of sulphur gas or other impurities. It is possible that some of these factors may have a bearing on the results of this shingle nail test and should be considered in comparing the results with tests made in other localities.

The nails used were purchased locally. Shingles were the Eureka brand of red cedar shingles purchased by the College for repair purposes. The roof was divided into 5 sections, about 12 feet by 20 feet, and the shingles laid 5 inches to the weather. The following nails were used: wire nail, blue clad or old wrought iron cut nail, zinc clad, pure zinc, and pure copper nails.

An examination of the roof after 19 years shows the copper nails, zinc nails and zinc clad nails to be practically as sound as when introduced. The results with the wire nails and blue cut nails, however, were not what was expected. The examination shows that these nails, except for surface rusting, are practically as sound as the naturally more rust resisting nails. Comparing the wire nails with the blue cut nails, the wire nails are as sound as the latter. This is surprising also as the portion of the roof nailed with wire nails receives the drip from the upright part of the building. About 20% of both the wire and blue cut nails were a quarter rusted through. No reason was assigned for this other than cracks or imperfections in the shingles. So the result is contrary to the generally accepted opinion of the modern wire nail.

The roof in question is on a one-story wing. The first floor is a general classroom. Above is a storage for wood specimens. In other words the roof covers a dry loft. There is but little moisture in the air beneath the roof and consequently little condensation of moisture on the nails. Roofs that have been removed by carpenters because of failure of the wire nail have usually been found on investigation to be barn roofs or sheds. Hay and other moist material placed in a barn naturally give off considerable moisture as do cattle and horses. The greater humidity in the air in such structures would naturally tend to cause greater condensation of moisture on the nails from the under side of the roof, and so a greater tendency to rapid rusting.

Is the rusting of nails in shingle roofs due more to the moisture content of the air inside the building than to external conditions? Would it be fair to infer that the kind of nail to use in a shingle roof should depend on the use to which the building is to be put? If the above assumption is true it should be possible to gauge the kind of nail that should be used with roofs shingled with western red cedar shingles by the use of the building, so that the life of the shingles and the nails would be practically equal.

MITOCHONDRIA OF INSECT INTESTINAL TRACT

By Clarence A. Horn
Albright College, Reading

This study is an outgrowth of a larger study of the general metabolic processes taking place in the anterior end of an insect's intestinal tract secreting enzymes for the digestion of the foods as they pass along the tract. There are secreted in this region of the intestine, proteolytic, carbohydrate and fat splitting enzymes. The fluid of the anterior intestinal tract has a pH 7.2. It was desirous to know what morphological changes take place in the mitochondria of the cells, and possibly some method of secretion of the enzymes.

Shaffer, E. L. (1920), Princeton, described the mitochondria in the germ cells of Cicada (Tibicen) septemdecim. In all stages of the spermatogonia, the mitochondria are in the form of granules, usually localized at the end of the cell directed toward the cyst cavity. Very often they are located diffusely throughout the cell. During mitosis the mitochondria are spread along the outer spindle fibers and by the time the telophase and cell constriction occurs, the mitochondria become grouped as granular masses, lying above the daughter nuclei. During the stage of maturation, the mitochondria appear in granular and filar forms. The number also increases, although there is no evidence that they increase by any process of pairing. In the cell, the mitochondria begin to migrate from one pole towards the opposite side and finally surround the entire spindle. In the spermatids, the mitochondria become more deeply stained and are collected into a compact mass called "Nebenkern." In the oocytes, the mitochondria are always in the form of granules, never assuming the filer form. During the latter synaptic stages the amount of mitochondria is greatly increased, which is localized at one pole in homologous position to that in the spermatogonia. After synapse the mass of mitochondria is still found at one pole of the nucleus, but gradually it completely encircles the nucleus. During the growth period, the mitochondria increase greatly in number and continue to be located in the delimited perinuclear zone. At the later stage of the growth period, mitochondria disperse toward the periphery. Vacuoles are formed, in which are mitochondria as is shown by their staining reactions. In the later stages of maturation of the oocytes, when this dispersal of mitochondria is at its height and vacuoles are formed, the cytoplasm will more easily take the basic dyes, at which time large amounts of yolk granules appear in the cytoplasm.

FIG. 8. A. Regenerated cell showing the spherical mitochondria diffusely scattered throughout the distal region of the cell, and the ciliated cuticle beginning to rupture. B. The secreting cell with ruptured cuticle with cytoplasmic material and fragments of mitochondria being poured into the lumen of the intestine. C. Regenerated cell with rod-shaped mitochondria located in the base of the cell extending distally as far as the nucleus.

Beans (1928) observed the mitochondria of the mammary glands of the albino rat during secretion. He says the mitochondria in the early stage of secretion of the cells are rod-shaped and at other times spherical and evenly distributed throughout the cell.

Shinoda (1926), Japan, was the first to study mitochondria of the intestinal tract of the insects. He used as his material the tract of the larva of the wild silkmoth. As to structure he classified the cells into two groups: cylindrical, and goblet cells. The first group is divided into two classes: secretory, and absorbing. The mitochondria of the first class during the stage of secretion were spherical in form and densely distributed throughout the cell which disappeared during the period of senescence and now restricted to the basal portion of the cell. In the second group, no mitochondria were seen. Shinoda fixed the tissues in Bouin's solution and in the different grades of alcohol.

The study of mitochondria to be described was made on the anterior portion of the intestinal tract of tobacco or tomato hornworms (Phlegethontius sexta). The actively feeding larva were opened and the digestive tract removed and placed in Bensley's fluid for 24 hours. Sections were cut 4–5 μ thick. Bensley's methyl green acid fuschin method for staining was used. The mitochondria stained red.

I have grouped these cells structurally into (1) The secreting cells. (2) Goblet cells. The cells of the first group are long columnar cells with the nuclei located nearly central slightly toward the base of the cell. The goblet cells are of the type found in vertebrate animals.

The secreting cells are divided according to location and structure of the mitochondria into three groups, namely, (1) Functional, 2) Degenerating cells, and (3) Regenerating cells.

The mitochondria in the functional secreting cells are small spherical granules densely and evenly distributed throughout the cell. In many of the cells large pinkish granules were seen scattered throughout the cell, more densely around the nucleus. In some cells during secretion the granules at the basal two-thirds of the cell are large spherical bodies, but as the distal third is approached there is a marked demarcation, where the granules seem to disintegrate into smaller spheres and particles.

Just before secretion takes place the free end of the cell is ciliated. This free end, the cell membrane or cuticle, breaks open and allows the cellular material to be given off into the lumen of the fore intestine. This cellular material is secreted from the cell in the form of round and oval masses, almost like globules of fat. After the secretion of the greater part of the material of the cell, the cell seems to degenerate to such an extent that the cell seems empty except that the basal region remains normal as far as cytoplasm is concerned. The nucleus also at this time becomes smaller and indistinct and moves more to the basal region of the cell. In some cases nearly all of the nuclear material has disappeared.

After a period of rest the cell begins to regenerate itself by forming a new cell membrane in the place where the cuticle was ruptured and torn. The new membrane then becomes ciliated. The mitochondria and cellular substance seem to be formed from the remaining materials from the base of the cell.

The mitochondria form as small spherical bodies arranging themselves along the inner surface of the cell wall. The distal end remains clear for a time, but as regeneration progresses the mitochondria become evenly distributed throughout the cell and become very numerous. In some of the cells, toward and near the base of the cell, rod-shaped granules were found, arranged parallel to the long axis of the cell; elsewhere in the cell spherical bodies appeared.

It seems that the breaking up of the spherical mitochondria into small particles at the time when secretion begins is significant and shows that a chemical and physical change of the cytoplasm takes place at this time. Giroud, A., conducted microchemical tests on the intestinal cells of Ascaris, in which was shown the presence of complex proteins and lipoids. The sulphydril group, which was always present, was shown to be more or less intimately linked with these substances.

When the regeneration of the cell is in progress, the formation of rod-shaped mitochondria in the basal region of the cell, which later become

A very usual, but by no means invariable, arrangement of the chromosomes at the first metaphase plate is with the four small members about equidistant from each other at the center, and the six larger chromosomes rather regularly spaced around them with the long axes radiating from the center of the plate. This suggests the comparisons between chromosome arrangement and the position assumed by floating magnets discussed by Kuwada and others.[3] The theoretical arrangement given for ten elements is three at the center and seven in the peripheral ring. However, in the figures given, the elements are of about the same size, while in the Polygonatums it is the four small chromosomes that are often found in the center of the ring.

Smear preparations made with dilute iron-aceto-carmine show, at least in each of the larger chromosomes, a single coiled chromonema at second anaphase. At first anaphase the ultimately single coils are already partly separated. At first metaphase the suspected quadripartite structure has not been observed, but it is apparent that these chromosomes represent some sort of a chromonematal complex. It is hoped that other Liliaceae with larger chromosomes will yield more information on this point.

SOME INTERESTING ALGAE FROM WESTERN PENNSYLVANIA

By J. Lincoln Cartledge
University of Pittsburgh

Since the time of Francis Wolle, whose identifications and descriptions have been the despair of algologists ever since, interest in fresh-water algae seems to have been at low ebb in Pennsylvania, and even the earlier collectors seem to have neglected the western half of the State. Recently Gottschall has reported on the plankton forms of Presque Isle Bay, and Morrissey has listed the algae of the pools on Presque Isle; both in the proceedings of this Academy. Van Dersal has prepared an extensive list of the Myxophyceae of Pennsylvania, which is considerably amplified by his own collections in the western part of the State. In connection with a course on algae at the University of Pittsburgh we have made a considerable number of collections in the western counties. An intensive study of the local algal flora would require repeated collections at brief intervals throughout the year. Many of the Chlorophyceae may be identified only when they are in fruiting condition, and many of these fruit

[3] Kuwada, Y. (*et al.*) Chromosome Arrangement. Mem. Coll. Sci. Kyoto Imp. Univ., Series B, 4(3): 199–369. 1929.

spherical bodies in the more distal region of the cell, has also a place in the metabolism of the cell in the formation of enzymes for digestive purposes.

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CHROMOSOMES OF POLYGONATUM

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Pollen-mother-cells of *Polygonatum biflorum* and *P. commutatum* were studied in iron-aceto-carmine smear preparations. The best results were obtained when the stain was much more dilute than is usually recommended. Some of the slides were later dehydrated and mounted in damar. The chromosomes were found to be ten in number for both species. Of these six are large and four are small, while all are smaller than the chromosomes of many of the better known species of the Liliaceae. Twelve haploid chromosomes have been reported for the species *P. multiflorum* by von Boenicke.[1] Ten is an unusual chromosome number for this family, although the rather closely related *Asparagus officinalis* has also ten haploid chromosomes, of which six are likewise large and four small.[2]

[1] von Boenicke, L. Ber. Deutsch. Bot. Ges. 29: 59–65. 1911.

[2] Kamo, I. Bot. Mag. (Tokyo). 43: 127–133. 1929.

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in the summer when we are unable to collect them. While these collections would be inadequate for a comprehensive account or list of the algal flora, a number of forms have been found, which, for some reason other than the record of their occurrence, seem to be of sufficient interest to note.

The yet unfinished portions of the lawn surrounding our towering monument to a period of past prosperity—the Cathedral of Learning—has numbers of rain pools in it, and these have yielded several species of algae. In a period of drying during October, the margin of one of these pools was carpeted with a pure stand of *Protosiphon botryoides*. Protosiphon is a terrestrial alga, which, it seems, is often both in nature and in the minds of the students of algae, mixed with members of the heterokont genus *Botrydium*. We found *Botrydium* mixed with *Protosiphon* on another part of this same lawn, and also separately at Pymatuning swamp. Although essentially similar in appearance, these two forms may be distinguished by the somewhat larger size, darker color, and more globular vesicle of the *Botrydium*; but especially by the behavior of *Protosiphon* in culture, and by the compact bundles of individuals in this latter form, apparently the result of vegetative division of the plant. When rapidly dried in the laboratory, the *Protosiphon* plants formed a number of rounded cysts. Those in the rhizoidal portions became orange-red; those in the vesicular portion remained green. Upon being flooded with water the green cysts released bi-ciliate swarm cells, in 2–4 hours, some of which were observed to function as gametes. Approach and contact was at the anterior end of the cell, and while attempting conjugation the two cells whirled round and round together, without moving very far from their place of meeting. After conjugation the zygote settled down, having lost motility. The unmated cells retained a high degree of motility for at least several hours. Further observations on the fate of both swarmers and zygotes have not been made.

A number of aquaria are kept in our laboratories, chiefly for the decorative effect, and for the domiciling of some water plants and some tropical fish. One of these aquaria became coated with a small attached green alga on one inner face. When this material was scraped off we found that we had an unusually pure and an unusually dense stand of a species of *Characium*, identified as *Characium pringsheimii*. About a month later, after most of the Characium had been disposed of, the same aquarium turned dense green throughout, the water being filled with minute, floating green cells. Many of the fish died, due possibly to the concentration of the alga. I am convinced that this was the same form as that described by Smith under the name of *Golenkinia radiata* in the plank-

ton of the Wisconsin lakes, although our specimens are somewhat smaller. The wall of the cell is studded with long and very delicate bristles—so delicate indeed that they are to be seen only with difficulty. The bristles become apparent when the cells are dried on the slide, or when they are stained in acid fuchsin. They might very easily be overlooked in usual methods of preserving or mounting specimens.

Microthamnion kuetzingianum has been found in several collections; attached to *Vaucheria* filaments, or free-floating with other algae. The miniature size and the curious and regular branching of this alga make it at once a most distinctive and a most ornate form. *Trentepohlia aurea*, an orange-colored alga which is well adapted to aerial habit, is said to be rarely found without lichenizing fungi. Possibly because of this we have not found it as common as was to be expected, but one collection made among mosses in a rather dry place yielded this form without any trace of lichenization.

Lemanea grandis (described by Wolle under the name of *Tuomeya grande*, although it is apparent from his own description that it belongs to the genus *Lemanea*, and not to *Tuomeya*) was collected in immature condition from rocks in swift running water. Differing from other *Lemanea* species in the absence of external nodal swellings, this species showed extensive development of the filamentous Chantransia stage. A much simpler red alga, the coccus form known as *Porphyridium cruentum* may occur in this region under natural conditions, but so far we have found it only in its adopted habitat, on the wet earth floors and benches of green-houses.

Of the forms mentioned in these notes the *Protosiphon* and *Golenkinia* seem not to have been previously reported for this State. However, Wolle's figures for *Botrydium granulatum* include some which are unmistakably *Protosiphon*. Wolle lists the *Lemanea* as found at Bethlehem, and it is inferred from his text that *Porphyridium* was also collected there. Collins cites *Characium pringsheimii* from Pennsylvania, but does not name this State in the distribution of the other forms, all of which are treated in Wolle's book without citation of locality. The appended bibliography includes the works used in identifying the species noted.

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THE BLUE-GREEN ALGAE OF PENNSYLVANIA

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The list of plants here presented includes all the members of the Myxophyceae occurring in Pennsylvania as far as known to the authors. The majority of them (94 species) have been reported in various other places; the remainder (54 species) are here published for the first time. It seems of value to publish a complete check-list since, in the comparatively unstudied group of blue-grass algae, the last work done in this State prior to 1930 was published by H. C. Wood in 1872 and by Francis Wolle in 1886. The species found by these men are included in Tilden's work on the Minnesota Algae.

As will be observed, the date of collection of specimens is not given below. The reports of Wolle and of Wood, who collected mostly in eastern Pennsylvania, do not include the date except in a few instances; nor do they, incidentally, include very exact localities. Collections by Mrs. A. B. Lord, of Pittsburgh, were made from 1925 to 1930. Dr. R. Y. Gottschall in connection with his plankton work at Lake Erie during 1931–32 found 13 species in the free-floating forms in Presque Isle Bay at Erie, Pennsylvania. Collections by Mr. W. R. Witz and the authors were made from 1932 to 1933. All the collections except those of Wood and Wolle, were made in western parts of the State.

In the determinations of specimens the following books were used by the authors in order named:

A. Pascher's Die Susswasserflora Deutschlands Österreichs, und der Schweiz, Heft 12, Cyanophyceae, by L. Geitler, 1925; Minnesota Algae, Volume I, by Josephine Tilden, 1910; J. B. De Toni's Sylloge Algarum, Volume V. Myxophyceae, by A. Forti, 1907; Algae, Volume I, Myxophyceae, etc., by G. S. West, 1916; Green Algae of North America, Tuft's College Studies, Volume IV, No. 8, by F. S. Collins, 1905–1909; Phytoplankton of the Inland Lakes of Wisconsin, Part 1, by G. M. Smith, 1920; Fresh-Water Algae of the United States, by Francis Wolle, 1887; and the Contributions to the History of the Fresh-Water Algae of North America, by H. C. Wood, in 1872.

In the list below, the classification given in the Sylloge Algarum is followed except that the genus *Arthrospira* is included in *Spirulina*, and any species of *Gloeotrichia* is separated from *Rivularia* if the specimen possesses spores (dauerzellen). Both these changes are in accord with Geitler's work given above.

All specimens noted below which were collected by Van Dersal are deposited in the Herbarium of the Carnegie Museum, both in the form of permanent slides and as bottled material preserved in suitable solutions. They are here available for further study.

LIST OF THE SPECIES OF MYXOPHYCEAE OCCURRING IN PENNSYLVANIA

Chroococcaceae

1. *Chroococcus rubrapunctus* Wolle. Old wood basins, etc.; Wolle.
2. *C. multicoloratus* Wood. Wet rocks; Wood.
3. *C. decorticans* A. Braun. Submerged timbers; Wolle.
4. *C. refractus* Wood. Wet rocks: Wood.
5. *C. minutus* (Kuetz.) Naeg. Idlewood, mixed with *Oscillatoria* growing along the edge of an open sewer; Lord. In cistern on road 5 miles south of Warrendale; Van Dersal.
6. *C. limneticus* Lem. Presque Isle Bay, Lake Erie; Gottschall.
7. *Synechococcus racemosus* Wolle. Glass sides of an aquarium; Wolle.
8. *Gloeocapsa granosa* (Berkeley) Kuetzing. Wet rocks; Wolle. On boards of greenhouse, Bakerstown; Van Dersal.
9. *G. polydermatica* Kuetzing. No locality; Wolle.
10. *G. sparsa* Wood. On rocks with other algae; Wood.
11. *G. magma* (Breb.) Kuetzing, var. *itsigshonii* (Bornet) Hansgirg. Shaded rocks; Wolle.
12. *G. kuetzingiana* Naeg. On old plank at edge of Geer's Pond, near Shermansville; Van Dersal. Wildwood, on wet rocks; Van Dersal.
13. *G. caldariorum* Rab. On old wood, Tree's greenhouse, Treesdale; Van Dersal.
14. *G. muralis* Kuetzing. Wet rocks, Wildwood; Van Dersal.
15. *Gloeothece confluens* Naegeli. Wet rocks; Wolle.
16. *G. magna* Wolle. On water plants or floating in ponds; Wolle.
17. *Aphanocapsa grevillei* (Hassall) Rabenhorst. Submerged stones in shallow pool; Wolle.
18. *A. rivularis* (Carmichael) Rabenhorst. In ponds on wood or stone; Wolle. On soil, Penn State greenhouse, State College; Van Dersal.
19. *A. elachista* W. and S. G. West. Presque Isle Bay, Lake Erie; Gottschall.
    var. *conferta* W. and S. G. West. Presque Isle Bay, Lake Erie; Gottschall.
20. *A. biformis* A. Braun. On soil, Phipp's Conservatory, Pittsburgh; Van Dersal.
21. *A. delicatissima* W. and S. G. West. Presque Isle Bay, Lake Erie; Gottschall.
22. *Aphanothece pallida* (Kuetzing) Rabenhorst. Wet or marshy ground; Wolle.
23. *A. nidulans* P. Richter. Presque Isle Bay, Lake Erie; Gottschall.
24. *A. naegelii* Wartm. On rocks and in moss clumps, near Dunbar; Van Dersal.
25. *Microcystis pulverea* (Wood) Migula. Bottom of limestone springs; Wolle.
26. *M. piscinalis* (Bruegg) DeToni. In pools; Wolle.
27. *M. flos-aquae* (Wittr.) Kirch. Presque Isle Bay, Lake Erie; Gottschall. Mud Lake, Hartstown; Van Dersal.
28. *M. holsatica* Lemm. Aquarium, Carnegie Museum Herbarium; Van Dersal.
29. *Clathrocystis aeruginosa* Kuetzing. Presque Isle Bay, Lake Erie; Gottschall.
30. *Gomphosphaeria aponina* Kuetzing. Presque Isle Bay, Lake Erie; Gottschall. Crystal Lake, Hartstown; Van Dersal.
    var. *cardiformis* Wolle. Small ponds; Wolle.
31. *Coelosphaerium dubium* (Grunow.) Rabenhorst. Scum on a stagnant brick pond; Wood.

32. *C. naegelianum* Unger. Crystal Lake and Mud Lake, Hartstown; Van Dersal.
33. *Merismopedium elegans* A. Braun. Entangled in filamentous algae, Schuylkill River, Philadelphia; Wood. Presque Isle Bay, Lake Erie; Gottschall.
34. *M. convolutum* (Brebisson) Kuetzing. Layer on mud, pool near Philadelphia; Wood.
35. *M. glaucum* (Ehr.) Naegeli. Presque Isle Bay, Lake Erie; Gottschall.
36. *M. tenuissimum* Lemm. Presque Isle Bay, Lake Erie; Gottschall.
37. *Eucapsis alpina* Clements and Shantz. In the cold water from the overflow of a gas well, Rochester Mills; Lord. (Doubtful).

CHAMAESIPHONACEAE

38. *Chamaesiphon incrustans* Grun. On roots in shallow water, Crystal Lake, Hartstown; Van Dersal.

OSCILLATORIACEAE

39. *Oscillatoria princeps* Vaucher. Bethlehem; Wolle.
40. *O. proboscidea* Gomont. Shallow ditches along railroad track, Manayunk; Wood.
41. *O. major* (Aubert) Scarbro. Ponds and pools; Wolle.
42. *O. bonnemasonii* (Crouan) Desmazieres. Wet, recently inundated soil; Wolle.
43. *O. tenuis* Agardh. Dripping mossy rocks, pools, and free-swimming in hot water; Wolle. On soil, greenhouse at Canonsburg; Van Dersal.
44. *O. chlorina* Kuetzing. Stagnant brick pond near Philadelphia; Wood.
45. *O. violacea* (Wallroth) Hassall. Greenhouses; Wolle.
46. *O. cruenta* (Grunow.) Rabenhorst. Mountain spring at 1500 feet; Wolle.
47. *O. cortiana* Meneghini. Floating on hot waste water at a large steam mill, Bethlehem; Wolle.
48. *O. agardhii* Gomont. Growing on the outside of a barrel at a spring, Raccoon Creek, Beaver County; Lord. On soil at Allen's Spring, Idlewood; Lord. On soil of dry creek bottom, Harmarville; Lord.
49. *O. limosa* Ag. Pot of soil, Phipp's Conservatory, Pittsburgh; Lord. Greenhouse pool, Canonsburg; Van Dersal. Stream-bottom near Shermansville; Van Dersal. In a mucilaginous mass attached to plants and dead leaves in a spring at Harmony Junction, Butler County; Lord. Edge of a stagnant pool, North Trafford; Lord. Surface of mud along Raccoon Creek, Beaver County; Lord.
50. *O. nigro-viridis* Thwaites. Bottom of an open sewer, Idlewood; Lord.
51. *O. amphibia* Agardh. Edge of an open sewer, Idlewood; Lord.
52. *O. brevis* Kuetzing. Bottom of a running stream of mine water, Thornburg, Allegheny County; Lord. Mud along a stream, Glenshaw; Lord. Drainage from a spring, Idlewood; Lord.
53. *O. formosa* Bory. At edge of a swamp among *Cylindrospermum* spp.; Lord. Edges of an iron bucket at a spring 2 miles east of Finleyville; Van Dersal.
54. *O. anguina* (Bory) Gomont. In an aquarium, Botany Department, University of Pittsburgh; on soil of pots, Phipp's Observatory, Pittsburgh; and on the walls of several private aquaria about the city of Pittsburgh; Van Dersal.
55. *O. animalis* Ag. Phipp's Conservatory, Pittsburgh; Van Dersal.
56. *O. limnetica* Lemm. Mixed with other algae, in an aquarium, Johnstown; Van Dersal.
57. *O. nigra* Vaucher. Olive green layer on mud, bottom of pools around Cathedral of Learning, Pittsburgh; Van Dersal.

58. *O. sancta* Kuetzing. On soil at Phipp's Conservatory, Pittsburgh; Van Dersal. var. *caldariorum* (Hauck) Lager. Greenhouse, Penn State, State College; on soil, Canonsburg greenhouse; Van Dersal.
59. *O. splendida* Grev. Shore of lake near Canonsburg; Van Dersal.
60. *Spirulina jenneri* (Stitz.) Geitler. (*Arthrospira jenneri* (Kuetz.) Stitz.) Stagnant water; Wolle. Ten feet deep in Mud Lake, Hartstown; Van Dersal.
61. *Borzia trilocularis* Cohn. Water reservoir, Swissvale; Van Dersal.
62. *Phormidium laminosum* (Ag.) Gom. Quiet waters; Wolle. In an open sewer, Idlewood; Lord. On pot of soil, Carnegie Museum Herbarium, Pittsburgh; Van Dersal.
63. *Ph. incrustatum* var. *cataractum* (Naegeli) Gomont. Waterfalls and milldams; Wolle.
64. *Ph. naveanum* (Grunow.) Nave. Pools; Wolle.
65. *Ph. autumnale* (Ag.) Gomont. Damp earth; Wolle. In aquarium, below water level in sand against glass, Botany Department, University of Pittsburgh, Pittsburgh; Van Dersal.
66. *Ph. tenue* (Meneg.) Gomont. In open sewer, Idlewood; Lord.
67. *Ph. foveolarum* (Montagne) Gomont. In hollow places in rocks along road at Red Row, Idlewood; Lord.
68. *Ph. corium* (Ag.) Gomont. On pot of soil, Phipp's Conservatory, Pittsburgh; Van Dersal.
69. *Lyngbya ochracea* (Kuetz.) Thuret. Pennsylvania; Wolle.
70. *L. aesturarii* (Mertens) Liebman. In small ponds; Wolle. Lake near Canonsburg among other algae; Van Dersal.
71. *L. bicolor Wood.* Adherent in tufts to bottom of stream, Schuylkill River near Spring Mills, Philadelphia; Wood.
72. *L. nana* Tilden. Wet soil along driveway of Carnegie Museum, Pittsburgh; Lord.
73. *L. martensiana* Menegh. In pools of water, Trafford; Lord. On *Elodea canadensis* leaves, Crystal Lake, Hartstown; Van Dersal, W. R. Witz. Attached to a water plant in an aquarium, South High School, Pittsburgh; Lord.
74. *L. aerugineo-caerulea* (Kuetz.) Gomont. With *Lyngbya martensiana* on leaves of water plants, aquarium, South High School, Pittsburgh; Lord. In an aquarium, Pittsburgh; on mud in the overflow of a dam east of Dunbar; Van Dersal.
75. *L. putealis* Mont. On leaves of *Cabomba*, aquarium at Johnstown; Van Dersal.
76. *L. distincta* (Nords.) Schmidle. On submerged wood, Crystal Lake, Hartstown, and commonly on grass, sticks, logs etc., in water anywhere; Van Dersal.
77. *Symploca fuscescens* (Kuetz.) Rabenhorst. Pennsylvania; Wolle.
78. *S. muscorum* (Ag.) Gomont. On old logs, partially submerged; Wolle. var. *rivularis* (Wolle) Tilden. River Lehigh, Bethlehem; Wolle.
79. *Hydrocoleus homeotrichus* Kuetzing. On stones in rapid water, and in sphagnum swamps; Wolle.
80. *H. heterotrichus* (Kuetz.) Gomont. In swamp near Bethlehem; Wolle.
81. *Hypheothrix* (?) *hinnulea* (Wolle) DeToni. In trenches for warm waste water for steam engines; Wolle.
82. *H. tenax* Wolle. On stones in stagnant water; Wolle.
83. *H. bullosa* Wolle. Shallow sluggish water, Susquehanna River, Harrisburg; Wolle.

84. *H. turicensis* (Naeg.) Kuetzing. Moist rocks; Wolle.
85. *Inactis tinctoria* (Ag.) Thuret. On aquatic plants; Wolle.
86. *Schizothrix hyalina* Kuetzing. Wet rocks; Wolle.
87. *Dasygloea amorpha* Berkeley. In rocks with trickling water, in mountain ravine, Glen Onoko; Wolle.
88. *Microcoleus lacustris* (Rabenh.) Farlow. According to Setchell, this form was distributed as *Phormidium congestum* by Wolle, and was probably collected in Pennsylvania.
89. *Microcoleus paludosus* (Kuetz.) Gomont. On damp earth along a creek, Mars; Van Dersal.

NOSTOCACEAE

90. *Nostoc sphaericum* Vaucher. Adhering to mosses and twigs in water, Spring Mills, near Philadelphia; Wood.
91. *N. pruniforme* (L.) Agardh. In stagnant water, Bethlehem; Wolle.
92. *N. verrucosum* (L.) Vaucher. Cold limestone spring in Centre County; Wood.
93. *N. parmelioides* Kuetzing. Stones, rocky bottom of Susquehanna River, Harrisburg; Wolle.
94. *N. spongiaeforme* Agardh. On *Blasia pusilla* L., the leaf auricles, generally two at the base of each lobe, become filled with the colonies of this species, Patton's Bridge, Beaver County; Lord.
95. *N. muscorum* Agardh. On mosses on the bank of the falls in the ravine, Glenshaw; Lord.
96. *N. foliaceum* Mougeot. In mosses on cliff at Wildwood; Van Dersal.
97. *Nodularia paludosa* Wolle. Pennsylvania; Wolle.
98. *Nod. harveyana* (Thwaites) Thuret. On mud near ravine, Glenshaw; Lord.
99. *Nod. spumigena* Mertens. Vicinity of Pittsburgh, collector unknown.
100. *Anabaena circinalis* (Kuetz.) Rabenhorst. In scum on a brick pond; Wood.
101. *A. oscillarioides* Bory. In dark grottoes framed by shelving rocks, Reading Railroad just above the Flat Rock Tunnel; on wet ground by a horse trough, near west end of upper bridge at Manayunk; on banks of the Schuylkill River, vicinity of Philadelphia; Wood. On dripping rocks and on wet ground; Wolle.
102. *A. gelatinosa* Wood. Near Philadelphia; Wood.
103. *A. subrigida* (Wood) DeToni. In scum floating on ditches near Philadelphia; Wood.
104. *A. flos-aquae* Kuetzing. Presque Isle Bay, Lake Erie; Gottschall.
105. *A. lemmermanni* P. Richter. Presque Isle Bay, Lake Erie; Gottschall. Floating, north end of Mud Lake, and in sluggish creek between Mud and Crystal Lakes, Hartstown; Van Dersal.
106. *A. limneticus* Smith. Floating along with diatoms in Mud and Crystal Lakes, Hartstown; Van Dersal.
107. *Aphanizomenon flos-aquae* (L.) Ralfs. In surface plankton in Crystal Lake, Hartstown; Van Dersal.
108. *Cylindrospermum majus* Kuetzing. Near a spring, McKeesport; edge of the swamp, Harmarville; Lord. On soil at Presque Isle, Erie; W. R. Witz, Van Dersal.
109. *C. minutum* Wood. With other algae on soil in dense shade, Powers Run; on banks along roadside, Sandy Creek; with moss protonemata, New Kensington; Lord.

110. *C. comatum* Wood. Damp soil along a stream, Raccoon Creek, Allegheny County; Lord. Phipp's Conservatory, Pittsburgh; W. R. Witz, Van Dersal. (?) Tree's greenhouse, Treesdale, Butler County, on soil; Van Dersal. (?)
111. *C. catenatum* Ralfs. Edge of creek tributary, Raccoon Creek, Allegheny County; Lord. On soil along road, Sandy Creek; on soil near edge of swamp, Harmarville; Lord.
112. *C. stagnale* (Kuetz.) Born. et Flah. Wall of an aquarium, Johnstown; Van Dersal.
113. *C. licheniforme* (Bory) Kuetzing. On soil of flowerpots, Phipp's Conservatory, Pittsburgh; on swampy ground, Raccoon Creek, Beaver County; Van Dersal.

SCYTONEMACEAE

114. *Plectonema tomasinianum* (Kuetz.) Bornet. Attached to mosses in a large spring which supplies Bellefonte with water; Wood. In spring, Bethlehem; Wolle.
115. *P. wollei* Farlow. Bethlehem; Wolle.
116. *Scytonema crispum* (Ag.) Bornet. In a pond near Bethlehem; Wolle.
117. *S. ocellatum* Lyngbye. Moist rocks and shaded walls; Wolle. On soil of pots in Phipp's Conservatory, Pittsburgh; Van Dersal.
118. *S. austinii* Wood. On rocks; Wolle.
119. *S. guyanense* (Montagne) Bornet et Flahault. On calcareous rocks; Wolle.
120. *S. myochrous* (Dillwyn) Agardh. Moist ground and on dripping rocks; Wolle. In mosses along cliff, ½ mile north of Oakmont; on rocks east of Dunbar; Van Dersal.
121. *S. crustaceum* Agardh. Not infrequent on wet cliffs; Wolle.
122. *S. javanicum* (Kuetz.) Bornet. On stones in the Godwin Greenhouses, Bridgeville; Van Dersal.
123. *Tolypothrix tenuis* Kuetzing. On very wet rocks, Dunbar; on old plank in water of Crystal Lake, Hartstown; Van Dersal.
forma *bryophila* Rabenhorst. Pennsylvania; Wolle.
124. *T. lanata* (Desvaux) Wartmann. Adherent to aquatic plants in an aquarium, Philadelphia; Wood.
125. *T. rupestris* Wolle. On dripping rocks, Delaware Water Gap; Wolle.

STIGONEMACEAE

126. *Hapalosiphon flexuosus* Borzi. On pupa cases attached to rock, and among other algae on which water is constantly falling; Lord.
127. *H. fontinalis* var. *tenuissimus* (Grunow) Collins and Setchell. Pennsylvania; Wolle.
128. *H. intricatus* W. West. On sphagnum in orchid pots, Phipp's Conservatory, Pittsburgh; on *Potamogeton* leaves, Crystal Lake, Hartstown (?); Van Dersal.
129. *Stigonema panniforme* (Ag.) Kirchner. Wet mountain cliff, Pike County; Wolle.
130. *S. minutum* var. *saxicola* (Naeg.) Bornet et Flahault. Pennsylvania; Wolle.
131. *S. turfaceum* (Berkeley) Cook. On rocks near Philadelphia; Wood.
var. *parvus* Wood. On rocks along Wissahickon Creek near Philadelphia; Hunt.
132. *Nostochopsis lobatus* Wood. Floating, Schuylkill River just above Manayunk; Wood.

RIVULARIACEAE

133. *Calothrix fusca* (Kuetzing) Bornet et Flahault. Pennsylvania; Wolle.
134. *C. violacea* (Walle) DeToni. Parasitic on *Plectonema* in shallow river waters; Wolle.
135. *C. castellii* (A. Massalongo) Bornet et Flahault. On shelves, walls and flower pots, greenhouses, Harrisburg; Wolle.
136. *C. donnellii* (Wolle) DeToni. Pennsylvania (?) Wolle.
137. *C. adscendans* (Naegeli) Bornet et Flahault. Pennsylvania (?) Wolle.
138. *Dichothrix baueriana* (Grun.) Bornet et Flahault. On old zinc tank walls, Phipp's Conservatory, Pittsburgh; Van Dersal.
139. *Mastigonema elongatum* Wood. Moss in an aquarium; Wood.
140. *M. fertile* Wood. Stagnant pool at Bear Meadows, Centre County; Wood.
141. *M. fibrosum* Wood. Wet dripping rocks near Manayunk; Wood.
142. *M. paradoxum* Kuetzing. Wet sides of wooden water box; Wolle.
143. *Mastigothrix turgida* Wolle. Gelatinous coatings on submerged timbers; Wolle.
144. *Gloeotrichia natans* (Hedwig) Rabenhorst. On water plants, Bethlehem; Wolle. Incrusting leaves of *Potamogeton robbinsii*, Crystal Lake, Hartstown; Van Dersal.
145. *G. incrustata* Wood. On water plants, Schuylkill River near Spring Mills. Philadelphia; Wood.
146. *G. pisum* (Ag.) Thuret. On leaves of *Potamogeton robbinsii* in Crystal Lake, Hartstown; Van Dersal.
147. *Rivularia paradoxa* (Wolle) DeToni. Pennsylvania; Wolle.
148. *R. haematites* (DC) Agardh. Stones, Susquehanna River; Wolle.

APPLIED GEOLOGY[1]

BY R. W. STONE
Geological Survey, Harrisburg

Many people, including members of the Legislature, have only a faint idea, if any, as to the uses of geology. They know perhaps that geology has to do with rocks and minerals and that the State Geological Survey makes maps showing the distribution of different kinds of rocks or rock formations. Some appreciate also that geologists can identify minerals and tell what they are good for and whether or where there is a market for them. Few people, however, have any real appreciation of the application of geology to business or the affairs of every-day life.

Geology is a science, and the sciences are divisible into two kinds, pure and applied. Pure science is the pursuit of knowledge for itself alone. Applied science is the making use of that knowledge in business. In geology as in other sciences, the attainment of knowledge must precede the application of knowledge. The geologist must determine by field experience the relation of mineral deposits to their inclosing bedrock before he can indicate the places where such deposits may reasonably be sought.

[1] Published with permission of the State Geologist.

The earlier Geological Surveys were engaged largely in pure science; they were seeking knowledge of Pennsylvania's rocks and minerals, laying the foundation for future application of that knowledge. The present Survey continues that search for knowledge, pure science, but it also is applying the accumulated knowledge in the solution of problems of public and private welfare and interest.

The work of the Survey directed toward the attainment of increased knowledge of the geology and mineral resources of the State is its principal and most important function, but the usefulness of the Survey to the taxpayers will be better understood by a recitation of some of the problems brought to it for solution.

In recent months some of the more important questions have had to do with ground-water supply. When a State hospital with nearly 200 patients was suddenly deprived of its water purchased from a town water company, the Survey helped by selecting a well site and suggesting the probable depth to be drilled. At a State school where several wells were being pumped the problem was where to locate a well for increasing the supply without affecting the discharge from wells already in use. A village in Adams County wanting more water asked the Survey if there was any choice in well sites and the selectmen were shown that an inconspicuous dike of trap rock probably limited the catchment area of their preferred site and that a well located on the other side of the dike would require a few hundred more feet of pipe line, but have a much greater catchment area and storage capacity and presumably larger and more permanent yield.

Studies of the occurrence of ground water have now been made of about two-thirds of the State. With the information thus obtained as to the principal aquifers, together with detailed knowledge of the stratigraphy and structure, it is possible in many instances to give definite answers as to the depth at which water may be obtained and as to the character of the water, whether hard, soft, fresh, or salt.

As for the coal areas, particularly the bituminous field, detailed geologic mapping shows the outcrop of the various coal beds, innumerable measurements in mines and deep wells give the variations in thickness of the individual beds, and of the distance between them. The lay of the beds also has been worked out. With all these data, the Geological Survey is prepared to tell a land owner whether his holdings are underlain by coal, and if so at what depth, how thick the coal beds are, and how many tons of coal are probably recoverable.

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The Associated Press asked the State Geologist last fall what was the chance of coal being found near Elizabethtown in Lancaster County by

150 men then busily prospecting for it. The reply was "No chance. Coal does not occur in commercial quantity in the Cambro-Ordovician and Triassic rocks that form the surface near Elizabethtown." It was not necessary for a geologist to visit the locality in order to answer the question for the area had been mapped geologically and knowledge of the age of the rocks made it possible to answer definitely that the project was futile.

Similarly when local residents claimed that beds of coal had been found in Mifflin County the Survey could say "You may have found something that looks like coal but it is not coal." The Survey does not get excited about such announcements and usually can calm the excitement of others. In this case the geologic maps show that the rocks in that area are of Silurian or older age, rocks that were laid down long before seed-bearing plants had appeared on the face of the earth and so before there was vegetation to make coal. The supposed coal proved to be black shale that had been squeezed and rubbed during folding of the rocks in the earth's crust and had developed shiny surfaces that made it look like coal. Being only a shale of course it would not burn.

For a similar reason all attempts to find oil and gas east and south of the Allegheny Front are discouraged by geologists. Although the rocks may have contained enough organic matter to form oil or gas when originally deposited, they have subsequently been so metamorphosed, fractured, and turned on end that any hydrocarbons once contained in them have long since been distilled off or become dissipated by escape. So by application of knowledge of the constitution and structure of the rocks needless expenditure for what would prove to be a vain search can be forestalled, if only prospectors or prospective investors would consult the Geological Survey first or abide by its advice.

A more constructive application of geologic science is that which directs the driller to the most likely or favorable structure to test for oil or gas, and tells him the depth at which he may expect to find certain sands that are productive in other fields. In the last two field seasons the Geological Survey has mapped the location of the continuation of the structures on which the Farmington and Hebron gas fields were discovered and traced the axes of other anticlines for many miles across the northern counties, thus indicating where future drilling is most likely to be productive.

A study of our molding sand resources resulted in showing certain foundrymen in central Pennsylvania that while they were paying more than $100 per car freight charge on sand from Albany, N. Y., molders of the same product in Buffalo, N. Y., were getting their sand from central Pennsylvania. In other words, they could get sand of the same quality within 50 miles and save $100 a car in freight.

Pointing out locations for roadside quarries to furnish construction material and save long distance truck haulage to specific jobs is applied geology, as is also the listing of mineral resources along rivers proposed for improvement or along projected railroads.

Another service performed by the Geological Survey, and at times proving of almost inestimable value to the inquirer, is that of discussing the pros and cons of a proposed mineral development. Many factors, including quantity of ore or mineral, accessibility, distance from a railroad or market, freight rates, competitive products, cost of preparation or refining, capacity of competing plants, etc., are sometimes overlooked by prospective producers and when called to their attention are determinative as to procedure.

Such common inquiries as to where limestone of specified chemical composition or building stone of a certain kind can be found, or by whom it is produced can now be answered from the data accumulated in past investigation.

We know now that lead and zinc ores are confined to certain limestone areas, that the principal occurrence of native copper is in the old lavas in South Mountain on the Adams-Franklin County line, that feldspar occurs in commercial quantity only in pegmatites in Delaware and Chester counties, and graphite deposits are limited to the greatly metamorphosed pre-Cambrian and early Paleozoic rocks of the southeast corner of the State. There is an annual output of gold to the value of several thousand dollars as a by-product from concentrates derived from the magnetic iron ore mined at Cornwall, Lebanon County, but reports of gold ore from other parts of the State are assumed at once to be erroneous identification and prove usually to be iron pyrite or yellow flakes of mica.

The Geological Survey not only serves the public but also the various departments of the State government. Recently the Highway Department called on the State Geologist for an opinion as to whether the dislodgment of several thousand tons of rock in a road cut could have been foreseen and so whether the cost of its removal devolved on the State or on the contractor.

The Survey has been asked by the Game Commission whether title to lands in a proposed game refuge was weak because of non-transfer of mineral rights. Money has been saved for the Aeronautical Commission in the designation of a source of white rock for markers on landing fields, the Welfare Department has been advised on sources of building material, and other departments similarly are assisted in problems having to do with geology and mineral resources.

Further instances would only reiterate the point that the practical application of geologic principles to the problems of every day justify the continued maintenance of trained geologists in the employ of the Commonwealth.

INEXTENSIBLE CHAINS ON FIXED PLANE CURVES

By Jos. B. Reynolds

Lehigh University, Bethlehem

It is the purpose of this paper to present a method of treating the theory of flexible chains so as to bring under one head subject-matter that is ordinarily given as several distinct treatments. Two equations of motion containing parameters are derived. When proper values are assigned to these parameters the equations lead to the analysis of the following cases:

I. The motion of a chain sliding down the line of greatest slope of a plane with or without a portion hanging vertically over the edge.
II. The theoretical rim tension in fly-wheels.
III. The theory of snubbing and cases neglecting the mass of the chain.
IV. Belt tension taking into account the speed and weight of the belt.
V. The uniform chain suspended between two points.
VI. The theory of cables of suspension bridges for uniform horizontal load.
VII. The chain of uniform strength suspended between two points.
VIII. The elastic catenary.
IX. The motion of a chain on a smooth inverted fixed cycloid and other curves.
X. The velocity attained when a chain slides down any fixed smooth curve in a vertical plane.

Details of the solution will be given in Cases I and X and the required substitutions and final results in the other cases.

To develop the general theory, suppose a perfectly flexible, inextensible chain (Fig. 9) threaded on a rough curve in a vertical plane.

Consider the equations of motion for a short length Δs of the chain of weight ΔW. Let the position of this Δs be at a distance s measured along the arc of the curve from some fixed point of reference. Let the

nearer end of the chain be at a distance σ from the reference point and the further end at a distance $\sigma + l$ measured along the arc of the curve. Suppose the chain to be moving with a velocity v in the sense of increase of s. Let the tangent to Δs at the end nearer the reference point make an angle ϕ with a fixed horizontal line, OX, of the plane.

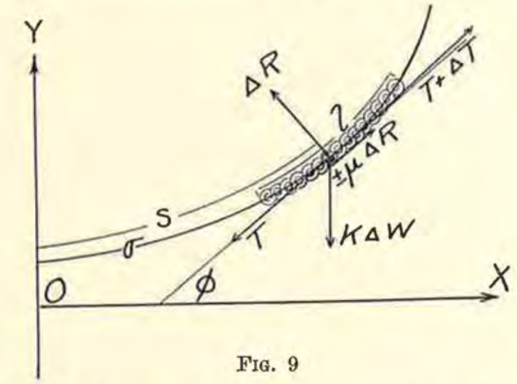

Fig. 9

Then there will act upon ΔW the reaction, ΔR, of the curve normal to it, the tension $T + \Delta T$ at an angle $\phi + \Delta\phi$ with OX, the tension T at an angle $\pi + \phi$ with OX, the friction, $\pm \mu R$, at an angle ϕ with OX and $k\Delta W$ at an angle π with OY. If OY is vertical and the weight is taken into account $k = 1$. If the weight is neglected $k = 0$. If the curve is smooth and lies in a plane inclined at an angle a with the vertical $k = \sin a$.

The equations of motion in terms of increments attained by the resolution of forces along the tangent and along the normal to the curve lead to the two following differential equations:

$$\frac{dT}{dW} \pm \mu \frac{dR}{dW} = k \sin \phi + \frac{l}{g} \frac{v dv}{d\sigma}, \tag{1}$$

$$T \frac{d\phi}{dW} + \frac{dR}{dW} = k \cos \phi + \frac{l}{g} \frac{v^2}{\rho} \tag{2}$$

in which ρ is the radius of curvature of the curve and μ the coefficient of friction.

If the curve is that freely assumed by the chain R is identically zero. In (1) the sign is + when the force of friction is in the positive sense of s. It is − when friction acts in the opposite direction. For uniform chains $dW = w d\sigma = w ds$ where w = weight per unit length.

Consider now Case I mentioned above for which we analyze the situation when part of the chain hangs vertically over the lower edge of a rial, and other departments similarly are assisted in problems having to do with geology and mineral resources.

Further instances would only reiterate the point that the practical application of geologic principles to the problems of every day justify the continued maintenance of trained geologists in the employ of the Commonwealth.

INEXTENSIBLE CHAINS ON FIXED PLANE CURVES

By Jos. B. Reynolds
Lehigh University, Bethlehem

It is the purpose of this paper to present a method of treating the theory of flexible chains so as to bring under one head subject-matter that is ordinarily given as several distinct treatments. Two equations of motion containing parameters are derived. When proper values are assigned to these parameters the equations lead to the analysis of the following cases:

I. The motion of a chain sliding down the line of greatest slope of a plane with or without a portion hanging vertically over the edge.
II. The theoretical rim tension in fly-wheels.
III. The theory of snubbing and cases neglecting the mass of the chain.
IV. Belt tension taking into account the speed and weight of the belt.
V. The uniform chain suspended between two points.
VI. The theory of cables of suspension bridges for uniform horizontal load.
VII. The chain of uniform strength suspended between two points.
VIII. The elastic catenary.
IX. The motion of a chain on a smooth inverted fixed cycloid and other curves.
X. The velocity attained when a chain slides down any fixed smooth curve in a vertical plane.

Details of the solution will be given in Cases I and X and the required substitutions and final results in the other cases.

To develop the general theory, suppose a perfectly flexible, inextensible chain (Fig. 9) threaded on a rough curve in a vertical plane.

Consider the equations of motion for a short length Δs of the chain of weight ΔW. Let the position of this Δs be at a distance s measured along the arc of the curve from some fixed point of reference. Let the

nearer end of the chain be at a distance σ from the reference point and the further end at a distance $\sigma + l$ measured along the arc of the curve. Suppose the chain to be moving with a velocity v in the sense of increase of s. Let the tangent to Δs at the end nearer the reference point make an angle ϕ with a fixed horizontal line, OX, of the plane.

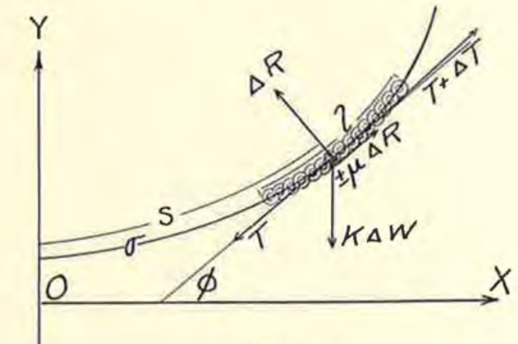

Fig. 9

Then there will act upon ΔW the reaction, ΔR, of the curve normal to it, the tension $T + \Delta T$ at an angle $\phi + \Delta\phi$ with OX, the tension T at an angle $\pi + \phi$ with OX, the friction, $\pm \mu R$, at an angle ϕ with OX and $k\Delta W$ at an angle π with OY. If OY is vertical and the weight is taken into account $k = 1$. If the weight is neglected $k = 0$. If the curve is smooth and lies in a plane inclined at an angle a with the vertical $k = \sin a$.

The equations of motion in terms of increments attained by the resolution of forces along the tangent and along the normal to the curve lead to the two following differential equations:

$$(1) \qquad \frac{dT}{dW} \pm \mu\frac{dR}{dW} = k \sin\phi + \frac{l}{g}\frac{v\,dv}{d\sigma},$$

$$(2) \qquad T\frac{d\phi}{dW} + \frac{dR}{dW} = k\cos\phi + \frac{l}{g}\frac{v^2}{\rho}$$

in which ρ is the radius of curvature of the curve and μ the coefficient of friction.

If the curve is that freely assumed by the chain R is identically zero. In (1) the sign is + when the force of friction is in the positive sense of s. It is − when friction acts in the opposite direction. For uniform chains $dW = w d\sigma = w ds$ where w = weight per unit length.

Consider now Case I mentioned above for which we analyze the situation when part of the chain hangs vertically over the lower edge of a rough inclined plane, the other part lying on a line of greatest slope on the plane (See Fig. 10), on the assumption that the lower end of the chain was initially at the lower edge of the plane.

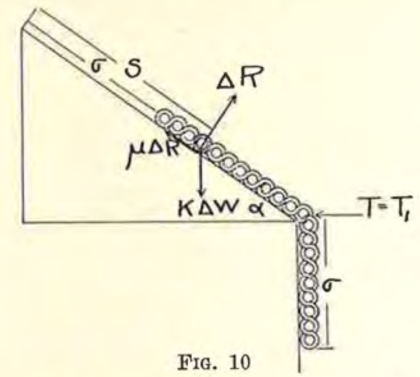

FIG. 10

Let s be measured from the initial position of the upper end of the chain and consider the instant when a length σ hangs vertically.

For the portion of the chain on the plane, $\phi = -\alpha$, $\rho = \infty$, $k = 1$ and $dW = wds$. Hence equations (1) and (2) give the equations

$$\frac{dT}{ds} - \mu\frac{dR}{ds} = -w \sin\alpha + \frac{w}{g}\frac{vdv}{d\sigma},$$

$$\frac{dR}{ds} = w\cos\alpha,$$

from which

$$\frac{dT}{ds} = -w\ (\sin\alpha - \mu\cos\alpha) + \frac{w}{g}\frac{vdv}{d\sigma},$$

whence

$$T = -w\ (\sin\alpha - \mu\cos\alpha)\ s + \left(\frac{w}{g}\frac{vdv}{d\sigma}\right) s + C.$$

From the conditions that $T = 0$ for $s = \sigma$ and $T = T_1$ at the edge of the plane where $s = l$ we get, by the elimination of the constant of integration, C

$$T_1 = -w\ (\sin\alpha - \mu\cos\alpha)\ (l - \sigma) + \frac{w}{g}\frac{vdv}{d\sigma}(l - \sigma).$$

For the hanging portion of the chain, $R = 0$, $\phi = -\pi/2$, $\rho = \infty$, $k = 1$, $dW = wds$. With these values equation (1) gives

$$\frac{dT}{ds} = -w + \frac{w}{g}\frac{vdv}{d\sigma},$$

whence

$$T = w\ \left(-1 + \frac{vdv}{gd\sigma}\right)\ s + C_1.$$

Since $T = T_1$ for $s = 0$ and $T = 0$ for $s = \sigma$ we get

$$T_1 = w\ \left(1 - \frac{1}{g}\frac{vdv}{d\sigma}\right)\sigma.$$

Equating the two values of T_1, we find after solving for $\frac{vdv}{d\sigma}$ the value

$$\frac{vdv}{d\sigma} = \frac{g}{l}\left[(\sin\alpha - \mu\cos\alpha)\ (l - \sigma) + \sigma\right],$$

whence

$$v^2 = \frac{2g}{l}\left[(\sin\alpha - \mu\cos\alpha)\ (l\sigma - \tfrac{1}{2}\sigma^2) + \tfrac{1}{2}\sigma^2\right] + C_3.$$

Since $v = 0$, for $\sigma = 0$, $C_3 = 0$. The speed of the chain when it leaves the plane is found by setting $\sigma = l$ to be

$$v = [gl\ (\sin\alpha - \mu\cos\alpha + 1)]^{\frac{1}{2}}$$

By eliminating $\frac{vdv}{d\sigma}$ from the two equations for T_1 we find for the tension at the edge of the plane where a length σ hangs over

$$T_1 = \frac{W\sigma}{2}(1 - \sin\alpha + \mu\cos\alpha)\ (l - \sigma).$$

With this illustration of the use of the equations (1) and (2) we pass on to short outlines of the next eight cases.

In Case II the formula for theoretical tension in the rims of fly-wheels is given by equation (2) with the substitutions $R = 0$, $s = r\phi$, $dW = wds$, $k = 0$ and $\rho = r$. It is

$$T = \frac{wv^2}{g}$$

For snubbing and circumstances where the mass of the chain may be neglected covered in Case III we have $v = 0$, $dW = 0$, $k = 0$ leading to the two equations

$$\frac{dT}{ds} + \mu\frac{dR}{ds} = 0,\quad T\frac{d\phi}{ds} + \frac{dR}{ds} = 0;$$

whence

$$T = T_0 e^{\mu\phi}$$

Under Case IV which takes into account the speed and weight of a belt (chain) running round a pulley of radius r, the substitutions are $dW = wds$, $k = 0$, $v =$ constant, $ds = rd\phi$, $\rho = r$, giving the two equations

$$\frac{dT}{ds}+\mu\frac{dR}{ds}=0,\ T\frac{d\phi}{ds}+\frac{dR}{ds}=\frac{w}{g}\ \frac{v^2}{r};$$

whence

$$T=T_0e^{\mu\phi}+\frac{wv^2}{g}\ (e^{\mu\phi}-1)$$

For a uniform chain (Case V) suspended between two points we set $dW=wds,\ v=0,\ R=0,\ k=1$; whence there arise the equations

$$\frac{dT}{ds}=w\sin\phi,\ T\frac{d\phi}{ds}=w\cos\phi;$$

The solution of these equations leads to the well known catenary from

$$2\,wy=T_0\ (e^{\frac{wx}{T_0}}+e^{\frac{-wx}{T_0}}).$$

For Case VI, that of cables of suspension bridges with uniform horizontal load (w per foot), $dW=wdx,\ v=0,\ R=0,\ k=1$; and therefore

$$\frac{dT}{dx}=w\sin\phi,\ T\frac{d\phi}{dx}=w\cos\phi.$$

The solution of these equations gives the parabola

$$2\ T_0y=wx^2.$$

For the case (VII) of a chain suspended between two points with variable cross-section c such that the chain is equally likely to break at any point in it we have, λ being a constant, $dW=\lambda Tds,\ R=0,\ v=0,\ k=1$; whence $dT=\sin\phi\ dW=\lambda T\ \sin\phi\ ds,\ Td\phi=\cos\phi\ dW=\lambda T\ \cos\phi\ ds$; from which we get

$$e^{\lambda y}=\sec\lambda x$$

and

$$c=c_0\sec\lambda x=c_0e^{\lambda y}.$$

Case VIII deals with the problem when the elasticity and stretch in a suspended chain or wire is taken into account. If λ is the coefficient of elasticity and w_0 the weight per unit length of the unstretched wire, the substitutions are $dW=wds=w_0ds/(1+T/\lambda),\ R=0,\ k=1,\ v=0$; whence

$$dT=dW\ \sin\phi=w_0\sin\phi\ ds/(1+T/\lambda)=w_0dy/(1+T/\lambda);$$
$$Td\phi=dW\ \cos\phi=w_0\cos\phi\ ds/(1+T/\lambda)=w_0dx/(1+T/\lambda).$$

if z be defined by $T=T_0\cosh z$ these equations lead to

$$x=\frac{T_0}{w_0}\ [z+T_0\sinh z/\lambda],\ y=\frac{T_0}{w_0}[\cosh z+T_0\cosh^2 z/2\lambda];$$

the parametric equations of the curve.

For the motion of a chain of length a sliding down a smooth, vertical, inverted, fixed cycloid of length $8a$, starting with the upper end of the

chain at one of the cusps of the curve which are in the same level, $dW=4aw\cos\phi\ d\phi$,

$$dT=2aw\ \sin\ 2\phi d\phi+\frac{4aw}{g}\left(\frac{vdv}{d\sigma}\right)\cos\phi d\phi.$$

These equations give

$$T=2aw\ \sin^2\phi+\frac{4aw}{g}\left(\frac{vdv}{d\sigma}\right)\sin\phi+C.$$

Since $T=0$ for $\sin\phi=\sigma/4a$ and for $\sin\phi=(\sigma+a)/4a$,

$$\frac{vdv}{d\sigma}=-g\ (2\sigma+a)/8a,$$

which gives for the velocity v at any position and the time t to that position

$$v=\tfrac{1}{2}\ [g\ (3a-\sigma)\ (4a+\sigma)/a]^{\frac{1}{2}}\ \text{and}\ t=2\left(\frac{a}{g}\right)^{\frac{1}{2}}\cos^{-1}[(2\sigma+a)/7].$$

The tension T at any point in the chain is given by

$$T=w\ (s-\sigma)\ (s-\sigma-a)/8a^2.$$

From these values we find that when the midpoint of the chain has reached the lowest point on the curve, that is when $\sigma=-\tfrac{1}{2}a,\ t=\pi(a/g)^{\frac{1}{2}}$; the same as for a particle sliding down the curve. At the midpoint of the chain where $s=\sigma+\tfrac{1}{2}a$ the tension is $T_m=-wa/32$; that is, the chain is under a constant pressure at its midpoint during the motion.

If a uniform flexible chain slides down any smooth, fixed curve in a vertical plane without leaving the curve from a position where its center of gravity is the point $(h,\ k)$ to a position where it is the point $(l,\ m)$ then in the latter position

$$v^2=2g\ (k-m)+v_0^2\ \text{(Case X)}.$$

In this case, $k=1,\ \mu=0,\ dW=cds$; so that, by equation (1)

$$dT=c\ \sin\phi ds+\frac{c}{g}\left(\frac{vdv}{d\sigma}\right)ds.$$

Upon integrating this we find

$$T=cy+\frac{cs}{g}\left(\frac{vdv}{d\sigma}\right)+C$$

in which the constant of integration C must satisfy the conditions that $T=0$ for $y=y(\sigma)$ and for $y=y\ (\sigma+l)$ which functions correspond to $s=\sigma$ and to $s=\sigma+l$. This leads to

$$\frac{vdv}{d\sigma}=(g/l)\ [y(\sigma+l)-y(\sigma)].$$

Suppose $y=\bar{y}(\sigma)$ is the ordinate of the center of gravity at any time then

$$\bar{y}(\sigma) = \int_{\sigma}^{\sigma+l} y\,ds = F(\sigma+l) - F(\sigma).$$

where $\int y\,ds = F(y)$. Hence

$$l\frac{d\bar{y}}{d\sigma} = \frac{d}{d\sigma}F(\sigma+l) - \frac{d}{d\sigma}F(\sigma) = [y(\sigma+l) - y(\sigma)]\frac{ds}{d\sigma}.$$

But, so long as the chain coincides with the curve, we have over the range covered by the chain $ds = d\sigma$ which gives

$$l\frac{d\bar{y}}{d\sigma} = y(\sigma+l) - y(\sigma)$$

and, therefore

$$\frac{vdv}{d\sigma} = \frac{g}{l}\left(l\frac{d\bar{y}}{d\sigma}\right),$$

whence

$$v^2 = 2g\,(k-m) + v_0^2$$

which is the same as for a particle sliding down a smooth curve.

Other problems such as the motion of a chain sliding on a rough vertical circle can be analyzed by the use of these equations, but the cases presented seem to illustrate sufficiently the breadth of theory covered by them.

A PRELIMINARY LIST OF THE AMPHIBIANS OF LACKAWANNA COUNTY

By William Stanaka
Everhart Museum, Scranton

This local list can hardly contribute more than to aid in establishing definite records for the different species of the amphibians, and with a knowledge of their relative abundance, may help in plotting their distribution. During the past three seasons, rather intensive collecting was done to determine what amphibians occur within the given area. By piecing such records from different localities a fairly complete checklist could be made.

The species are arranged according to the prevailing classification, and are annotated with remarks of interest.

Hellbender. *Cryptobranchus alleganiensis.* During the fishing season this large salamander is commonly taken on hooks in the Susquehanna River. Most specimens average 18 inches. One taken measured 24.

Newt. *Triturus viridescens.* A very common species found throughout this region. The land form is most abundantly found during the summer. The aquatic adult is in the ponds throughout the year.

Spotted Salamander. *Ambystoma maculatum.* During the breeding season from the middle of March to the second week of April it is abundant in all the ponds. Difficult to find at other times.

Marbled Salamander. *A. opacum.* Rare. Two specimens taken, a full grown adult in June under moss in a dry hollow, and a young adult under a log in August.

Jefferson's Salamander. *A. jeffersonianum.* Not common. Only two females were taken when they came to breed in a spring along with the Spotted Salamanders. Both laid eggs in captivity. The first eggs of this species were found on March 17 of this year.

Dusky Salamander. *Desmognathus fuscus.* Perhaps the most abundant species. Found along the banks of every creek and spring.

Mountain Dusky Salamander. *D. fuscus ochrophaeus.* Common, especially in the springs of the higher mountains.

Slimy Salamander. *Plethodon glutinosus.* This species has a preference for wet, rocky ledges, where it is usually found at the base under moss and stones.

Red-backed Salamander. *P. cinereus.* Both forms, the red-backed and grey, are common. Often taken together under a single stone.

Purple Salamander. *Gyrinophilus porphyriticus.* The larvae are common in creeks and springs. During the day the adults hide along the bank.

Red Salamander. *Pseudotriton ruber.* Young specimens are of a paler red with smaller dots over their body. The middle-aged specimens are the most brilliant in color, while in the old the spots merge to form a blue-grey color. The characteristic blue toes are noticeable in all ages.

Two-lined Salamander. *Eurycea bislineata.* Common in the streams which flow out of springs.

Long-tailed Salamander. *E. longicauda.* Common. Specimens were taken during June, July and August, usually along the banks of creeks where they were hiding under rocks.

Common Toad. *Bufo americanus.* Abundant everywhere.

Fowler's Toad. *B. fowleri.* Common in some sections along river banks and ponds.

Common Tree Toad. *Hyla versicolor.* Found everywhere.

Spring Peeper. *Hyla crucifer.* Common in every swamp.

Bullfrog. *Rana catesbiana.* Ponds and lakes. Common.

Green Frog. *R. clamitans.* Common.

Leopard Frog. *R. pipiens.* Not common. Specimens taken in springs.

Pickerel Frog. *R. palustris.* Common along all creeks and springs.

Wood Frog. *R. sylvatica.* Common.

THE AMPHIBIANS OF PENNSYLVANIA

By M. Graham Netting
Carnegie Museum

Recently I had the opportunity to examine the keys to salamanders and to frogs which students are expected to use in one of our colleges. These keys were hoary with age. Whether they were compiled last year or 30 years ago I could not say, but it was evident that they were based on the herpetological knowledge of 1900. Yet I do not hold the biology teacher responsible for the fact that these keys included species which do not occur within many miles of this area or for the fact that common local species were omitted. The fault lies rather with me and with my fellow herpetologists for we have held ourselves aloof from static lists. We have written little in popular vein about the amphibians of our own regions. In the face of this crying need for general information I feel that we should lay aside, from time to time, the more intricate problems which tempt us and devote ourselves to the common cause.

The present list is based upon the Pennsylvanian collections of the Carnegie Museum, which consist of 4000 salamanders and 2000 frogs, and upon the records which I have accumulated in the past six years. Additional work will clarify certain details of distribution; it may result in a few changes in nomenclature; and it may add one or two species, of salamanders probably, to the list. The Green Salamander, *Aneides aeneus* (Cope and Packard), which I took last year at Cooper Rock in West Virginia, six miles south of the border of Pennsylvania, should certainly be added. With these reservations I believe that the following is as accurate as present knowledge permits.

I regret that I cannot include a key to the species in a paper of this length, but I believe that the remarks on distribution will enable teachers to list the species of their respective areas and from such lists simple keys can be prepared. The external morphology of these forms is adequately treated in the standard works on vertebrates and in certain major works on herpetology, but questions of nomenclature and of distribution are the especial province of the museum worker who has an extensive library and a large collection of specimens at his disposal.

Salientia—Salamanders

Most herpetologists divide the living salamanders into nine families and about 250 species. Five families and 19 kinds occur in Pennsylvania. Salamanders are frequently, and erroneously, called "water lizards." True lizards are reptiles and have a body covering of scales while salamanders, although similar in body shape, have the smooth skin of amphibians. Salamanders have tails throughout life and their hind legs are only slightly larger than the fore legs.

Family Cryptobranchidae—Giant Salamanders

In addition to the Hellbender this family includes the largest living salamander, the Giant Salamander of Japan, which attains a length of five feet.

1. Hellbender, Creek Alligator, *Cryptobranchus alleganiensis* (Daudin)

The Hellbender is the largest, and probably the ugliest, salamander in Pennsylvania. It is gray, red-brown or dark brown in color with a broad, flat head and a flattened body. There are folds of loose skin along the sides and on the hind margins of the legs. The eyes are very small and without eyelids; gill slits are present. The Hellbender crawls along the bottom of streams, being completely aquatic, and feeds upon fish, crayfish, worms, mussels, insects, and even its own eggs. Many of the fish which it secures are dead specimens which it finds floating in the water. The eggs are laid in long strings in the water about September 1st. This salamander, although completely harmless, is greatly feared by fishermen, many of whom will cut their lines rather than remove Hellbenders from the hooks. Laymen frequently confuse it with the Mudpuppy (no. 19 in this list). The Hellbender occurs in the larger unpolluted, or slightly polluted, streams of the Ohio drainage, and it has also reached the Susquehanna drainage, probably by stream çapture. It has been recorded from 21 counties in Pennsylvania.

Maximum length—27 inches.

Family Ambystomidae—Blunt-nosed Salamanders

2. Jefferson's Salamander, *Ambystoma jeffersonianum* (Green)

This species is dark gray or black in color, often marked with a sprinkling of small bluish silver spots. It is sometimes confused with the Slimy Salamander, which it resembles in coloring, but its spots are smaller and less distinct and its toes are much longer and more slender. It is rarely found except in the early spring when it migrates to ponds to breed. The eggs, which may be deposited singly or in grape-like clusters attached to leaves or sticks, hatch in from two to four weeks; the larvae transform in mid-summer and then leave the ponds. Eventually this species should be found throughout the state, since it has been recorded from 17 scattered counties.

Maximum length—7½ inches.

3. Spotted Salamander, *Ambystoma maculatum* (Shaw)

The name of this species refers to the yellow spots, often more than one-eighth inch in diameter, which are arranged in a row on each side of the blackish body from the head to the end of the tail. An early spring rain rouses this salamander from hibernation and starts its migration to the ponds. The eggs, enclosed in jelly, are laid in masses the size of a woman's fist. These masses may be either cottony white or clear and transparent. After breeding the species leaves the ponds and during the remainder of the year adults are very hard to find. The Spotted Salamander probably occurs in every county in Pennsylvania for it has been recorded from 48 counties to date.

Maximum length—9 inches.

4. Marbled Salamander, *Ambystoma opacum* (Gravenhorst)

This species is black with a series of about fourteen gray, hour-glass shaped markings crossing the back and tail. The eggs are laid in the fall in hollows on the ground, or under debris, in places which will later be flooded. It has been recorded from 6 counties, distributed from Chester County in the east to Crawford County in the west, but it must be exceedingly rare in this section for I have never succeeded in collecting specimens in western Pennsylvania.

Maximum length—5 inches.

5. Tiger Salamander, *Ambystoma tigrinum tigrinum* (Green)

This salamander is marked with yellow spots as is the Spotted Salamander, but the spots are more irregular both in shape and in distribution and the belly tends to be mottled with yellow as well. The egg masses are deposited in ponds in the spring, generally attached to leaves or to the stems of water plants. This species is a Coastal Plain form in the eastern part of its range, and it is consequently rare in Pennsylvania. It has been definitely recorded from Londongrove, Chester County, and there is, in addition, a questionable record for Cumberland County.

Maximum length—8 inches.

Family Pleurodelidae—Newts

6. Common Newt, Red-Spotted Newt, *Triturus viridescens viridescens* (Rafinesque)

This species, which is familiar to most aquarium fanciers, can be recognized by the presence of from one to eight or more red dots, encircled with black, on each side of the body. The eggs are laid in the spring, attached singly to the leaves of plants under water. The larvae may transform in the late summer and live on land for two or three years, or they may remain in the water after transformation. The Newt probably occurs in every county since it has been recorded from 52.

Maximum length—4¾ inches.

Family Plethodontidae—Lungless Salamanders

This is the most important family of salamanders at the present time. A large proportion of the species are specialized for a mountain brook habitat and numerous specializations in breeding habits have arisen. Members of this family may be recognized by the naso-labial groove which extends from each nostril down to the edge of the lip.

7. Purple Salamander, *Gyrinophilus porphyriticus* (Green)

The color of this salamander is not purple but pinkish or salmon clouded with brown. It is readily identified by a cream colored line which extends from the eye to the nostril on each side of the head. It inhabits farmers' spring houses and cold mountain springs and streams, and feeds upon other salamanders, worms, insect larvae, and spiders. The eggs are laid on the under surface of stones in running water during the summer. Like the preceding, this species occurs throughout the state, having been recorded from 50 counties.

Maximum length—7½ inches.

8. Rare Red Salamander, *Pseudotriton montanus montanus* (Baird)

This dull red salamander is distinguished from the next species by the fact that it has only a few scattered black spots on the body. It lives in, or close to, springs and small streams. To the best of my knowledge, it has been taken in Pennsylvania only near Carlisle in Cumberland County.

Maximum length—7 inches.

9. Common Red Salamander, *Pseudotriton ruber ruber* (Sonnini)

This bright red salamander is plentifully sprinkled with black dots, which may fuse in old specimens so that only a little red is visible. It is most easily found in cold mountain springs and streams, but it may occur under bark or debris in muddy places. It feeds on other salamanders, insect larvae, worms, snails and slugs and lays its eggs on the under surface of stones in cold running water. The species occurs throughout the state since it has been taken in 43 scattered counties.

Maximum length—6½ inches.

10. Two-lined Salamander, *Eurycea bislineata bislineata* (Green)

This slim and dapper salamander ranges from golden yellow to dark brown in color, and the back is bordered on each side with a black line. The species is common in leaf mold and under stones in wooded regions, or in streams. From 12 to 68 eggs are laid on the under surface of a stone in running water in late spring. This species has been collected in 44 counties so it must occur throughout the state.

Maximum length—4½ inches.

11. Long-tailed Salamander, *Eurycea longicauda* (Green)

This species is bright yellow in color, and the long tail, which is responsible for its name, displays a row of black herring-bone markings on each side. It occurs under logs and stones in the woods, under debris in stream bottoms, and in springs. It has been taken in 45 counties so it, also, must occur throughout the state.

Maximum length—6¼ inches.

12. Red-backed Salamander, *Plethodon cinereus* (Green)

This extremely common terrestrial salamander may display on its back either a bright red stripe or a dark stripe, ranging from gray to black, but in all cases the belly is finely mottled with black and white, which produces a salt-and-pepper appearance. From 3 to 13 eggs are laid during the summer in rotten logs or under logs or stones in the woods. It is distributed throughout Pennsylvania with records for 51 counties.

Maximum length—5 inches.

13. Slimy Salamander, *Plethodon glutinosus* (Green)

This species is dark black, more or less spotted with white, and it is aptly named, for when roughly handled it secretes considerable slime, which is perfectly harmless on the hands but which is difficult to wash off. It occurs in the woods, and near cliffs, under much the same conditions as the Red-backed Salamander but generally under larger rocks and logs.

It has been taken in 55 counties in Pennsylvania and must occur in every county.

Maximum length—7¼ inches.

14. Wehrle's Salamander, *Plethodon wehrlei* (Fowler and Dunn)

This rare species is difficult to separate from the Slimy Salamander. However, the throat is generally whiter and the white spots are restricted to the sides of the body. In West Virginia I have found the species in cave entrances, in deep rock crevices, and near "ice caves." The only records for Pennsylvania, of which I am aware, are for Indiana and McKean Counties.

Maximum length—6 inches.

15. Four-toed Salamander, *Hemidactylium scutatum* (Schlegel)

This, the smallest salamander of our state, is best recognized by the constriction around the base of its tail and by the jet black flecks on its ivory white belly. The eggs are laid under grass, moss, or sphagnum close to water in boggy areas. The Four-toed Salamander should eventually be found in suitable localities in most of the counties of the state. To date, it has been taken in 22.

Maximum length—3 inches.

16. Dusky Salamander, *Desmognathus fuscus fuscus* (Rafinesque)

This, the commonest salamander in Pennsylvania, is red brown to gray brown in color. Only a trained herpetologist can accurately separate it from the next species. It is everywhere common near streams, and its eggs are deposited in moist cavities within a few feet of the water. Specimens of this species are on record for 58 of the 67 counties. Beyond any doubt it occurs in every county and in each county it probably occurs at more localities and in greater numbers than any other salamander.

Maximum length—5¼ inches.

17. Mountain Salamander, *Desmognathus fuscus ochrophaeus* (Cope)

The stripe which extends down the back of this species ranges from bright red or yellow to dull brown or black in color. It is more apt to be found in the woods a long distance from streams than is the Dusky Salamander. This species is almost confined to the Appalachian Plateau in Pennsylvania, and it is largely absent from the southeastern corner of the state. It has, however, been recorded from Adams and Monroe Counties in the east as well as from 25 counties further west and north.

Maximum length—3¾ inches.

18. Seal Salamander, *Desmognathus phoca* (Matthes)

This salamander is brown in color with black and occasionally red or yellow markings above. It frequents cool mountain streams and waterfalls and attaches its eggs to the under surface of stones in the stream beds. It has been found only in Allegheny, Clearfield, Fayette, Indiana, and Westmoreland Counties.

Maximum length—5¼ inches.

Family Proteidae—Mudpuppies

19. Mudpuppy, Waterdog, *Necturus maculosus maculosus* (Rafinesque)

This species is easily distinguished from all other Pennsylvanian salamanders by the presence of three bushy, bright red gills on each side of the neck. It has been called the "Peter Pan" of salamanders for it "never grows up." Other local salamanders have external gills only during the larval stage but the Mudpuppy never loses its gills. The smooth skin may be brown or gray in color with several rows of round, dark spots on the back. Young specimens are brown with a light stripe on each side of the back which extends from the tip of the snout to the end of the tail. The Mudpuppy never leaves the water. It rests on the bottom of the streams and lakes during the day, and feeds at night on crayfish, small fish, worms and insects. During the summer it lays about sixty pea-sized eggs under a board or stone in the water. The Mudpuppy occurs in the Ohio, Susquehanna, and Delaware drainages, but it is most common in the Ohio drainage, and there is a possibility that the Delaware record may be based upon escaped or introduced specimens.

Maximum length—17 inches.

Salientia—Frogs and Toads

The living frogs are divided into ten families and about 1900 species. Four families and 15 kinds are represented in this State. Frogs and toads have tails only in the larval, or tadpole, stage and their hind legs are greatly enlarged for jumping.

Family Pelobatidae—Spade-Foot Toads

1. Spade-foot toad, *Scaphiopus holbrookii holbrookii* (Harlan)

This rare burrowing species has an enlarged digging spade on each hind foot. It may be separated from all the other frogs of the State by the vertical pupils of its eyes. It is occasionally found in the spring when it emerges from its burrows for a few days to deposit its eggs. In this State it has been collected in Delaware, Monroe and Montgomery counties only.

Maximum size—3 inches.

Family Bufonidae—Toads

The local species possess the warty skin and prominent paratoid glands which characterize hundreds of other species of this family. They secrete mucous which protects them from some animal enemies but which is non-irritating to our skin.

2. American Toad, *Bufo americanus* Holbrook

This, the common toad of our gardens, generally has a black-spotted belly and only one or two warts within each dorsal spot. It lays about 4000 eggs in long strings in the water during April or May. It should occur in every county in the State for it has been recorded from 47 counties.

Maximum size—4¼ inches.

3. Fowler's Toad, *Bufo fowleri* Garman

This gray and dapper species is an inhabitant, primarily, of river banks and of lake and ocean beaches. It can generally be distinguished from the American Toad by its immaculate or lightly spotted belly and by the fact that it has more than two warts to each dorsal spot. It lays its eggs in the same fashion as the preceding species but it breeds about one month later in this region. In Pennsylvania it has been recorded from 14 scattered counties.

Maximum size—3 inches.

Family Hylidae—Tree Frogs

The frogs of this family possess adhesive disks on the tips of the fingers and toes. The seven local species may be separated, partially, by the difference in size of the disks and by the amount of webbing present. Thus, *Acris* has very small disks and toes which are almost completely webbed; the forms of *Pseudacris* have very small disks and toes which are slightly webbed; and the forms of *Hyla* have prominent disks which are moderate in size in the Spring Peeper, and large in size in the other two species.

4. Cricket Frog, *Acris gryllus* (Le Conte)

This rough-skinned frog is found along the banks of streams and ponds. It derives its name from its cricket-like song which really sounds like two pebbles being struck together. The Cricket Frog changes its color readily, leaps into the water with great agility when disturbed, and feeds upon insects. It has been recorded from eight counties in the southeastern corner of the state, and from Allegheny and Potter Counties as well.

Maximum size—1¼ inches.

5. Mountain Swamp Tree Frog, *Pseudacris brachyphonus* (Cope)

The few dark accent marks or blotches which this species displays on its back sometimes bear a faint resemblance to a cross and cause it to be confused with the Spring Peeper. However, its skin is rougher, its disks smaller, its call quite distinct, and frequently it has yellow markings on the hind legs. The eggs are deposited in April in the water of small ditches and marshes. It has been collected in Allegheny, Beaver, Fayette, and Westmoreland Counties only.

Maximum size—1¼ inches.

6. Eastern Swamp Tree Frog, *Pseudacris feriarum* (Baird)

This frog is marked with three, more or less broken longitudinal dark stripes on the back. Laymen will have difficulty separating it from the following form except by locality, and herpetologists will probably come to consider it a subspecies of *triseriata*. It has been collected in Bucks, Carbon, Chester, Cumberland, and Huntingdon Counties only.

Maximum size—1 inch.

7. Western Swamp Tree Frog, *Pseudacris triseriata* (Wied)

The markings of this form are essentially the same as the preceding. It has been collected in Allegheny and Venango Counties only.

Maximum size—1¼ inches.

8. Anderson's Tree Frog, *Hyla andersonii* Baird

The upper parts of this beautiful frog are uniform pea-green. The color of the upper parts is sharply demarcated from the violet-gray of the under surfaces by an edging of white, which in turn is black-edged below. To the best of my knowledge the species has been recorded only in Delaware County in Pennsylvania.

Maximum size—2 inches.

9. Spring Peeper, *Hyla crucifer* Wied

The bird-like whistle of this tiny, smooth-skinned species is the earliest frog voice each year. It may be heard during warm spells in January and February but breeding does not begin until March. About 800 eggs are attached singly or in masses to grass or other vegetation under water, and the larvae which hatch in about ten days are ready to transform in July. The specific name refers to the dark cross on the back which is visible whether the frog is light tan or dark brown in color. The species is state wide in distribution although it has been recorded from only 35 counties.

Maximum size—1 inch.

10. Common Tree Frog, Rain Toad, *Hyla versicolor versicolor* (Le Conte)

The call of this frog is known to many country-dwellers but few are acquainted with the rough-skinned creature itself. It can change its color from light gray to bright green but the groin remains orange yellow and a number of dark markings on the back are usually visible. As many as 1500 eggs are deposited in clusters at the surface of ponds and swamps in May or June. After breeding the frogs may be heard calling high in the trees on moist nights. The species occurs throughout the state and has been recorded in 23 counties.

Maximum size—2 inches.

Family Ranidae—Large Frogs

The local representatives of this family are smooth-skinned, medium to large sized frogs. The largest living frog, the Goliath Frog of the Cameroons, which reaches a length of one foot, belongs to this family.

11. Bullfrog, *Rana catesbeiana* Shaw

This completely aquatic species lacks the two longitudinal, or dorso-lateral, folds extending from the eyes to the rump which the other local Ranas display. It is green or greenish brown in color and frequently mottled with darker spots. Up to 20,000 eggs are laid in floating masses about two feet in diameter. These hatch in about a week but the tadpoles do not transform for two years.

This is the species which is specifically mentioned in the Fish Code, but the Board of Fish Commissioners applies the closed season and bag limits to the remaining four species as well, on the ground that few wardens and fewer laymen can distinguish the various species. Originally the Bullfrog may have occurred throughout the state but recent records are of little value since considerable restocking has taken place.

Maximum size—8 or 9 inches.

12. Green Frog, *Rana clamitans* Latreille

This frog may be separated from the preceding by the presence of dorso-lateral folds, and by the bright green color of the head and upper back. From two to four thousand eggs are laid in the water in masses about one foot in diameter in May or June, and the tadpoles transform in about one year. The Green Frog occurs throughout the state and has been recorded from 45 counties.

Maximum size—5 inches.

13. Pickerel Frog, *Rana palustris* Le Conte

This brown frog has two rows of squarish, dark spots on its back, and bright orange on the under surfaces of the hind legs. It lays two to three thousand eggs in several globular masses in brooks and marshes in late April or early May. The tadpoles transform in the fall of the same year. Adults leave the water after breeding and wander about the fields and valleys. The species is widely distributed in Pennsylvania with records for 41 counties.

Maximum size—4 inches.

14. Leopard Frog, Grass Frog, *Rana pipiens* Schreber

This greenish or brownish frog has two rows of rounded, dark spots on its back, and no orange under the hind legs. Its reproduction is essentially the same as that of the preceding species but generally more eggs are laid several weeks earlier. The species is state wide in distribution with records for 30 counties.

Maximum size—4 inches.

15. Wood Frog, *Rana sylvatica* Le Conte

This terrestrial species is prominently marked with a dark patch or mask on each side of the head. The general color varies from dark brown to bright pink and a wash of light green is frequently present on the sides. The Wood Frog migrates to the water in late March or early April where it is usually associated with Spring Peepers and Spotted Salamanders. After several thousand eggs have been laid in rounded masses it leaves the water and retires to the woods. There are 30 county records which indicate a state wide distribution.

Maximum size—3 inches.

AN ARTERIAL ANOMALY IN *RANA CATESBIANA*

BY WM. HUDSON BEHNEY
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The anomaly described in this paper was observed in a large sized adult *Rana catesbiana* which had been injected. Its length fully extended and measured from the tip of the snout to the tip of the 4th digit of the hind limbs was 41 centimeters. The specimen had been arterially

injected through the truncus arteriosus. Examination of the other systems of the specimen revealed the fact that the reproductive system was also abnormal. Since there is no obvious connection between the two anomalies they are being described separately.

In this specimen the right systemic arch is missing from the point where it gives rise to the occipito-vetebral and the brachial on down to the point where it should join the left arch to form the dorsal aorta. The right systemic arch, the abnormal vessel, branches off from the right branch of the truncus arteriosus in a normal manner but is smaller in

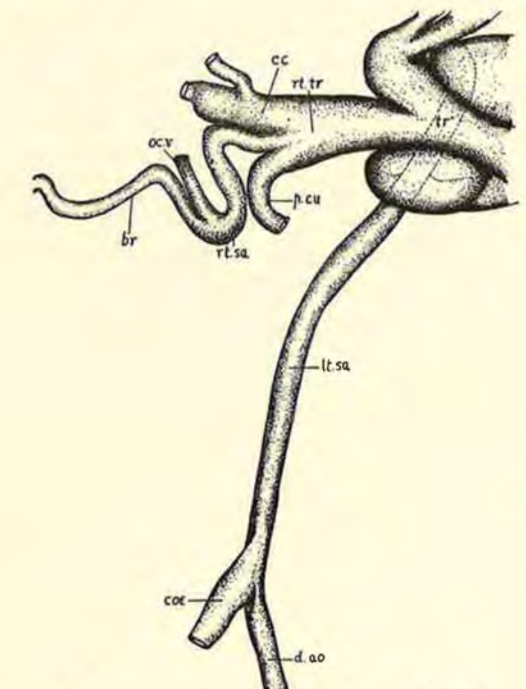

FIG. 11. ARTERIAL SYSTEM—Tracing of photograph showing anomaly of the arterial system of *R. catesbiana*. tr., truncus arteriosus; rt. tr, right branch of truncus; cc, common carotid; oc. v, occipito-vertebral; br, brachial; rt. sa, right systemic arch; pc, pulmocutaneous; lt. sa, left systemic arch; coe, coeliaco mesenteric; d. ao, dorsal aorta.

size than the left systemic arch at its point of origin. It merely bifurcates to form its two branches and does not show any tendency to continue from this point. No rudiment could be located here or at the junction of the left systemic arch and the dorsal aorta. The left systemic arch appears larger than in a normal frog, but this may possibly be due to increased pressure in injecting this specimen rather than because of its compensatory enlargement from taking over the work given up on the right side.

SEX REVERSAL IN *RANA CATESBIANA*

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The numerous cases of hermaphroditism in the frog which are to be found in the literature attest to the fact that the condition is far from being an uncommon one. This statement applies to European forms to a greater degree than to American species. In consideration of the number of frogs dissected yearly in the classrooms and laboratories of this country the hermaphroditic specimens reported are very few. Evans ('31) sums them up to the extent of twelve cases covering all species. Clemens ('21) described one case of hermaphroditism in *Rana catesbiana* but no study of the histological structure of the organs was made. Chidester ('26) in a brief abstract described other cases. These seem to be the only recorded instances of hermaphroditism in *R. catesbiana.*

The specimen described herein was found in a shipment of class material which was obtained from a supply house in Dallas, Texas. The exact date of preservation of the specimen could not be definitely determined. From their records it was "in the spring of the year."

Description

The specimen is a large sized adult of *R. catesbiana* with the following measurements: length from anus to tip of snout, 17.5 cm.; length of hind legs extended from anus to tip of 4th digit, 23.5 cm.; width of head at posterior angles of jaws, 9.0 cm.; width of tympanic membrane, 2.0 cm.

The gonads have the external appearance of testis, the right one being 20 mm. long while the left is only 7.5 mm. long. The right gonad is somewhat irregular in shape, slightly but distinctly lobed, and pigmented in the depressions between the lobes. Large fat bodies are located anterior to the gonads. A small fat body is also present on the posterior end of each gonad. Vasa efferentia lead from each gonad to the kidney. Seminal vesicles are present on the posterior ends of the ureters.

The right oviduct is very small with the exception of its posterior portion. The left oviduct is of nearly normal female size and much convoluted. The terminal ends of both oviducts are visible in the cloaca when seen in cross-section.

Cross-sections were made of both gonads including the posterior ends of the fat bodies. The cloaca, seminal vesicles and right oviduct were sectioned posterior to the kidneys. The left oviduct was sectioned throughout its entire length.

Fig. 12. Cross-section of left oviduct taken at a point on a line with the posterior end of the kidney. Three ova are shown as lightly stippled areas. Numerous pigment masses are present in the wall of the tube. Clear areas represent the lumen of the oviduct. Camera lucida × (53).

The sections of the gonads show them to be distinctly testicular in nature. The seminiferous tubules of both contain mature spermatozoa although none were found in the vasa efferentia or seminal vesicles. The left gonad is histologically similar to a normal testis. The right gonad contains a greater number of interstitial cells between the tubules than are present in a normal testis. Large numbers of pigment masses are present between the tubules in the region which was externally pigmented. One tubule of this same gonad contains a degenerate ovum which occupies half the lumen.

The sections through the posterior end of the right oviduct show that its lumen communicated with the cloaca. The same condition exists in the left oviduct. In this latter case many degenerate ova are located in the folds of the walls. No attempt was made to estimate the number present but practically every section shows from one to a dozen ova. The lumen is continuous throughout the entire length of the left oviduct.

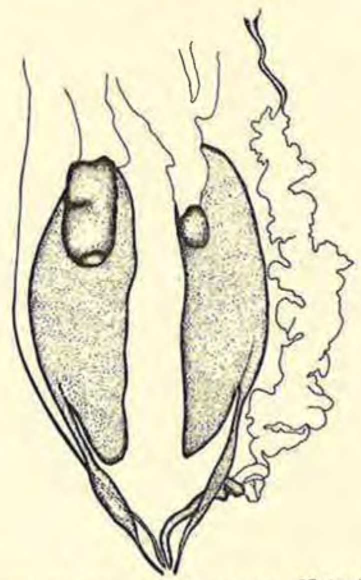

FIG. 13. Ventral view of urinogenital organs. Note the large right gonad and the small left one. Large fat bodies attached to anterior end of each gonad. The convolutions of the left oviduct were impossible to follow because of the absorption of water by the glandular portion.

TABLE OF SEX CHARACTERS

Right Side	*Left Side*
Gonad abnormally large, slightly lobed. Pigment visible externally in folds between lobes. Eight vasa efferentia. Mature spermatozoa present. Pigment present between tubules in region which was externally pigmented. What appears to be degenerate ovum present in several sections within one tubule. Sperm crowded to one side.	Gonad smaller than normal and of abnormal shape. Approximately ⅛ size of right gonad. Six vasa efferentia. No pigment present within gonad. No ova present within gonad.

SECONDARY SEX ORGANS

Oviduct extremely rudimentary. Since oviduct is not normally present even in rudimentary condition in the female sex of this species, its presence is significant. Oviduct opening into cloaca not visible under dissecting microscope. Sectioning however shows that the cavity of the duct is open into cloaca.	Oviduct approximately normal mature female size. Convoluted from anterior end of kidney posterior. Posterior convoluted portion (glandular portion) much swollen having absorbed water. Indication of functional ability. Oviduct opening into cloaca visible with naked eye in center of mound of tissue

Seminal vesicles present.	somewhat larger than the mound on right oviduct opening. Seminal vesicles present. X-sections show that oviduct opening is continuous throughout its length.

Vocal sacs present.
Thumbs callused.

DISCUSSION

Reproductive system: The presence of gonads made up of seminiferous tubules which contain mature spermatozoa, vasa efferentia connecting them with the kidneys and seminal vesicles located on the posterior portions of the ureters distinguish this specimen as a functional male.

The slightly lobed condition of the right gonad is an indication that it was at one time an ovary (Crew, '21). According to the same authority the presence of pigment masses also indicates a gonad which is still in the process of transformation from female to male. This gonad had more interstitial cells present between the tubules than are present in a normal testis. This agrees with the findings of Christensen ('29), and as in his case is in disagreement with Maclean ('29). In this respect the smaller left gonad is histologically nearer to being a normal testis than its larger companion on the right side of the body. However the larger size of the right gonad agrees with the cases cited by Crew ('21) in which he states that the transformation is usually initiated on the right side of the animal.

This last conclusion is borne out by the condition of the oviduct on that side. Degeneration of the ovary and the disappearance of the oviduct seem to accompany one another.

The larger size of the oviduct on the left side along with the smaller size of the gonad leads us to think that the transformation on this side started at a later date than on the right.

The sections of the middle part of the left oviduct show great numbers of large gland cells. The absorption of water to the extent of making the oviduct brittle and swollen is a good indication that the cells were functional at the time of the death of the individual. Unfortunately the date of death cannot be definitely stated as the specimen was preserved when obtained.

The presence of ova even though in a degenerated condition shows that the individual was once a functional female, although with the exception of the degenerating ovum found in the right gonad no ovarian material was found in sections of the gonads and the posterior ends of the fat bodies.

It is this last group of facts which make this specimen of especial interest. The ova in the ovisac are without doubt degenerated and so were not placed there just prior to death. In all probability between the time of deposition of the ova in the ovisac and the time of death, such ovarian material as existed on either side was resorbed and replaced by testicular material.

There does not seem to be any obvious connection between the absence of the one aortic arch and the condition of the reproductive organs. Both sides of the urino-genital system were supplied by the dorsal aorta.

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THE PARASITIC WASP, HABROBRACON JUGLANDIS (ASHM.) AS LABORATORY CLASS MATERIAL

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Habrobracon has proved to be ideal material for laboratory class work on account of ease of manipulation, low expense, and brief generation, ten days. Caterpillars of the Mediterranean flour-moth serve as host insects. The wasps are about three millimeters in length. They are reared in shell vials through which their various activities may be readily observed. Points of interest are striking effect of temperature on body color, parasitism, parthenogenesis, gynandromorphism, and heredity of numerous mutant traits. They have been used in high school as illustrative material for insect life history. They serve for elementary class work in genetics. Numerous unsolved problems make them desirable as research material for graduate students. (Technical methods and general account are published in The Journal of Heredity, 12:255–266, June–July 1921.)

REPRODUCTIVE REACTIONS OF GYNANDROMORPHS

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Habrobracon shows definite types of reaction characteristic of sex. Females sting caterpillars upon which they subsequently feed and lay eggs. Males are entirely indifferent to caterpillars, but show characteristic reactions toward females flipping wings, mounting, and beating with wings and antennae in process of mating.

Gynandromorphs (sex mosaics) prove that in general reactions are determined by head rather than by reproductive organs, those with male head and female abdomen reacting toward females but not toward caterpillars, while those with female head and male abdomen are indifferent to females but show responses toward caterpillars characteristic of the female. Gynandromorphs with mixed heads act in general either like males or like females.

Aberrant individuals were as follows: (1) those showing "momentary reversal" for one or more brief periods giving responses characteristic of the opposite sex; (2) "bisexual" type, which attempted to sting caterpillars as well as to mate with females; (3) "wires crossed" type, which attempted to mate with caterpillars or to sting females. Such irregularities are regarded as due to mosaic character of sensory and nervous system rather than to hormonal action. (Full account is published in The Journal of Comparative Psychology, 14:345–363, December 1932.)

PRODUCTION OF GYNANDROMORPHS IN HABROBRACON

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Work on male mosaics and gynandromorphs in Hymenoptera has been mainly descriptive. However, bee breeders, in general, agree that when the temperature within the hive is lowered an increase in the number of gynandromorphs can be observed. The present investigation deals with percent of mosaics and gynandromorphs in Habrobracon, when the "queens" were exposed to certain low or high temperatures. Some strains of Habrobracon, especially shot-vein, produce a comparatively large number of male mosaics and gynandromorphs. Shot-vein (wings) females were mated to ivory (eyes) stumpy (legs) males. In one experiment, 78 triheterozygous F_1 females were exposed to a temperature of 5 to 10° C. of one hour duration at four day intervals. No appreciable difference from their controls in the number of male mosaics or gynandromorphs was observed. Likewise from 147 F_1 females which were exposed to -14 to $-10°$ C., in the same way, no noticeable variation occurred. None of the 192 females kept at a constant temperature of 18 to 20° C. produced any male mosaics or gynandromorphs. By keeping the F_1 females at a high temperature, 35 to 37° C., a significant increase in both the number of male mosaics and gynandromorphs was obtained. Further tests have also shown that a high temperature, one approaching the upper survival limit of Habrobracon, rather than a low temperature, increases the rate of production of mosaics.

VARIEGATED EYES IN HABROBRACON

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In Habrobracon several mutations in eye color have occurred. These are dahlia, orange, and ivory, forming with type (black) a quadruple allelomorphic series; carrot and white, forming with type a triple allelomorphic series; and maroon and cantaloup, both recessive to type and segregating independently. In combining white eye with a wing mutation, shot-vein, it was found that each eye was variegated, showing a definite pattern of red and pink spots on the posterior ventral side. The factor shot-vein is now being combined with various other eye color combinations in the males, which being parthenogenetic, contain a single dose of each factor and are not complicated by heterozygosis. Thirty-five of the 96 possible combinations have thus far been made. Variegated eyes have appeared only in presence of white and shot-vein. Dahlia reduces amount of variegation slightly and orange reduces it still more. It fails to occur in presence of ivory, maroon, or cantaloup, even if white and shot-vein be present.

HOW WE DRAW HABROBRACON

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The stage of a compound microscope is cut so that only the rim remains. To this is cemented (Duco) a piece of glass which has been painted black in a small spot immediately under the objective. A concave reflector (Stickalite) placed on the transparent glass stage concentrates light from the substage mirror onto the specimen. The latter is placed above the black spot which blocks all transmitted light. The microscope is focused on the specimen through the hole in the centre of the reflector. The specimen is mounted in alcohol on a depression slide and is seen by intense reflected light. The method is especially useful for study of surfaces of opaque objects. Since the source of light is distant, little heat is present and even this may be filtered out between the source and the mirror. Minute structures (tarsi, ocelli, etc.) may be highly magnified, studied and drawn by reflected light.

CHROMOSOMES OF HABROBRACON

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Genetic evidence long ago forced the conclusion that in Habrobracon, as in Hymenoptera in general, females come from fertilized eggs and are diploid while males come from unfertilized eggs and are haploid. Occasionally males are produced that inherit from the father as well as the mother and, therefore, seem to be diploid. Genetic evidence indicates their daughters to be triploid.

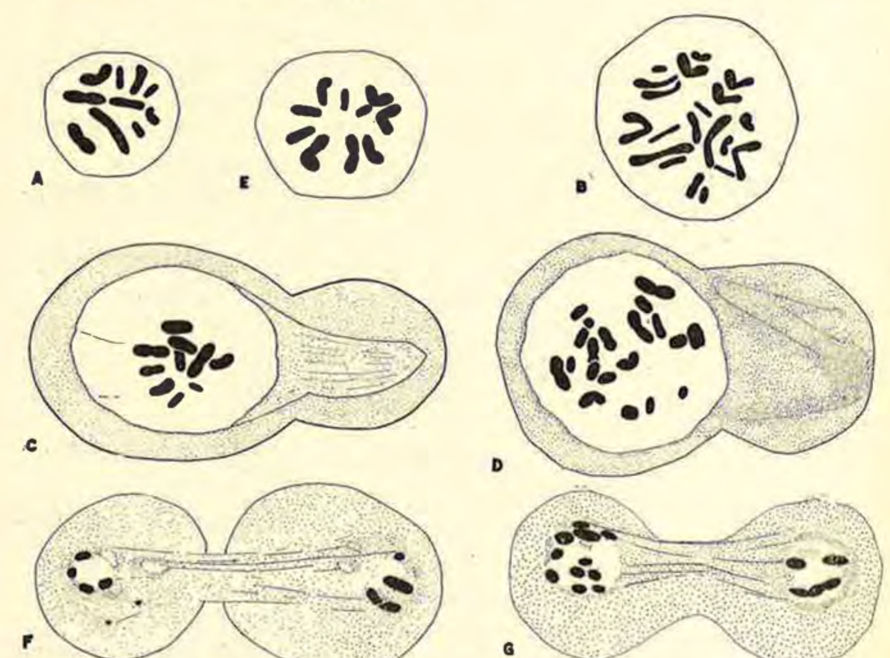

FIG. 14. Chromosomes of *Habrobracon*. Spermatogonial metaphases: A. Normal haploid male; B. Biparental diploid male. Abortive first maturation division: C. Normal male; D. Biparental male. Second spermatocyte metaphase: E. Normal male. Second maturation division: F. Normal male; G. Biparental male.

Cytological study bears out the above conclusions. Present studies indicate that there are 10 chromosomes in the normal haploid male and 20 in the biparental diploid male. The normal female, which has been studied only superficially, seems also to have about 20 chromosomes and the daughters of biparental males have an undetermined but larger number.

A spermatogonial count has been made in each type of male. Following the spermatogonial divisions both haploid and diploid males show an abortive first maturation division—a small bit of cytoplasm containing no chromatin is pinched off at the narrow end of a pear-shaped cell. The second maturation division is apparently equational in both. Metaphase plates in secondary spermatocytes are similar to those in spermatogonial cells except that the former cells are somewhat larger and chromosomes can, therefore, be less crowded. The two cells resulting from the second maturation division metamorphose into mature sperm cells.

THE CHROMOSOME MAP OF HABROBRACON

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In *Habrobracon juglandis* stock 50 mutations have been obtained at separate loci which are being used to make up the chromosome map. Of these one was located in chromosome VI and later lost. Of the remaining 49 genes 27 have been located in 8 linkage groups as follows:

I. orange, o, (eyes)—miniature, m, (body)—dwindling, dw, (antennae)—kidney, k, (eyes);

II. crepe wings,—cw,—defective, d_{1195}, (r_4 vein)—honey, ho, (body)—Minnesota Yellow, My, (antennae)—cantaloup, c, (eyes)—long, l, (antennae)—narrow, n, (wings);

III. wrinkled, w, (wings);

IV. reduced, r, (wings)—glass, g, (eyes)—fused, f, (antennae and legs);

V. wavy, wa, (wings)—broad, br, (thorax)—eyeless, el,—gynoid, gy, (body)—aciform, ac, (antennae);

VI. stumpy, st, (legs)—white, wh, (eyes)—attenuated, at, (antennae);

VII. shot veins, sv,—truncate$_2$, tr_2, (wings)—maroon, ma, (eyes);

VIII. crescent, cr, (ocelli)—droopy, dr, (wings).

The last group has not been thoroughly tested with the other seven. The longest chromosome, V, is thus far 59 units. There are 22 genes remaining to be located in the 10 possible linkage groups.

X-RADIATION AND SEX RATIO IN HABROBRACON

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Earlier experiments have shown that in crosses of closely related stocks, x-radiation of females increases ratio of males among their diploid progeny, whether radiation be administered during larval or adult life. In two later experiments, radiation of males was not demonstrably effective in increasing ratio of males among diploids. Radiation of males, however, not only lowers diploid ratio (by killing sperm), but also lowers general fecundity, presumably by producing dominant lethal mutations. In the first of these two experiments (stock 3 × stock 1), male parents fell into two groups, some producing diploid sons in all matings, others producing no diploid sons. In the second cross (stock 11_0 × stock 11), all femals had large percentages of diploid sons, so that here male parent seemed to be of no significance in determination of diploid males.

It is evident that if x-radiation of females might be shown to stimulate production of diploid males from crosses which would not normally produce them, the demonstration of effectiveness of x-rays in producing male biparentalism would be greatly strengthened. Such an experiment was performed with stocks 11_0 and 25, which are unrelated. Neither controls nor treated females had any diploid sons. This result is not necessarily opposed to the finding that x-radiation of females has an effect on ratio of male biparentalism, since we may suppose that this effect requires a close relationship between the stocks crossed as a basis on which to work.

COMPARISON OF THE CHROMOSOMES OF THE SOLDIER AND THE KING OF *RETICULITERMES FLAVIPES* KOLLAR

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With the determination of the chromosome number in the soldier caste of the termite, the second step in a study to determine whether or not there are any observable chromosomal variations associated with caste differentiation has been partially completed.

Five castes are distinguishable in a colony of these termites. Two of these castes are blind and sterile. The other three have eyes and are fertile. The most obvious character by which the various castes may be recognized is the presence or absence of wings or wing vestiges. The three reproductive castes are: (1) the first form reproductive caste, long wings possessed during the swarming period and afterward remaining only as short stubs, the so-called "scales"; (2) the second form reproductive caste, short scale-like wing pods, vestiges of wings; (3) the third form reproductive caste, absence of wings or wing pads. The two sterile castes are: (1) the worker, small head, small body, no wings, both sexes; (2) the soldier, large head with mandibles very much enlarged, small body, no wings, both sexes.

In the first part of the study[1] it was found that the diploid chromosome number of the male of the first form reproductive caste was probably 42. The present work indicates that the haploid number of the male of the soldier caste is probable 21, which would place the diploid number of the caste at 42. However, no metaphase plates showing 42 chromosomes have been discovered. We are convinced that the chromosome number in the different castes as far as the males are concerned is probably the same. Future work lies along the line of comparison of the chromosomes of the sexes, and a study of the heteromorphic chromosomes.

THE USTILAGINALES OF PENNSYLVANIA[1]

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The smuts are a group of parasitic fungi that attack a wide variety of herbaceous plants. They are usually best recognized by the sooty mass of spores that are produced singly, in pairs, or as spore balls. The smuts may be divided roughly into two groups: black smuts such as occur in the genera *Ustilago, Sphacelotheca, Tilletia,* etc., and white smuts, such as occur in the genera *Doassansia, Entyloma, Burrillia,* and *Tracya.*

There are two families within the order Ustilaginales. They are separated by the manner of sporidial production. In the family *Ustilaginaceae* the sporidia are produced laterally on the promycelium, while in the family *Tilletiaceae* the sporidia are produced terminally on the promycelium.

Apparently, before it is possible for a smut to infect its host, some sort of fusion of nuclei must occur; there is either a conjugation between

1 Benkert, J. M., Chromosome number of the male of the first form reproductive caste of *Reticulitermes Flavipes* Kollar: Proc. Pennsylvania Acad. of Science, vol. IV, pp. 97-97, 1930.

1 Contribution from the Department of Botany, The Pennsylvania State College, No. 82.

two sporidia or between a sporidium and a cell of the promycelium. It seems that the various sporidia and the individual cells of the promycelium are of different gender.

The mycelium is internal, slender, hyaline, somewhat septate and branched. It is either uninucleate, binucleate, or occasionally multinucleate. The hyphae are usually intercellular and send capitate or racemoid haustoria into the host cells for food. Most of the cereal smuts, however, have intercellular mycelium without haustoria. A third class of smut fungi is represented by *Ustilago Zeae* in which the mycelium penetrates the host cells resulting in their death.

Various organs of the host such as the ovary, anther, inflorescence, stem, leaf, or root may be infected. The result of infection may be the production of galls; striae on leaves, or culms; the enlargement of the ovary; stunting of the host or the failure of the host to produce an inflorescence.

The smuts are of economic importance largely because of the damage they produce in the destruction of the various cereal crops. Other farm and floral crops that are attacked include the onion, the violet, the gladiolus, and the potato.

The collection of smuts in Pennsylvania has never been intensive and little attention has been given to this group of fungi. Schweinitz[2] in 1832 reports only six species of smuts from the entire North American continent, of which five were from Pennsylvania. Four of the species were collected near Bethlehem, and one near Waterford, Erie County. In 1877, Berkeley and Curtis[3] reported *Urocystis Carcinodes* B. & C. The next report of smuts from Pennsylvania was by Herbst[4] in 1899 who reported five species of smuts in four genera from the Lehigh valley, viz. *Phacelotheca*[5] *polygoni* (*Ustilago utriculosa*) on *Polygonium amphibium; Entyloma Merispermi* on yellow Parilla; *Tilletia foetans* B. & C. on wheat; *Ustilago Maydis* Corda. on Indian corn; *Ustilago segetum* Pers. on oats. *Entyloma Menispermi* Farl. & Trel. has not since been reported from Pennsylvania.

Clinton[6] in 1906 in his last monograph of North American Ustilaginales reports only nine species of smuts from Pennsylvania.

In 1930[7] the writer reported thirteen species of smuts from Pennsylvania.

2 Trans. Am. Phil. Soc. II. *4*: 290. 1832.
3 Grevillea *3*: 58. 1874.
4 Fungal Flora of the Lehigh Valley 182–184. 1899.
5 Phacelotheca is a misspelling of Sphacelotheca.
6 North American Flora 7: 1–82. 1906.
7 Mycologia *22*: 97–100. 1930.

The present list of Pennsylvania smuts is the first comprehensive list to be compiled. It is made possible by the cooperation of several agencies. The first source of information is the collections of the writer, made at intervals during the years 1928 to 1932. Besides this, the collections in the Carnegie Museum in Pittsburgh, the collection in the Bureau of Plant Industry, State Department of Agriculture, in Harrisburg, and the collections in the Cryptogamic herbarium, Botany Department of the Pennsylvania State College, have been used as source material. In the present paper, 44 species in ten genera are reported. This number of species compares very favorably with other state lists.

In 1906 there were reported 207 species in 19 genera for the whole of North America. The writer in his forthcoming list of the Ustilaginales of the world reports over 800 species in 23 genera.

From a study of the known ranges of North American species, it would appear that there are possibly about 19 species to be expected in Pennsylvania which have so far not been recorded.

Key to Genera Found in Pennsylvania

I. Spores simple
- A. Usually forming a dusty sorus at maturity.
  - 1. Spores large usually 16–35 µ. — TILLETIA
  - 2. Spores small to medium, usually 5–18 µ.
    - ø Sorus with elators. — FARYSIA
    - ø Sorus without elators.
      - a. Sorus covered with a false membrane of definite fungous cells. — SPHACELOTHECA
      - b. Protecting membrane of plant tissue only. — USTILAGO
- B. More or less firmly agglutinated at maturity. — CINTRACTIA
- C. Permanently imbedded in leaves, producing discolored areas. — ENTYLOMA

II. Spores chiefly in pairs, forming an agglutinated sorus. — SCHIZONELLA

III. Spores in more or less permanent balls forming a dusty or granular sorus at maturity.
- A. Spore-balls consisting only of spores.
  - 1. Often evanescent, spores olive-brown or black-brown. — SOROSPORIUM
  - 2. Spore-balls rather permanent, spores yellowish or reddish. — THECAPHORA
- B. Spore-balls with a cortex of sterile cells. — UROCYSTIS

Family **USTILAGINACEAE**

USTILAGO (Pers.) Roussel, Fl. Calvados ed. 2. 47. 1806.

1. **Ustilago anomala** J. Kunze (Fungi Sel. Exs. 23; hyponym. 1877); Winter in Rab. Krypt. Fl. 1[1]: 100. 1881.
   On *Polygonum cilinodis* Michx.: Sullivan County, La Porte (Lake Makoma); Susquehanna County, Montrose.
   On *Polygonum dumetorum* L.: Dauphin County, Middletown, Rockville.

2. **Ustilago Avenae** (Pers.) Jens. Charb. Céreales 4. 1889.
   On *Avena sativa* L. cult. Found in the following counties: Allegheny, Armstrong, Cambria, Centre, Clearfield, Delaware, Erie, Franklin, Jefferson, Lancaster, Luzerne, McKean, Westmoreland, and Wyoming. This smut has been observed throughout the state wherever oats are grown.
3. **Ustilago Crameri** Körn. Jahrb. Nassau. Ver. Naturk. *27–28:* 11. 1873.
   On *Setaria italica* (L.) Beauv.: Centre County, State College (In the Pennsylvania State College orchard).
4. **Ustilago Herfleri** Fuckel, Symb. Myc. 39. 1869.
   On *Erythronium americanum* Ker.: Lebanon County, Lawn; Philadelphia County, Fairmount Park, Philadelphia (Collected by W. C. Stevenson, Jr., May, 1880, in N. A. Fungi exsicc. No. 1095 as *Ustilago Ornithogali* Schm. & Kunze).
5. **Ustilago Hordei** (Pers.) Kellerm. & Swingle, An. Rep. Kansas Agr. Exp. Station *2:* 268. 1890.
   On *Horedeum vulgare* L. cult. Found in the following counties: Butler, Cambria, Centre, Clearfield, Clinton, Dauphin, Delaware, Elk, Jefferson, Lehigh, and Venango. This smut has been observed in the state wherever barley is grown.
6. **Ustilago levis** (Kellerm. & Swingle) P. Magn. Abh. Bot. Ver. Prov. Brand. *37:* 69. 1896.
   On *Avena sativa* L. cult. Found in the following counties: Allegheny, Armstrong, Centre, Clearfield, Erie, Jefferson, Lancaster, McKean, Warren, Westmoreland. This smut is found throughout the state wherever oats are grown.
7. **Ustilago longissima** (Sow.) Tul. Ann. Sci. Nat. III. *7:* 76. 1847.
   On *Glyceria grandis* Wats.: Centre County, Centre Furnace.
   On *Glyceria nervata* (Willd.) Trin.: Dauphin County, Manada Gap.
   On *Glyceria obtusa* (Muhl.) Trin.: Centre County, State College (Along Spring Creek).
8. **Ustilago neglecta** Niessl.; Rab. Fungi Eur. 1200. 1868.
   On *Setaria glauca* (L.) Beauv.: Found in the following counties: Allegheny, Armstrong, Beaver, Berks, Bradford, Cambria, Centre, Clinton, Columbia, Cumberland, Dauphin, Erie, Franklin, Jefferson, Juniata, Lackawanna, Lancaster, Lebanon, Luzerne, Mercer, Monroe, Northampton, Northumberland, Pike, Potter, Susquehanna, Union, Warren, Washington, Wayne, Westmoreland, and Wyoming.
9. **Ustilago nuda** (Jent.) Kellerm. & Swingle, Ann. Rep. Kansas Agr. Exp. Sta. *2:* 277. 1890.
   On *Hordeum vulgare* L. cult.: Found in the following counties: Centre, Chester, Clearfield, Dauphin, Elk, Franklin, Jefferson, Lehigh, Susquehanna, and Venango. This smut is found throughout the state wherever barley is grown.
10. **Ustilago Oxalidis** Ellis & Tracy, Jour. Myc. *6:* 77. 1890.
    On *Oxalis corniculata* L.: Found in the following counties: Armstrong, Bedford, Berks, Bradford, Cambria, Centre, Chester, Clinton, Columbia, Cumberland, Dauphin, Delaware, Elk, Erie, Fayette, Forest, Franklin, Huntingdon, Jefferson, Juniata, Lackawanna, Lancaster, Lawrence, Lehigh, Luzerne, Monroe, Northumberland, Pike, Potter, Snyder, Union, Venango, Warren, Washington, Wayne, Westmoreland, and Wyoming.

On *Oxalis stricta* L.: Found in the following counties: Adams, Bedford, Blair, Bucks, Cambria, Columbia, Dauphin, Delaware, Jefferson, Juniata, Luzerne, Monroe, Northumberland, Potter, Snyder, Warren, Wayne, and Wyoming.

11. **Ustilago perennans** Rostr. Overs K. Danske Vid. Selsk. Forh. *1890:* 15. March, 1890.
    On *Arrhenatherum elatius* (L.) Beauv.: Centre County, State College; Venango County, Oil City.
12. **Ustilago Rabenhorstiana** Kühn, Hedwigia *10:* 4. 1876.
    On *Digitaria sanguinalis* (L.) Scop.: Found in the following counties: Armstrong, Beaver, Centre, Dauphin, Erie, Franklin, Lebanon, Lycoming, Snyder, Wyoming, and York.
    On *Panicum proliferum* Am. auct. (*P. dichotomiflorum* Michx.): Philadelphia County, Philadelphia (Coll. by F. L. Scribner, Oct. 2, 1885).
13. **Ustilago residua** Clinton, Jour. Myc. *8:* 133. 1902.
    On *Danthonia compressa* Aust.: Found in Sullivan and Westmoreland counties.
    On *Danthonia spicata* (L.) Beauv.: Found in Butler, Centre and Forest counties.
14. **Ustilago sphaerogena** Burrill; (Ellis & Ev. N. Am. Fungi No. 1892; hyponym. 1887) Sacc. Syll. Fung. 7^{2}: 468. 1888.
    On *Echinochloa crusgalli* (L.) Beauv.: Union County, Mifflinburg; Clearfield County, Clearfield; Franklin County, Rouzerville.
15. **Ustilago striaeformis** (Westend.) Niessl, Hedwigia *15:* 1. 1876.
    On *Agropyron repens*[8] (L.) Beauv.: Pike County, Milford (three miles south at the junction of Raymondskill Creek and the Delaware river).
    On *Agrostis alba* L.: Found in Berks, Centre, Columbia, Dauphin, Erie, Franklin, and Susquehanna counties.
    On *Agrostis palustris* Huds.: Delaware County, Media.
    On *Agrostis perennans* (Walt.) Tuckerm.: Erie County, Northeast.
    On *Agrostis* sp.: Adams County, Gettysburg.
    On *Bromus commutatus* Schrad.: Cumberland County, Bowmansdale.
    On *Dactylis glomerata* L.: Found in the fololwing counties: Bradford, Butler, Crawford, Centre, Erie, Franklin, Luzerne, Mercer, Potter, Susquehanna, and Union.
    On *Phleum pratense* L.: Found in the following counties: Berks, Bucks, Butler, Cambria, Carbon, Centre, Chester, Clearfield, Clinton, Columbia, Cumberland, Dauphin, Delaware, Elk, Erie, Franklin, Jefferson, Juniata, Lackawanna, Lawrence, Luzerne, Lycoming, McKean, Mercer, Mifflin, Monroe, Montgomery, Northumberland, Potter, Susquehanna, Tioga, Union, Venango, Wayne, and Wyoming.
    On *Poa compressa* L.: Cumberland County, Bowmansdale; Lancaster County, Pequea.
    On *Poa pratensis* L.: Columbia, Franklin, and Perry Counties.
    On *Poa* sp.: Centre County, State College.
16. **Ustilago Tritici** (Pers.) Rostr. Overs. K. Danske Vid. Selsk. Forh. *1890:* 15. March, 1890.
    On *Triticum vulgare* L. cult.: Found in the following counties: Allegheny, Armstrong, Butler, Centre, Chester, Erie, Franklin, Lehigh, Mercer, Monroe,

[8] Usually the smut on Agropyron spp. is considered to be *Ustilago macrosporium* Desm., however, the spores of this specimen are wholly within the measurements of *Ustilago striaeformis* (West.) Niessl.

Northumberland, Westmoreland, and York. This smut is usually found throughout the state wherever wheat is grown.

17. **Ustilago utriculosa** (Nees) Tul. Ann. Sci. Nat. III. *7:* 102. 1847.
    On *Polygonum amphibium* L.: Erie County (Reported by Schweinitz).
    On *Polygonum lapathifolium* L.: Found in the following counties: Bradford, Mercer, Northumberland, Westmoreland, and Wyoming.
    On *Polygonum pennsylvanicum* L.: Found in the following counties: Cumberland, Luzerne, Lycoming, Pike, Susquehanna, Union, Wayne, and Wyoming.
    On *Polygonum* sp.: Found in Wayne and Wyoming counties.
18. **Ustilago vilfae** Wint. Bull. Torrey Club *10:* 7. 1883.
    On *Vilfa vaginaeflora* Torr. (*Sporobolus vaginiflorus* (Torr.) Wood). Chester County, Chester County is the type locality of this smut (Bull. Torr. Club *10:* 7. 1883).
19. **Ustilago Zeae** (Beckm.) Unger, Einfl. Bodens 211. 1836.
    On *Zea Mays* L.: Found in the following counties: Allegheny, Armstrong, Centre, Delaware, Lancaster, Montgomery, and York. This smut is prevalent throughout the state wherever corn is grown.

FARYSIA Racib. Cracow Acad. Sci. Math. Nat. I. *1909:* 354. 1909.

20. **Farysia olivacea** (DC.) H. & P. Sydow, Ann. Myc. *17:* 41. 1919.
    Uredo olivacea D.C. Fl. Fr. *6:* 78. 1815.
    Caeoma olivaceum Schlecht., Fl. Berol. *2:* 130. 1834.
    Erysibe olivacea Wallr., Fl. Crypt. Germ. *2:* 215. 1833.
    Ustilago olivacea Tul., Ann. Sci. Nat. III. *7:* 88. 1847.
    On *Carex rostrata* Stokes: Centre County, Philipsburg (Black Moshanna Meadows); Sullivan County, La Porte (Lake Makoma).

SPHACELOTHECA De Bary, Verg. Morph. Biol. Pilze 187. 1884.

21. **Sphacelotheca Hydropiperis** (Schum.) De By. Verg. Morph. Biol. Pilze 187. 1884.
    On *Polygonum sagittatum* L.: Found in the following counties: Berks, Bradford, Cumberland, Dauphin, Fayette, Franklin, Lycoming, Monroe, Northumberland, Snyder, Union, and Wayne.
22. **Sphacelotheca Sorghi** (Link) Clinton, Jour. Myc. *8:* 140. 1902.
    On *Sorghum vulgare* Pers. var. *saccharatus* (L.) L. H. Bailey (Kafir Corn): Centre County: State College.
    On *Sorghum vulgare* Pers. var. *technicus* (Körn. & Wern.) L. H. Bailey (Broom Corn): Centre County, State College.
    On *Sorghum* sp.: Centre County, State College.

CINTRACTIA Cornu, Ann. Sci. Nat. VI. *15:* 279. 1883.

23. **Cintractia Caricis** (Pers.) Magn. Abh. Bot. Ver. Prov. Brand. *37:* 79. 1896.
    On *Carex limosa* L.: Pike County, Milford.
    On *Carex pennsylvanica* Lam.: Chester County, West Chester.
    On *Carex varia* Muhl.: Wyoming County, Mehoopany.
24. **Cintractia Junci** (Schw.) Trel. Bull. Torrey Club. *12:* 70. 1885.
    On *Juncus tenuis* Willd.: Found in the following counties: Adams, Centre, Clinton, Forest, Huntingdon, Lancaster, Northampton, and Philadelphia.
    On *Juncus* sp.: Centre County.

SCHIZONELLA Schröt. Beitr. Biol. Pfl. *2*: 362. 1897.

25. **Schizonela melanogramma** (DC.) Schröt. Beitr. Biol. Pfl. *2:* 362. 1877.
    On *Carex communis* Bailey (*C. pedicillata* Britton): Erie County, Presque Isle.
    On *Carex pennsylvanica* Lam.: Armstrong County, Kittanning; Centre County, Pine Hall, State College; Huntingdon County, Alan Seeger Monument.

SOROSPORIUM Rud. Linnaea *4:* 116. 1829.

26. **Sorosporium Ellisii** Wint. Hedwigia *22:* 2. Jan. 1883. Bull. Torrey Club *10:* 7. Jan. 1883.
    On *Aristida dichotoma* Michx.: [9]Chester County, near West Chester; Delaware County, near Media.
27. **Sorosporium Everhartii** Ellis & Gall. Jour. Myc. *6:* 32. 1890.
    On *Andropogon furcatus* Muhl.: Monroe County, Stroudsburg.
    On *Andropogon virginicus* L.: Monroe County, Stroudsburg.
28. **Sorosporium Syntherismae** (Peck) Farl.; Farl. & Seym. Host Index N. Am. Fungi 152. 1891.
    On *Cenchrus carolianus* Walt.: Pike County, Milford.
    On *Cenchrus tribuloides* L.: Northumberland County, Montandon.
    On *Panicum dichotomiflorum* Michx.: Found in the following counties: Armstrong, Beaver, Chester, Clinton, Dauphin, Erie, Franklin, Luzerne, Lycoming, Mifflin, Northumberland, Washington, and Wyoming.

THECAPHORA Fingerh. Linnaea *10:* 230. 1835.

29. **Thecaphora deformans** Dur. & Mont.; Tul. Ann. Sci. Nat. III. *7:* 110. 1847.
    On *Desmodium* (*Meibomia* Ktze.) *nudiflora* (L.) DC.

Family **TILLETIACEAE**

TILLETIA Tul. Ann. Sci. Nat. III. *7:* 112. 1847.

30. **Tilletia Anthoxanthi** Blytt, Forh. Vid.-Selsk. Christ. 1896^6: 31. 1896.
    On *Anthoxanthum odoratum* L.: Lycoming County, Unityville, (J. E. Neuhart farm); Sullivan County, Forksville (at Loyalsock Rod and Gun Club); Wyoming County, Noxen (Engleman orchard).
    This rare smut has previously been collected twice in North America—once in Connecticut and once in Nova Scotia. Both collections were made by Dr. George P. Clinton.
31. **Tilletia foetans** (B. & C.) Trel. Par. Fungi Wisc. 35. 1884.
    On *Triticum vulgare* L.: cult. Found in the following counties: Bedford, Berks, Blair, Butler, Centre, Chester, Crawford, Cumberland, Dauphin, Delaware, Franklin, Lancaster, Lehigh, Lycoming, and Montgomery.
32. **Tilletia Holci** (Westend.) Rost. Bot. Tidskr. *22:* 256. 1899.
    On *Holcus lanatus* L.: Forest County, Red Brush, Tionesta Township; Jefferson County, Pansy.
33. **Tilletia pulcherrima** Ell. & Gall.; Clinton, Proc. Boston Soc. Nat. Hist. *31:* 441. 1904.
    On *Panicum capillare* L.: Centre County, State College (extremely rare).

UROCYSTIS Rab.; Klotzsch, Herb. Viv. Myc. ed. 2. 393. 1856.

34. **Urocystis Agropyri** (Preuss) Schröt. Abh. Schles. Ges. Abth. Nat. Med., *1869–; 872:* 7. 1870.

[9] Reported in Bull. Torrey Club *10:* 7. 1883. No specimens have been available for examination.

On *Agropyron repens* (L.) Beauv.: Found in Erie, Luzerne, Susquehanna, and Tioga counties.
On *Poa pratensis* L.: Montgomery County.

35. **Urocystis Anemones** (Pers.) Wint.; Rab. Krypt. Fl. 1^1: 123. 1881.
    On *Hepatica acutiloba* DC.: Butler County, on Slippery Rock Creek, Slippery Rock, Huntingdon County, Spruce Creek.
36. **Urocystis carcinodes** (B. & C.) Fisch. de Waldh. Apercu Syst. Ust. 38. 1877.
    On *Actea* sp.: Berks County, Wernersville.
    On *Cimicifuga racemosa* (L.) Nutt.: Blair County, hills beyond Hollidaysburg; Franklin County, Edenville; Huntingdon County, Charter Oak.
37. **Urocystis Cepulae** Frost, Farl. in Ann. Rep. Sec. Mass. Board Agr. *24:* App. 175. 1877.
    On *Allium Cepa* L.: Crawford County, Linesville; Erie County, Girard; Susquehanna County, Glenwood.
38. **Urocystis occulta** (Wallr.) Rab.; Klotzsch. Herb. Viv. Myc. ed. 2. 393. 1856.
    On *Secale cereale* L.: Berks County, Reading; Dauphin County, Harrisburg; Erie County, Northeast; Lycoming County, Muncy.

ENTYLOMA DeBary, Bot. Zeit. *32:* 101. 1874.

39. **Entyloma australe** Speg. Anal. Soc. Ci. Argent. *10:* 5. July, 1880.
    On *Physalis heterophylla* Nees.: Found in Adams and Cumberland Counties.
    On *Physalis pubescens* L.: Erie County, Northeast.
    On *Physalis subglabrata* Mackenzie & Bush: Lancaster County, Clay.
    On *Physalis virginiana* Mill.: York County, Dillsburg.
    On *Physalis* sp.: Found in the following counties: Berks, Dauphin, Monroe, Northampton, and York.
40. **Entyloma compositarum** Farl. Bot. Gaz. *8:* 275. 1883.
    On *Ambrosia artemisiifolia* L.: Centre County, Colyer Gap.
    On *Ambrosia trifida* L.: Columbia County, Catawissa.
    On *Aster* sp.: Centre County, State College.
    On *Senecio aureus* L.: Huntingdon County, Charter Oak.
    On *Senecio Smallii* Britton: Perry County, New Bloomfield.
41. **Entyloma irregulare** Johans. Oefv. K. Sv. Vet.-Akad. Förh. 41^9: 159. 1885.
    On *Poa pratensis* L.: Centre County, State College.
42. **Entyloma Lobeliae** Farl. Bot. Gaz. *8:* 275. 1883.
    On *Lobelia inflata* L.: Found in the following counties: Adams, Dauphin, Huntingdon, Juniata, and Perry.
    On *Lobelia spicata* Lam.: Centre County, Scotia.
43. **Entyloma Menispermi** Farl. & Trel. Bot. Gaz. *8:* 275. 1883.
    On *Menispermum canadense* L.: Lehigh County, Lehigh Valley (Reported by Herbst in "Fungal Flora of the Lehigh Valley" 183. 1899. Reported on leaves of yellow Parilla).
44. **Entyloma polysporum** (Peck) Farl. Bot. Gaz. *8:* 275. 1883.
    On *Ambrosia trifida* L.: Perry County, Millerstown.

SOME CHARACTERISTICS OF DARLUCA IN CULTURE

By Paul D. Keener[1]

The fungus genus Darluca is of considerable interest chiefly because of its reported parasitism on the rust fungi. The members of the genus have been reported on hundreds of rust hosts scattered throughout the entire world. Various reports have listed them as occurring on the aecial, uredinial, and telial sori of the various rusts but they are most commonly found on the uredinia.

The genus Darluca is classed in the Family Sphaeropsidaceae of the Order Sphaeropsidales of the Class Fungi-Imperfecti. It was established in the year 1851 by Luis Castagne (1). The most widely distributed species of the genus was first described in 1813 as Sphaeria Filum by A. de Bivona-Bernardi (2). In 1851, Castagne made this same fungus the type species of his new Genus Darluca (1). Since the founding of the genus there have been described in the literature, approximately 25 species of Darluca in a wide variety of relationships to their hosts. Probably the majority of these are not valid species, and reports of their occurrence as other than true rust parasites, are probably erroneous.

In nature the fungus is found in the form of small, globose to subglobose, or elongated, black, shiny, fruiting bodies known as pycnidia. These structures vary considerably in size, are slightly beaked, and possess distinct ostiolar openings through which the spores are exuded in thin, white or grayish, twisted, mucilaginous threads.

The pycnidia occur either innately or superficially on the rust sorus, and rarely they are found directly on the host plant epidermis, apparently unassociated with any rust sori. In the latter case the fungus is probably parasitic on the rust hyphae concealed within the tissues of the host plant.

The spores or conidia are produced in large numbers within the pycnidia. They are borne singly at the tips of pedicels which are about as long as the spores themselves. The spores are mainly 2-celled, sometimes 3-4-celled, hyaline, oblong to fusoid, 10–21 x 3–7 μ, smooth-walled, and when young possess two apiculate spine-like projections, 2 μ long, at either end of the spore. These spines tend to disappear as the spores become mature.

The hyphae of the fungus vary from 3–5 μ in diameter and are of unusual interest in that they contain but a small amount of cytoplasm.

[1] Contribution from the Department of Botany, The Pennsylvania State College, No. 86.

Culture Work

Up to this time, so far as can be determined from the literature, the members of the genus Darluca have never been grown in culture.

For this reason, beginning in the fall of 1931, isolations of Darluca from various rusts were made with the ultimate purpose of discovering cultural and pathological evidence as to the degree of biological specialization within the species Filum. This paper is intended as a preliminary report on the progress of the first phase. Inoculation work is under way in the greenhouse to secure pathological evidence and a report on this phase will be made later.

Methods and Materials

Field materials of rusted plants heavily infested with Darluca from which isolations were to be made were first washed in a weak soap solution and sterile water, to rid them of as much field contamination as possible.

With the aid of a binocular microscope, pycnidia of the fungus were lifted from the rust sori by means of a sterile scalpel. For each isolation, a suspension of pycnidia and spores was prepared by thrusting the scalpel into a tube of sterile water and at the same time crushing out the pycnidia by pressing the scalpel against the side of the tube. The quantity of sterile water should be just sufficient to cover the surface of solidified agar in a petri dish. This suspension was then poured over the surface of solidified agar in a dish and was spread evenly over the agar surface by rotating the dish. Any excess of water was poured off by holding the dish in a vertical position and raising the lid slightly. Dishes prepared in this manner were then inverted on the stage of a compound microscope. The low power objective was used to locate individual spores and pieces of pycnidia which were then marked with circles of India ink on the bottoms of the dishes. When growth had started, the lids of the dishes were removed, and pieces of agar in the areas designated by the circles were cut out and transferred to agar slants in test-tubes.

For the isolations three agars were used. These were Lima Bean, Potato Dextrose, and Malt. The first two were prepared by using the commercially-produced extracts and weighing out the specified amounts in 1,000 c.c. of distilled water. The Malt agar was prepared with 15 grams Malt extract, 20 grams of agar-agar, in 1,000 c.c. of distilled water.

By the use of this method, 10 isolations from 10 different rusts (5 in the rust genus Puccinia and 5 in the genus Uromyces), from 9 different hosts, collected in three states, were made. The following is a list of these isolations with their arbitrary culture numbers, and the states from which the original field materials came.

1. Darluca isolated from Puccinia Sorghi on Zea Mays. (Pennsylvania).
2. Darluca isolated from Puccinia graminis on Phleum pratense. (Pennsylvania).
3. Darluca isolated from Uromyces Silphii on Juncus tenuis. (Pennsylvania).
3b. Darluca isolated from Uromyces Silphii on Juncus tenuis sent by Doctor C. R. Orton from the University of West Virginia.
4. Darluca isolated from Uromyces fallens on Trifolium pratense. (New Jersey).
5. Darluca isolated from Puccinia hibisciata on Muhlenbergia Schreberi. (New Jersey).
6. Darluca isolated from Puccinia Violae on Viola sp. (New Jersey).
7. Darluca isolated from Uromyces Polygoni on Polygonum aviculare. (Pennsylvania).
8. Darluca isolated from Uromyces Junci-effusi on Juncus effusus. (Pennsylvania).
9. Darluca isolated from Puccinia Hieracii on Leontodon Taraxacum. (Pennsylvania).

Results

The characteristic field features of the fungus are for the most part retained under culture conditions.

In general, pycnidia and spores are readily produced in culture and the size range of these structures corresponds closely to that in the field. The shape and color of the pycnidia are also retained on culture media.

In the field the shape of the conidia varies from oblong to fusoid. In culture, however, while the majority of the spores retain their oblong to fusoid shape, there is a noticeably large number of aberrant forms. (See Figure 15, 2.) In culture, 3–4-celled spores occur in large numbers while in the field material the number of cells is almost constantly 2, with only an occasional multi-cellular spore.

Under field conditions the vegetative hyphal growth of the fungus is confined to an area within or beneath the rust sorus and within the tissue of the host plant, so that there appears to be no aerial mycelium developed. In culture many of the isolations develop two types of mycelium. The first type grows above and on the surface of the agar and may be termed the "aerial mycelium." This type is relatively thin-walled, light colored, and contains a small amount of cytoplasm. The second type of mycelium is confined to a region beneath the agar surface and may be called the "sub-aerial mycelium." This type is comparatively thick-walled, dark in color and often becomes densely granular. Some of the cultures were lacking in both of the above mycelial types, and developed on the surface of the agar, a hard, black, "stromatic layer" in which were fused many pycnidia. (See Plate I, Figs. 3-A, 3-B.) Still others were totally lacking in this stromatic development. The presence of a stroma, even after the preparation of free-hand sections, could not be detected in any of the field specimens from which the ten isolations were made.

As a general rule, spore production is limited on Potato-dextrose agar. However, this agar affords an excellent isolation medium as it gives a stimulus to quick vegetative development. Those isolations which developed a stroma produced it in the greatest amount on this agar. In the case of the majority of isolations, vegetative hyphal development was extremely heavy on this medium.

Malt agar was especially well adapted to both vegetative growth and spore production. Stromatic development was variable on this agar.

In general, the best growth and the most abundant pycnidial and spore production were obtained on Lima Bean agar. Spore germination takes place in a short time on this medium, and pycnidia are produced in from five to seven days after inoculation.

The development of Darluca on Lima Bean agar was found to be as near to that in the field as could be desired. In view of this fact, this medium was selected for a greater part of the culture work, as the best medium on which to grow the various isolations for comparison and detection of possible strains.

It was found that all the isolations tended to produce certain spore types not found in field material. In the literature these structures have been called Oidia (see Figure 15, 8) and Chlamydospores (see Figure 15, 4). The former are produced in variable numbers in chains, while the latter occur as either intercalary or terminal hyphal cells.

Comparing the several isolations on Lima Bean agar it appears that there are six distinct groups based on the following characteristics of growth: (1) the presence or absence of a stroma and the degree to which this is developed; (2) the degree of spore production; (3) the presence or absence of "aerial mycelium"; (4) the color of the aerial mycelium; (5) the presence or absence of "sub-aerial mycelium"; (6) the color of the sub-aerial mycelium.

The essential differences as shown in Table 1 persisted to a greater or lesser extent on other media. A series of acid media, consisting of Malic, Maleic, Malonic, Tartaric and Succinic acids, were used primarily to determine the ability of the various isolations to make use of these acids for growth. The results obtained add further evidence to show that the groupings as made on Lima Bean agar are valid.

In the group descriptions below, characters other than those brought out in Table 1 are discussed briefly.

GROUP I. (See Plate I. Figs. 1-A, 1-B). On *Potato-Dextrose agar,* this group develops a very heavy layer of aerial mycelium; medium stromatic growth, and medium to heavy pycnidial and spore production. The sub-aerial mycelium is yellow changing to deep brown. On *Malt agar,* the group is also apt to produce heavy aerial

TABLE 1

Comparison of Six Groups of Darluca Filum on Lima Bean Agar

Group number	Isolation number	Stroma	Spores	Aerial mycelium	Sub-aerial mycelium
I	1 4 5 6 7	—	++	+ White	+ Yellow turning to orange
II	2	—	+	+ White	+ Salmon pink to yellow
III	3	++	+++	—	—
IV	3b	—	±	± Light brown	± Light brown turning to darker brown
V	8	±	+	+++ White	+++ Black
VI	9	—	±	+ White turning to yellow	++ Brownish yellow turning to deep reddish yellow

Key to Table 1

+++ = present and very heavily developed.
++ = present and heavily developed.
+ = present and slightly developed.
± = poorly developed.
— = no development.

mycelium, and medium to heavy stromatic growth. The sub-aerial mycelium is dark brown to black. Spore production on this agar is variable. The group can probably be subdivided after more culture work has been accomplished. It is composed of intergrading characters which correspond somewhat to those of Group II. However, it is separated from the latter group in that growth of Group I is very poor on *Maleic acid,* while the growth of Group II is very good on this same medium. Group I is unable to utilize the other acid media to any great extent.

GROUP II. (See Plate I. Figs. 2-A, 2-B). On *Potato-Dextrose agar,* this group produces a very heavy, thick, crust-like aerial mycelium which at first is white but later turns to a yellow color. The sub-aerial mycelium on this medium varies from a yellow to a deep orange brown color, and comprises a rather heavy layer. Spore production on this agar is poor. On *Malt agar* the sub-aerial mycelium in of a deep brown color, and of rather shallow nature. There is heavy spore production on this medium. The group may be differentiated from Group I in that Group II produces a heavy crust-like aerial mycelial mat accompanied by relatively few spores on Potato-Dextrose agar. On *Maleic acid* growth of this group is good, which fact further separates it from Group I. Only mediocre growth was obtained on the other acid media.

GROUP III. (See Plate I. Figs. 3-A, 3-B). This group is perhaps one of the most distinct of the six. On *Potato-Dextrose agar* there is very heavy spore production which is unusual as a general rule for this agar. The stromatic growth is much heavier on this agar than indicated for Lima Bean agar in Table 1. On *Malt agar* the growth is similar with the exception that there is a slight development of fine, grayish, aerial mycleium over the surface of the pycnidia. This group is easily separated from the others by its extremely heavy stromatic growth developed on Potato-Dextrose agar, and the presence of a certain degree of stromatic development on all agars. It may be further separated in that there is no growth at all on *Malic agar,* with only poor to fair growth on the other acid media.

GROUP IV. (See Plate I. Figs. 3B-A, 3B-B). Although this isolation was made from the same species of rust and host plant as that of Group III, there seems to be cultural evidence that the strains are not the same. On *Potato-Dextrose agar,* there is produced gray aerial mycelium which is closely appressed to the underlying stroma in which the pycnidia are fused. The stromatic growth is only of medium intensity. There is no sub-aerial mycelium produced on this agar. On *Malt agar* the strain produced a rather thin layer of gray to brown colored aerial mycelium. Stromatic growth on this medium is rather heavy, and spores are produced profusely. The group may be differentiated from Group III in that it develops less stroma on Potato-Dextrose agar, and a heavier stroma on Malt agar than does the isolation of Group III. Furthermore, this isolation develops a thin layer of brown aerial mycelium on Lima Beam agar. The pycnidia are also brown in color. The Group III isolation produced no aerial mycelium and black pycnidia on Lima Bean agar. The spore production of Group III was very heavy on Lima Bean, while in this group it is limited. The group is further separated from Group III in that growth is extremely good on *Malic acid.* Group III did not grow at all on this acid medium. Growth of Group IV is poor on Maleic acid.

GROUP V. (See Plate I. Figs. 8-A, 8-B). On *Potato-Dextrose agar* this group makes a great departure from the growth habits of the other groups on the same medium. There is a heavy stromatic development over which grows a thick, mold-like layer of blue to green aerial mycelium. The color fades to gray on aging. On *Malt agar* the aerial mycelium is stringy and deep gray in color. Spores are not readily produced on this medium. It may be further separated from the other groups in that this group is the only one of the six that attains good growth on *Tartaric acid.* Growth is poor to fair on the other acid media.

GROUP VI. (See Plate I. Figs. 9-A, 9-B). The growth features of this group as shown in Table 1 held true on the other media used. Growth as a whole was poor to fair on all agars.

Discussion and Conclusions

This preliminary study of the ten isolations of Darluca Filum from various rusts, indicates that there is some cultural evidence of biological specialization within that species. From the study, we can discern six distinct groups based on general growth features. It is the author's opinion that these six groups constitute a series of six biological strains of the species Filum. The author is also of the opinion that after further studies have been completed, Darluca Filum will be found to consist quite definitely of many biological strains which will be found to have distinct preferences for their rust hosts.

While many species of Darluca have been described, one has only to read over the various descriptions to decide for himself that with few exceptions, the specific separations have been based on very slight morphological differences. Some of these names have already been reduced to synonomy so that it appears that there are but a few valid species of the genus. No doubt many of these will eventually be combined with the common species Darluca Filum.

Up to the present time it is evident that specific separations within the genus Darluca, for the most part, have been made on extremely weak evidence. At the same time, it is apparent that no thought has been given to the possible existence of biologically specialized strains within a species. Biological specialization itself is of wide-spread occurrence throughout both animal and plant kingdoms and it is well known in many of the fungi. Probably most of the previously described Darluca species, rather than existing as distinct species, are merely biological strains of the species Darluca Filum.

The rust fungi are well known as one of the most highly specialized groups of fungi, and there is a high degree of biological differentiation within their genera and species. Up to this time, the rusts have never been grown on artificial culture media. In spite of the constant association of the Darluca with rusts, it seems quite evident that they are not as highly developed parasitically as are the rusts themselves. The culturing of Darluca Filum on artificial media, as brought out in this work, tends to warrant such assumption.

The author realizes that culture work on artificial media alone will never suffice to separate definitely the various biological strains, but that this type of work must be supplemented by culture work on the natural hosts. The best criteria of strain differentiations among the parasitic fungi are the "pathological tendencies" which they display. This phase of the problem is now being undertaken with cultures on the rust hosts.

The work here reported gives merely an indication of the existence of strains within the species Darluca Filum.

It is perhaps also true that after isolations have been made from other rust species and from the same rusts in widely separated localities, many intergrading forms will be found to exist.

The author is greatly indebted to Dr. H. W. Thurston, Jr., of the Department of Botany, Pennsylvania State College, for his helpful advice in the carrying out of the experimental work, and in the preparation of this manuscript; to Dr. C. R. Orton, of the University of Virginia, Morgantown, for the collection of the material from which the Group IV isolation was made; and to W. L. White, also of the Department of Botany, Pennsylvania State College, for the rust determinations mentioned herein and for the collection of the material from which the Group II isolation was made.

Summary

1. This is the first report of cultural work with any member of the genus Darluca.

2. Ten isolations of Darluca Filum from ten different rusts (5 in the rust genus Puccinia and 5 in the genus Uromyces), on nine host plants collected in three States, were made.

3. The essential features of the fungus, as seen in the field, were retained on culture media.

4. The isolations were found to fall into six distinct groups based on several criteria of growth on artificial culture media.

5. Certain spore types, not found under field conditions, were common to all the isolations on all media. The significance of these forms is extremely doubtful.

6. From this preliminary study, there seems to be strong evidence of biological specialization within the species Darluca Filum.

7. The degree of specialization is probably not as strong as in the case of the rust fungi themselves.

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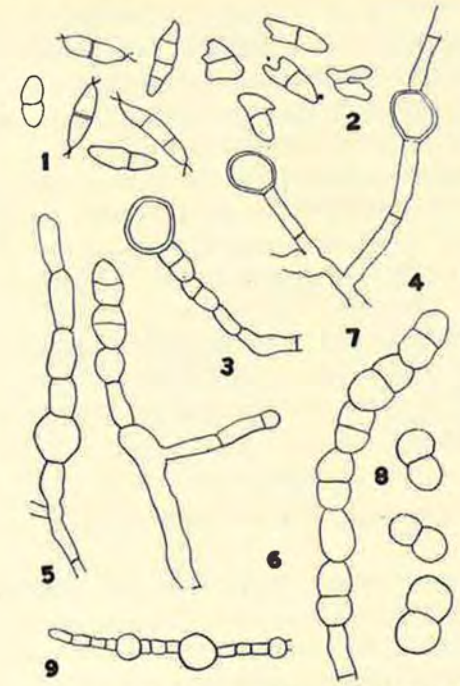


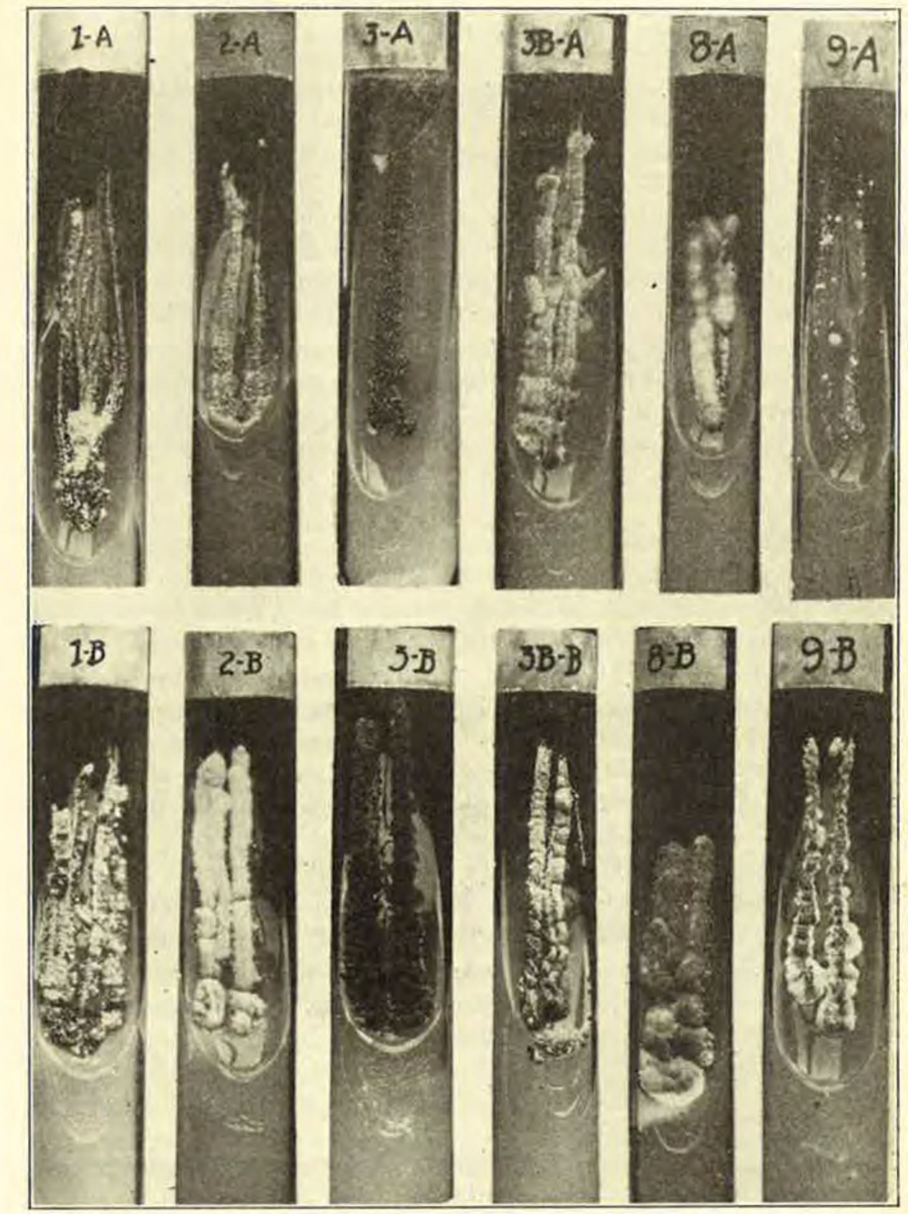
FIG. 15. 1–9, from lima bean agar cultures of Darluca Filum. All drawings made with a camera lucida at an approximate magnification of 975 ×. 1, Normally formed macro-conidia. 2, Aberrant forms of macro-conidia. 3 and 4, Chlamydospore-like hyphal cells. 5, 6, 7 and 8, Stages in the development of the oidia-like cells. 9, Differentiated hyphal cells (probably a stage preliminary to the formation of the Chlamydospore-like cells).

EXPLANATION PLATE I

Series A: six strains of Darluca Filum on lima bean agar.
(Group I) Fig. 1-A, Isolation from Puccinia Sorghi.
(Group II) Fig. 2-A, Isolation from Puccinia graminis.
(Group III) Fig. 3-A, Isolation from Uromyces Silphii (Pennsylvania).
(Group IV) Fig. 3B-A, Isolation from Uromyces Silphii (West Virginia).
(Group V) Fig. 8-A, Isolation from Uromyces Junci-effusi.
(Group VI) Fig. 9-A, Isolation from Puccinia Hieracii.

Series B: six strains of Darluca Filum on Potato-dextrose agar.
(Group I) Fig. 1-B, Isolation from Puccinia Sorghi.
(Group II) Fig. 2-B, Isolation from Puccinia graminis.
(Group III) Fig. 3-B, Isolation from Uromyces Silphii (Pennsylvania).
(Group IV) Fig. 3B-B, Isolation from Uromyces Silphii (West Virginia).
(Group V) Fig. 8-B, Isolation from Uromyces Junci-effusi.
(Group VI) Fig. 9-B, Isolation from Puccinia Hieracii.

PLATE I



NOTES ON THE RUSTS OF PENNSYLVANIA*

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The rust fungi have been for many years the object of certain studies carried on by various members of the Department of Botany of the Pennsylvania State College. In the report of the first meeting of the Pennsylvania Academy of Science, held in November, 1924, there appeared an abstract of a paper on the Rusts of Pennsylvania.[1] At this time the number of species known in the State was 154 and the number of host plants 368. In 1929[2] the list was first published in its entirety, and contained the names of 158 species of rusts on 412 species of host plants. During the past four years we have added a large number of collections from various parts of the State. Study of these collections reveals eleven species not recorded in the previous list. Two species in the old list were found to have been reported in error, thus bringing the total number of rusts now known in Pennsylvania to 167, and the number of hosts to 440.

The purpose of these notes is twofold: 1, to record the species which are new for the State and, 2, to offer additional information and comments upon several of the previously recorded forms, which have come to hand largely as a result of collecting during the past four years. In the 1929 list almost one-third of the recorded species bear the notation "rare" or "known only from a single collection." While no effort has been made to collect systematically in all parts of the State, our collections now cover a period of twenty years and consist of several thousand specimens. In this connection it is of interest to point out that twelve species have been recorded but once in a hundred years, or in fact, only once in the history of Pennsylvania mycology. These twelve collections are all to be credited to Louis David Von Schweinitz, known as the Father of American Mycology, who lived and collected fungi in the vicinity of Bethlehem, Penna., between the years of 1821 and 1834. Schweinitz collected in all 71 species of rusts in Pennsylvania. All of these but the 12 mentioned have been found at least once since. A list of these forms is included in our notes in the hope that by calling attention to them we may stimulate some interest in this group of fungi and

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[1] C. R. Orton, H. W. Thurston, Jr. and F. D. Kern. The Rusts of Pennsylvania. Proc. Penna. Acad. Sci. 1: 63–64. 1926.

[2] F. D. Kern, H. W. Thurston, Jr., C. R. Orton, and J. F. Adams. The Rusts of Pennsylvania. Penna. Agric. Exp. Sta. Bull. 239. 1929.

some search for these forms in particular. It is our belief that most of them are not really so rare in the State as our collection records would indicate.

SPECIES NOT REPORTED IN PREVIOUS PENNSYLVANIA LISTS

MELAMPSORELLA ELATINA (Alb. & Schw.) Arth., North Am. Flora **7**: 111. 1907.

On *Alsine longifolia* (Muhl.) Britton. II & III.

This rust seems to be widely distributed in the eastern United States but is known in Pennsylvania only from a specimen collected at Trout Run, Lycoming County, June 1925. The pycinia and aecia occur on *Abies* sp. but have not been found in Pennsylvania.

PUCCINIA ALLENII (Clinton) Barth, Handbook North Am. Ured. 83. 1928.
On *Carex viridula* Michx. II & III.

This species is represented in Pennsylvania by a single collection made at Presque Isle in 1868, by A. P. Garber. The pycnia and aecia are known to occur on *Shepherdia* sp. but have not been found in Pennsylvania. We are indebeted to Doctor J. C. Arthur, Purdue University, for a specimen of this collection.

PUCCINIA ARALIAE Ell. & Ev., Jour. Myc. **6**: 120. 1891.
On *Panax trifolium* L. III. Shaver's Creek, 3 miles southwest of Pine Grove Mills, Centre County, May 9, 1930, M. C. Ries.

A conspicuous short-cycled rust not heretofore known outside of the type locality in Massachusetts.

PUCCINIA BATESIANA Arth., Bull. Torrey Club **28**: 661. 1901.
On *Heliopsis helianthoides* (L.) Sweet. O, I, III.

Known in Pennsylvania from a single collection from Bedford County, Sept. 18, 1918, by Mrs. Joseph Clemens. Our specimen was contributed from the Arthur Herbarium, Purdue University.

PUCCINIA DOUGLASII Ell. & Ev., Proc. Acad. Phila. 1893: 152. 1893.
On *Phlox subulata* L. O, I, III.

A specimen of this rust collected near Philadelphia by Thos. Meehan in 1893 has been contributed to our collection by Doctor J. C. Arthur. No other collections from the State are known.

PUCCINIA TUMIDIPES Peck, Bull. Torrey Club **12**: 24. 1885.
On *Lycium halimifolium* Mill. II, III. State College, Oct. 26, 1931, H. W. Thurston, Jr.

This rust was reported (Bull. Penna. Ag. Expt. Sta. 239, 1929) as *P. globosipes*. At the time of the previous report only urediniospores had been found in the State. Subsequent collections of telia in Pennsylvania as well as in New York and West Virginia make it seem certain that all of the eastern collections on this host should be referred to *P. tumidipes*, and that *P. globosipes* is a western species. The two are not separable in the uredinial stage.

PUCCINIASTRUM GALII (Link) Ed. Fischer, Beitr. Krypt. Schweiz. **2**: 471. 1904.

On *Galium triflorum* Michx. II, III. Olivet, Armstrong Co., Aug., 1932, W. L. White.

This rust is reported in North American Flora from Vancouver Island southward to central California and eastward to central Colorado, with one locality in central New York and one in Wisconsin. *Galium triflorum* is its only recorded host in this country. The pycnia and aecia are unknown.

UREDINOPSIS COPELANDI Sydow, Ann. Mycol. **2**: 30. 1904.
Uredinopsis Atkinsonii Magn., Hedwigia **43**: 123. 1904.

On *Asplenium Felix-foemina* (L.) Bernh. II, III. Ingleby, Centre Co., July, 1931, H. W. Thurston, Jr.

This species has for sometime been known to occur in northeastern United States but has not been recorded previously from Pennsylvania. The aecial stage is known to occur on *Abies* sp. but has not been found in Pennsylvania.

UROMYCES ALOPECURI Seym., Proc. Bost. Soc. Nat. Hist. **24**: 186. 1889.

On *Alopecurus aristulatus* Michx. II, III. State College, Centre Co., July 28, 1931, H. A. Wahl & W. L. White.

This is a western species, not heretofore reported east of Minnesota. The pycnia and aecia have been reported on *Ranunculus* sp. from Colorado and western Canada but have not been found in Pennsylvania.

UROMYCES HALSTEDII DeToni, in Sacc. Syll. Fung. **7**: 557. 1888.

On *Leersia oryzoides* (L.) Sw. II, III. Hunter's Run, Cumberland Co., Sept. 1, 1921, C. R. Orton.

This is apparently an uncommon but widely distributed species. The pycnia and aecia are unknown.

UROMYCES VERRUCULOSUS Schroet., Jahresb. Schles. Gaz. **50**: 140. 1873.

On *Lychnis alba* Mill. II.

There are at hand two collections from Pennsylvania, one from Northeast, Erie Co., Oct., 1920, W. A. McCubbin, *1185*, and the other from

State College, Oct., 1932, P. D. Keener. The former collection was recorded in Bull. Penna. Ag. Expt. Sta. 239, 1929, as *Uromyces Silenes* (Schlecht.) Fuckel. on *Silene noctiflora* L. This was an error, and it now appears that *U. Silenes* has never been found in Pennsylvania. The rust is apparently rare, having been reported elsewhere only from Michigan and New York.

Notes on Some Previously Reported Species

COLEOSPORIUM CAMPANULAE (Pers.) Lev., Ann. Sci. Nat. III. **8**: 373. 1847.

On *Campanula rapunculoides* L. II, III. Campus, State College, Centre Co., Sept. 22, 1932, H. W. Thurston, Jr.

This collection adds a host to the Pennsylvania list. The rust apparently is not common. It was included in the previous list based on a specimen collected in Westmoreland County, by Sumstine in 1908, and on the report of this species from Pennsylvania on *Specularia perfoliata* (L.) DC. in the North American Flora.

GYMNOSPORANGIUM GERMINALE (Schw.) Kern, Bull. Torrey Club **35**: 506. 1908.

On *Crataegus macracantha* Lodd. O, I. Bald Eagle Mts., above Fillmore, Centre Co., Sept. 18, 1930, L. O. Overholts.

On *Crataegus Oxyacantha* L. (Cultivated), O, I. Campus, State College, Centre Co., July, 1931, W. L. White.

On *Crataegus roanensis* Ashe. O, I. Bald Eagle Mts., above Fillmore, Centre Co., Sept. 18, 1930, L. O. Overholts.

We have found no record of the occurrence of this rust on any of the above named hosts in North America. *Crataegus Oxyacantha* L. is sometimes confused with *C. monogyna* Jacq. The host here reported is to be referred to the former name and is not *C. monogyna* Jacq. as the two species are described in Bailey's Encyclopedia.

MELAMPSOROPSIS CASSANDRAE (Peck & Clinton) Arth., Result Sci. Congr. Bot. Vienna 338. 1906.

On *Chamaedaphne calyculate* (L.) Moench. II, III.

This rust has been considered rare in Pennsylvania, the report of it in the previous list being based on a single collection from a high mountain bog in Centre Co. known as Bear Meadows where it is known to appear each summer. A collection was made in Mercer Bog, Mercer County, June, 1932, H. W. Thurston, Jr., which adds a new locality for the State. Since the host is limited in its distribution to scattered bogs and swamps, it is to be expected that the rust would be collected infrequently. Judging, however, from our collections in widely separated localities and from reports of its occurrence in surrounding states, it is likely that the rust is more constantly associated with this host than was formerly believed.

PUCCINIA ACETOSAE (Schum.) Körn., Hedwigia **15**: 184. 1876.
On *Rumex Acetosella* L. II, III.

This rust has been previously recorded from only two inland states, Indiana and Pennsylvania, the latter based on a single Clinton County collection. During the summer of 1932 collections have been made from three additional counties—Armstrong, Centre, and Indiana.

PUCCINIA CLEMATIDIS (DC.) Lagerh., Tromsö. Mus. Aarsh. **17**: 47. 1895.
On *Ranunculus recurvatus* Poir. O. I. Near State College, Centre Co., Mar. 16, 1930, C. S. Moses & L. O. Overholts.

This plant is not recorded in the North American Flora as a host for *Puccinia Clematidis,* though the rust is a common and widely distributed species and known to occur on a large variety of Ranunculaceous hosts.

PUCCINIA CURTIPES Howe, Bull. Torrey Club **5**: 3. 1847.
On *Micranthes virginiensis* (Michx.) Small, III.

This rust, which had previously been represented in our herbarium by a single Huntingdon County collection, has been taken several times in the vicinity of State College, during the last two years.

PUCCINIA CYPERI Arth., Bot. Gaz. **16**: 226. 1891.
On *Erigeron anuus* (L.) Pers. O, I. Three collections from southern Pennsylvania are at hand.
On *Cyperus strigosus* L. II, III. Biglerville, Adams Co., Sept. 22, 1931, W. L. White.

The rust is known only from the southern part of the state and had not been reported from Pennsylvania on the above named hosts. The pycnia and aecia have been unknown until Doctor J. J. Davis proved recently (Trans. Wis. Acad. Sci., Arts & Let. **27**: 187. 1932) by cultures that they occur on *Erigeron.* In the past all aecia on *Erigeron* in Pennsylvania have been referred to *Puccinia asterum* (Schw.) Kern, which is common in the state and develops its uredinial and telial stages on *Carex.* It is pointed out by Doctor Davis that the aecidial stage of *Puccinia Cyperi* Arth. is very similar to that of *P. asterum,* the principal difference observed being a thickening of the spore wall at or near the apex in the former species. Subsequent examination of material previously filed in

our herbarium as *P. asterum* showed that some of the collections should now be referred to this species having its alternate stages on *Cyperus.* It is of interest to note that the collections on *Erigeron* having aeciospores with thickened walls were from the same general region in the southern part of the state, and that it is only in this section that the uredinial and telial stages have been collected on *Cyperus.*

PUCCINIA GROSSULARIAE (Schum.) Lagerh. Tromsö. Mus. Aarsh. **17**: 60. 1895.
On *Carex digitalis* Willd. II. Near Windber, Bedford Co., July 11, 1928, A. R. Bechtel.
On *Carex pedunculata* Muhl. II, III. Near Philipsburg, Centre Co., June 2, 1923, L. W. Nuttall.
On *Carex torta* Boot. II. Oleona, Potter Co., May 28, 1932, G. L. Zundel & W. L. White.

A common rust not heretofore reported on the above named hosts from Pennsylvania.

PUCCINIA HIERACIATA (Schw.) H. S. Jackson, Brooklyn Bot. Gard. Mem. **1**: 251. 1918.
On *Hieracium venosum* L. O, I. Barrens, Centre Co., June 19, 1931, H. W. Thurston, Jr.
On *Lactuca canadensis* L. O, I. Near Scotia, Centre Co., June 9, 1931, L. O. Overholts.
On *Lactuca hirsuta* Muhl. O, I. Barrens, Centre Co., June 19, 1931, S. Wentzel.
On *Lactuca* sp. O, I. Along Susquehanna River, above Lock Haven, Clinton Co., May 29, 1932, L. O. Overholts & W. L. White.

The rust is known to occur in near-by states on the above named species of *Lactuca,* but the first host named is new for North America. Previous to this the only record of the occurrence of the rust in Pennsylvania was from the single collection of Schweinitz (2868) on *Hieracium paniculatum* L. It is interesting to note that the uredinial and telial stages on the alternate host, *Carex,* have not yet been recorded from Pennsylvania. This may be due to the fact that, although these stages undoubtedly occur here, they are so similar to those of the more common *Puccinia Peckii* that the two species of rust on *Carex* can be separated only with difficulty.

PUCCINIA IMPATIENTIS (Schw.), Arth. Bot. Gaz. **35**: 19. 1903.
On *Impatiens pallida* Nutt. O, I. Wolf Creek, Mercer Co., July 23, 1932, H. W. Thurston, Jr.

On *Cinna arundinacea* L. II, III. Mt. Holly Springs, Cumberland Co., Sept. 2, 1921, C. R. Orton.

A collection of this rust from Pennsylvania on *Impatiens pallida* is listed in North American Flora, but that recorded above is the first on this host in Pennsylvania to be seen by the writers. There seems to be no previous report of it on *Cinna* from the state.

PUCCINIA PECKII (DeToni) Kellerm., Jour. Myc. **8**: 20. 1902.

On *Carex annectans* Bicknell. II. Biglerville, Adams Co., July 26, 1932, W. L. White.

On *Carex normalis* Mackenzie. II, III. State College, Centre Co., Dec. 7, 1932, H. W. Thurston, Jr., & P. D. Keener.

On *Carex vulpinoidea* Michx. II, III. Olivet, Armstrong Co., Aug. 20, 1932, W. L. White.

This is one of the less common of the seven *Carex* rusts known to occur in Pennsylvania. The hosts named above are new for the state.

PUCCINIA POCULIFORMIS (Jacq.) Wettst., Verh. Zool. Bot. Gez. Wien. **35**: 544. 1886.

On *Anthoxanthum odoratum* L. II. Biglerville, Adams Co., July 26, 1932, W. L. White.

Though the rust is very common and is represented in our herbarium by a great number of collections, it had not previously been collected on this host.

PUCCINIA RHAMNI (Pers.) Wettst., Verh. Zool. Bot. Gez. Wein. **35**: 545. 1886.

On *Lolium perenne* L. II, III. Forksville, Sullivan Co., July 16, 1932, W. L. White.

On *Poa compressa* L. III. New Albany, Bradford Co., Mar. 4, 1932, G. L. Zundel.

These are additional hosts for Pennsylvania.

UROMYCES PERIGYNIUS Halsted, Jour. Mycol. **5**: 11. 1889.

On *Carex cristata* Schw. II, III. Ingleby, Centre Co., July, 1931; Olivet, Armstrong Co., Aug., 1932, W. L. White.

On *Carex tribuloides* Wahl. III. State College, Centre Co., March, 1933, W. L. White *et al.*

These collections add two new hosts for the State. The rust is of rather frequent occurrence but it had previously been represented in our herbarium only on *Carex scoparia* Schkuhr.

SCHWEINITZ COLLECTIONS NOT SINCE RECORDED

GYMNOSPORANGIUM BOTRYAPITES (Schw.) Kern, Bull. Torrey Club **35**: 506. 1908.

On *Amelanchier canadensis* (L.) Medic.

Said by Schweinitz to be rare.

GYMNOSPORANGIUM CALVARIAEFORME (Jacq.) DC. Fl. Fr. **2**: 217. 1805.

On *Juniperus communis* L.

Reported by Schweinitz as occurring on a single Juniper near Easton.

GYMNOSPORANGIUM TRACHYSORUM Kern; Arth. Mycologia **2**: 237. 1910.

On *Crataegus monogyna* Jacq.

Called *caeoma cylindrites* by Schweinitz who said it was common near Philadelphia.

PUCCINIA GNAPHALIATA (Schw.) Arth. & Bisby, Proc. Am. Phil. Soc. **57**: 221. 1918.

On *Gnaphalium obtusifolium* L.

Schweinitz says very common about Bethlehem.

PUCCINIA HYOSOPI Schw. Trans. Am. Phil. Soc. II. **4**: 296. 1832.

On *Agastache scrophulariaefolia* (Willd.) Kuntze.

Said by Schweinitz to be "occasional" near Bethlehem.

PUCCINIA MACULOSA Schw. Trans. Am. Phil. Soc. II. **4**: 295. 1832.

On *Andropogon virginicus* (L.) Kuntz.

Schweinitz says, "not common."

PUCCINIA VERNONIAE Schw. Trans. Am. Phi. Soc. II. **4**: 296. 1832.

On *vernonia Noveboracensis* (L.) Willd.

PUCCINIA VIRGATA Ell. & Ev., Proc. Acad. Phila. 1893: 154. 1893.

On *Sorghastrum nutans* (L.) Nash.

Reported as "rare" by Schweinitz, who used the name *Caeoma andropogi.*

PUCCINIA WINDSORIAE Schw., Trans. Am. Phil. Soc. II. **4**: 295. 1832.

On *Tridens flavus* (L.) Hitchc.

UROMYCES FABAE (Pers.) DeBary, Ann. Sci. Nat. III. **20**: 80. 1863.

On *Vicia Faba* L.

UROMYCES PEDATATUS (Schw.) J. Sheldon, Torreya **10**: 90. 1910.
On *Viola pedata* L.
Viola primulifolia L.
Viola sagittata L.

UROMYCES SPERMACOCES (Schw.) M. A. Curt. Cat. Pl. N. Car. 123. 1867.
On *Diodia teres* Walt.

CHEMUNG OF SOUTHWESTERN PENNSYLVANIA[1]

BRADFORD WILLARD
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INTRODUCTION

During the last three field seasons the author has studied the Devonian of northeastern, central and southwestern Pennsylvania. Detailed stratigraphic investigations of the post-Helderberg Devonian of the State have heretofore been confined to a few sporadic instances, except for the intensive work in northwestern and northern part of the State done in recent years (Caster 4; Chadwick 5; Torry 16).[2] The reports of the Second Pennsylvania Geological Survey are economic and descriptive rather than stratigraphic and paleontologic. Such stratigraphic interpretations as were made by that Survey have often proved erroneous and unreliable. These older ideas are gradually being checked and corrected, and at the same time new ideas are being developed. The finer subdivisions of the Devonian system in Pennsylvania are becoming known with detailed stratigraphic work and the identification of large numbers of fossils. The Hamilton group of eastern Pennsylvania has recently been subdivided (Willard and Cleaves 22) into its four formations after the New York usage (Cooper 9), and these four in turn resolved into lesser subdivisions, each with its lithologic and faunal characters. Subdivisions of the Portage group are being worked out over central and eastern Pennsylvania. The Chemung and post-Chemung groups are also being broken up (Caster 4; Chadwick 5, 6; Willard 23) over much of the State. The relation of the Chemung to the "Catskill" has been studied to demonstrate the several times at which the Devonian red beds commenced to form from northern New Jersey southwestward as far as Upper Devonian outcrops occur in Pennsylvania (Willard 23).[3] Studies of the Chemung in southwestern Pennsylvania have supplied the data for this article.

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

[2] Numbers refer to bibliography at end of paper.

[3] "Catskill" is used in this article to include all of our Devonian red beds of whatever age.

CHEMUNG LOCATIONS AND FAUNULES

The Chemung group in south-central New York as well as in north-central Pennsylvania is divided into two formations (Williams 25):

Wellsburg formation, thin-bedded sandstone and shale to flaggy sandstone and coquinite lenses.
Cayuta formation, drab to bluish shale and thin sandstones.

The base of the Chemung group is commonly drawn where the first *Spirifer disjunctus* fauna appears. Its upper limit is less readily defined. Conglomeratic bands (Fall Creek, Salamanca, etc.) sometimes mark its top in northwestern Pennsylvania, but this criterion fails in the southwest (White 20) where conglomeratic bands appear at intervals in the group. Traced eastward, the Chemung passes over into the "Catskill" red beds with which it gradually merges completely in eastern New York and Pennsylvania with loss of distinctive faunal characters. Faunally, the upper limit of the Chemung may be, and in this paper is, placed at the top of the highest beds to carry *Spirifer disjunctus* and *Spirifer mesacostalis* simultaneously. Since the red beds usually supplant the nonred in southwestern Pennsylvania while these species are still present, the upper limits of the marine Chemung are seldom sharply recorded there. Lithologically, the two Chemung formations, Wellsburg and Cayuta, are not easily separable, but intergrade gradually. Paleontologically, they are more readily separated. A number of fossil invertebrates are common to both, but the Cayuta fauna seems to be specifically more prolific than is that of the Wellsburg.

In Maryland the Chemung group is designated as the "Chemung sandstone member" or the uppermost division of the "Jennings formation." Below, the Chemung intergrades lithologically and faunally with the Parkhead sandstone (which, however, lacks *Spirifer disjunctus*), and its upper limits are placed where it passes over into red "Catskill" beds. Neither Cayuta nor Wellsburg formations are designated in Maryland. Instead, five lithologic subdivisions are defined (Prosser and Swartz 12):

5. Upper shale and sandstone beds
4. Upper conglomerate
3. Middle shale and sandstone beds
2. Lower conglomerate
1. Lower shale and sandstone beds

The lowest division, number 1, is Cayuta in age; and probably so too are the lower conglomerate and middle shale and sandstone beds, numbers 2 and 3, a correlation based upon comparison of the Maryland faunas with those reported by Williams (25) for the Ithaca region in New York. This correlation has been further substantiated by the observations in the geographically intermediate, Pennsylvania sections. The affinities of the underlying Parkhead sandstone in Maryland have not been fully proved. It has been tentatively correlated with the Enfield of the upper Portage of New York (Prosser and Swartz 12). It carries some forms suggestive of the Cayuta although it lacks other diagnostic Chemung fossils. The Maryland Chemung faunas differ from those of New York. Some species run higher or are more abundant in later beds in the southern sections. Conversely, the lower Chemung of Maryland carries species not reported from the New York sections; and, of these, some are transitional downward into the Parkhead.

The foregoing discussion of the relative lithology and paleontology of the Chemung of New York and Maryland has been given because of its bearing upon the correlation of the Chemung in south-central and southwestern Pennsylvania. The Upper Devonian faunas and lithology of these portions of the State are often more suggestive of the Maryland than the New York type. This is true of other members beside the Chemung. Parkhead rather than Enfield is recognized below the true Chemung in the Susquehanna-Juniata valleys region (Willard 21), and the lower Chemung of southwestern Pennsylvania carries species described from Maryland but absent from that member in New York.

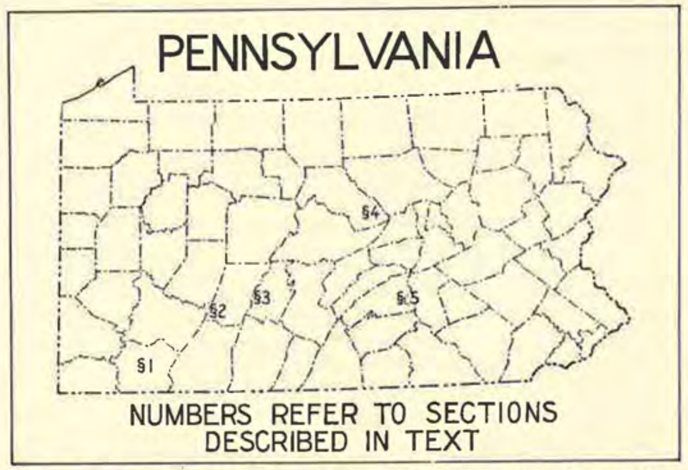

FIG. 16. Sketch map showing locations of sections discussed.

LOCALITY 1, FAYETTE COUNTY[4]

In Fayette County the southwesternmost exposures of the Devonian system in Pennsylvania occur on the Chestnut Ridge anticline. As at Johnstown (see Locality 2), only a small portion of the Upper Devonian beds capped by "Pocono" (probably not the equivalent of the Pocono of northwestern or even eastern Pennsylvania) is exposed. Years ago Stevenson (13, 14, 15) reported on the fossils and stratigraphy of the Devonian here. At the Johnstown section Devonian red beds are exposed, and fossils are scarce, but here no red beds outcrop, and fossils are quite plentiful up to the base of the "Pocono." Stevenson listed the following as identified by James Hall, and his unmodified list is here quoted:

1. *Lingula*, Sp.
2. *Discina grandis?*
3. *Spirifer disjunctus*
4. *Rhynchonella Stephani*
5. *Streptorhynchus Chemungensis*
6. *Palaeoneilo maxima*
7. *Sanguinolites rigida*
8. *Sanguinolites clavulus*
9. *Sanguinolites ventricosa*
10. *Mytilarca Chemungensis*
11. *Pteronites*, Sp.
12. *Pteronites*, Sp.
13. *Actinodesma recta*
14. New and undt. form
15. *Orthoceras crotalum ?*

This faunule establishes the general age of the beds which Stevenson believed were lower Chemung. From collections made in cuts along the National Pike east of Uniontown the author has identified the following:

"Worm trails"

Crinoidea, columnals

Bryozoa, indet.

Stropheodonta cf. demissa (Conrad)
Productus ?
Dalmanella ?
Camarotoechia congregata var. *parkheadensis* Clarke and Swartz
C. contracta (Hall)
C. contracta ? (Hall)
C. eximia (Hall)
Liorhynchus ?
Spirifer disjunctus Sowerby
S. mesacostalis Hall
Brachiopod, indet.

Glossites lingualis Hall
Cypricardella sp.
Pelecypod, indet.

Orthoceras cf. pertextum Hall

Fucoids
Plant fragments

This fauna is assigned to the lower Chemung. *Spirifer disjunctus* is common and *S. mesacostalis* rare, but post-Chemung elements are lacking. Maryland affinities are noted in *Camarotoechia congregata* var. *parkheadensis* there confined to the Parkhead and lower Chemung. *Glossites lingualis* is reported from the lower part of the upper Chemung in Tioga County, Pennsylvania (Williams and Kindle 24), and *Stropheodonta demisa* seems generally more typically Portage than Chemung, al-

[4] For convenience and comparison the localities described here are taken up in the same order and numbered the same as those which the author described in his work on the "Catskill" (Willard 23).

though the Maryland Survey (Prosser and Swartz 12) reports it from the latter without restricting its occurrence to a particular portion, and in the southern Appalachians Williams and Kindle (24) found it running up into the Chemung.

Another faunule was collected from the Chestnut Ridge Devonian exposures where transected by Youghiogheny River. Here, west of the mouth of Indian Creek in cuts along the Baltimore and Ohio Railroad, nonred beds are exposed which carry a few, poorly preserved fossils including:

Bryozoa, undet.	*Grammysia communis ?* Hall
	Modiomorpha ?
Lingulella ?	*Sphenotus clavulus* (Hall)
Camarotoechia congregata var. *parkheadensis* Clark and Swartz	*Cypricardinia* sp.
C. horsfordi (Hall)	Fucoids
	Plant fragments

Consisting chiefly of ill-preserved pelecypods, the age determining value of this small group appears questionable until these remains and the lithology of the enclosing sediments are checked with those on the National Pike, when the two appear to represent nearly the same stratigraphic position. The *Camarotoechias* of the Youghiogheny Valley are of the lower Chemung of Maryland. *Sphenotus clavulus* implies affinities with the upper Chemung of southwestern New York, but evidently is found in older strata here since Stevenson also reported it on the National Pike (his *Sanguinolites clavulus*). *Grammysia communis* is known from the upper Ithaca but not the Chemung in Maryland, although it runs higher in New York. Evidently, the highest recognized Devonian marine fossils in southwesternmost Pennsylvania belong to the lower Chemung and may be considered to represent the Cayuta of the New York sections.

Locality 2, Johnstown

In the Conemaugh gorge northwest of the city of Johnstown, the top of the Devonian is exposed in the Laurel Hill anticline. In the east limb the "Pocono" rests upon about 110 feet of barren red beds (cf. Phalen 11; Butts 2) which are absent in the western limb where the "Pocono" overlies directly a succession of brown to gray sandstone and shale containing the following fossils:

Productus (*Marginifera ?*) *hallanus* Walcott	Ostracoderm plates
Camarotoechia horsfordi (Hall)	Fusoids
C. eximia (Hall)	Plant stems (carbonized and casts)
Spirifer disjunctus Sowerby	

This faunule is unsatisfactory because of its meagerness. The presence of *Spirifer disjunctus* without *S. mesacostalis* might be interpreted as indicative of the post-Chemung as in northwestern Pennsylvania, were it not that the two species of *Camarotoechia* occur in the Parkhead of Maryland where *C. horsfordi* is doubtfully reported also from the middle and *C. eximia* identified from the middle and lower Chemung. *Productus* (*Marginifera ?*) *hallanus* was reported by Clarke (8) from the lower Chemung of western New York, and is listed from the Chemung member in Maryland but assigned to no particular subdivision. From these ranges and the fact that *Spirifer mesacostalis* may occur here but was not found (it is quite rare at Locality 1) it appears probable that the exposed Devonian in the Laurel Hill anticline is lower Chemung (Cayuta) or at highest equals the middle Chemung of Maryland. The red remnant in the eastern limb then becomes Montrose (of Vanuxem 17, not White 18, 19). Neither here nor at Locality 1 was any definite, lithologic correlation with the Maryland section attempted.

Locality 3, Altoona

Butts (1, 3) has described the Devonian succession along the "Horseshoe Curve" of the Pennsylvania Railroad above Altoona, and Kindle (10) listed a few faunules from this section. The latter's Chemung faunule appears to be a composite list and so fails to tell us definitely what part or parts of the group are present. Because it does not differ greatly from the sum of those now to be given it is not necessary to quote it here. A number of faunules were collected by S. H. Cathcart of the Pennsylvania Topographic and Geologic Survey and the author while studying the section. The highest of these came from beds intermingled with the lower portion of the red series; the others were scattered through about 3,000 feet of nonred, marine Chemung underlying the "Catskill." These fossils offer less opportunity for correlation with the New York types than with those of Maryland, and the lithology of the section is of little help in subdividing the Chemung. It should be observed, however, that Butts (3) reported the "Saxton" conglomerate in the upper third of the nonred Chemung and the "Allegrippus" sandstone near the base of the middle third. Since, as will be demonstrated, the marine beds below the red series are lower and middle Chemung, these two subdivisions may equal the upper and lower conglomerate of the Maryland sections.

No *Tropidoleptus carinatus* zone was found to which the top of the Cayuta might be referred (see Lock Haven section, Locality 4). In fact, it was only by comparison with the Maryland lists that any faunal subdivision was possible. The highest fossils discovered are unimportant fragments of fish plates and plant remnants in the red succession. A small assembly occurs in marine beds interspersed with the earlier red strata and is probably upper Chemung:

Schuchertella chemungensis (Conrad)
Schizophoria striatula (Schlotheim)
Spirifer disjunctus Sowerby
S. mesacostalis Hall

Sphenotus contractus Hall

Several faunal zones were found in the upper part of the nonred Chemung which, combined, are as follows:

"Worm tube"

Crinoidea, columnals

Stropheodonta maynardi Clarke and Swartz
Leptostrophia perplana var. *nervosa* (Hall)
L. interstrialis ? (Vanuxem)
Douvillina cayuta ? (Hall)
Schuchertella chemungensis (Conrad)
Productella lachrymosa (Conrad)
Dalmanella tioga (Hall)
Schizophoria striatula (Schlotheim)
Camarotoechia horsfordi (Hall)
C. cf. eximia (Hall)

Atrypa hystrix Hall
Cyrtina hamiltonensis ? Hall
Spirifer disjunctus Sowerby
S. mesastrialis Hall
S. mesacostalis Hall
S. sp.
Ambocoelia umbonata (Conrad)

Lunulicardium ?
Leptodesma sp.
Pelecypod, indet.

Tentaculites decissus Clarke and Swartz

Trilobite, pygidium undet.

Plant stems

Among these remains, *Stropheodonta maynardi, Productella lachrymosa, Dalmanella tioga, Schizophoria striatula, Camarotoechia horsfordi* and *Cyrtina hamiltonensis* are reported as occurring in the lower and middle but not the upper Chemung of Maryland. The lowest Chemung faunule found contains only the following species:

Crinoidea, columnals

Productella lachrymosa (Conrad)
Schizophoria striatula (Schlotheim)
Spirifer disjunctus (Sowerby)
Ambocoelia umbonata (Conrad)

Tentaculites sp.

These fossils are not particularly distinctive, but the presence of *Ambocoelia* very near the base of the Chemung is interesting because of its abundance there in New York and north-central Pennsylvania. It was found in only one higher zone in this section. Possibly the lower occurrence is actually *Ambocoelia gregaria* as recorded by Williams and

Kindle (24). From the observations here recorded, the base of the red beds is dated as Montrose since the lower or middle Chemung runs up almost into the red beds. Presumably the Chemung below the red beds is roughly the equivalent of the New York Cayuta, thus making the lower Chemung even thicker here (about 3,000 feet) than at Lock Haven (Locality 4), but such a thickness is not incompatible with those reported in Maryland. It should be noted, however, that the pre-red Chemung probably equals lower and middle Chemung in Maryland and so may run somewhat above the Cayuta.

Locality 4, Lock Haven

The thickness of the Chemung of the Lock Haven section is of the order of 3,000 feet, probably somewhat under that figure. Chance (7) gave 3,314 feet for the "Portage-Chemung" which included some of the Portage (Naples ?) dark shale at the base and a considerable portion of interbedded red and nonred beds at the top. Lithologically, the whole Chemung group of this section is a succession of gray or olive-colored sandstones and shales with little distinctive variation, although the shale seems more prevalent in lower and the sandstone more common in higher portions. Marine fossils occur below and above the earliest red beds. The Cayuta-Wellsburg separation is placed above the following faunule, occurring about 1,000 feet below the first red bands, because it suggests Williams's Third Tropidoleptus Zone (25) which he located at the top of the Cayuta.

Aulopora ?

Crinoidea, columnals

Fenestella sp.
Bryozoa, indet.

Lingulella sp.
Leptostrophia interstrialis ? (Vanuxem)
L. sp.
Douvillina cf. cayuta (Hall)
Schuchertella chemungensis (Conrad)
Productella lachrymosa (Conrad)
Dalmanella tioga (Hall)
Schizophoria striatula (Schlotheim)

Camarotoechia eximia (Hall)
Liorhynchus mesacostale Hall
Tropidoleptus carinatus (Conrad)
Spirifer disjunctus Sowerby
S. mesacostalis Hall
Ambocoelia umbonata (Conrad)

Palaeoneilo sp.
Pterinia chemungensis (Conrad)
P. chemungensis ? (Conrad)
P. sp.
Pelecypod, indet.

Fucoids

These fossils associated with *Tropidoleptus carinatus* agree only slightly with Williams's list, but this zone forms a convenient, if arbitrary, separation point between lower and upper Chemung. The underlying Cayuta is fairly unfossiliferous, and neither fauna nor lithology has yet proved any of the Ithaca type present above the dark Portage shales in the lower part of the section. The first important faunal and lithologic break marking the base of the Chemung therefore seems to be that at the top of the highest dark shale about 2,000 feet below the Tropidoleptus zone, and here the base of the Chemung is tentatively drawn. Williams's First and Second Tropidoleptus Zones were not identified.

The red beds appear in this section simultaneously with the disappearance of *Spirifer mesacostalis*, marking the top of the Wellsburg and dating the base of the Catskill type as Blossburg. A composite of the Wellsburg fauna is as follows:

Aulopora cf. serpens Goldfuss

Stropheodonta maynardi Clarke and Swartz
Schuchertella chemungensis (Conrad)
Leptostrophia perplana var. *nervosa* (Hall)
Douvillina cayuta ? (Hall)
D. cayuta var. *graciliora ?* Clarke and Swartz
Chonetes cf. scitulus Hall
Productella lachrymosa (Conrad)
P. lachrymosa ? (Conrad)
P. hystricula Hall
Productus (Marginifera ?) hallanus ? Walcott
Dalmanella tioga (Hall)
Schizophoria striatula (Schlotheim)
Camarotoechia horsfordi ? (Hall)
C. eximia (Hall)
Spirifer disjunctus Sowerby
S. mesastrialis Sowerby
S. mesacostalis Hall
Ambocoelia umbonata (Conrad)

Fucoids

Although this fauna is assigned to the latter Chemung, it carries members which suggest an earlier age. Possibly it would be wiser to say that it is nearest equivalent to the middle Chemung of Maryland rather than attempt to correlate it precisely with the Wellsburg of New York. So many of its species occur lower at Localities 1, 2 and 3 that one hesitates to assign it to so high a position. The first red beds contain comminuted fish remains. Above these a restricted marine assemblage contains:

Crinoidea, columnals

Spirifer disjunctus Sowerby
Ambocoelia umbonata (Conrad)

Leptodesma longispinum ? Hall
L. medon Hall
L. sp.
Pelecypod, indet.

Tentaculites, sp.

It is noticeable in the Lock Haven section that southern (Maryland) types although they are still present have decreased in abundance in favor of New York species.

Locality 5, Susquehanna-Juniata Valleys

Because of its important bearing upon and relations to the Chemung of southwestern Pennsylvania, this section from the Susquehanna-Juniata Valleys region of south-central Pennsylvania is inserted. Most of the

lower part of the "Catskill" here is Catawissa since it carries interbedded, marine, lower Chemung (Cayuta) faunules (Willard 21, 23). The nonred Chemung below the red beds is thin or absent, in which latter case the basal red beds are chronologically equal to the Parkhead with which they intergrade even when sporadic Chemung forms recur higher among the "Catskill" strata.

Along Susquehanna River, west bank, below Half Falls Mountain the nonred, marine Chemung is exposed and carries the following:

Orbiculoidea sp.
Productella lachrymosa (Conrad)
Camarotoechia sp.
Atrypa reticularis (Linnaeus)
A. sp.
Spirifer disjunctus Sowerby
S. mesastrialis Hall
S. mesacostallis Hall
S. marcyi var. *superstes* Clark and Swartz

Tentaculites decissus Clarke and Swartz
T. cf. spiculus Hall

This assembly is seen to possess both Cayuta elements and fossils characteristic of the lower Chemung of Maryland. Interbedded with the lower third of the red beds in Perry County have been found a few marine fossils. A composite fauna of some of these localities is assignable to the Cayuta, thus:

Crinoidea, columnals

Spirifer disjunctus Sowerby
S. mesacostalis Hall

Palaeoneilo cf. plana Hall
P. sp.
Leptodesma sp.
Schizodus rhombeus Hall
Pelecypod, indet.

Ostracoderm plates, indet.

Evidently, the marine Chemung in this region is assignable to the Cayuta and at the same time to the lower Chemung of Maryland. No Wellsburg or upper Chemung was recognized as such.

We observed that where nonred Chemung is absent below the "Catskill" the red beds may intergrade with marine strata possessing a Parkhead fauna. An example of this fauna from Perry County is:

Crinoidea, columnals

Fenestalla sp.
Bryozoa, indet.

Orbiculoidea sp.
Stropheodonta maynardi Clarke and Swartz
Leptostrophia perplana var. *nervosa* (Hall)
Schuchertella chemungensis (Conrad)
Productella lachrymosa (Conrad)
Rhipidomella vanuxemi (Hall)
Schizophoria striatula (Schlotheim)
Camarotoechia congregata var. *parkheadensis* Clarke and Swartz
C. eximia (Hall)
Liorhynchus globuliforme (Vanuxem)
Tropidoleptus carinatus (Conrad)
Atrypa reticularis (Linnaeus)
Cyrtina hamiltonensis Hall
Spirifer mesastrialis Hall
S. mucronatus var. *posterus* Hall and Clarke
S. mesacostalis Hall
Athyris spiriferoides ? (Eaton)

Palaeoneilo plana Hall
Liopteria cf. linguliformis Hall
Actinopteria epsilon Hall
A. boydi (Conrad)

Bellerophon nactoides Clarke and Swartz
Buchanopsis maera (?) (Conrad)

The above fauna is peculiar in that it contains *Liorhynchus globuliforme* hitherto not found as high as the Parkhead as also *Actinopteria boydi*. Conversely, *Stropheodonta maynardi* and *Actinopteria epsilon* are assigned to the Chemung in Maryland. The Parkhead has been aligned with the Enfield, but this correlation is not yet fully established. Rather, some Parkhead elements suggest a Portage-Chemung transition. In this case, the red beds chronologically equal to the Parkhead are unnamed and lie between or partly embrace the Catawissa of Enfield age and the "true Catskill" (Chadwick 6) of Cayuta age. For these red beds of Parkhead age the name *Wheatfield* is proposed. This is taken from Wheatfield Township, Perry County, where the lowest red beds interfinger with marine Parkhead. Higher, the same red beds are interrupted by a zone carrying Cayuta fossils. The Wheatfield member of the Devonian red beds is thus represented by 200 feet or more of continental strata. The red beds of southeastern Perry County are believed to cut down still lower into the Parkhead, possibly even to the underlying Ithaca, but this has yet to be fully established.

Summary and Conclusions

From the observations made and faunas identified, we may conclude:

1. The Chemung group of the Upper Devonian of southwestern and south-central Pennsylvania carries fossils which possess strong affinities with the Maryland types and as such may be correlated with the Maryland rather than New York sections with a greater degree of assurance.

2. The age of the highest exposed Chemung strata below the red Catskill type of sediment in southwestern and south-central Pennsylvania rises northwestward. Considering conditions known for the Upper Devonian in northern and north-western Pennsylvania where are exposed the youngest marine Chemung (and later) beds in the State, there must be a progressive northwesternward rise of Upper Devonian marine conditions in our concealed western regions. Subsurface data from below the bituminous coal fields should be investigated to demonstrate the Upper Devonian off-lap in a northwestly direction.

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FOUR SHALE-BARREN PLANTS IN PENNSYLVANIA[1]

EDGAR T. WHERRY

Associate Professor of Botany, University of Pennsylvania

In the writer's summary[2] of data as to the endemic plants of the Appalachian shale-barrens, this type of habitat was mapped as developed only between latitudes 37° 15′ and 39° 45′ north. At the same time, however, it was pointed out that at least one of the endemics in question—the large flowered Evening-primrose, *Oenothera argillicola* Mackenzie—occurs on shale, of the same geological age as that underlying the barrens, in Perry County, Pennsylvania. Other similar range-extensions can now be reported.

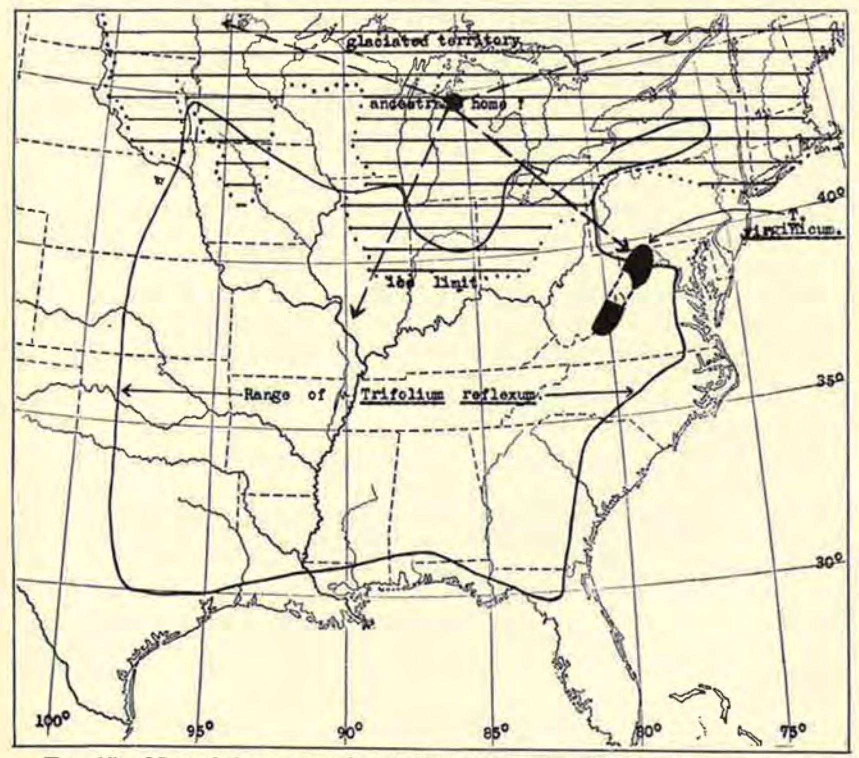

FIG. 17. Map of the ranges of *Trifolium virginicum* and *T. reflexum* as known up to April, 1933, bringing out their interpretation as the only surviving descendants of an ancestor which lived somewhere in the upper Great Lakes region during pre-Glacial time.

[1] Contribution from the Botanical Laboratory and Morris Arboretum of the University of Pennsylvania.

[2] Journal Washington Academy Sciences 20: 43. 1930.

TRIFOLIUM VIRGINICUM Small.

Discovered in 1893, this plant was described by Small[3] the following year, the type locality being Kates Mountain, Greenbrier County, West Virginia, which for many years remained the only known station for it. In 1908 Miss McDermott[4] stated it to be "abundant throughout the Appalachian Mountains," and although this is somewhat exaggerated, it has subsequently been found in at least 10 new localities. Since several of these lie not far south of the Pennsylvania line, there seemed a possibility that it might extend locally into the latter State, and in 1932 Professor S. C. Palmer, of Swarthmore College, joined me in a search for it there. Several hours were spent in scanning shaly slopes of various degrees of sterility without results, but finally, on June 17th, a colony of it was found one mile south of the villlage of Artemas, in Bedford County, a like distance north of the Mason and Dixon line. Its closest relative, *T. reflexum* L., ranges far and wide over the interior provinces. The Shale-barren Clover differs in being perennial with more elongated, fleshier roots, dwarfer stature, and narrower leaflets, though does not exhibit any recognizable floral differences. Miss McDermott, in the paper cited, considered these features to justify only varietal separation; since, however, no intermediates between the plants occur, they may as well be maintained as distinct species.

OENOTHERA ARGILLICOLA Mackenzie.

Like the preceding, this plant was discovered at Kates Mountain, and subsequently found to be wide-spread in the shale-barren country. In

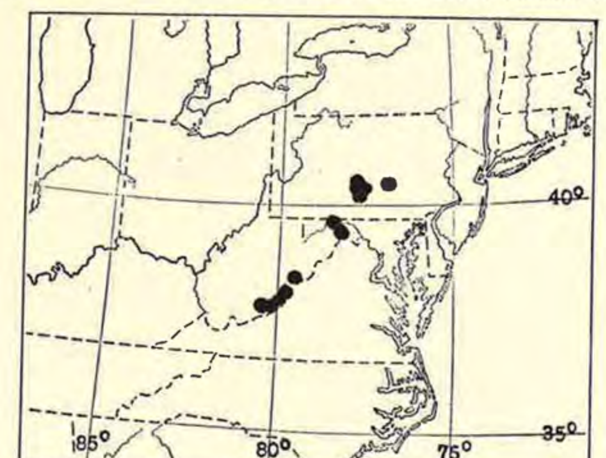

FIG. 18. Map showing by dots the 12 localities of *Oenothera argillicola* known up to April, 1933.

[3] Mem. Torrey Botan. Club 4: 112. 1894.

[4] North American Species Trifolium: 273. 1908.

1920 I observed it opposite Losh Run Station in Perry County, Pennsylvania,[5] but the construction of a highway (U. S. No. 22) along the northeast bank of the Juniata subsequently exterminated it there. It was collected 2 miles southeast of Huntingdon by State Botanist E. M. Gress a few years later, and in the State College herbarium there is a specimen of it from Hawn Bridge, also in Huntingdon County. A visit to outcrops of Devonian shale during August, 1932, resulted in finding it at two new localities—on a stream bank 3 miles southwest of Orbisonia, Huntingdon County; and on steep slopes between highway and river two miles west of Newton-Hamilton, Mifflin County.

Convolvulus purshianus Wherry.

In announcing the discovery of three shale-slope plants in Maryland,[6] the name *Convolvulus stans* Michaux was revived for the derivative of *C.*

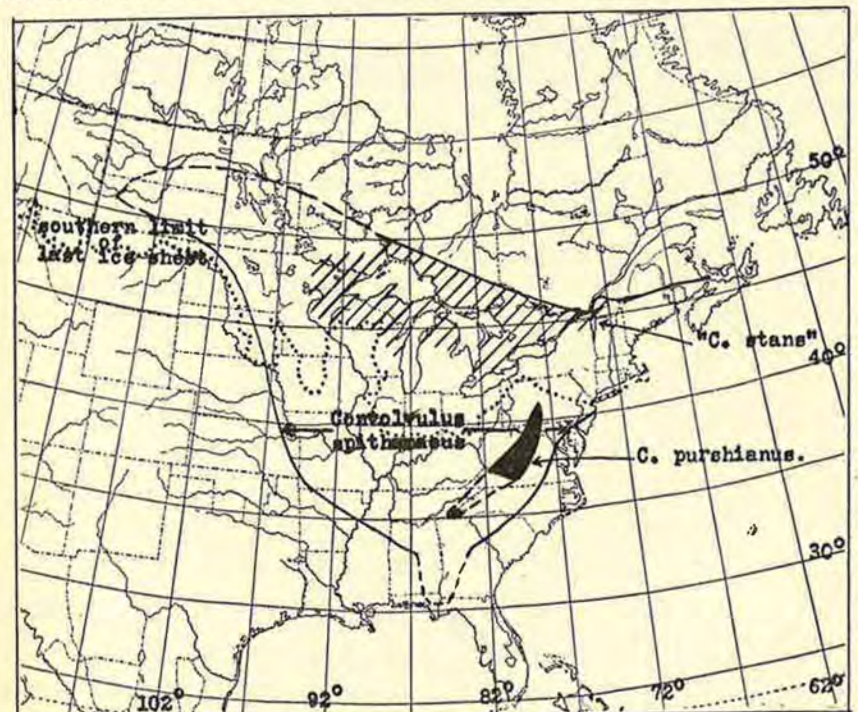

Fig. 19. Map of the ranges of *Convolvulus spithamaeus, C. purshianus,* and *C. stans* as known up to April, 1933, bringing out the interpretation of the last two as regional segregates from the first.

[5] This occurrence has recently been discussed, and the plant illustrated in color, in Addisonia 17: 55, *pl. 572.* 1932.

[6] Torreya 29: 105. 1929.

spithamaeus L. occurring on the shale-barrens, since his description seemed to apply to the Appalachian plant, although the locality cited was "Canada near Lake Champlain." In September, 1932, under the guidance of Brother Marie-Victorin, I visited the sand-plains east of Montreal and collected what may be regarded as topotype material of Michaux's species. It proved to be merely a hairy extreme of *C. spithamaeus,* not identical with the shale-barren plant, so that the name *C. stans* is not correctly applied to the latter, after all. Pursh's name,[7] *Calystegia tomentosa,* can not be recombined because there is already a *Convolvulus tomentosus* in another part of the world. Accordingly, the Velvet Convolvulus of the shale-barren country is here renamed in honor of its discoverer.

Convolvulus purshianus, nomen novum.

Calystegia tomentosa Pursh, 1814, not *Convolvulus tomentosus* L. 1753.
Convolvulus stans Wherry, 1929, not Michaux.

Plant spreading into large colonies on shale-slopes by rootstocks; aerial branches 10 to 40 cm. tall, the internodes little exceeding the petioles; herbage densely white velvety-pubescent; leaf-blades mostly oblong or elliptic-sagittate with conspicuous auricles 5 to 10 mm. long; petioles 10 to 20 mm. long, about $\frac{1}{3}$ the length of the blades; bracts ovate, often cordate, and rather strongly keeled; corolla white.

Type specimen collected in dry woods on "Top of the ridge behind Rattlesnake Den, Sweet Springs," Monroe County, West Virginia, by Frederick Pursh in 1806, in herbarium Academy Natural Sciences, Philadelphia.

The range of this Convolvulus hitherto reported is from Alleghany County, Virginia, to Allegany County, Maryland. In June, 1920, it was collected at Charter Oak, Huntingdon Co., Pa., by W. C. Muenscher, but distributed to herbaria as *C. spithamaeus.* Search for it in 1932 resulted in finding it at several places in Bedford, Fulton, and Huntingdon Counties, Pennsylvania, on slopes of Devonian shale.

Senecio antennariifolius Britton.

The occurrence of this plant in Pennsylvania has already been recorded by State Botanist Gress,[8] and no new stations for it have been discovered. This plant shows a different geographic relation than the other species here included: instead of being related, like these, to plants which approach or enter the Appalachians, its nearest relative occurs in the Rocky Mountains, two thousand miles away. The only reasonable ex-

[7] Flora America Septentrionalis 1: 143. 1814.

[8] Proc. Penna. Acad. Sciences 4: 29. 1930.

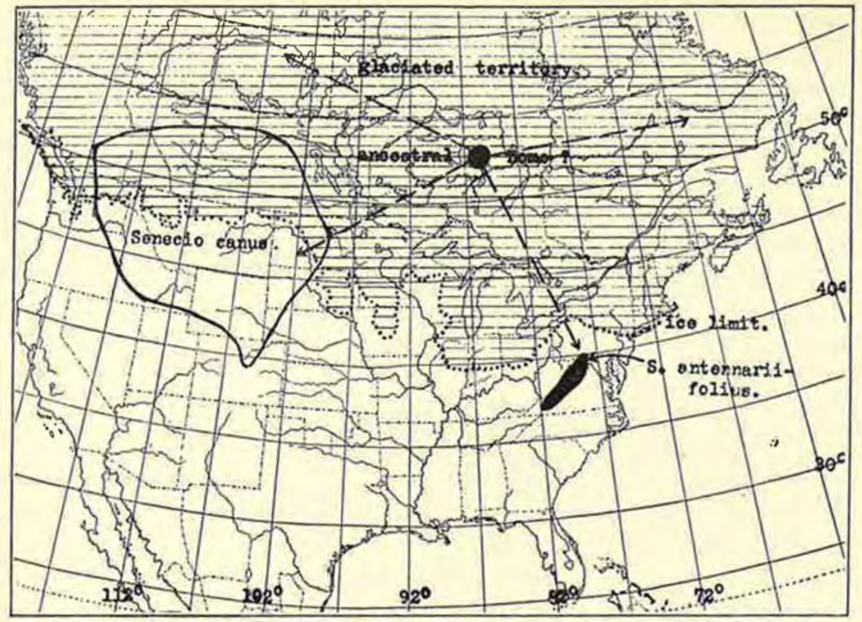

FIG. 20. Map of the ranges of *Senecio canus* and *S. antennariifolius* as known up to April, 1933, bringing out their interpretation as the only surviving descendants of an ancestor which lived somewhere in the Hudson Bay region during pre-Glacial time.

planation of such a distribution is that during Tertiary times the ancestor of both species grew somewhere in what is now central Canada, and descendants chanced to migrate out far enough to escape destruction by the Quaternary ice sheets in two regions. Since the ice retreated the western species has been able to regain some of the lost territory, but the eastern one, having seemingly become more conservative, has not yet returned even as far as the Wisconsin terminal moraine.

A CONIFER FROM THE TRIASSIC OF BUCKS COUNTY, PENNSYLVANIA

EDGAR T. WHERRY
University of Pennsylvania

In the railroad cut south of Sellersville, Bucks County, where a problematical fossil plant had previously been found, there has been collected a single specimen representing the impression of a female strobilus of a conifer. It does not show sufficient structure for very certain identification, but resembles a cone named by Seward *Strobilites laxus*, from the Triassic of South Africa. The specimen is to be deposited in the State Museum at Harrisburg.

REACHING A DISTRIBUTED SCIENTIFIC PUBLIC

THOMAS D. COPE
University of Pennsylvania

Physicists, like other scientists, are distributed geographically, and no two are interested in just the same things. Fields of interest are widely distributed. To hold the whole group together during recent years has demanded effort and resourcefulness. Until recently decentralizing forces were at work. Old groups were tending to break up, each part following its own special interest.

Movements organized a few years back have turned the tide. Two years ago The Institute of Physics was established by federation of existing organizations, with the result that the physicist wherever he lives or whatever his interest is now served by one central body, whose constituent organizations, cultivating various fields, appeal to a wide variety of tastes.

The number of periodicals devoted to physics has multiplied until eight separate journals are now issued by the Institute. One of them *The Journal of Scientific Instruments* with *Physics News and Views,* reaches every member of each constituent group and every subscriber to each of the other seven journals. For it is claimed the widest circulation of any journal of physics in the world.

These remarks introduce the newest member of the Institute's rapidly growing family—*The American Physics Teacher.* Volume 1, number 1, is just off the press.

A famous Pennsylvanian, and an eminent physicist, Benjamin Franklin, once asked the rhetorical question "Of what use is a baby?" The progenitors of this baby have great hopes for him.

Until the Institute was established the teacher of physics had scant recognition in national bodies. Simultaneously almost with the Institute was formed the American Association of Physics Teachers. This Association was federated into the Institute as one of its constituent bodies. The newborn *American Physics Teacher* is its official organ, and affords the first opportunity for teachers of college physics to communicate with one another professionally.

And there remains much to be done. Scattered over the country are independent local physics groups. Our State has two of the oldest and best known, the club in Pittsburgh and the club in Philadelphia. Probably there are others in the State. An effort is now being made to establish contact with all such groups throughout the country.

In fact the recent college graduate who is teaching physics in the village or township is an important factor in determining the part taken by physics in our public life and thought. There are hopes that the powerful organization just described may presently reach, stimulate, and support this graduate. Perhaps our new journal may function in this service, as its altogether exemplary elder relative *The Journal of Chemical Education* has done in a closely related field.

SURFACE FILMS ON METALS

Raymond Morgan
University of Pennsylvania

(*Abstract*)

The study of surface films becomes quite important in relation to the corrosion of metals. In the case of the world's supply of iron and steel alone, the annual loss due to rusting is over three billions of dollars. There are numerous cases where the natural oxide films formed on metal surfaces are of great value as inhibitors of corrosion. To-day the films are being studied in many interesting and varied ways.

At the University of Pennsylvania the author, with the assistance of Mr. Newbern Smith, has in progress two researches upon the problem. Over fifty potential-time curves have been plotted for variously prepared surfaces. Apparatus for the study of surfaces by electron diffraction has been assembled and observations are being made. It is hoped that by the combination of the two methods the nature and influence of the surface layers may be still more fully established. In this connection it is interesting to note that on the day this paper was presented there came to the writer an editorial on surface films in the April issue of *Metals and Alloys* which was much the same in content as this paper.

REMOVAL OF IONS FROM CONVECTION CURRENTS BY ELECTRIC FILTRATION

John J. Heilemann
Randal Morgan Laboratory of Physics, University of Pennsylvania

(*Abstract*)

A piece of demonstration apparatus is described which is simple and easily set up, the purpose of which is to show (1) that ions are present in the convection current from a gas flame and (2) that these ions can be removed by means of an electrically charged filter.

The filter consists of a metallic funnel which directs the convection current through a wire gauze. The funnel and gauze are oppositely charged.

A CONCHOLOGICAL EXPEDITION TO CUBA

Horace G. Richards
Academy of Natural Sciences of Philadelphia

In January, 1933, I had the opportunity of making a brief visit to the island of Cuba. The main object of the trip was to visit a number of Pleistocene localities in the provinces of Matanzas and Pinar del Rio and to collect material from them. This work was done at the suggestion of Dr. Roy E. Dickerson, Chief Geologist of the Atlantic Refining Company of Cuba. To Dr. Dickerson and the staff of the Refining Company, I am deeply indebted for much valuable assistance in the field. In addition I was very fortunate in having as my companion on several of my trips, Dr. Pedro J. Bermudez, who was kind enough to point out to me many interesting localities. While the main object of the trip was to collect fossils, a certain amount of time was spent collecting recent mollusks, and the present paper is a report on the land and fresh-water mollusks collected on the trip.

Three days were spent in the field in the vicinity of Matanzas, most of the time collecting at Pleistocene localities in the vicinity of the Bahia Matanzas.

The land mollusks of the Matanzas region have been rather thoroughly collected and it was hardly to be expected that anything new would turn up. The varieties of *Cerion* along the Bahia Matanzas are always fascinating to collect. The species or subspecies are usually restricted to a very limited region and always close to salt water.

Following the collecting in Matanzas Provence, a brief trip was taken to the Sierra de los Organos (Organ Pipe Mountains) in the western part of Pinar del Rio. These mountains are the snail hunter's paradise. Many snails live almost exclusively on limestone, and consequently these limestone mountains afford an excellent habitat for these forms. These mountains, especially in the western part of the range, have been eroded into series of individual limestone hills or mogotes with extremely steep limestone sides. In many cases certain species of snails, particularly of the family *Urocoptidae*, are restricted to a particular mogote, and consequently even though the region has been rather thoroughly collected by Poey and many of the earlier Cuban naturalists, further information of the distribution of these calciphils is always desirable.

Near the town of Guane, at the western extremity of the railroad, the Sierra ends with two very prominent mogotes, the Sierra de Guane, just east of the town, and Sierra Mendoza (or Paso Real) a few kilometers southwest of the former mogote. Beyond these mogotes, to the west and southwest, the land becomes very flat as it narrows into the

Peninsula de Guanahacabibes stretching out toward Cabo San Antonio and Yucatan Channel, less than sixty miles from Guane.

Most of one day was spent in exploring the region around Guane, the almost perpendicular limestone mogote, the fascinating caves and cañons and the beautiful Rio Cuyaguatje. With the aid of a guide and a young boy from Guane, I was able to collect a considerable number of mollusks. The following day we turned our attention to the other mogote, Sierra Mendoza, with even greater success. On our way back to Guane we collected at some swamps near Catalina and Mendoza, the latter locality yielding a new *Pomacea*.

The flat country to the west of Guane did not promise very rich collecting, but in a few places near Rio Guasimal, between Guane and Mantua, there were some very small outcrops of limestone, on two of which I collected snails. While only two or three species were represented, they were quite interesting because they were not the species which I had found on the two mogotes, but rather were those which I had collected around Matanzas, some two hundred miles to the east.

Upon leaving Guane, I rejoined Dr. Dickerson at Artemisa, and motored with him to Mariel, on the Bahia Mariel, an arm of the Gulf of Mexico. Here we returned to fossil collecting and with the help of a swarm of youngsters made a large collection from the bluffs on the west side of the Bay.

My final day in Cuba, January 15, was largely spent in collecting marine mollusks and Cerions at Marianao, Habana Provence.

List of Land and Fresh-water Mollusks Collected in Cuba

GASTROPODA

Helicinidae

Helicina adspersa Pfr.
Sierra Guane

Eutrochetella jugulata (Poey)
Sierra Guane
Sierra Mendoza
Road near Catalina

Viana subunguiculata (Poey)
Sierra Guane
Sierra Mendoza
Road near Catalina

Enoda sagriana (Orb.)
Sierra Guane
Sierra Mendoza
Road near Catalina

Enoda remota (Poey)
Sierra Guane

Alcadia dissimularis (Poey)
Sierra Guane
Sierra Mendoza

Proserpinidae

Proserpina depressa (Orb.)
Sierra Guane
Sierra Mendoza

Cyclophoridae

Megalomastoma apertum Poey
Sierra Guane
Road near Catalina

Megalomastoma auriculatum (Orb.)
6½ km. east of Colon, Matanzas Prov.

Ampulariadae

Pomacea paludosa garciae new subspecies (figure 21)

Thin shell; very low spire; surface smooth to finely malleate; outer color brown or olive brown; inner color dark brown or purple brown with more or less prominent deep brown bands; inner border pale purple; umbilicus open but not very prominent. Distinguished from *P. paludosa* (Say) by its lower spire and the purple border on the inside of the shell.

Type: length, 43.3; gr. width, 41.6; aperture length, 38.0; width, 18.0.

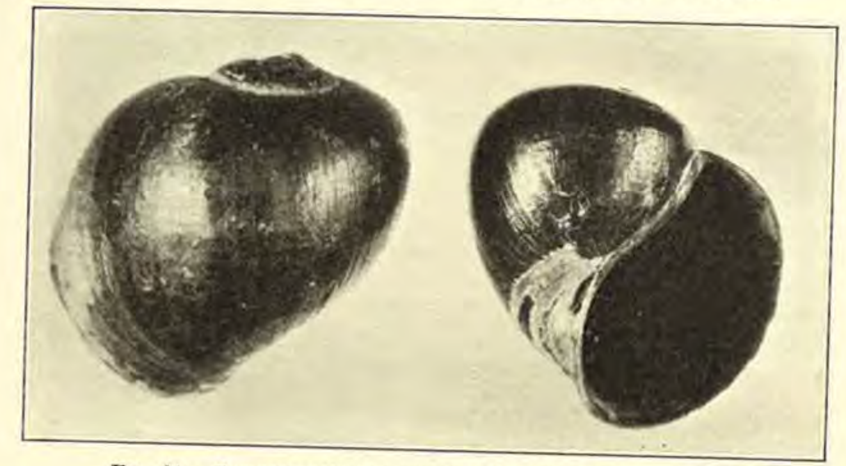

Fig. 21. *Pomacea paludosa garciae* Richards (type on right).

Ten specimens were collected from a swamp near the town of Mendoza (or Paso Real) about five kilometers from the terminus of the Ferro-Cariles Unidos de la Habana at Guane, Pinar del Rio, Cuba.

Named in honor of my young guide, Carlos Garcia.

Type in the Academy of Natural Sciences of Philadelphia. (Catalogue number 160873.)

Pomatiasidae

Chondropoma sagebieni (Poey)
Sierra Guane

Chondropoma obesum (Menke)
Along Bahia Matanzas, east of town of Matanzas
Beuyvaquita Playa, Bahia Matanzas
Near Punta Sabanilla, Bahia Matanzas

Chondropoma gouldianum Poey
Along Bahia Matanzas, east of town of Matanzas

Chondropoma pfeifferanum (Poey)
Ridge overlooking Yumuri Valley, Matanzas

Chondropoma pictum (Pfr.)
Cave near Ermita de Montserrat, Matanzas

Chondropoma bilabiatum (Orb.)
Rocks 1 km. from Guane, Pinar del Rio
Sierra Guane

Sierra Mendoza
Road near Catalina

Chondrothyra shuttleworthi (Pfr.)
Sierra Guane
Sierra Mendoza

Troschelvindex illustris (Poey)
6½ km. east of Colon, Matanzas Prov.

Pupillidae

Pupoides marginatus nitidulus (Pfr.)
Sierra Mendoza

Achatinidae

Subulina octona (Chemn.)
San Juan Road, town of Matanzas
Mariel, Pinar del Rio

Oleacinidae

Oleacina cubensis (Orb.)
Rocks, 1 km. from Guane
Sierra Guane

Oleacina oleacea staminea (Desh.)
Cave near Ermita de Montserrat, Matanzas

Oleacina solidula (Pfr.)
Sierra Guane

Oleacina subulata (Pfr.)
Cave near Ermita de Montserrat, Matanzas

Polygyridae

Praticolella griseola Pfr.
Cave near Ermita de Montserrat, Matanzas

Sagididae

Thysanophora incrustata (Poey)
Sierra Guane

Suavitas stigmatica (Pfr.)
Sierra Guane
Sierra Mendoza

Volvidens tichostoma (Pfr.)
Cave near Ermita de Montserrat, Matanzas

Camaenidae

Zachrysia auricoma (Fer.)
Along Bahia Matanzas, east of town of Matanzas
Cave near Ermita de Montserrat, Matanzas
Yumuri Gorge, Matanzas
Bellamar Playa, Matanzas
6½ km. east of Colon, Matanzas Prov.
2 km. west Rio Guasimal on road to Mantua (P. del R.)

Zachrysia guanensis (Poey)
Sierra Guane
Sierra Mendoza

Cepolidae

Cepolis parellela (Poey)
Sierra Guane
Sierra Mendoza

Cepolis bonplandi (Lam.)
San Juan Road, town of Matanzas
Sierra Guane

Cepolis cubensis (Pfr.)
East side Bahia Matanzas
Cave near Ermita de Montserrat, Matanzas

Bulimulidae

Liguus fasciatus Müller
San Juan Road, town of Matanzas
Cave near Ermita de Montserrat, Matanzas
Punta Sabanilla, Bahia Matanzas
Sierra Guane, Pinar del Rio
Road near Catalina, P. del R.

Liguus murreus vignalensis Pilsbry
Rocks, 1 km. from Guane
Sierra Guane
Sierra Mendoza

Bulimulus sepulcralis Poey
Mariel, P. del R.

Cerionidae

Cerion infandum (Shuttl.)
Punta Sabanilla, Bahia Matanzas
2½ km. N. E. Punta Sabanilla
4 km. N. E. Punta Sabanilla

Cerion mumia magister Pils. & Van.
Bahia Matanzas, east of town of Matanzas
Bellamar Playa, Matanzas

Cerion mumiola (Pfr.)
Beuyvaquita Playa, Bahia Matanzas

Cerion medium Maynard
Beuyvaquita Playa, Bahia Matanzas

Cerion spp.
East and west shores of Bahia Matanzas

Cerion marielinum Torre
Near Lighthouse, Mariel, east side of Bahia Mariel, P. del R.

Cerion marielinum var.
Mariel

Urocoptidae

Urocoptis coerulans (Poey)
Rocks 1 km. from Guane, Pinar del Rio
Sierra Guane
Sierra Mendoza

Urocoptis discors (Poey)
Rocks, 1 km. from Guane
Road near Catalina

Urocoptis poeyana variegata (Pfr.)
Cave near Ermita de Montserrat, Matanzas Prov.
Yumuri Gorge, Matanzas
2 km. west Guane on road to Mantua, Pinar del Rio
2 km. west Rio Guasimal on road to Mantua

Urocoptis nubila (Poey)
Sierra Mendoza
Road near Catalina

Urocoptis dautzenbergiana (Crose)
Sierra Mendoza
Road near Catalina

Urocoptis lowei Torre
Sierra Mendoza

Urocoptis handi Torre
Road near Catalina

Melanidae

Hemisinus ornatum (Poey)
Rocks, 1 km. from Guane
Sierra Guane

Planorbidae

Planorbula albicans (Pfr.)
Sierra Guane

PELECYPODA

Unionidae

Nephronais scamnatus (Mor.)
Rio Cuyaguatje, Guane

DAILY AND MONTHLY METEOR RATES

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The determination of hourly meteor rates for each day of the year may at first glance seem to be a mere compilation of uninteresting data, but these data, like others of seeming insignificance, serve for the solution of important problems and for the testing of various hypotheses.

The American Meteor Society has in its files a wealth of data referring to the observation of meteors, and at present a considerable percentage of the total has been studied for hourly rates. Two sets of results are compared in this paper: the first set depends upon work from 1898 to 1918 inclusive (21 years), about 30,000 observations made in 665 periods of observation on 301 out of a possible 366 days of the year; the second set depends upon work from November, 1929, through October, 1932 (3 years), about 15,000 observations made in 916 periods of observation by 68 observers on 313 dates.

In both cases the unit for "rate" is the number of meteors recorded per hour by one observer only, the sky being clear and the Moon absent. When these weather conditions did not exist, the observed rates were corrected by standard factors to allow for the unfavorable circumstances. The periods of observation ranged from one hour to six hours. For most

of the observations used, the conditions were 0.7 perfect or better; for none were they less than 0.5 perfect.

The rates in general depend upon meteors plotted per hour, not upon those merely counted. Obviously the higher the recorded rate, the more meteors would have been missed while plotting paths. Hence the highest points of the curve are relatively too low.

The results can best be shown by means of two graphs. Figure 21 shows the monthly means, the hollow circles representing the 1898–1918

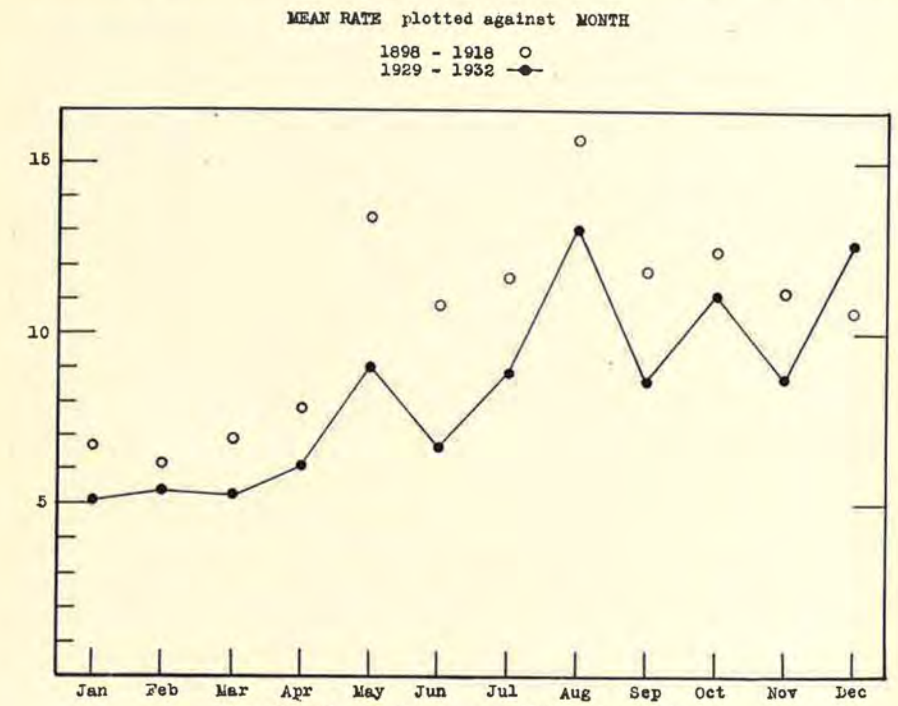

FIG. 22. Graph showing monthly meteor rates.

data, the solid circles those of 1929–1932. Henceforth these will be called for brevity Group A and Group B. For both A and B the fact is obvious that meteors are more numerous in the latter half of the year in roughly the ratio 2 : 1. The somewhat smoother curve in B is partly due to the inclusion of observations from the southern hemisphere which formed in those later years an appreciable percent of the total.

Figure 23 is the more interesting, for it shows the minor irregularities on different dates of the year. Each point is the mean of from 3 to 30 separate periods of observation. This use of means required the combination of 2 to 4 calendar days' observations, but the result represents

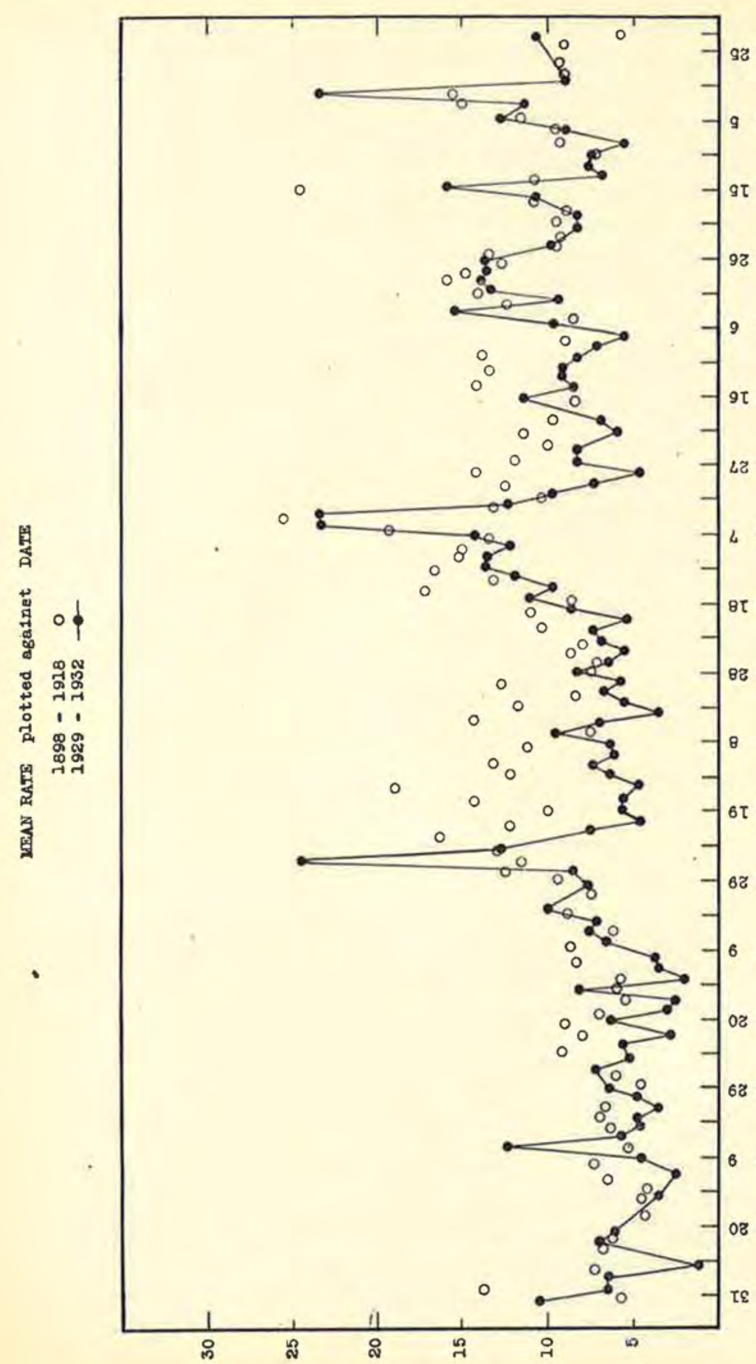

FIG. 23. Graph showing daily meteor rates.

the true rates even more accurately. The line connects points of Group B (solid circles), but it is easily seen that many of the irregularities it shows are confirmed by points of Group A (hollow circles). The highest points of course appear at the dates of the chief annual showers: early in May the Eta Aquarids, in August the Perseids, in October the Orionids, in November the Leonids, in December the Geminids. The high points in late May and June for Group A are due to meteors connected with Pons-Winnecke's comet in 1916, which made that an exceptional year and hence raised points of A unduly high in those months.

However, when full allowance is made for those special showers, even then more meteors are recorded from July to January than in the first six months of the year. If meteors are uniformly scattered in space, not associated with our solar system, more should be met from the direction in which the solar system is traveling.

The number of meteors met, however, is largely dependent upon the altitude of the meteoric apex, *i.e.*, the point towards which the Earth is moving at a given time. The total number observed is therefore dependent upon both of these factors but an attempt at their separation is entirely too complicated a matter to be undertaken here.

Hourly rates can be used to determine the mean velocity of meteors in space. We have not as yet determined any velocities from these data, but from similar observations Hoffmeister found a preponderance of hyperbolic velocities. Such velocities mean that the meteors did not originate in our solar system. It is hoped that the present data will eventually be discussed with regard to velocity determinations. Meantime, however, the close similarity of our A and B series gives some reason to believe that a majority of the meteors may have originated in the solar system. For if even minor irregularities in rates are duplicated for different weeks in periods whose mean epochs are 23 years apart, would it not suggest that the meteors responsible may be so connected with our solar system (*i.e.*, an integral part thereof) that they could thus appear cyclically?

This is a most tentative suggestion, and one that can be brought forward only as possibly indicated by these graphs. Not until the data are treated analytically and velocities derived can we be fairly sure of their real meaning.

C. P. Olivier is personally responsible for about 7,000 of the observations and for the derivation of Group A; Mrs. Wills, for the derivation of Group B and for the actual graphs. This paper is the joint work of the two.

FOLLICULAR ATRESIA IN *TRITURUS VIRIDESCENS*

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The spring breeding season of the salamander, *Triturus viridescens*, occurs from the end of March to the end of June. The above dates as given by Pope ('24) are actually the dates of egg laying, which is regarded as the true breeding season in contrast to the false breeding season which occurs from October to February. During the false breeding season mating takes place exactly as it does in the spring. The secondary sexual characters of both males and females are prominent. The males deposit spermatophores and the females gather them up into the spermathecae but during the entire season no eggs are laid. Mating becomes less frequent in the months of December and January but on sunny days many pairs can be seen in amplexus. The secondary sexual characters remain continuously from October until the end of the egg laying period in the following June. Active mating is resumed in February and continues throughout the true breeding season. For the male the author ('32) has described two spermatogenetic cycles which ripen sperm respectively for the false and true breeding seasons.

The ovaries of the salamander from October to February contain many large yolk laden eggs which are actually ready for ovulation. In addition there are numerous small eggs which have not yet formed yolk and still others in the process of yolk formation. It is known that the large eggs are ready for ovulation because many workers have induced egg laying by the use of pituitary implants.

During the false breeding season atretic follicles are found in the ovaries. By this process the eggs are phagocytized by the follicle cells instead of being laid. Follicular atresia occurs in freshly collected stock and is not due to laboratory conditions since these specimens were fixed in Bouin's solution immediately after they were collected. The degenerative changes in the ovary of the freshly collected specimens are the same as those described as due to laboratory conditions (Hilsman) and to hypophysectomy (Burns).

In the salamander population during the false breeding season only a few of the yolk laden eggs are disintegrated at a time. When salamanders are brought into the laboratory atresia proceeds at a much more rapid rate. In the field, however, only the very largest and oldest of the ovarian eggs become atretic. At the same time yolk formation continues and atretic eggs are being replaced progressively. The successive

growth of smaller eggs to replace those removed by atresia parallels the male reproductive rhythm in which there are two distinct spermatogenetic cycles.

The occurrence then of follicular atresia during the false breeding season may be an abortive germ cell cycle which corresponds to the male fall cycle. (Hilsman '32.) Eggs are not deposited at the time of the false breeding season because of the disintegration of mature follicles by the process of follicular atresia.

The work of (Burns) ('32) in which he has shown that atresia follows hypophysectomy, and the work of Adams ('32) and others who have produced egg laying after pituitary implants indicates that the hypophysis may be the remote cause in producing follicular atresia during the false breeding season.

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THE EFFECTS OF HUMAN PREGNANCY URINE AND URINE EXTRACTS ON THE SALAMANDER

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The work of Smith and Engle ('27) and Zondek and Aschheim ('27) has conclusively demonstrated a definite interrelationship between the gonads and the hypophysis. Human pregnancy urine, when injected into immature rats and mice, produces growth of the ovaries and characteristic hemorrhagic follicles. This reaction has been used as a test for pregnancy. It is well known that the pituitary hormones of the anterior lobe which are responsible for the induction of ovulation in the rodents are found in pregnancy urine. Injection of pregnancy urine and urine extracts were tried on the amphibian *Triturus viridescens* with the expectation that it would also induce ovulation in this salamander.

Pregnancy urine extracts were used by Adams ('31) on the toad without inducing ovulation. The toad, however, reacts only to homoplastic-transplants of the pituitary gland; heteroplastic-transplants and injections of any kind are ineffective in inducing ovulation. This animal then does not afford a suitable test for determining the effects of pregnancy urine for the amphibia in general.

Injections of whole urine in quantities of 0.25 cc., 0.5 cc., and 1.0 cc. were given, respectively, to three series of animals for one month. The injections were made subcutaneously three times a week. At the close of the experiment autopsies were performed and the specimens were preserved in Bouin's solution. These had failed to lay eggs and no appreciable changes could be noted in the ovary.

A concentrated extract of pregnancy urine was made by the precipitation method (Mazer and Goldstein, '32). Injections were given as before. This extract concentrated the sex stimulating hormone from 60 cc. of urine to 12 cc. of an aqueous solution. The results of injections made three times a week are as follows:

1. Two animals of 16 laid eggs.
2. Thirteen animals had atretic ovaries.
3. One animal was normal and, had the experiment been continued, would have laid eggs.

Control specimens injected with Ringer's solution and untreated controls did not lay eggs. All the specimens used in this experiment were collected on February 22, 1933. In a previous paper I have mentioned the occurrence of follicular atresia in the ovaries of the salamander during the false breeding season, from October to February. So that these salamanders already had atretic ovaries before the experiment began. However, in homotransplantation experiments, salamanders with atretic ovaries did lay eggs in three to five days after daily pituitary implants. At autopsy it was found that the large eggs had been laid and so atresia was limited to those eggs in which it had already started. Atresia, therefore, was definitely checked by the pituitary implants and thus was not considered a drawback in the present injection experiment.

The pituitary extract made from pregnancy urine failed to stop atresia in the treated animals. Ovulation was therefore an impossibility in these thirteen specimens as degneration was allowed to continue. It is not yet known whether this extract will stimulate immature follicles to growth; this paper deals only with ovulation of already mature eggs present in the ovary. The thirteen treated specimens differed in degree

of atresia. Some had only a few atretic follicles, while others had no large yolk-laden eggs at all.

Since the controls treated with Ringer's solution developed atresia exactly as did the experimental animals and the counter-controls which were untreated stock likewise developed atresia, the treatment with the pregnancy urine extract had little or nothing to do with the follicular disintegration. We have thus explained the seemingly unrelated data and we may now consider the induction of ovulation.

The ovaries of the remaining salamanders had no new atretic spots, but only corpora atretica of some previously formed disintegration. These three specimens must be considered in advance of the others as they had already passed the final atretic stage. Two of these salamanders laid eggs; one starting after two injections and continuing as long as the injections were given. After about nine injections, during a period of three weeks, the injections were discontinued. Egg-laying ceased in 24 hours. When the injection was again administered, egg-laying was resumed and continued until the end of the experiment. Altogether 45 eggs were laid during the experiment by this female. The other one started after five injections and laid a total of 21 eggs. The third specimen did not ovulate during the experiment. The extract then in this group of specimens was effective in producing ovulation in two specimens, and in checking atresia in the remaining one, as laboratory conditions ordinarily would have started atresia in the time of the experiment. It may be noted that, of 16 experimental animals, only these three could have laid eggs under the given conditions.

Of hundreds of individuals collected on March 23, 1933, none have laid eggs in the laboratory. Neither were there any eggs noted in the field during the field trip. This precludes the possibility that the above mentioned females would have laid eggs without treatment.

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A BIOLOGIST LOOKS AT EDUCATION

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Lately I have been wondering whether we had the right slant on this thing we call education. Called upon to defend the field of our activities we, who are trained to go to the heart of problems and do, so long as the problems do not deal with personalities, fidget and mumble something about leadership and the good life and hurriedly rest our case. We have saved our master for a long time with this feeble defense but there is now a more vigorous prosecution going on. Our case is really strong as we know from the results, so let's trot out a few points beside leadership and the good life—the first depending to a large extent upon heredity and the latter being an inevitable by-product anyway if the main job is well done. Of what good then is education?

Man is the only animal not born into its world practically fully equipped to cope with its surroundings as it finds them. Although training is not hereditary each new generation of men faces the social and mental accumulations of all previous generations and must, starting from scratch, learn its way through this increasingly complex and man-made environment. The comfort and success of the members of the rising generation will be determined by the speed and thoroughness with which they become adapted to man's world. This world is one filled with men who can do but one phase of the world's work, with air-conditioned houses, music in the air, high speed transportation, huge cities that depend for sustenance on food produced at great distances, social organization, politics. Truly this is an awesome place to be catapulted into at birth with no inherited notions as to how to fit in and indeed with a fair chance that the unnatural conditions may make life itself difficult to maintain. To ease this shock, to bring about this adaptation to a rapidly changing world as smoothly, as quickly, and as effectively as possible is the purpose of education.

Consequently education is just another man-made institution designed to accomplish the adaptation of the younger generation to a highly artificial environment and for which his inheritance has not prepared him. From this point of view leadership and the good life would not seem so immediately important and in any case are more likely to rise spontaneously out of the innate qualities of the individual than to be forced out by formulas.

If all education, biologically viewed, is for the purpose of better environmental adaptation then some of its primary functions become more

obvious. The cub generation must, on the physical side, be taught to live healthily and satisfactorily. Unless the body is comfortable little else matters or is possible. The scope of such training may begin with the attention of the individual focused on the functions of his own body but would fall far short of its duty if it did not use these activities to orient the student in his world.

The physical side of existence cared for, social habits must receive their due attention. Each member of society must learn to get along with his fellows and this involves social conformity and a decent respect for custom in the broadest sense. In detail this requires that each of us must be able to express ourselves in terms and to exhibit evidences of culture that will make us understood by our associates.

Another phase of this educated adaptation to an unnatural environment is that it must fit for earning a living. The individual must serve society according to its needs and along lines indicated by his aptitude and training. The more extensive the training, the better the knowledge of how other men have behaved under various historic circumstances, the better should be the chances of solving current problems (that cannot in principle differ greatly from those of the past).

Since man has now (at least in theory) mastered his environment so well, as far as making a living is concerned, he is left with more and more free time which, with the old threat of Satan's influence on idle hands in mind, we recognize must be profitably filled. Such amusement must be varied to suit man's variability. When vocation and avocation can be linked the ultimate would seem to be reached. There can be little question that education, properly directed, may contribute materially to a happy solution of these problems.

If we summarize the attempt of our educational system to foster better biological adaptation it might be said that the departments of learning are not over four in number.

1. Life Processes—Biology, psychology.
2. Social Processes—Sociology, history, political science, economics.
3. Communication—Language and literature.
4. Technology—Chemistry, physics, geology, etc.

So grouped, the many and seemingly diverse fields of educational interest unite in a concerted effort to contribute to the art of living. From this biological angle it is easier to see why education becoming too centered on a given theory may, through its application, serve a few rather than the many. Variability is the keynote of the living world and few theories can cover such a range. Recognizing the desirability of view-ing each human as an individual and training him according to his needs it is also easier to see education as a process of trial and error, slow in its results and perhaps none too sure. Such a view may induce a little more patience on the part of those who evaluate the results of these experiments on human adaptation and a little more common sense and ingenuity on the part of the experimenters.

There is nothing new in this, of course, but it is sometimes helpful to our understanding of a problem to call a spade by its right name and to avoid the "damn" shovel terminology of Waterson.

SOME CAUSES OF CHROMOSOMES NUMBER VARIATION

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The constancy of chromosome number for any species has been so stressed as to be almost commonplace at this time. Recent work on non-disjunction and polyploidy has served to emphasize the importance of chromosomes in relation to variation. There is, however, another cause for number differences in the same species as reported by different workers that does not seem to be clearly understood. These differences may be caused by the breaking up of the longer chromosomes, thereby actually increasing the number although not the quantity of chromatic material. Or the observer may fail to see connecting links between portions of chromosomes and therefore report too large a number.

The latter is particularly apt to be the case in the cells of birds that are studied in the late prophase of division. My own attention was attracted to this possibility in a study of mitosis in chick tissue cultures and later in sectioned embryos. The number of chromosomes in late prophase was always greater than found when true metaphase was formed. In many cases it was possible to see the threads connecting chromatic granules that would probably later coalesce, thereby reducing the number of individual bodies. The real test of the basic number is to be found in the count of the chromosomes just after division has begun (anaphase). In well preserved material it is possible to pick up both groups of chromosomes in polar view and to count them with accuracy. These counts will not be influenced by such factors as unfinished condensation as might be the case in late prophase chromosomes.

This may be the explanation for the very high chromosome number in the domestic fowl (*66*) reported by White ('32). My own count had indicated 35 as the approximate number in this bird. The smaller chromosomes of the chick are very tiny and it is not at all difficult to be led astray as to the possible independence of chromosome particles. Any other explanation would at once suggest a difference between the chromosome make-up of British and American chickens, which is the less likely since the variation seems wholly concerned with the smallest and least easily observed bodies.

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A NEW MICROTOME KNIFE

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A new microtome knife has been designed to include the superior cutting qualities of the usual type of heavy blade and the convenience of the safety razor blade. The new blade has the rigidity lacking in the safety blade, can be easily sharpened on an inexpensive hone or the palm of one's hand, is durable but cheap to replace if badly nicked. This outfit can be sold at a price sufficiently low so that each student in histology may be required to have one, thus ending the usual difficulties of keeping a single microtome knife of the old style in good condition. This new knife has been in use for the past year in a large class in histology and resulted in much better sections from the entire class than had been usual before.

THE INTRACELLULAR OXIDATION-REDUCTION POTENTIAL OF YEAST

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The aerobic oxidation-reduction potential for Fleischmann's yeast suspended in phosphate buffer solutions of pH 7.0 and 8.0, as determined by the immersion colorimetric method described by Chambers, Beck, and Green[1] was found to lie between 0.115 and 0.047, the E_0 values at pH 7.0 of toluylene blue and cresyl blue respectively. The anaerobic oxidation-reduction potential was found to lie below -0.167, the E_0 value of cresyl violet.

[1] Chambers, Beck, and Green. 1933. J. Exp. Biol., vol. 10, p. 142.

Five percent ethyl urethane, and M/1000 arsenious acid have been found to markedly inhibit both cellular dehydrogenations and cellular respiration.[2,3] Iodoacetic acid, in a concentration of one part in 5000, was found by Lundsgaard[4] to markedly inhibit yeast fermentation of glucose and muscle glycolysis. Solutions of the three compounds, in the concentrations indicated above, were made up in phosphate buffer, and the solutions brought to pH 7.0 by quinhydrone titration. Yeast suspended in all three solutions were found to exhibit markedly more positive aerobic potentials than the normal.

M/1000 cyanide, which almost completely inhibits respiration in yeast, without affecting dehydrogenations,[3] was found not to affect the aerobic potential of yeast, as measured colorimetrically.

The conclusion is drawn that the aerobic oxidation-reduction potential is a measure of the cellular respiratory steady state equilibrium point.

METHYLENE BLUE AS A TOOL FOR CLASS STUDY OF CELLULAR RESPIRATION

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The apparatus required for direct measurement of oxygen consumption of cells and tissues is both too complicated and too expensive for class work in many courses and schools. A simple and inexpensive method for class study and demonstration of cellular and tissue respiration is described below.

Thunberg, Ahlgren[1] and others have shown that the rate of oxygen consumption and the rate of methylene blue reduction, *i.e.*, decoloration, are affected in the same manner and to the same degree by a large number of factors. Increase in temperature speeds up both oxygen consumption and methylene blue reduction, up to about 45° C., beyond which further increase in temperature has irreversible destructive effects on both processes. Penetrating acids, as carbon dioxide, inhibit both; penetrating bases, as ammonia, in low concentration accelerate both. Narcotics, as ethyl urethane, and many poisons, as arsenious acid and mercuric chloride, markedly inhibit both. On the addition of foodstuffs, especially glucose, fructose, sodium lactate, and sodium succinate, both processes are accelerated.

[2] Banga, Schneider, and Szent-Gyorgyi. 1931. Bioch. Zeit., vol. 240, p. 462.
[3] Keilin, D. 1928. Proc. Roy. Soc. Biol., vol. 104, p. 206.
[4] Lundsgaard. 1930. Bioch. Zeit., vol. 220, p. 1.
[1] Ahlgren, Gunnar. 1926. Skand. Arch. fur Physiol. Suppl. zum. 47 Band.

The only exception is that the oxidase poisons, hydrogen sulphide and cyanide, which markedly inhibit oxygen consumption, in concentrations as low as M/1000 and M/10,000 have no effect on methylene blue reduction in the same low concentration.

The effects of these various agents on methylene blue reduction may be readily demonstrated qualitatively in the following manner. A cake of Fleischmann's yeast is suspended in about 200 cc. of phosphate buffer of pH 7.0 and the resulting suspension is distributed in 5 cc. samples into the desired number of test-tubes. One or two drops of M/10,000 methylene blue (about 0.4 percent) is added to each test-tube. The compounds whose effects one wishes to test have previously been made up to a concentration ten times that desired in the final suspension and brought to a pH of 7.0 by titration. 0.5 cc. of each of these solutions is added to one of the test-tubes, and the test-tubes are marked. 0.5 cc. of phosphate buffer of pH 7.0 or 0.5 cc. of distilled water should be added at the same time to the control-tube. The tubes are corked, thoroughly shaken to mix their contents, and allowed to stand one to two hours, to permit penetration of the reagents into the cells. On again shaking up the tubes at the end of this period the methylene blue coloration will be seen to instantly reappear in all of the tubes. If the tubes are now permitted to stand again without shaking, the methylene blue coloration will be seen to gradually fade out from all of them, as the cells use up the oxygen in the suspensions, and then begin to reduce the methylene blue. The rate at which this color fading proceeds is a measure of the rate at which the yeast has used up the oxygen introduced into the suspension by shaking. It will be seen to be markedly slower for suspensions containing ethyl urethane, arsenious acid, etc., than the normal, and markedly more rapid than the normal for suspensions containing glucose, fructose, or other foodstuffs.

If desired, cut up animal tissues, as frog muscle, marine eggs, or other cells, may be used for such demonstrations instead of yeast cells.

For quantitative experiments Thunberg tubes, together with a water vacuum pump, may be used. Both the tubes and the pump are relatively inexpensive. The technic for quantitative determinations of methylene blue reduction is fully described by Ahlgren.[1]

EFFECTS OF CAPTIVITY ON THE FEMALE REPRODUCTIVE SYSTEM OF *TRITURUS VIRIDESCENS* RAF.

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For a long time it has been known that laboratory salamanders fail to breed in captivity. This is exceedingly inconvenient for the zoologist who would like to obtain eggs for the study of embryology. When salamanders are brought into the laboratory during the breeding season, they may lay a few eggs during the first two or three weeks of captivity but they soon stop laying, lose their secondary sexual characters and become almost sexless.

The fact that salamanders fail to breed in captivity is definitely related to histologic changes in the ovary. By the process of follicular atresia the large yolk laden eggs are disintegrated. Atresia is a process of degeneration in which the follicle cells act as phagocytes and digest the yolk particles and protoplasm of the egg. This degeneration is accompanied by the presence of eosinophiles and lymphocytes.

Many different stimuli may cause atresia, but whatever the cause atresia always proceeds in the same way. It effects only eggs with yolk and acts on the largest ones first. Coincident with the death of the nucleus is the presence of large numbers of white blood cells at the periphery. The follicle cells then loose their "stretched" appearance and assume a true epithelial shape while the capillaries become more numerous. Soon the follicle cells become more deeply imbedded in the egg material and approach several layers in thickness. Resorption reduces the follicle to a mass of cells containing much débris and dense pigment. The final stage in reduction is the corpus atreticum or the remnant of the thecal coat which soon passes over into connective tissue and is lost in the general stroma of the ovary. Burns ('32) has described the process of atresia in detail for the axolotl so that a full account here is not necessary. Atresia in Triturus is essentially the same and agrees with that of axolotl as described by Burns.

After a female salamander has been in the laboratory for one month, the secondary sexual characters have disappeared. All the large yolk-laden eggs are in some stage of atresia and the entire ovary has a peculiar brownish color. This is characteristic of early stages of atresia which involves the greater portion of the ovary. Histologically the atretic follicles contain much unremoved yolk material. The epithelial cells range from a single layer to several layers in thickness. Yolk particles can be seen inside the follicle cells. Growth of the other follicles is not inhibited by atresia; many are in active stages of yolk formation at the same time.

After the process of atresia has continued for three months the old corpora atretica appear as dense black knots of connective tissue while new atretic follicles have appeared in some of the eggs which have just formed yolk. The number of atretic follicles is less than in the preceding because the greatest number of yolk-laden eggs were already involved. The eggs which have developed yolk since the specimens were in captivity are now becoming atretic. The ovary appears lighter in color marked by the dense black corpora atretica, by some pigmented eggs and those beginning to form yolk, and by clear translucent small eggs which have not yet formed yolk.

At six months of captivity or longer the ovaries have become static, that is, atresia has reduced all the yolk-laden eggs to corpora atretica, and as soon as a new egg reaches the point of yolk formation it too becomes atretic. An equilibrium has been reached between atresia and growth of new follicles. At this stage the entire ovary is a translucent structure dotted with the black corpora atretica. Microscopically the ovary reveals only small eggs without yolk and atretic spots in various stages of degeneration.

The oviducts have gradually become smaller and less convoluted. They approach the form of straight tubes in animals kept in the laboratory a year or longer. The cloaca also shows the effects of captivity. The characteristic nuptial pigment present in breeding females is lost during the first month of captivity never to be regained under ordinary laboratory conditions. The cloacal glands are reduced so that the females can only be distinguished from males by the smaller size of the hind legs.

Many different laboratory conditions are sufficient to cause atresia. Stieve ('21) working on Triton has shown that abnormal temperatures, food conditions, darkness, absence of plants, sand and gravel are each sufficient to produce follicular disintegration. Other factors which may be added to this list are crowding and frequent changes of tap water. To quote from Burns ('32) who has also demonstrated ovarian degeneration after hypophysectomy: "It can scarcely be supposed that each of these modifying factors acts specifically. Probably all work alike through the agency of some common factor of a very general nature, and we may consider that any condition which depresses the general level of physiological activity will inhibit normal development in the ovary."

May it not be that laboratory conditions so modify the normal metabolism of the animal that it also modifies more or less directly the hypophysis itself.

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BRAIN AND SKULL SIZES AND FORMS IN RATS

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A great diversity of opinion is found concerning the rôle played by the skull and brain upon each other's size and form. Most of the literature is based upon opinion instead of experimental evidence. It is the purpose of this paper to present an abbreviated review of the literature, and to submit my own findings which are yet only casual.

The following references have been gleaned from publications and communications with various authorities. Von Gudden ('74) concluded that both brain and skull have within themselves the basic requirements for form and size even though, to a certain extent, they may modify each other's size and form. Virchow holds to the same opinion. E. G. Engel thinks that the skull is primarily altered by factors other than the brain, and the brain, in turn, accommodates itself to the altered skull. According to Fick, the brain molds the skull. Donaldson ('95) thinks that mechanical pressure is not the most important factor in determining brain and skull forms and sizes. Lull ('17 and '33) regards skull growth as conditioned by internal pressure. Conel ('29) considers (in Bdellostoma) the brain to be limited by the skull. Symington ('03) holds that the skull form is determined by the brain and organs of mastication. Hooton ('32) believes that cessation of brain growth in apes is caused by pull of muscles on the brain case. Kappers ('29) asserts that on an average the brain gives form to the skull. Little ('32) believes that the brain has much to do with the size of the calvarium. Schwalbe (1802) thought that the brain molds more of the floor of the skull than the roof. Keith ('56) believed that the brain molds its vault. Topinard thought that the brain did not influence the skull. Lucca states that both cause and effect may be attributed to skull and brain. Pickering ('30) believes that the brain influences skull form.

Weed ('20) proved that if the bones forming the brain case are firmly united intracranial pressure will not enlarge the skull. Nicholas ('30) showed that an actively growing substance introduced into the skull cavity of amphibians distorts the skull. Hrdlicka ('32) believes that conditions of the skull influence the brain. Herrick ('32) believes that in higher vertebrates the skull is shaped by the brain.

It is well to inquire if the skull and brain can be altered by factors other than the brain and skull acting upon each other. An investigation amongst peoples who practise intentional head distortion will reveal that it is quite possible to alter skull form. The deformation is accomplished by means of bandages and weights. Basler ('30) reported that if a child lies upon the back of the head for a considerable period, the head form will be modified. The skull is supposed to return to normal within two years.

The possibility of altering brain form and size by mechanical means is always accompanied by injury to the tissues, which complicates the problem. Von Gudden showed that decrease in nervous activity of some peripheral ending brought about a decrease in size in that part of the brain concerned with this particular activity. Donaldson pointed out that brains in intentionally distorted skulls were altered. He stressed the fact that this was due not to mechanical pressure of the skull, but due to disturbed nutrition. He explains that within certain limits the brain form is independent of pressure, for even in the absence of the skull the gyri will develop as before. If one hemisphere is removed, according to Donaldson, the other will not extend much beyond its normal boundaries. Von Gudden showed that in several cases, however, the remaining hemisphere grew into the remaining cavity.

It is known that endocrine disturbances can alter the skull, such as found in acromegaly. Enormous distentions of the skull in young kittens were obtained by Weed. This was brought about before the bones of the skull had firmly united.

The pull of strong muscles upon the back and sides of the head is thought to bring about a dolichocephalic condition. Pickering believes this to be restricted to postnatal life. He thinks that the brain can mold the skull long before the muscles exert any traction on the bones. It is quite possible that prenatal skull and brain relationships differ considerably from postnatal relationships.

This investigation, for the present, is concerned with postnatal skull and brain relationships. It was explained how the skull form and size could be altered by mechanical pressure, and how the size of the brain may be influenced by sensory activity. It might be added here that chemical and physical states of the brain proteins might affect the brain (Bancroft, '30).

It was thought that the skull might restrain the growth of the brain so a decompression was brought about by the removal of portions of skull bone. The specimens used were both males and females of hooded, white and Norway gray rats. In the first group of specimens, a part of the right parietal bone was excised. In about 270 days, the rats exhibited a lateral flexure to the left side of the skull. This was especially pronounced in the bones surrounding the nasal cavity and the maxillaries. Post-mortem examination revealed an atrophy of parts of the right cerebral lobe and a reduction in the size of the right olfactory lobe. The nasal cavity in many cases was nearly obliterated on the right side. The lateral flexure was caused by the broadening of the left bones of the roof and floor of the nasal cavity. The brains fitted quite closely to the skulls regardless of the inequality of the sizes of the two cerebral hemispheres.

Von Gudden secured an atrophy of the optic lobes of the brain by destroying the eye, and an atrophy of the olfactory centers by ligating one side of the nasal cavity. My experiment just explained shows that an injured rhinencephalon can also bring about a reduction of growth in the very bones of the nasal cavity. Here it is seen that even though the brain may be altered by conditions around its peripheral region, it is indispensable that a normal brain be developed to bring about normal growth of structures associated with its peripheral endings. Von Gudden also observed that over the atrophied brain, the skull grew thick and strong. Measurements have not been completed on these specimens as yet. Since the injured brain can bring about an altered condition of the craniad bones of the skull, it is possible that these, in turn, will have effect on the other skull bones. Measurements in the future will bring this out more clearly. The uninjured roof bones and lateral bones of the skull do not appear to be much altered, if any. It is possible to assume that both the nasal bones and the olfactory lobe underwent a simultaneous atrophy not related to each other in any way. This could not be due to disturbed nutrition in the nasal region because the olfactory lobes receive branches directly from the circle of Willis which was intact and uninjured in every case. The blood vessels supplying the nasal region were not injured. The brain was the only injured member, the nasal region bones were undisturbed during operative work.

In several other groups large portions of the roof of the skull, including practically all of the parietals (both sides), the dorsal regions of both temporals and most of the both frontals, were removed. In about six to eight weeks a protuberance appeared on the skull above the area of

the excised bone. The protuberance continued to enlarge very slowly until killed the rats at about four months of age. Post-mortem examination revealed a bulging repair membrane, vascularized and stretching from the edges of the cut bone across the excised-area. The membrane was quite transparent and it was possible to view the remaining brain regions beneath it. When the membrane was punctured, the fluid was ejected from it with considerable force, indicating an internal pressure. The cortex was reduced to a thin shell on the sides of the skull, and it had disappeared entirely on the dorsal and mesial regions. The lateral ventricles were entirely uncovered with their choroid plexus intact. The caudate nuclei, which stood out very plainly isolated from the cortex, maintained their normal position in relation with the thalamus. Only the main body of the fornix remained. The hippocampi were unmolested except their connection with the fornix.

All of the specimens were operated upon within one or four days after birth.

The cause of this cortical atrophy is still problematical. It is possible to suggest what might bring about such an atrophy. In young animals, the meninges are thought to cling closely to the skull. If the skull is removed a part of the meninges beneath this region could be torn out. If the skull cap is removed the falx would come with it. This would interfere with the nutrition of that region and its proper drainage. The great accumulation of liquid in the skull cavity would explain that. Von Gudden noticed the same effect after he had removed both cerebral hemispheres in his specimens. The continual accumulation of fluid would soon bring the brain under great tension. In the specimens that were demonstrated the elasticity of the repair membrane compensated for this for a period. The tension of the cerebrospinal fluid would finally exceed the blood pressure of the exposed cerebral arteries and collapse them. Such a condition would cause an atrophy of the regions exposed to this pressure. The pressure did not seem to affect the larger vessels on the floor of the brain. It is possible that an accessory drainage system compensated for the increased pressure for a time while the dermis of the skin was in direct contact with the cortex after the operation. The appearance of the repair membrane would soon occlude the possibility of this method by interposing itself between the dermis and cortex. All of this is only more speculation, however.

It was shown how the skull may be altered by mechanical means, by endocrine disturbances, and by injury to the brain. The brain, in turn, may be influenced by injuries to regions about its peripheral endings. Von Gudden by ligating the nasal cavity brought about an atrophy of the corresponding centers in the brain. Injury to the olfactory centers of the brain seem to influence the normal development of structures associated with its corresponding peripheral endings. The last statement is only tentative, however, until further investigation completely verifies it. This, of course, stands only for rabbits in von Gudden's experiments and for rats in this investigation, and post natal influences at that.

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SOME INTERRELATIONS OF PLANTS AND BIRDS ON PRESQUE ISLE, ERIE, PENNSYLVANIA

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Some of the most interesting things which have come out of the various studies being carried on at the Lake Laboratory of the University of Pittsburgh at Erie, Pennsylvania, are the interrelations between the

plant and animal life in the rapidly changing environments on Presque Isle.

The peninsula of Presque Isle is about six miles long and, at its wider outer end, is separated from the mainland by Erie Bay, which is there from one to two miles wide. The peninsula is shifting eastward at the average rate of about half a mile per century, so that the different vegetational societies and associations must also shift their positions eastward at about the same rate.

How the plants have migrated to the peninsula and how, in general, they manage to migrate eastward at the average rate of about half a mile per century has been engaging the attention of some of us while working at the Lake Laboratory. The part which birds play in this migration is coming to be regarded as very important.

At the eastern end of the peninsula, where the sands have only recently accumulated to form new land, there are open beaches, and beach-pools and ponds. This part of Presque Isle is the favorite hunting place of the sandpipers and plovers, and, particularly around the sandy beach-pools, it is the customary resting place of the terns and gulls. The vegetation of the lake beach, itself, however, consisting of Scurvy Grass (*Cakile*), Clot-bur (*Xanthium*), Beach Bean (*Strophostyles*), and Seaside Spurge (*Euphorbia polygonifolia*), evidently arises from seeds washed up by the waves rather than from seeds distributed by birds.

Around the newly-formed pools, however, there are seedling cottonwoods and willows from seeds blown there by the wind and, also, a number of kinds of plants which have very small seeds, such as the rushes (*Juncus*), sedges (*Carex*), wild flax (*Linum*), *Lobelia Kalmii,* and others which evidently owe their presence in this habitat to the assistance of birds. Many small seeds, such as those of the flax, become more or less sticky or mucilaginous when wet, or will readily stick to wet objects such as the feet or feathers of birds. The various small-seeded plants around the more recently formed, sand-bordered pools probably have largely migrated there by reason of the seeds having been carried on the feet or feathers of birds. Such pools have no border of trees and are not frequented by perching birds of the kinds that usually eat berries or other soft fruits. It is noticeable that there are no plants bearing berries or other edible fruits around these sandy beach-pools.

Farther back, away from the beach, where the willows are full-grown, the land is older and the cottonwoods have become trees suitable for shelter and for resting places for perching birds, there appear considerable numbers of plants with edible berries or other small fruits commonly eaten by various kinds of birds, which thus distribute the seeds. It has been claimed that certain wild cherry seeds showed a better germination after having passed through the digestive tract of chickens. Certain it is that many small-fruited plants have their seeds successfully distributed in this manner by various kinds of birds which either habitually or occasionally feed upon such fruits.

Studies begun around isolated clumps of cottonwoods near the Lake Laboratory in the more or less open expanse of sand-plain where the land is now probably about fifty years old, soon disclosed the important part that birds have played in the migration of plants into that habitat. Further studies showed similar results, also, for the wet meadows and the shrubby borders of the older ponds in this part of the peninsula. Birds may be seen flying about, alighting here and there in the scattering shrubs and trees, and undoubtedly seeds are dropped both on the open places during the flight of the birds and, also, under the trees during times when they are perched there. Nowhere else on the peninsula have the birds played so large a part in the migration of plants as is the case in this newer, open part. In fact, aside from the scattering cottonwoods and willows and the bunch-grasses and the wet-meadow grasses, all distributed by wind, the prevailing aspect of the vegetation is here determined by plants distributed by birds and enumerated in the following lists, grouped by habitat:

Under cottonwoods on ridges:
- Poison Ivy (*Rhus Toxicodendron*)
- Stag-horn Sumach (*Rhus typhina*)
- Wild Black Cherry (*Prunus serotina*)
- Choke Cherry (*Prunus virginiana*)
- Wild Lily-of-the-Valley (*Maianthemum canadense*)
- False Solomon's Seal (*Smilacina stellata*)
- River-bank Grape (*Vitis vulpina*)
- Virginia Creeper (*Psedera quinquefolia*)
- Climbing Bittersweet (*Celastrus scandens*)
- Red Raspberry (*Rubus idaeus aculeatissimus*)

On the sand-plain:
- Bearberry (*Arctostaphylos Uva-ursi*)

In wet meadows or around the margins of ponds:
- Barberry (*Berberis vulgaris*)
- Bayberry (*Myrica carolinensis*)
- Dew Berry (*Rubus villosus*)
- Strawberry (*Fragaria virginiana*)
- Fire Cherry (*Prunus pennsylvanica*)
- Cornels (*Cornus Baileyi, C. Amomum,* and *C. stolonifera*)
- Winter Holly (*Ilex verticillata*)

In the older part of the sand-plain, and on the ridges, the bearberry has extended its range and formed the heath, into which there have been no notable additions through the activities of birds. The Red Cedar is undoubtedly distributed by birds and, a number of years ago, there were some interesting examples of young red cedars underneath cottonwoods, but almost invariably on the eastern (leeward) side of the trunk. Another interesting case is that of the Pin Oak (*Quercus palustris*). Seedlings and saplings of this tree are to be found scattered here and there on moister spots in the sand-plain or around the borders of wet meadows. The acorn of this oak is relatively very small and it is reported as being commonly carried about by the blue jay, and by some of the woodpeckers. Blue jays are frequently seen flying about from tree to tree, peering about and examining the bark of the cottonwoods. Probably this bird is responsible for the fact that the Pin Oak advances much more rapidly into the newer parts of the peninsula than do the other oaks with larger acorns.

Farther back in the older parts of Presque Isle where the Heath has given way to the mixed White Pine forest and that, in turn, to the Red Oak forest, there are various other plants which were probably introduced, and which keep their place in the eastward shifting of the peninsula and its vegetation, largely, if not entirely, by the activities of birds. Among such plants are the Sassafras (*Sassafras variifolium*), Sour Gum (*Nyssa sylvatica*), Greenbrier (*Smilax rotundifolia*), Swamp Rose (*Rosa carolina*), and the High-bush Huckleberry (*Vaccinium corymbosum*).

Beginning at the newest part of the peninsula, out at the eastern tip, and proceeding westward through successively older land into the Red Oak forest, where the land must have appeared about six centuries ago, the most important agents in plant migration arrange themselves as follows: (1) Beach habitat, water; (2) Beach pools, water birds and wind; (3) Sand plain, perching birds; (4) Heath and wooded older parts of the peninsula, wind and birds and squirrels. Birds are most important as agents in plant migration during the younger stages of the development of the peninsula when the vegetation is more open and not occupied by forest.