PROCEEDINGS

OF THE

PENNSYLVANIA ACADEMY OF SCIENCE

VOLUME X

1936

HARRISBURG, PENNSYLVANIA
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1936–37

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THE SCIENCE PRESS PRINTING COMPANY
LANCASTER, PENNSYLVANIA

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PENNSYLVANIA ACADEMY OF SCIENCE

MINUTES OF THE 1935 SUMMER SESSION

August 9 and 10

East Stroudsburg, Pennsylvania

About 50 members and visitors met at 2 P. M. the 9th at Tannersville to visit a typical northern quaking bog, about 1½ miles east of Tannersville. The following plants, unusual for the district, were seen:

Kalmia polifilia—Andromida glaucophylla—Menyanthes trifoliata—Chamaedaphne calyculata—Habenaria blephariglottis—Decodon verticillatus—Picea mariana—Abies balsamea.

Other typical bog plants were observed.

At an evening session in the East Stroudsburg High School, subjects pertaining to the well-being of the Academy were discussed.

The offer of $125.00 as a research grant from the American Association for the Advancement of Science was, upon motion, accepted and the Executive Committee empowered to decide upon the grantee for the year 1935.

The following persons were elected to active membership:

Richard Snyder, Lansdale.
E. E. Wildman, Administrative Bldg., Parkway, Philadelphia.
Frank P. Primiano, 1620 Ellsworth St., Philadelphia.
Hans Wilkins, 241 South 11th St., Reading.
Elwood D. Heiss, State Teachers College, E. Stroudsburg.
D. E. Dimmick, 183 State Street, East Stroudsburg.

Members of the executive committee present were in favor of making the 1935 A. A. A. S. grant to Ralph Miller, a graduate student in Columbia University, to be used in continuing his study of the Jacksonburg limestone in eastern Pennsylvania; and that the award be made as of September 1st. Later, this grant to Mr. Miller was confirmed.

On August 10th the geology of the Stroudsburg district was observed with a field trip. The trip was outlined and conducted by Dr. Bradford Willard, Pennsylvania Topographic and Geologic Survey, Harrisburg. The following rock systems and formations were studied:

Quaternary: Glacial drifts—Terraces.
Devonian: Catskill to Helderberg.
Silurian: Bloomsburg and Shawangunk.
Ordovician: Martinsburg.

A total of 65 members and their friends registered for the meeting.

T. L. Guyton, *Secretary*

MINUTES OF THE TWELFTH ANNUAL MEETING

State Teachers College, Indiana, April 10 and 11, 1936

At a meeting of the executive committee April 9, the following actions were taken:

A request from the Philadelphia Chamber of Commerce to have our next regular meeting at Philadelphia was declined. In collaboration with the permanent committee appointed to schedule meeting places, and at the request of the Lancaster Branch of the American Association for the Advancement of Science, Franklin and Marshall College, at Lancaster was selected as the meeting place of the Academy for 1937, and Bucknell University, Lewisburg, for 1938.

It was decided that a place on the letter head of the Academy be given to a statement of the places selected for the next annual meetings as well as the summer meetings.

There was some discussion concerning the advantages of having annual institutional members. This matter was held for advisement until the summer meeting.

The secretary was authorized to communicate with all former officers as well as present officers of the Academy to obtain from each one a photograph and a short biography to be preserved in the archives of the Academy.

The secretary will represent the Academy at the Atlantic City meeting of the American Association in 1936.

Authorization was given to make up 100 sets of the first five issues of the Proceedings which are to be offered for sale at $1.00 per set. At a later date R. W. Stone, of the Geological Survey, E. M. Gress, of the Department of Agriculture, and the Secretary of the Academy were named by the President of the Academy to make up the sets. The Secretary was asked to circularize the members of the Academy concerning this offer.

Dr. Cope, as President, was asked to contact the Pennsylvania Physics Teachers Association and invite them to become associated with the Academy at the next annual meeting at Franklin and Marshall College.

A program of 61 subjects was presented by members on Friday and Saturday. These appear in the tenth volume of the Proceedings.

Dr. Johnson, chairman of the committee of the Academy on certification of science teachers in the secondary schools in Pennsylvania presented the following report:

> The minimum requirement to teach in the secondary schools of Pennsylvania should be as follows (to take effect by Sept. 1, 1937, if possible):

I. a. Biology or Chemistry or Physics (as a major field) ..... at least 18 sem. hrs.

b. Biology or Chemistry or Physics (as minor fields) each ..... at least 12 sem. hrs.

(No one may teach Biology or Chemistry or Physics who has not completed at least 12 sem. hrs. of college or university credit in that field. In addition, he must have completed 18 sem. hrs. in some field. The field may be Biology, Chemistry, Physics, History, English, etc.)

c. To teach General Science (in Jr. H. S.) at least ..... 30 sem. hrs. must be completed in science courses with at least 6 sem. hrs. each in Biology, Chemistry and Physics. Other science courses that may be included are Astronomy, Geology, and Physiography.

II. Education and Psychology Courses, including Observation and Practice Teaching (with one course of above in Methods and Techniques of Teaching Science) ..... 24 sem. hrs.

III. English and Literature ..... 12 sem. hrs.

IV. Social Studies (History, Sociology, Economics, Political Science) ..... 12 sem. hrs.

V. Free Electives (Varies according to number of science courses taken ..... 7 sem. hrs.

Total 120 sem. hrs.

Physical Exercise courses are in addition to the 120 sem. hrs. according to the wishes of each individual college or university.

Students interested in teaching any of the sciences in the secondary schools should be encouraged to take at least 18 sem. hrs. each in Biology, Chemistry, and Physics.

Each college or university, of course, is at liberty to add to any of the above to secure a major or minor in any science in their own institution.

Without a dissenting vote, the entire Academy voted its approval of the recommendations of its committee on "The Certification of Science Teachers in the Secondary Schools of Pennsylvania."

It was also unanimously adopted that four years hence, in 1940, the Pennsylvania Academy of Science would recommend still higher requirements for certification to teach science in the secondary schools of Pennsylvania, so that the requirements would be equal to those of the more progressive States.

The program committee was asked to schedule and arrange for a symposium dealing with "Methods of Science Teaching" for the program next year.

The following committees were appointed:

Auditing:	Nominating:	Resolutions:
Edw. H. Graham	R. T. Hance	I. P. Tolmachoff
John E. Anderson	John C. Johnson	Donald M. Fraser
	E. M. Gress	R. W. Stone

The following items were acted upon during the final business session of the annual meeting:

The Resolutions Committee report:

The Resolutions Committee has difficulty in finding words adequate to express the appreciation felt by the members of the Pennsylvania Academy of Science for the hospitality and fine facilities given to us by the administrative officers of Indiana State Teachers College.

The Academy expresses its thanks to the members of the local committee and to the students who made and carried out the plans for the meeting so efficiently.

Our special thanks are extended to Dr. A. L. Patrick, U. S. Department of Agriculture, for his address at the evening meeting.

We cannot avoid pointing out the fact that the second ten-year period of the Academy begins with a very remarkable increase in its membership. This increase which shows the appreciation of the work of the Academy ought to be attributed undoubtedly to the self-sacrificing work of its officers during the whole time of the existence of the Academy and particularly of those of last year.

Our special thanks are due Dr. E. T. Wherry for his work in guiding the organization during the past year, Dr. V. Earl Light for his efficient handling of the secretarial work and to R. W. Stone who for many years has so ably edited the Proceedings.

We wish to express our sorrow at the passing of three of our members: D. Roberts Harper, 3rd., George G. Chambers, and Edward I. Keffer.

Respectfully submitted,

I. P. Tolmachoff
Donald M. Fraser
R. W. Stone

The report was received and adopted by the Academy.

The Treasurer gave the following report which was later examined and checked by Edward H. Graham and John E. Anderson of the auditing committee:

FINANCIAL STATEMENT

April 11, 1935 to April 1, 1936

Receipts:	
Balance on hand April 11, 1935	$266.73
Dues received	467.00
Sales	12.00
Printing, extra pages	68.93
	$814.66
Disbursements:	
Science Press (on account)	$300.00
Nittany Printing Company	5.25
Telegraph Printing Company	17.75
Secretary's Account	69.25
Treasurer's Account	52.00
R. W. Stone	2.25
Junior Academy Account	4.55
John C. Johnson	2.11
Balance on hand	361.50
	$814.66
Accounts payable to the Science Press	$251.32
Net balance	$110.18

(Signed) H. W. Thurston, Jr.,
Treasurer

Examined and checked
Edward H. Graham
John E. Anderson
Auditors.

The chairman of the membership committee presented the names of 56 persons for active membership. This report was adopted and the following persons were elected to membership:

Raymond E. Barnhart, Delta.
Edison O. Bates, 201 N. Main St., Port Allegany.
John C. Bechtel, 6608 Wayne Ave., Philadelphia.
Frank D. Beck, Laureldale.
Kenneth A. Bergstresser, 5533 Ellsworth Ave., Pittsburgh.
Karl H. Blanch, 1015 Center St., East Mauch Chunk.
Frank Eugene Bolden, 2621 Center Ave., Pittsburgh.
Philip R. Bond, 1484 Ormand Ave., Camden, N. J.
Olive Bown, 6210 Wellesley Ave., Pittsburgh.
J. J. Burke, Carnegie Museum, Pittsburgh.
Robert Cassel, 118 High St., Woodbury, N. J.
Sophie E. F. Cope, 239 Lenoir Ave., Wayne.
James M. Darlington, LaPlume.
L. B. Earhart, 709 Shadeland Ave., Drexel Hill.
Luther F. Ehlman, 3300 Jonestown Road, Harrisburg.

Paul S. Ellenberger, R. No. 1, Annville.
Anna Mary Erdman, 59 E. Derry Road, Hershey.
Maurice Ewing, Bethlehem.
Esther Flom, 2200 N. Fifth St., Harrisburg.
Jane E. Frankston, Orchard Ave., Woodsdale, Wheeling, W. Va.
Raymond M. Freed, 637 E. Allen Lane, Philadelphia.
Norman R. Goldsmith, 5802 Beacon St., Pittsburgh.
Alvin R. Grove, Jr., 2417 N. 5th St., Harrisburg.
John Walter Haldeman, 16 9th St., Perkasie.
William H. Harris, Jr., 523 2nd St., Donora.
W. H. Hoffman, 806 Third St., Juniata, Altoona.
Norman H. Horowitz, 2201 Shady Ave., Pittsburgh.
Alexander Horwitz, 6718 Rowland Ave., Philadelphia.
T. D. Howe, Duquesne University, Pittsburgh.
Sister Mary Cosmas Hughes, 121 Church St., Plymouth.
Merrill B. Iams, State Teachers College, Indiana.
Ernest E. Johnson, 5850 N. 6th St., Philadelphia.
J. LeRoy Kay, Carnegie Museum, Pittsburgh.
Kenneth R. King, 19 West Granada Ave., Hershey.
Clarence Lehman, R. No. 2, Palmyra.
John C. McCune, 75 Analomink, East Stroudsburg.
Elda L. Miller, R. No. 2, Ruffsdale.
Ralph V. Mostoller, Stoystown.
Walter J. Nickerson, Jr., 311 S. New St., West Chester.
Clark D. Read, 214 Cherry St., Clearfield.
Mae E. Reider, 53 S. Railroad St., Palmyra.
Charles B. Rigney, 8 S. Good St., Jeannette.
Gerald B. Russell, Wallingford.
Charles Anthony Schaich, 1301 Walnut St., Reading.
Clara Roberta Schlesinger, 606 Hill Ave., Wilkinsburg.
E. Douglas Sechler, 845 N. Charlotte St., Pottstown.
Thomas Smyth, State Teachers College, Indiana.
Andrew Sherockman, Burgettstown.
W. Gilbert Spangler, 1913 Chestnut St., Harrisburg.
Mary A. Spencer, 406 Broadway, South Boston, Mass.
J. Kenneth Terres, U. S. Soil Conservation Service, Indiana.
Olive S. Tilton, State Teachers College, Indiana.
Clement C. Williams, Lehigh University, Bethlehem.
L. K. Wright, 303 Botany Bldg., State College.
Dorothy Wyckoff, Bryn Mawr.
William E. Zimmerman, 725 Locust St., Indiana.

The committee on places of meeting reported as follows:

Summer meeting for 1936—Negro Mountain, Somerset County, August 14 and 15. Annual meetings—1937 Franklin and Marshall College, Lancaster. 1938—Bucknell University, Lewisburg. This report was adopted.

The report of the nominating committee:

For President—Thomas D. Cope.
Vice-President—George H. Ashley.
Secretary—V. Earl Light.
Assistant Secretary—Charles E. Mohr.
Treasurer—H. W. Thurston, Jr.
Editor—R. W. Stone.
Press Secretary—Bradford Willard.

Upon motion the secretary cast a ballot in favor of each of the above nominations.

April 30 was designated as the last date for submitting papers to the editor for publication in the tenth volume of the Proceedings.

An application by Raymond J. Greb for the A. A. A. S. grant for 1937–1938 was read.

Dr. Netting proposed that a committee be appointed to keep in touch with legislators in an endeavor to conserve our wild life.

Moved and carried that the officers of the Academy be authorized to make up any deficit that may have been caused by shortage of expected attendance at the banquet.

The new president was escorted to the chair, and the twelfth annual meeting came to a close.

V. Earl Light, *Acting Secretary.*

PRESIDENTIAL ADDRESS

REFLECTIONS ON THE ORIGIN OF LIFE

By Edgar T. Wherry
University of Pennsylvania

During the first half of its span of existence, the Earth was in an azoic or lifeless state. Then, about a billion years ago, life appeared upon it, and the living matter proceeded to evolve into a vast series of organisms, which have occupied nearly the whole of its surface. The purpose of this address is to consider some of the details of this remarkable phenomenon.

It is difficult to formulate criteria which will distinguish living from non-living matter, for exceptions always have to be admitted. Ability to reproduce itself is an attribute of living matter in general; although a gas flame is not to be classed as living merely because it can light an infinite number of identical flames, nor a mule as non-living merely because this power of reproduction is lost. Responsiveness to external stimuli is another characteristic of life; yet our non-living flame is able to move away when we blow upon it, and our living mule may at times exhibit a provoking failure to respond to stimuli. However, living matter is certainly characterized by its variability; for although any one non-living molecule of a given composition is identical with innumerable others, no two living organisms seem ever to be exactly alike.

The possibility that life as we know it did not originate on this Earth, but was started by a spore which came in from some other part of the solar system is a well-known subject for speculation. However, as with those plays which were not written by Shakespeare but by another man of the same name, if the place of origin of life was not on our Earth, then it was on another planet of the same makeup, and the discussion here given will apply equally well to this other Earth.

Protoplasm, the fundamental substance underlying living matter, contains relatively large amounts of proteins, which in turn are built up of amino acids. These are organic molecules with an acidic radicle on one side and a basic radicle on another, and accordingly produce, when dissolved in water, both positive and negative ions, in unlike amounts. The strains set up in the structure by this double and unequal ionization may well be one source of the responsiveness to external stimuli exhibited by aggregates of such molecules. The "peptide linkage" by which amino acids are held together into proteins is perhaps another place in the structure at which response to external influences may occur. More important than either of these, however, is the spiral strain shown by these "building-stones" of the protein mass. For many of the amino acid molecules

contain one or more "asymmetric" carbon atoms, some twisted to the right, others to the left. And when a series of these becomes attached, an intricate system of balancing of the strains develops, resulting in extreme sensitivity of the system to stimuli. This subject of spirally strained molecules requires, then, further consideration.

Pasteur is deservedly famous as the first scientist clearly to recognize and incontestably demonstrate the rôle of bacteria in the causation of disease; but he also made discoveries in the inorganic realm, at least one of which was of fundamental importance. Quoting from Mrs. Devonshire's translation of Vallery-Radot's Life of Pasteur:

> Pasteur noticed that the crystals of tartaric acid and the tartrates had little faces, which had escaped even the profound observation of Mitscherlich and La Provostaye. These faces, which only existed on one half of the edges or similar angles, constituted what is called a hemihedral form. When the crystal was placed before a glass [mirror] the image that appeared could not be superposed to [upon] the crystal. . . . Pasteur thought that this aspect of the crystal might be an index of what existed within the molecules, dissymetry of form corresponding with molecular dissymetry. . . . Therefore, reasoned Pasteur, the deviation to the right of the plane of polarization produced by tartrates and the optical neutrality of paratartrates would be explained by a structural law. The first part of these conclusions was confirmed; all the crystals of tartrate proved to be hemihedral. But when Pasteur came to examine the crystals of paratartrate, hoping to find none of them hemihedral, he experienced a keen disappointment. The paratartrate also was hemihedral, but the faces of some of the crystals were inclined to the right, and those of others to the left. It then occurred to Pasteur to take up these crystals one by one and sort them carefully, putting on one side those which turned to the left, and on the other those which turned to the right. He thought that by observing their respective solutions in the polarizing apparatus, the two contrary hemihedral forms would give two contrary deviations. . . .
>
> With anxious and beating heart he proceeded to this experiment with the polarizing apparatus and exclaimed "I have it!" His excitement was such that he could not look at the apparatus again . . . never was there greater or more exuberant joy on a young man's lips. He foresaw all the consequences of his discovery. The hitherto incomprehensible constitution of paratartaric or racemic acid was explained; he differentiated it into righthand . . . natural tartaric acid of grapes, and lefthand tartaric acid. These two distinct acids possess equal and opposite rotatory powers which neutralize each other when . . . in aqueous solution . . . in equal quantities.

That carbon atoms whose bonds are attached to four different atoms or groups are under a spiral strain is shown by the fact that they will twist the plane of a transmitted beam of polarized light. However, just as our two hands are mirror-images of one another, but not superimposable, so every spiral has both a right-handed and a left-handed form. Numbering the attached radicals consecutively, the molecule $\begin{smallmatrix}1\\4\end{smallmatrix}C\begin{smallmatrix}2\\3\end{smallmatrix}$ is not identical with $\begin{smallmatrix}1\\2\end{smallmatrix}C\begin{smallmatrix}4\\3\end{smallmatrix}$; the two are related as an object to its mirror image,

but cannot be superimposed. A solution or crystal of the one will twist the plane of the polarized light beam to the right, of the other will twist that beam to the left. Pasteur's great contribution was the recognition that "hemihedral" faces on the crystals of such substances may themselves show respectively right- or left-handed twist, and that when solutions of the two forms of this substance are mixed, the two can be separated by crystallizing and sorting the crystals into two piles.

In a given type of living matter, the amounts of right- and left-handed forms of each "asymmetric" compound are in general unequal, and, indeed, one may be present to the exclusion of the other. Thus, in grapes, as noted in the above reference to Pasteur, only right-handed tartaric acid is found, some selective action of the living plant preventing the formation of the left-handed equivalent. On the other hand, when an asymmetric compound is synthesized without the intervention of life, equal amounts of the right- and left-handed molecules are always formed, the solution being correspondingly optically inert. This result is due to the operation of a law of chance—the chances being even that a given radical will attach itself at the right- or at the left-hand position on an asymmetric carbon atom. If, now, it requires life to escape the consequences of this law, and to force the incoming radical to attach itself only in one of the two positions, how could living matter ever have originated from non-living matter?

Prior to the appearance of living matter, carbon compounds were undoubtedly forming spontaneously at various points on the earth's surface, and even asymmetric amino acids were no doubt occasionally produced. Equal quantities of the right- and the left-handed modifications of these would, however, be formed, and when they became aggregated a twist in one direction would be balanced by the corresponding twist in the other direction, precluding the development of the extreme degree of responsiveness which living matter owes to the presence of unbalanced spiral strains. To account for the origin of life, a phenomenon which could evade the law of chance and lead to the production of an excess of one or the other form of a synthesized compound must be sought.

It is well known that the attractional forces which hold the atoms or molecules in the regular positions characteristic of crystals extend above the surface of the crystal. When sodium nitrate separates from solution in a glass vessel, its crystals take on random orientations, but when placed on a clean surface of a calcite crystal, the sodium nitrate crystals deposit in definitely oriented positions. Likewise, when substances yielding liquid-crystals are placed on crystal-faces, oriented arrangement is produced by these exserted forces.

Quartz, the most abundant mineral on the earth's surface, has its silicon atoms so united with oxygen atoms that spiral strain is developed. As required by the law of chance, there are in the world, to be sure, just as many right-handed as left-handed quartz crystals; but these individually may grow to large size.

The unsatisfied attractional forces extending up in the unique or c-axial direction from a right-handed quartz crystal must have a right-handed twist, and those from a left-handed quartz crystal a corresponding twist in the opposite direction. If, then, spontaneous synthesis of asymmetric amino acids took place on the surface of a single quartz crystal which chanced to be, say, right-handed and to have broken across the unique axial direction, the molecules which formed may well have been all right-handed ones.

If conditions favored the successive production of different molecules on the same right-handed, twist-invoking quartz surface, and these were stimulated to unite, protein aggregates capable of exhibiting the attributes of living matter could ultimately have formed. The adsorptive properties of the clay colloids produced by the weathering of rocks may well have been the stimulus leading to such aggregation, and the richness of these clay colloids in potassium rather than sodium corresponds to the fact that plant life utilizes potassium in its physiologic processes. Animal life, being parasitic on plants, must have developed later, and the fact that it utilized sodium indicates its origin in the sea, where this element accumulates. However, for the reasons herein outlined, I would locate the site of origin of the earliest life in a mud-puddle on the surface of a broken quartz crystal.

FOOD DETERMINATION OF THE RUFFED GROUSE BY ANALYSIS OF EXCREMENT

By Thomas Smyth
State Teachers College, Indiana

Several years ago the writer was engaged in an extensive investigation of the life history of the ruffed grouse while he was a graduate student under the direction of Dr. A. A. Allen of Cornell University. In connection with the studies of food habits it became necessary to try to compensate for the concentration of data for the autumn season. The attempt to do this resulted in the collection and analysis of excreta at intervals throughout the months from January to September. This study indicated in general the chief foods of this grouse during the months of closed season when analyses were made of only a few stomachs. Inasmuch as

little appears to have been published on this subject a condensation of this particular study of food habits by detailed analysis of excreta is herewith presented.

Most of the material examined from January to the last of April was from the Six Mile Creek region, extending for several miles above Ithaca, N. Y. There were two places in particular in this section which the grouse chiefly resorted to during the winter. One was just above the lower reservoir for Ithaca, N. Y., where there is a growth of wild grapes and staghorn sumachs. The other spot was to the southeast of the upper reservoir, where there is a splendid growth of sumachs and grapes. Eight grouse were flushed from this last place in an afternoon.

The material examined from the last of April to August was obtained from the Michigan Hollow region, near the small village of Danby, which lies about 6½ miles south of Ithaca. This region has a swampy area and a wooded hill. Here wild grapes and sumachs grow rather sparsely; witch-hazel, however, is exceedingly abundant, and there is some hawthorne. A brief statement regarding the material examined for each month is set forth below.

JANUARY. Snow was on the ground during practically the whole of January. During this month the material from Six Mile Creek contained chiefly the remains of wild grapes and of staghorn sumach, together with a few wood fibers from buds. Most of the material was gathered from the grape-sumach patch a short distance above the lower reservoir. From the tracks in the snow, the birds seemed to restrict themselves to an area extending for about 100 yards along the base of the northwest hill, and about 50 yards up the side, and 25 out from the base. It was estimated that about 98% of the food eaten by these birds during the month was made up of grape and sumach.

FEBRUARY. Snow was on the ground during almost the entire month of February. The food materials were practically the same as the preceding month. Very few bud fragments were evident and sometimes the excrement consisted almost entirely of the fuzzy husks from around sumach seeds. Some hawthorne seeds appeared in some of the material.

MARCH. Snow was common during March. Material gathered from about the plateau at the southeastern end of the upper reservoir showed practically no change in the food habits of these birds. A sample of material from Lick Brook, a few miles south of Ithaca, where sumach was very scanty, revealed about 99% diet of buds.

APRIL. Most of the excreta examined during April from the Six Mile Creek region was composed almost entirely of the remains of staghorn sumach. Four droppings were found which contained only bud fibers, and another was made up almost exclusively of the downy fibers from young catkins. Considerable of the material examined from April through August was obtained from drumming logs.

On April 28 fresh material from Michigan Hollow indicated that most of the birds were feeding largely on the young, tender buds of trees, a few eating fragments of twigs also. Occasionally material contained sumach or witch-hazel seeds. Some of these appeared to have been broken during the digestive process, while others were not acted upon. Large piles of winter droppings were found throughout the area. Most of them were composed almost exclusively of bud fibers and small particles of wood, but some contained a few sumach seeds. Numbers of piles contained several dozen droppings, some even as many as four dozen and more, the birds evidently having gone to roost with their crops gorged with buds.

MAY. Early in May the material examined contained a large proportion of bud scales, a few thick woody fibers and stray seeds, and an abundance of wooly fibers. On May 12 beetle fragments were noted for the first time: a piece of a leg and a part of one of the elytra. By May 21 beetle remains were common.

JUNE. Buds were not evident in the material collected in June, while beetle remains and fruit seeds, particularly those of *Fragaria* (wild strawberry), were commonly found. Some material examined June 6 in the Michigan Hollow Swamp showed many beetle remains, and these largely of the leaf-eating Chrysomelid, *Galerucella sexvitatta.*

JULY. Material found during the month of July usually showed fewer beetle remains than that of June, and an increase in the seed contents, the seeds largely coming from raspberries and blueberries. Some of the analyses showed around 75% raspberry seeds.

AUGUST. The month of August was very dry, and the resulting effect on the small fruits manifested itself in the diet of the grouse for this period. Some of the material found during the month apparently was composed entirely of the remains of leaves, while some contained a few berry seeds, and some (from young birds) indicated that certain of the meals were almost exclusively insectivorous. For example, one dropping from a young bird, found just below a large raspberry patch, contained one raspberry seed, and the remainder, 99.5%, seemed to be mainly beetle and ant fragments. Other droppings from the same section showed nearly 100% insect remains, mostly beetles and ants, and still others (also from young birds) were about 100% ground up vegetable matter, presumably of the soft parts of plants. One dropping contained 18 sumach seeds of the new 1923 crop. It seems rather surprising that a staple winter food should be taken at this season of the year, unless, indeed, the

choicer foods of this period should be scarce. Such, however, seemed to be the case, rather than the existence of an especial fondness for the staghorn sumach at this season.

Summary and Conclusion

1. A study of the excreta of the ruffed grouse showed that, when opportunity offered, the grouse under observation preferred staghorn sumach, rather than buds, as the staple winter diet, with grapes second.

2. Most seeds appear to be little acted upon by the digestive processes of the ruffed grouse, a fact noted by Judd (1904). Mast is an exception to this statement. By reason of this general resistance of seeds to digestion, the kind and extent of the feeding upon fruits and seeds can be told with a fair amount of accuracy by an examination of excreta.

3. Almost the only insects whose remains are recognizable after traversing the alimentary system are those possessing excessively durable chitinous parts, such as beetles, and to a lesser extent, ants, grasshoppers, etc.

4. The presence of buds in the diet can be detected by finding sawdust-like particles of wood and wood fibers, and, especially in the spring, by the remains of bud scales.

In conclusion, it would seem desirable to collect data of this sort—a true conservationist type of investigation—for the ruffed grouse from various portions of its range, thereby revealing the most desirable types of planting for a natural winter food supply. Question—Should desirable plants for budding predominate in the planting for winter food; should emphasis be given to persistent fruits, such as sumach and grape; or is the climate such that the character of the ground cover is significant in the consideration of winter foods? The relative standing of these three types of food—buds, persistent fruits, foods from the ground—in various parts of the range of the grouse must be determined if conservationists are to have the most effective winter food program for the grouse population.

Information regarding the actual consumption of these three food types can readily be obtained by careful analysis of fresh excreta gathered during the winter as the above study indicates.

THE WILDLIFE PROGRAM OF THE SOIL CONSERVATION SERVICE

By J. Kenneth Terres
U. S. Soil Conservation Service, Indiana

In 1934, when unprecedented dust storms ripped away millions of tons of good mid-continental soil and carried them far out into the Atlantic Ocean, the minds of many Americans were, for the first time, sharply focused upon the need for an immediate nation-wide, coordinated program of soil conservation through erosion control. The shadow of these "dust blizzards" brought home in no uncertain manner the tragic fact that our rich soil heritage is wasting away, and that if sound erosion control methods are not used in our farming, grazing, and woodland areas our civilization—based so essentially upon the land—must, in common with certain ancient empires, disappear.

One of the pioneer concepts of the American people has been that the soil is virtually imperishable. Our forefathers found lands fabulously rich in fertility and in all manner of forest, water, mineral and wildlife resources. But we have learned through sad experience that the once vast acreage of new, virgin land was not inexhaustible. Our last frontier has disappeared, and we are left with the realization—which, fortunately, did not come entirely too late—that we must save what good soil we have remaining.

Far-sighted statesmen, scientists, and husbandmen of the United States have long known the very real dangers of soil wastage brought about by unwise land use which lays the earth bare to all the ravages of the elements, and scientists in various departments of the Federal Government have had definite ideas about correcting erosion. However, the agronomists saw strip-cropping, pasture improvement, and contour cultivation as the effective soil-saving measures. The foresters considered revegetation or reforestation the proper method of erosion control. The engineers placed all reliance on devices, such as terraces, diversion ditches, and gully structures. All are useful, of course, but it was not until October, 1933, that a unified national program of soil conservation was organized.

This program was entrusted to the Soil Erosion Service of the Department of the Interior. On March 25, 1935, the Soil Erosion Service was transferred intact from the Department of the Interior to the Department of Agriculture and became the present Soil Conservation Service. Thus a large trained organization has now swung into action, and the battle against erosion is well under way.

The diverse ideas of the various schools of science have been correlated

by the Soil Conservation Service into a single integrated program which is applied to the land through demonstration projects throughout the country. This program is broad enough to include our highly important, yet sadly neglected, natural resource represented by the familiar wildlife of the farm.

Soil conservation and wildlife conservation go hand in hand. When agricultural lands are made more habitable for man, they generally become more habitable for wild creatures. Fertile soil and a rich and varied wildlife population go together. Improved lands producing vegetation offer far better environments for wildlife, than eroded, infertile soil, plagued by floods or stifling dust storms.

Every erosion control practice may either directly or indirectly benefit wildlife. Realizing the resultant environmental benefits to wild creatures in habitats created by soil conservation methods, a wildlife section has been established in the Soil Conservation Service to coordinate erosion control operations in the interest of wildlife.

The erosion-control program is a balanced combination of practical methods in soil conservation. These methods consist of strip-cropping, contour cultivation, gully control, terracing, pasture improvement, reforestation, woodland management, and wildlife encouragement.

Strip-cropping is the practice of taking a large sloping cultivated field out of a single crop and devoting it to strips of several crops that may vary in width from 75 feet to 200 feet, the width depending upon the steepness of the slope, the kind of soil, and the crops. The strips are laid out horizontally around the hill to follow the contour of the land. They are planted alternately; that is, a strip of clean-tilled corn or potatoes is followed by a strip of some close-growing crop like small grain or clover. Crops are rotated so that the same open crop is not planted on the same strip two years in succession. Heavy rains falling on such a planted field are checked in their dash downhill by the close-growing crops with a resultant conservation of top-soil and moisture. In more picturesque words, the running waters are slowed down to a walk.

Strip-cropping will have a very important effect on wildlife. It will directly benefit quail, for example, which have a varied diet that includes waste grain, insects, fruits, nuts, and berries. Quail having a rather low mobility, a greater number may be benefitted by strip-cropping than otherwise. In other words, a covey of quail man benefit from four kinds of crops where previously they were benefitting from only two kinds.

Contour cultivation is the practice of cultivating the hill on the contour, rather than up and down the slope, as has previously been so commonly done.

Gully control practices are of two kinds—structural and vegetational. Structural control of gullies is obtained by the construction of check-dams at intervals along the length of the gully. These dams check sudden run-off and the resulting deepening of the gully by erosion. Vegetational control of gully erosion is accomplished by the planting of trees, shrubs, and vines whose root-systems bind the remaining soil and so stabilize the gullies. The latter system of gully control directly benefits wildlife. Species of trees, shrubs, and vines that are of special value to wildlife as food, cover, and nesting sites are selected for this purpose. These plants are known as "dual purpose" plants because of their value both in checking erosion and in benefitting wild creatures. In practice, structural and vegetational methods of control are combined in gully treatment.

Terracing in a soil conservation method that has more generally been used in the South and West. It requires a deep soil to build out these gently rolling terraces that follow the contour of the hill or slope. Terraces are combination retention and diversion structures that absorb moisture to their fullest capacity and divert the excess water harmlessly from the field through strategically placed run-off channels.

Pasture improvement consists of thickening the stand of pasture by treatment with lime and fertilizer, and re-seeding. The resulting improved pasture checks run-off and erosion. Undoubtedly, many game animals and birds which depend upon forage will also benefit from such improvement in the stand of grasses. Species of plants are being carefully selected for planting and regard is given to their value to wildlife in building new habitats and bettering wildlife environments.

Woodland management strives for wise use of the woodlot in the production of a marketable crop of timber. This means the selective cutting of trees of a certain size, leaving a good healthy stand for future use. Opening up of the woodlot by systematic selection of particular trees directly benefits wildlife. The increased light from the opened canopy encourages the growth of the smaller fruit-bearing trees and shrubs which are of great importance to wildlife as food, as well as sprout growth from the stumps which produce fine cover for game animals and browse for deer. A notable feature of woodland management is the retirement of wooded areas from grazing.

Wildlife encouragement should be a natural result of almost every erosion control practice. In order to ensure that positive encouragement of wildlife shall result from erosion control operations on the farms of our cooperators, the biologists of the Soil Conservation Service are charged with certain definite responsibilities. These include:

(1) Appraisal of the wildlife situation on project areas.

(2) Selection for erosion control planting of species of trees and shrubs that will not anly control erosion, but will at the same time furnish valuable food and cover for wildlife, and the direction of placement of such species as will bring about maximum dispersion throughout the demonstration areas. A number of small, well-placed plantings on a farm will be of far greater value to wildlife than one of two larger, concentrated plantations.

(3) Promotion of the establishment and maintenance of emergency feeding stations on northern projects where winter starvation is a serious factor in survival.

(4) Maintenance of close cooperation with wildlife officials in the attainment of common aims.

(5) Use of every opportunity to educate farmers, sportsmen, the general public, and especially organizations of young people, to a better appreciation of the value of wildlife and a better understanding of its needs.

These responsibilities are being discharged by trained men scattered from coast to coast.

In Pennsylvania there are four soil conservation demonstration projects and nine C.C.C. camps engaged in erosion control. The combined work areas embrace a total of approximately 420,000 acres. The Indiana (Pennsylvania) Project includes 120,000 acres.

In the operation of the wildlife program on the Indiana Project, an inventory was made last summer of the birds of particular benefit to agriculture, and it was found that over 90 different species breed within the demonstration area. Also some valuable information on the preferred foods of these birds was gathered in cooperation with the U. S. Biological Survey.

During the latter part of the summer and early fall of 1935 an inventory was made of the game birds and mammals of this project. We found only one quail to every eight acres and one grouse to every 22 acres. Food shortage and lack of cover were the major factors contributing to these relatively low populations. Further census figures revealed a very small number of predatory birds (hawks and owls) for the region, which eliminates these creatures as a limiting factor here.

In fact, research has shown that predators are an extremely minor consideration in areas where the proper vegetative cover is maintained. Hence, it is definitely against the policy of the Soil Conservation Service to aid or abet predator control campaigns, or "vermin" hunts, as they are so often termed. We are charged with the increase of valuable wildlife populations up to the maximum compatible with the primary use of the land, and it is our thesis that this can be accomplished by rebuilding adequate habitats. It should also be emphasized that our program is not confined to the encouragement of game, but is designed to benefit wildlife in general.

During fall and early winter of last year, a state-wide seed collection program was carried out by the forestry and wildlife sections of the Service, resulting in the accumulation of 300,000 pounds of uncleaned seeds of trees, shrubs, and vines. Over 16,000 pounds of these seeds have already been planted in the 25-acre Soil Conservation Service nursery at Five Points, Pa. The remainder will be planted in a new nursery to be located somewhere in the central part of the State. From these nurseries we may expect much of the future planting stock which will revegetate eroded Pennsylvania farm lands and furnish the improved habitats required for the welfare of our wild creatures.

In addition to the seed collecting, a half million cuttings of woody shrubs was made by the wildlife section before this phase of the work was taken over by the forestry section. The ultimate goal for Pennsylvania is 5,000,000. The cuttings are layered and callused during the winter, then planted in the nurseries in spring.

Over 75 lectures have been given by members of the wildlife section on soil conservation and wildlife conservation to 5,000 people in Pennsylvania since early in the summer of 1935. These audiences have been drawn from farms, schools, service clubs, C.C.C camps, churches, colleges, Boy Scout troops, and 4–H Clubs.

A program of wildlife education has been fostered, especially in the schools of the project area. This has included the erection of winter feeding shelters on school grounds to help stimulate the interest of school children in wildlife conservation. These shelters are being cared for by the school children themselves. Lectures are given with special emphasis on the bird-life of the region, with the objective, in most cases, of showing the economic relation of birds to mankind. These lectures are illustrated with museum specimens, lantern slides, and in some instances with a living subject.

Feeding shelters have been built on the farms of every cooperator participating in the emergency winter feeding campaign, and to date 138 have been constructed on 88 farms of the Indiana Project. Feeding stations are looked upon as an emergency measure, and are generally constructed by the farmers themselves. Over 30 acres on approximately 40 farms have been designated for wildlife planting this spring. Within a few years these areas, planted to shrubs and vines selectively chosen

for wildlife value, should begin to produce the essential food and cover and render emergency feeding less and less necessary as time goes on.

Summary

Approximately 52,500,000 acres of land are embraced in the work project areas of the Sol Conservation Service, similar to those we have here in Indiana and Armstrong Counties. This acreage may be classified roundly as:

Private land demonstration projects	6,500,000 acres
C.C.C. camp work areas	7,000,000 "
Public land demonstration projects	39,000,000 "

The Soil Conservation Service personnel is composed of scientists and technicians specializing in many different fields, such as agronomy, biology, engineering, farm management, forestry, hydrology, soils, and so on. These men are combining their knowledge in a practical, concerted attack on erosion on 141 demonstration areas and 455 C.C.C work areas scattered throughout the country.

Farmers within the demonstration and camp work areas cooperating with the Soil Conservation Service, sign an instrument in which they agree to follow for a period of five years the agricutural, forestry, and wildlife practices stipulated by Service technicians for the particular farm after careful study *on the ground* of the conditions existing on that farm.

As every erosion control practice either directly or indirectly affects wildlife, a wildlife conservation plan has been integrated with the soil conservation program to safeguard and further wildlife welfare. The project biologist is charged with increasing wild creatures to the maximum practicable numbers, but he must not ignore the agricultural demands of the region, or lose sight of the main objective—erosion control.

Periodic censuses of wild creatures are conducted on project areas to evaluate population increases or decreases and determine the governing factors. Wildlife management practices help to educate the farmer to the economic value of wildlife and to acquaint him with those acts, detrimental to wild creatures, that he may well avoid on his farm.

A wide program of education is fostered to acquaint farmers, sportsmen, the general public, and especially school children, in the economic and esthetic values of wildlife, and in means for its preservation. Winter feeding shelters built on farmer-cooperator lands and on school grounds stimulate interest in providing for wildlife in periods of emergency.

Basically the Soil Conservation Service wildlife program is one of

restoration and improvement of habitats. A huge planting program is under way throughout the country. Trees, shrubs, and vines are selectively chosen for planting on eroded lands to accomplish erosion control and the production of wildlife food and cover.

A nation-wide application of methods designed to restore upland wildlife should have a pronounced effect on total farm wildlife populations, for the problems of soil erosion and upland wildlife depletion are being attacked at their common source—on the farm. Both problems arise from reckless devegetation of the land; the common remedy must be revegetation.

THE AMPHIBIANS AND REPTILES OF INDIANA COUNTY, PENNSYLVANIA

By M. Graham Netting
Carnegie Museum

Heretofore I have avoided cluttering scientific literature with county lists, but the location of an active Soil Conservation Project in Indiana County provides a valid reason for presenting this list. I hope that it will aid the biologists now working in the area, and that it may stimulate them to collect additional specimens to augment our present knowledge of the region. I feel that we are now witnessing one of man's most widespread efforts to regulate the balances of nature, and that any present attempt, no matter how fragmentary, to record the location of species and their approximate relative abundance, should be welcomed rather than condoned. I regret, therefore, that the exigencies of space compel me to include only bare essentials, and force me to omit all published records except those which serve as a basis for the inclusion of species not represented in the Carnegie Museum collection. Seventy-three forms of amphibians and reptiles are known to occur in Pennsylvania, but only 59 are logically to be expected in Indiana County. Forty-three of the latter are listed here, many of them constituting the first published records for the county. Much of the credit for this list belongs to my good friend, Mr. R. W. Wehrle, who collected, and presented to the Carnegie Museum, slightly over half of the 1083 specimens listed below. The remaining specimens were secured largely by the writer, and by D. A. Atkinson, F. H. Chermonk, and W. R. Van Dersal.

Salamanders

1. *Necturus maculosus maculosus* (Rafinesque), Mudpuppy
   Fowler and Dunn (1917: 7) list a specimen from Indiana.
2. *Cryptobranchus alleganiensis* (Daudin), Hellbender
   Seven specimens from Yellow and Little Mahoning Creeks.

3. *Ambystoma maculatum* (Shaw), Spotted Salamander
Five examples from Two Lick Creek, Bennett Farm, and Black Lick.
4. *Ambystoma opacum* (Gravenhorst), Marbled Salamander
Mr. Wehrle collected a single specimen of this rare salamander in Porter Field, on the Bennett Farm, near Indiana in 1933.
5. *Triturus viridescens viridescens* Rafinesque, Red-Spotted Newt
Two specimens from Chestnut Ridge and Black Lick.
6. *Gyrinophilus porphyriticus porphyriticus* (Green), Purple Salamander
21 specimens from Indiana and Burrell Twp.
7. *Pseudotriton ruber ruber* (Sonnini), Red Salamander
Three examples from Two Lick Creek and the Bennett Farm.
8. *Eurycea bislineata bislineata* (Green), Two-Lined Salamander
34 specimens from Two Lick Creek, Bennett Farm, Sleepy Hollow, and Burrell Twp.
9. *Eurycea longicauda* (Green), Long-Tailed Salamander
Six specimens from Bennett Farm, Black Lick, and Burrell Twp.
10. *Plethodon cinereus* (Green), Red-Backed Salamander
21 specimens from Bennett Farm, Sleepy Hollow, Two Lick Creek, near Armagh, near Dias, Strong Hill, and White's Woods.
11. *Plethodon glutinosus* (Green), Slimy Salamander
48 specimens from Indiana, Sleepy Hollow, Burrell Twp., Bennett Farm, Two Lick Creek, Chestnut Ridge, near Armagh, near Blairsville, near Dias, Penn View Summit and Game trail no. 1.
12. *Plethodon wehrlei* Fowler and Dunn, Wehrle's Salamander
Five specimens from 1 mile south of Dias, June 20, 1935.
13. *Desmognathus fuscus fuscus* (Rafinesque), Dusky Salamander
528 specimens from ten scattered localities.
14. *Desmognathus fuscus ochrophaeus* Cope, Mountain Salamander
258 specimens from Indiana, Game trail no. 1, White's Woods, Chestnut Ridge, Sleepy Hollow, Bennett Farm, Two Lick Creek, and Burrell Twp.
15. *Desmognathus phoca* (Matthes), Seal Salamander
26 examples from Indiana, Sleepy Hollow, White's Woods, Strong Hill, and Burrell Twp.

Frogs

16. *Bufo americanus americanus* Holbrook, American Toad
A single specimen from Chestnut Ridge.
17. *Pseudacris brachyphona* (Cope), Mountain Chorus Frog
Cope (1889: 341) based this species on specimens collected "near the Kiskiminitas River."
18. *Hyla crucifer* Wied, Spring Peeper
Five specimens from a swamp along Two Lick Creek.
19. *Hyla versicolor versicolor* Le Conte, Common Tree Frog, Rain Toad
Dr. Thomas Smyth has heard this species at White's Woods.
20. *Rana catesbeiana* Shaw, Bullfrog
Two specimens from Black Lick.
21. *Rana clamitans* Latreille, Green Frog
16 specimens from Indiana, Two Lick Creek, Chestnut Ridge, Black Lick, and Cherry Run Reservoir.
22. *Rana palustris* Le Conte, Pickerel Frog
Ten from Two Lick Creek, Black Lick, and Cherry Run Reservoir.
23. *Rana pipens* Schreber, Leopard Frog
Four specimens from Black Lick and Cherry Run Reservoir.
24. *Rana sylvatica* Le Conte, Wood Frog
11 from Indiana, Two Lick Creek, Sleepy Hollow, and Black Lick.

Turtles

25. *Chelydra serpentina* (L.), Snapper
Two specimens from Tanoma and Home.
26. *Clemmys insculpta* (Le Conte), Wood Turtle
Six examples from Indiana, Home, Creekside, and Homer City. One taken by the writer on Game trail no. 1 was found feeding on wild strawberries.

27. *Terrapene carolina* (L.), Box Turtle
A single specimen from Indiana Co.
28. *Chrysemys bellii marginata* Agassiz, Western Painted Turtle
A single specimen from Little Mahoning Creek is in the collection of the State Teachers College at Indiana.
29. *Amyda spinifera* (Le Sueur), Spiny Soft-Shelled Turtle
One from Plum Creek, and one which was found alive on the bank of Crooked Creek on Dec. 27, 1932.

Harmless Snakes

30. *Diadophis punctatus edwardsii* (Merrem), Ring-Necked Snake
Three examples from Cherry Tree, near Blairsville, and near Dias.
31. *Heterodon contortrix* (L.), Spreadhead
15 specimens from Cherry Tree, July 11, 1908.
32. *Liopeltis vernalis* (Harlan), Grass Snake
Two specimens from Nolo and Kintersburg.
33. *Coluber contsrictor constrictor* L., Black Racer
Surface (1908: 167) lists a specimen from Indiana County.
34. *Elaphe obsoleta obsoleta* (Say), Pilot Blacksnake
Four examples from Marion Center, Little Yellow Creek, Strong Hill, and near Blairsville.
35. *Lampropeltis triangulum triangulum* (Lacépède), House Snake
Four embryos from eggs found at Black Lick on Sept. 1, 1934, and one adult from Indiana County.
36. *Natrix septemvittata* (Say), Queen Snake
Two from Indiana and Cherry Run Reservoir.
37. *Natrix sipedon sipedon* (L.), Banded Water Snake
Three specimens from Indiana and Tanoma.
38. *Storeria dekayi* (Holbrook), DeKay's Snake
Fifteen specimens from Indiana and Cherry Tree.
39. *Storeria occipito-maculata* (Storer), Red-Bellied Snake
Surface (1906: 137) lists a specimen from Indiana County.
40. *Thamnophis sauritus sauritus* (L.), Ribbon Snake
One specimens (no. 7223) in the U. S. National Museum from "Indiana County" is the basis for the following published records: Yarrow, 1883: 114; Cope, 1900: 1022; Ruthven, 1908: 113.
41. *Thamnophis sirtalis sirtalis* (L.), Common Garter Snake
Nine specimens from Cherry Run Reservoir, Cherry Tree, Indiana, and Kintersburg. Fowler (1915: 15) lists a female from Indiana which contained 65 embryos.

Poisonous Snakes

42. *Agkistrodon mokasen mokasen* Beauvois, Copperhead
Four specimens from Meis Mine, between Homer and Brush City.
43. *Crotalus horridus horridus* L., Banded Rattlesnake
Surface (1906: 194) lists a specimen from Indiana County.

Species Which Probably Occur in Indiana County

Ambystoma jeffersonianum (Green), Jefferson's Salamander
Hemidactylium scutatum (Schlegel), Four-Toed Salamander
Bufo woodhousii fowleri (Hinckley), Fowler's Toad
Pseudacris nigrita triseriata (Wied), Western Chorus Frog
Sternotherus odoratus (Latreille), Musk Turtle
Kinosternon subrubrum subrubrum (Lacépède), Mud Turtle
Clemmys guttata (Schneider), Spotted Turtle
Graptemys geographica (Le Sueur), Map Turtle
Sceloporus undulatus undulatus (Latreille), Fence Lizard
Eumeces anthracinus (Baird), Black Skink
Eumeces fasciatus (L.), Blue-Tailed Skink
Carphophis amoena amoena (Say), Worm Snake

Opheodrys aestivus (L.), ROUGH GREEN SNAKE
Natrix erythrogaster erythrogaster (Forster), RED-BELLIED WATER SNAKE
Natrix kirtlandii (Kennicott), KIRTLAND'S WATER SNAKE
Virginia valeriae elegans Kennicott, VIRGINIA'S SNAKE

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WEHRLE'S SALAMANDER, *PLETHODON WEHRLEI* FOWLER & DUNN, IN PENNSYLVANIA

BY M. GRAHAM NETTING
Carnegie Museum

This meeting of the Academy would not be complete without a tribute to the oldest and best-loved naturalist of Indiana County, Mr. R. W. Wehrle. For many years Mr. Wehrle has been an indefatigable collector of cold-blooded vertebrates, and, in addition, his broad interest and insatiable curiosity have led him to collect many unusual specimens of other groups. Careful perusal of the several herpetological bulletins of H. A. Surface testifies to the number of specimens donated to the State collection by Mr. Wehrle. He later contributed hundreds of specimens to the Academy of Natural Sciences, and during the past decade the herpetological collections of the Carnegie Museum have been greatly enriched by his efforts. It gives me great pleasure, therefore, publicly to acknowledge the debt which Pennsylvania zoologists owe to Mr. Wehrle, and to discuss briefly the interesting salamander which bears his name.

In 1917 Fowler and Dunn[1] described a new species of the genus *Plethodon* which they named *wehrlei*, in honor of the collector of most of the following specimens, upon which their description was based.

[1] Proc. Acad. Nat. Sci. Phila., 69: 23–24.

1 Type. Two Lick Hills, Indiana Co., Pa., Sept. 1911, R. W. Wehrle.
4 Paratypes. Two Lick Hills, Indiana Co., Pa., Sept. 1911, R. W. Wehrle.
1 Paratype. Indiana, Indiana Co., Pa., fall 1908, R. W. Wehrle.
1 Paratype. Port Allegheny, McKean Co., Pa., June 9, 1906, Keim & Fowler.
1 Paratype. Tuscarora, Juniata Co., Pa., Sept. 1896, S. N. Rhoads.

On subsequent examination the last of these specimens proved to be a specimen of *Plethodon glutinosus*.

Plethodon wehrlei is a slim, black salamander which closely resembles *P. glutinosus*. However, it differs superficially from the Slimy Salamander in having its white spots restricted to the sides and in having its chin, throat, and belly more prominently marked with white. Living specimens of the two forms vary markedly in actions and appearance, but preserved specimens, especially young, are at times puzzling.

In 1925 I wrote to Mr. Wehrle requesting that he collect a dozen topotypes of *P. wehrlei* for the Carnegie Museum. I smile now at the temerity of my request for the species has proved difficult to collect and hard for any except trained herpetologists to identify at sight. Since that time Mr. Wehrle has sent over 500 salamanders to the Carnegie Museum, but a careful examination of these has failed to reveal a single specimen of *P. wehrlei*. In spite of experience with this species in West Virginia my own first attempts to collect it at numerous localities in Indiana, and contiguous counties, proved equally fruitless. It was not until I glimpsed, on the late afternoon of June 20, 1935, a spot which reminded me of the type locality of *Plethodon shermani* in North Carolina, that my search was rewarded. We stopped our car on a ridge south of Black Lick Creek, at a point about one mile due south of Dias, and at an altitude of 1600 feet. Flanking the road were stands of second growth hardwoods, consisting principally of oak, maple, hickory, locust, and some cherry. A small plot of a few acres had been denuded of underbrush by pastured animals. A hard rain had occurred earlier in the afternoon, but the ground was comparatively dry. Here in less than an hour Dr. W. R. Van Dersal, Dr. Thomas Smyth, and I secured six adult and three immature specimens of *P. wehrlei*. Eight of these were under stones or deeply buried boulders, and one was under a log. Associated with *P. wehrlei* we found 2 *P. glutinosus*, 1 *P. cinereus*, 1 *Diadophis punctatus edwardsii*, and a beetle, *Calosoma scrutator*. This collection exhausted all of the movable stones or logs in the pastured area. We then turned our attention to the larger areas of heavy undergrowth, but here we failed to find any salamanders whatever. Dr. Wesley Clanton and Mr. Coleman Goin visited the same region for me on July 25, 1935, but three hours of hard collecting yielded only 1 *P. glutinosus*.

The habitat described above is strikingly different from the West Vir-

ginia habitats, which I have found to be montane red spruce forests, cave entrances, and rocky crevices. All this pother about the habitat preferences of a single salamander is occasioned by more than a desire to secure a large museum series. There are many endemic species of *Plethodon* in the southern Appalachians which have very restricted ranges, but within these confines they are extraordinarily abundant. In attempting to determine which species are relicts in the ancestral habitat and which are living in a secondary and less favorable habitat I must continue to collect *Plethodon wehrlei* until I find the area where it occurs in comparable numbers to its southern congeners. This then is my parting tribute to Mr. Wehrle, that he collected the most recently discovered salamander in the northeastern United States, and thus presented us with an ecological puzzle which is yet unsolved.

A HAMILTON CORAL REEF IN PENNSYLVANIA[1]

By Bradford Willard
Pennsylvania Topographic and Geologic Survey

Introduction

A prominent Devonian coral reef in eastern Pennsylvania has been mentioned several times in the literature.[2] It is found in the lower part of the Ludlowville formation of the Hamilton group. From its position, character and fauna it is best correlated with the Centerfield limestone of New York State. The name Centerfield was first applied by Clarke,[3] and the member has recently been redescribed by Cooper.[4] At its type locality one mile north of Centerfield, N. Y., it consists of a series of thin limestones and sandy limestone layers. It is highly fossiliferous, and corals

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

[2] White, I. C., The geology of Pike and Monroe counties, Penna. Second Geol. Surv., vol. G6, pp. 109–110, etc., 1882.

Prosser, C. S., The Devonian system of eastern Pennsylvania and New York, U. S. Geol. Surv., bull. 120, 1895.

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Willard, Bradford, *Spirifer divaricatus* Hall in Pennsylvania, Jour. of Paleontology, vol. 10, pp. 67–69, 1936.

[3] Clarke, J. M., Classification of the New York series of formations, N. Y. State, Mus., Handbook 19, 1903.

[4] Cooper, G. A., Stratigraphy of the Hamilton group of New York, Am. Jour. Sci., 5th ser., vol. 19, pp. 116–134, 214–236, 1930.

Cooper, G. A., Stratigraphy of the Hamilton group of eastern New York, Part I, Am. Jour. Sci., 5th ser., vol. 26, pp. 537–551, 1933; Part II, *op. cit.*, vol. 27, pp. 1–12, 1934.

are especially abundant. The fauna has been listed by Cleland[5] under what he designated as "Zone D" or "First Terebratula Zone."

Fauna of "Zone D" or "First Terebratula Zone" after Cleland

Streptelasma rectum
Heliophyllum halli
Syringopora sp.
Crinoid, stems and plates
Bryozoa, undet.
Camarotoechia congregata
C. sappho
Liorhynchus laura
Cryptonella planirostris
C. rectrirostris
Eunella lincklaeni
Tropidoleptus carinatus
Atrypa reticularis
Cyrtina hamiltonensis
Spirifer audaculus
S. a. mucronatus
S. divaricatus
S. pennatus
Delthyris consobrina
D. sculptilis
Ambocoelia umbonata
Reticularia fimbriata
Nucleospira concinna
Vitulina pustulosa
Athyris spiriferoides
Meristella haskinsi
Orbiculoidea lodiensis media
Craniella hamiltoniae
Stropheodonta inequistriata
S. perplana
Orthothetis chemungensis archtisriatus
O. c. perversus
Chonetes coronatus
C. lepidus
C. mucronatus
C. vicinus
Productella spinulicosta
Pentamerella pavilionensis
Orthonota parvula
Grammysia cuneata
G. arcuata
Tellinopsis subemarginata
Nuculites oblongatus
Nucula corbuliformis
Palaeoneilo constricta
Parallelodon hamiltoniae
Sphenotus solenoides
Pterinea flabella
Lunulicardium fragile
L. curtum
Plethomytilus oviformis
Actinopteria boydi
Leiopteria laevis
L. rafinesquii
L. conradi
Modiella pygmaea
Schizodus appressus
S. contractus
Aviculopecten princips
A. fasciculatus
Pterinopecten intermedius
Lyriopecten orbiculatus
Modiomorpha subalata
M. concentrica
M. mytiloides
Goniophora hamiltonensis
Pholadella radiata
Cypricardella bellistriata
C. indenta
Paracyclas tenuis
Pleurotomaria capillaria
Bellerophon patulus
B. leda
Loxonema delphicola?
Coleolus tenuicinctum
Hyolithes aclis
Conularia undulata
Orthoceras crotalum
O. sp. undet.
Nautilus liratus juvenis
N. fragments
Homalonotus dekayi
Phacops rana
Dalmanites boothi
Plant fragments

[5] Cleland, H. F., A study of the fauna of the Hamilton formation of the Cayuga Lake section in central New York, U. S. Geol. Surv., Bull. 206, pp. 95–105, 1903.

The Centerfield stretches from near Lake Erie east to the Onondaga Valley, and Cooper reports faunal traces of it in the Chenango Valley, but none as far east as the Unadilla Valley. It is thin, probably seldom over 20 feet thick. Cooper places the Centerfield in the lower part of the Ludlowville formation. Smith[6] has recently expressed the belief that it should be transferred to the upper part of the Skaneateles formation. He recognizes a downward transition from the Centerfield, but thinks its top is sharply cut off by the base of the fine, gray, Otisco shale.

Pennsylvania Occurrence

Distribution

The coral reef in Pennsylvania which is believed to be the correlate of the Centerfield limestone of New York is recognized as a very narrow band extending west from Pike County, through Monroe, Carbon, Schuylkill, Lebanon and Dauphin Counties and disappearing in Perry County.[7] It is about 20 feet thick in the east and thins gradually to perhaps three or four feet in the Susquehanna Valley.

Stratigraphy

The stratigraphy of the coral reef of the middle Hamilton in Pennsylvania may be understood from the following summary of the group as exposed in Monroe County:

Hamilton Group

Moscow formation: clayey shale and fine, dark gray to buff or olive sandstone, usually very fossiliferous. *Vitulina* common with or without *Spirifer tullius* especially near the top.

Ludlowville formation: alternating gray sandstone and shale, usually very fossiliferous.

Coral Reef: commonly present beneath a storm roller zone at or near the base of this formation in eastern Pennsylvania.

Skaneateles formation: dark gray sandstone and shale divisible into several smaller units. Fossils less plentiful than in higher formations of the group.

Marcellus formation: dark gray to black, sometimes finely arenaceous, locally highly fossiliferous, but more often barren shale.

Onondaga formation: cherty limestone and sandy (Esopus) shale in the east, non-cherty limestone and limy shale farther west. Quite fossiliferous.*

* Note: The author has only recently decided to include the Onondaga in the Hamilton group in Pennsylvania. He reached this decision from his newly completed studies of the Onondaga, the results of which are in press.

6 Smith, Burnett, Geology and mineral resources of the Skaneateles quadrangle, N. Y. State Mus., bull. 300, 1935.

7 Willard, Bradford, and Cleaves, A. B., *ibid.* This article shows the distribution (with map) of the Hamilton group in eastern Pennsylvania.

Grabau[8] has characterized the coral reefs of the Paleozoic as follows:

> In general aspect they are roughly lens-shaped or dome-shaped masses of calcareous material, devoid of regular structure, without any, or with only faintly developed stratification, and composed of corals, hydrocorallines, sponges, bryozoa, calcareous algae and other reef-building organisms, which grew practically where they are now found. With these, but more abundantly on the flanks of the reef, are found the remains of innumerable crinoids, brachiopods, and other attached organisms, while remains of vagrant types, such as mollusks and crustacea, occur in every part of the reef, frequently in great profusion. On its flanks where the reef was constantly attacked by the waves, large masses of broken coral occur, which are more or less worn and embedded in the coral or crinoidal sand which forms the chief enclosing mass of the reef. . . . Away from the reef we often find rock of the finest lime mud, which settled in the quiet and deep water at a distance from the source of the material.

The reef which we have under consideration is rarely, if ever, a true limestone, but rather a shale replete with corals and other organisms, many of them reef-builders. Although not developed to the extent which Grabau has observed, and lacking an abundance of crinoids, it is unmis-

Fig. 1. Road cut, west side Brodhead Creek valley north of Stroudsburg in the middle Hamilton coral reef. Note honey-comb weathering. Photograph by the author.

8 Grabau, A. W., Paleozoic coral reefs, Geol. Soc. Am., Bull., vol. 14, pp. 337–352, particularly 344–345, 1903.

takably of a very similar nature and origin. I. C. White[9] mistook the reef for the Tully, but he has left us an admirable description of the bed at its best development:

> Here [Pike and Monroe counties] it is a perfect mass of *corals*, and *shells* about 30′, a great number of *species* and genera being represented ------. This is by far the richest *coral horizon* in the district, being in fact a regular *fossil reef*. The calcareous portions of the *coral stems* have often been removed by solution, and then the matrix (usually a dark gray calcareous shale) is penetrated by small branching cavities extending in every direction, thus giving it a honey-combed appearance.

A splendid section (Figure 1) is to be seen on the highway up the west side of Brodhead Creek valley above Stroudsburg. This reef is not typical Centerfield lithology, though it must closely equal the New York unit. It is not possible to establish the correlation with the Centerfield through tracing it into New York, but its position at or near the base of the Ludlowville is quite unmistakable. The following faunule from the Brodhead Creek valley exposure is typical of the reef at its greatest development.

CORAL REEF FAUNULE, BRODHEAD CREEK VALLEY

Receptaculites? sp.
Streptelasma rectum
Zaphrentis prolifica
Z. simplex
Z. sp.
Aulacophyllum sp.
Craspidophyllum archiaci
Ceratopora jacksoni
Syringopora maclurei?
Favosites hamiltoniae
F. clausus
Corals, undet.
Crinoid, undet.
"Crinoidea", columns
Hederella? ps.
Monticulipora sp.
Fenestella biseriata?
F. laevinodonta?
F. parallela
F. sp.
Thamniscus sp.
Bryozoa, undet.
Stropheodonta demissa
Leptostrophia perplana
Chonetes mucronatus
Productella spinulicosta
Dalmanella sp.
Rhipidomella vanuxemi
Camarotoechia sp.
Tropidoleptus carinatus
Atrypa reticularis
Spirifer angustus
S. mucronatus
S. granulosus
S. audaculus
S. sculptilis
S. divaricatus
Elytha fimbriata
Vitulina pustulosa
Athyris spiriferoides
Brachiopod, undet.
Aviculopecten sp.
Modiomorpha concentrica
Glyptodemsa erectum
Actinopteria sp.
Turbo sp.
Dalmanites boothi
Phacops rana
P. sp.
Plantae, fragments

[9] White, I. C., *loc. cit.*

Comparing our list with Cleland's we find rather close agreement among the brachiopods, but that our fauna is richer in corals and, conversely, Cleland's has many more mollusks.

Westward, the reef loses its plethora of fossils. Corals particularly become fewer as if we were passing slowly away from the main body, but the reef may be recognized still as a highly fossiliferous band near the base of the Ludlowville. As a check upon its correlation, it is usually not far below a storm roller zone which seems to be widespread in the lower Ludlowville of eastern Pennsylvania.[10] On the Lehigh the reef is probably present as I. C. White said, near Bowmanstown, on the south limb of a broad syncline. The author found what he believes is the same bed on the north limb of this fold near the Lehighton bridgehead. In Schuylkill County the Ludlowville formation is exposed along Swatara Creek near Suedberg. A rather sparse faunule is present, but suggests Cleland's zone D; and here again occurs the overlying storm roller zone. As we enter the Susquehanna Valley much of the Hamilton group becomes sandy, even conglomeratic locally.[11] This lithologic change tends to obliterate faunal and stratigraphic keys in Dauphin and Perry counties. However, in the Ludlowville at Rockville was found a coarse to pebbly sandstone carrying scattered, large corals and other fossils. This bed with its curiously anomalous association of corals and coarse clastics appears to represent the reef of our eastern sections. Nothing surely identifiable with it has been found beyond this point either west or north in Pennsylvania. Presumably, the reef as a whole was of the barrier type. The shore line at the time it formed is believed to have been some 30 miles east and southeast.[12]

Conclusions

Although no true limestone marks the Centerfield member in Pennsylvania, that well-known unit of the New York Hamilton group is thought to have its correlate to the south in a reef occurring in the lower Ludlowville of eastern Pennsylvania. It is a bed in which, particularly in the east, corals and other reef-building organisms are very common, besides many additional fossil forms. Carried west, its identity is established even as its characters fade, for it maintains its faunal types and relative stratigraphic position to the Susquehanna Valley. The chief

[10] Willard, Bradford, and Cleaves, A. B., *loc. cit.*

[11] Willard and Cleaves, *ibid.* Subsequent to the publication of this paper, Willard changed slightly the interpretation of the Hamilton in the Susquehanna Valley: Willard, Bradford, Hamilton group of Central Pennsylvania, Geol. Soc. Am., bull., vol. 46 pp. 194–224, 1935.

[12] Willard and Cleaves, *ibid.*

interest in this member is that we have here a well-defined Middle Devonian coral reef. Aside from this purely scientific interest, the reef is a fairly useful correlation datum over a limited area of eastern Pennsylvania.

WEIGHT RELATIONSHIPS OF THE ORGANS OF THE ENGLISH SPARROW (*PASSER DOMESTICUS DOMESTICUS* (LINN.))

By Robert Cassel
Lebanon Valley College

In view of the extensive work on correlations of various measurements of the human anatomy, and on other animals, the question arose whether there is a correlation in weight of some of the vital organs of the English Sparrow. The first specimens were taken by means of a trap built according to United States Department of Agriculture specifications. More than half the specimens were secured with a .32 calibre rifle using shot cartridges.

The first 34 specimens were secured on a farm two miles out from the town of Annville. Whether caught or shot they were dissected within an hour. Those shot were never noticed to lose blood, or to be mangled to a point where losses in weight were more than negligible. The group taken from the farm locality was secured from February 25 to July 14, 1935, a few being taken each month. The next group amounting to 49 was all shot in town, and handled the same as the above. This group was secured from October 8, 1935, to February 5, 1936. In both cases the birds were taken in chicken yards or near-by. The range of time over which these specimens were secured gives a very representative group, since the conditions of environment pass from one extreme to another.

Weather conditions in which the sparrows were found ranged from very hot humid days to those with a below zero temperature. Stomach contents consisted of some or all of the following articles: grit, weed seeds, cracked corn, wheat, parts of oyster shells, and blades of green lawn grass, bread and cinders especially in the winter months. During January and February, 1936, with 25 inches or more snow and intense cold lasting over periods of two or three weeks, stomachs were often found empty, likewise the remainder of the alimentary tract.

The correlations of three different groups were ascertained. The first or total group includes all 83 specimens examined. The second or female group considers the females alone. The third or male group does the same for the males. Each group was calculated as follows: the corre-

Table of Weights and Correlations

		Total Group—n = 83	Female Group—n = 38	Male Group—n = 45
Mean Weights:	Total	28.35 gr. P.E. ± .228	27.66 gr. P.E. ± .254	29.1 gr. P.E. ± .271
	Stomach	1.22 gr. P.E. ± .025	1.23 gr. P.E. ± .107	1.24 gr. P.E. ± .241
	Liver	1.18 gr. P.E. ± .026	1.26 gr. P.E. ± .033	1.14 gr. P.E. ± .038
	Heart	0.403 gr. P.E. ± .107	0.420 gr. P.E. ± .017	0.380 gr. P.E. ± .016
Mean total length		153.3 mm. P.E. ± .526	149.8 mm. P.E. ± .873	153.6 mm. P.E. ± .564
Coefficient of Correlation	Total Weight and Stomach weight	+ .394	+ .196	+ .098
	Total Weight and Liver weight	+ .529	+ .490	+ .533
	Total Weight and Heart weight	+ .102	+ .010	+ .205
	Body length	+ .581	+ .493	+ .627
	Stomach weight and liver weight	+ .518	+ .132	+ .707

lations between the total weight of the body and the liver weight, the total weight and the stomach weight, and the total weight and the heart weight, and the total weight and total length of the body, measured between bill tip and end of the tail, were all ascertained. In addition the correlation between liver and stomach weights was calculated.

The mean weight given for the body includes all organs. The mean weight of the stomach was taken with the contents removed. The mean weight of the remaining viscera, including testes, kidneys, lungs, pancreas, and intestines, which were not correlated separately, was 1.58 grams.

The correlation between total weight and stomach weight, being low in groups which had a variety of environmental factors operating, indicates the weight of the stomach is subject to variations according to the work imposed upon it. There is a more definite and unvarying correlation of the liver weight and the total weight.

The liver and stomach weights reveal excellent correlations between themselves, except for the female group, for which we have no explanation as yet. A very definite lack of correlation exists in the case of the heart and the total weight. This may be caused by greater activity in some birds than in others, or differences in physical conditions, which could not be measured.

There is a positive correlation between the total weight of the body and the total length.

Conclusions

1. The average weight of this group of English Sparrows is 28.35 grams. There is a positive correlation of this weight with the weight of the stomach and liver and to a small degree the heart.
2. A positive correlation of stomach and liver weights exists.
3. There is positive correlation between the total weight of the body and the total length of the body.
4. The correlations as a group show in general that there is a sensitive balance in weights of the organs of the English Sparrow with the total weight of its body.

COMPARATIVE STUDY OF THE TESTES OF THE DOG, CAT, SHEEP, BULL, COTTONTAIL RABBIT AND GRAY SQUIRREL

By Thomas H. Knepp
Everett High School

At the suggestion of Dr. Bruce D. Reynolds, Dept. of Biology, University of Virginia, I have made a comparative study of the testes of six carnivorous and herbivorous mammals, the dog, cat, sheep, bull, cottontail rabbit and gray squirrel.

In each case the testis was fixed in Bouin's picro-formol. The material was sectioned in paraffin, then stained with Heidenhain's iron-hematoxylin.

All microscopic measurements were made with an ocular micrometer with a Bausch and Lomb compound microscope. In finding the percentage of interstitial tissue cells and seminiferous tubules the paper method employed by Bascom (1925) was used. A representative section from a slide was projected onto good quality drawing paper by means of a projection apparatus, and a tracing was made; the area defined was cut out with scissors, then weighed on a balance to the nearest milligram. Then from the area were cut the seminiferous tubules. The weight of these was found and subtracted from the entire weight, and thus percentages were computed.

No allowance was made for tunica albuginea and mediastinum in calculating the amounts of seminiferous tubules and interstitial cells.

In finding the diameter of the seminiferous tubules the average of 20 different measurements was taken. The same method was employed in finding the thickness of the tunica albuginea. In finding the average size of the sperms 25 measurements were made.

The cross-section area of the tubules in square millimeters was found by using the formula $pi \times r^2$ equals the area, the radius being computed from the mean diameter. The length of the seminiferous tubules was found by dividing the total tubule volume in cubic millimeters by the cross section area in square millimeters, this giving total tubule length in millimeters. Meters of tubules per gram of testicular weight were found by dividing the number of meters of tubules by the number representing total weight of the testis in grams.

Drawings were made to show the structural arrangement of the seminiferous tubules. A section from a slide was projected onto a piece of paper at a distance of 32 inches from the mirror of the projector.

Before sectioning each testis was weighed, and its displacement of

water was recorded. Because of the similarity of the volume and weight it was assumed that the specific gravity was 1. Material measured and weighed before fixation gave similar results.

	Dog	Cat	Sheep	Bull	Rabbit	Squirrel
Weight of animal, kilograms	16.04	2.38	59.42	272.0	1.21	0.482
Weight of testis without epididymus, grams	9.92	0.76	337.06	114.42	9.6	1.97
Volume of water displaced by testis, c.c.	10.0	0.75	337.35	114.0	9.5	1.8
Mean tubule diameter, microns	151.2	158.76	199.92	164.97	173.88	169.68
Mean cross-section area of tubules, square millimeters	0.017	0.019	0.031	0.021	0.023	0.022
Mean thickness of tunica albuginea and connective tissue, microns	174.72	140.28	1070.16	994.56	374.64	99.9
Intestitial tissue, percent	35.15	28.40	10.89	61.64	18.69	18.44
Seminiferous tubules, percent	64.84	71.59	89.10	38.35	81.30	81.55
Seminiferous tubules length, meters	552	27	10,737	5354	328	71
Meters of tubules per gram of testicular weight	55.71	36.16	31.85	46.79	27.8	36.05
Meters of tubules per gram of tubules	85.89	50.52	37.75	109.53	42.11	44.22
Length of average sperm, microns	14.54	12.92	20.6	25.01	29.57	27.47

There is more testis per gram of weight in the rabbit than in any of the animals listed. Per gram of body weight the rabbit has 25 times as much testicular material as the cat.

The figures in the table indicate a fairly constant sex cord diameter. In the bull testis many tubules were nearly circular, having a diameter of about 160 microns.

The tunica albuginea of the carnivores and herbivores approximates each other in thickness: that is, there is a fairly constant but distinct thickness in each of the two groups.

The increase in weight of the testis is not due to increase in tubule diameter, but evidently to increase in length of tubules.

A study of the tubule pattern shows that in the rabbit the tubules are in an elongated pyramidal arrangement, the base of the pyramid resting on the tunica albuginea, while the apex reaches toward the center of the testis. The cat testis shows lobules of varying shape separated by well defined strands of connective tissue which are continuous with the tunica albuginea. Lobules are present in the testis of the dog, but are not so well defined as in the cat. Lobules are also very apparent in the testis of the bull. My sections did not show any pattern in the sheep testis; however, since my section represented only a very small part of the enormous mass of the sheep testis, it would not do to assume that no lobules are present.

There is a great difference in the amount of material found in the lumen of the seminiferous tubules. An empty lumen was found in the cat, but not of such vast proportions as in the gray squirrel. The lumen of the dog was distinctly clear, containing either none, few, or many sperm cells. In the bull the lumen was practically filled with a material of two kinds: (1) that bordering the nurse cells being of a granular appearance; (2) that in the center of the tubules in some cases appearing to be of a "pebbly" nature, staining quite well. This "pebbly" material was also seen in the sheep lumen.

Conclusions

1. There is no relationship between gross body weight and testicular weight.

2. There is a fairly constant diameter of seminiferous tubules regardless of the size of the animal, evidence showing the small animal may have a larger tubule diameter than a large animal.

3. The thickness of the tunica albuginea has no relation to the size of the testis. It is apparent, though, that the tunica albuginea of the herbivorous animals is quite thick. A distinct layer of connective tissue is present beneath the tunica albuginea of the rabbit and sheep.

4. The herbivorous specimens represent the two extremes when interstitial tissue is considered.

5. The highest percentage of seminiferous tubules is found in the sheep and the rodents; the smallest percentage is found in the bull.

6. The length of the seminiferous tubules in the testes of the herbivorous animals is enormous. There is a ratio between increase in testicular weight and length of seminiferous tubules.

7. With the exception of the bull and rabbit there is a ratio between decrease in tubule diameter and increase in tubule length per gram of

testicular weight. These facts also hold true in considering meters of tubules per gram of tubules (bull only exception).

8. From my observations it is impossible to state whether a pattern of tubules is present in the testis of the sheep and gray squirrel.

9. The lumen of the tubules of the sheep and bull is distinct in appearance from that of the rodents and carnivores.

10. The carnivores have the smallest sperms, the herbivores much larger, and the rodents the largest sperms.

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THE CALVERT FORMATION IN SOUTHERN MARYLAND

By Lincoln Dryden
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Introduction

The Calvert formation (Miocene) of Maryland has been known and studied for more than one hundred years. Attention was early directed to it by the presence of thick fossil beds in the walls of the Calvert Cliffs, along the western shores of Chesapeake Bay. Many papers have been written on the fossils found there, though but few have considered even in a general way the interrelations of the different beds so clearly exposed in the Cliffs. Harris (1) was the first to outline the main structural and stratigraphic details, and to name (or, rather, to letter) some of the prominent beds. Shattuck (2) on the Miocene of Maryland, treated all three of the Miocene formations. He gave much greater detail than had been formerly available, although for the same area—the Calvert Cliffs—he added little to the account given by Harris. The writer has been

interested for several years in the Calvert formation, both in its exposures along the Bay, and in other, less easily studied parts of southern Maryland. He has gathered information showing that some of the older ideas, which have been current for many years, need critical examination, if not revision. In presenting a summary of some recent investigations, the writer assumes the reader's familiarity with the publications cited above.

Validity of the "Zones" of the Calvert Formation

Shattuck divided the Calvert formation into fifteen "zones." The lower part of the formation, which he called the "Fairhaven diatomaceous earth," includes the lowest three of these, the upper part, or "Plum Point marls," those "zones" lying above. This classification has great simplicity, but it is faulty in that it leads the reader to expect these units not only at their type section, but in any place where the Calvert is exposed. There are certain reasons why such expectations are not realized.

The three lower "zones" were established in the area of Fairhaven (Fig. 1, locality 1), though only the uppermost one is said to be exposed in the cliffs along the shore of the Bay. Their connection with the upper zones cannot be definitely proved in the field (see below) since there is a hidden area some three to four miles long between localities 1 and 4.

"Zone 1" is described as follows: "At the base of the Calvert formation and lying unconformably on the Eocene deposits is a bed of brownish sand carrying *Phacoides contractus*. This stratum varies somewhat in thickness from place to place, but does not depart widely from six feet on the average." In the publications of the Maryland Geological Survey some half-dozen exposures of the Eocene-Miocene (Calvert) contact are described, and they presumably represent all that was known of that contact. The writer has found about fifteen additional exposures which admit of study of the base of the Calvert formation. In no exposure, either described or new, has anything like Shattuck's "Zone 1" been seen. It cannot be denied that at some place there may be such a layer or "bed of brownish sand—," but the writer has not been able to find it. He has found conditions which vary a great deal from place to place, so that there is no persistent stratum lying just above the Eocene. "Zone 1," then, may be considered non-existent.

"Zone 2" must suffer a like fate. It is described as lying immediately above "Zone 1" and as "a thin stratum of white sand of about one foot in thickness which is locally indurated to sandstone." Such a "zone" has been found in one small area (near locality 2) of southern Maryland. Over nine-tenths of the area known to the writer there is no such indura-

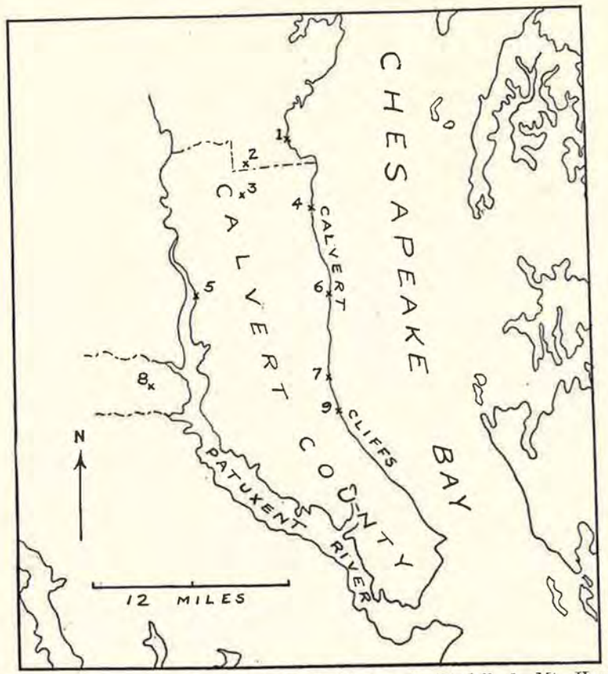

FIG. 1. Localities cited in text: 1—Fairhaven, 2—Pindell, 3—Mt. Harmony, 4—north end of Calvert Cliffs, ½ mile south of Chesapeake Beach, 5—Hollin Cliff, 6—Plumpoint Wharf, 7—Parker Creek Valley, 8—fossil locality in Charles County, 9—Governor Run. For general setting of this map see Dryden (3) or any map of Maryland.

tion about six feet above the Eocene contact. There are, it is true, indurations near the Eocene-Miocene contact, but they are not "bedded" structures, nor do they bear any constant relation to the contact. They may be at the contact, or at variable distances above or below it. Furthermore, the dozen or so species of fossils reported from this zone by Shattuck are almost never found near the base of the Calvert formation. They owe their preservation to the indurations, and when these are absent, so are the fossils.

"Zone 2" was established, it is believed, not only on the evidence from the one small area mentioned (near locality 2), but from the pres-

ence of an indurated bed exposed near locality 5. This indurated bed has not been described specifically in the literature, but there seems little doubt that it was mistaken for the one near the base of the Calvert formation, and was thought of as "Zone 2." Actually, it lies at or near the contact between the upper and lower parts of the Calvert formation, a hundred or so feet above the Eocene contact. On any score, the omission of direct reference to this indurated bed is not understandable in view of the fact that at Hollin Cliff (locality 5), where a section was measured, and where fossils are reported, this bed was not mentioned, although it forms a prominent projection in the cliff face, and large blocks of it strew the shore. If it had been clearly seen at this locality that the indurated bed lay far from the Eocene contact perhaps "Zone 2" would not have been erected.

But little attention will be given here to "Zone 3," since it has been considered elsewhere by the writer (3). It should be said again, however, that the whole "Fairhaven diatomaceous earth" does not consist of diatomaceous material. Indeed, the writer has never seen more than 10 feet of diatomite,— *i.e.*, 10 feet of material which can be, or has been, worked commercially. Most of the lower Calvert in southern Maryland (excluding the District of Columbia and area to the northwest, of which the writer has no knowledge) consists of fine, "fluffy" sands. If the lower Calvert is to be subdivided, more than one "zone" will be necessary.

The upper "zones," numbers 4 to 15, are splendidly exposed along the Calvert Cliffs, from locality 4 on the north, to south of locality 9; and it was in these exposures that they were differentiated. Figure 2 is a diagrammatic cross-section of the northern end of the Cliffs.

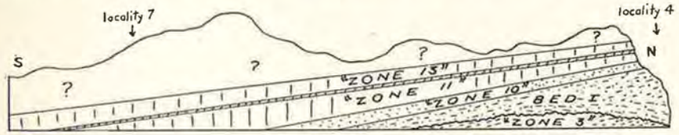

FIG. 2. Diagrammatic cross-section of northern end of Calvert Cliffs. Not drawn to scale; vertical scale greatly exaggerated. For localities see Fig. 1.

Both Harris and, later, Shattuck assumed the identity of the lowest bed at locality 4 with the highest bed at Fairhaven (locality 1), this relation being brought about by the southerly slope. Above the lowest bed at locality 4 (top of "zone 3") lies a band of *Ostrea percrassa* a few inches thick ("Zone 4" of Shattuck, "zone a" of Harris) which shows an "anomalous" behavior in that it slopes ("dips") to the north, against the regional slope of all other strata. This unusual slope (wrongly

attributed to the other beds also by Harris) was not explained. A consideration of figure 2 will show that there is no anomaly to be explained.

The top of the lowest bed (or "unit") is plainly a surface of unconformity. Shattuck divided the Calvert formation into two parts, the top of this unit being the top of the lower part (Fairhaven diatomaceous earth). It is not clear why he did not seek for some physical reason for this division, which was apparently (though little more than tacitly) founded on paleontologic evidence. The nature of the contact gives plenty of reason for division: (a) it rises against the regional dip,—this in itself being a good indication of unconformity; (b) the top of the lower unit is bored, pitted, and eroded (4); (c) there is a sharp change in mechanical and heavy mineral composition across the contact (4); (d) the uppermost beds at Fairhaven would, on estimated slope, appear approximately at tide at the locality in question; and (e) the overlying bed conforms to the shape of the surface of unconformity. The lower bed or unit, then, represents an ancient surface of erosion, on which a colony of oysters established themselves; since the surface sloped (and slopes) to the north, the bed of oysters does the same,—there is nothing anomalous about its position. Whether the north slope is still the same *in amount* as it was originally is a question bound up with the origin of the regional slope of the overlying beds,—whether their slope is mainly depositional or due to tilting.

The contact between the two parts of the Calvert formation is not surely known elsewhere, for the reason that neither the top of the Fairhaven beds nor the bottom of the Plum Point marls is recognizable without doubt in any place other than the northern end of the Cliffs. It is thought, however, that the contact should be found at Hollin Cliff (locality 5), where the lower bed is almost surely present, and where perhaps the bed lying above the contact is "zone 10" of Shattuck. This point will be discussed more fully in considering the distribution of the Plum Point marls.

Lying above the unconformity just discussed, and at the base of the Plum Point marls, is a series of olive-green sands and sandy clays. At the north end of the Cliffs they are about 35 feet thick; they diminish in thickness to 7 feet at the last exposure of the unconformity, some 4½ miles to the south. In figure 2 this material is labelled collectively bed I. Shattuck divided it into five zones above the *Ostrea* bed, differentiating the several zones solely on the presence or absence, scarcity or abundance, of *Corbula elevata,* a small pelecypod.

The propriety of such division is questionable: (a) the general concept of a zone established paleontologically is a bed or series of beds characterized by the presence of one or more species of fossils which are either absent or rare in the rock above and below. Shattuck describes "Zone 5" as made up of "greenish sandy clay, which carries scattered bands of *Corbula elevata.*" This definition might serve to distinguish it from "Zone 6," which "consists of a greenish sandy clay carrying large numbers of *Corbula elevata,* which are distributed thickly throughout the stratum—," but it will not serve to differentiate it from "Zone 7," which is described in phrases identical with those quoted for "Zone 5,"—in fact the character of "Zone 7" is noted as "resembling very much in appearance Zone 5"; (b) more important, perhaps, are a number of practical objections to Shattuck's zoning: 1. the writer has in certain places been unable to find or differentiate the zones described; 2. in other places it is found that what seem to be the "zones" wedge out and disappear in a short distance, so that they cannot be followed along the Cliffs for more than an unimportant distance. For example, the writer has been able to follow but one single "unit" along the Cliffs for almost the whole exposure of bed I. This is a thin clay bed, often no more than 6 inches in thickness. It lies at an elevation of 19½ feet at locality 4 and can be traced for about 3½ miles to the south, where it lies at an elevation of 4 feet. Careful work may show that some of the *Corbula* "zones" have a continuous extent of this sort, but this has not been demonstrated. (The *Ostrea* band, "Zone 4," which properly should be included within bed I, can be followed for a little less than 1½ miles from the north end of the Cliffs.) This fact indicates that the "zones" have little value for correlation; 3. a study of the mechanical and mineralogical composition of the sediments of bed I shows that no separation can be made on that score. This agrees with what one would expect from the appearance of these sediments in the field,—their lense-like character, minor cross-bedding in a few places, and their rapid alternations of sandy and clayey material point to a probable mixing of sediments of different mechanical, if not mineralogic, composition. From the rather small number of samples examined with this point in mind, there seems to be little relation between even the presence of *Corbula elevata* and character of the enclosing sediment, though it may be that there are more of these fossils in the browner, more sandy layers.

The only exception to the statements made above is offered by the lowest foot or two of bed I. All along the exposures (some 4½ miles) this material has almost the same lithologic characters,—the graphs of composition are markedly similar, and differ a significant amount from those of the overlying part of the bed. It may be that the sediments first deposited on the underwater shoal (surface of unconformity) came

at the beginning all from the same source, or that they were sifted about enough to grade them somewhat (the maximum contains about 40–45% on the $\frac{1}{16}$ mm. sieve, the next to the maximum about 25% on the $\frac{1}{8}$ mm. sieve). It was under these uniform conditions that the oyster bed was formed, and nowhere in the upper part of the bed are more than a few *Ostrea* found.

It is believed that sufficient evidence has been given to justify the grouping of "Zones 4, 5, 6, 7, 8, and 9" under one single bed or unit. This bed was laid down on an unconformable surface, to the outline of which, paradoxically speaking, it conforms. The thin clay seam about in the middle of the bed has the same slope as the top of bed I and immediately overlying beds. The bottom of the bed, however, rises to the south, so that in that direction the bed thins. Whether it wedges out underground is a question not easily answered, since it depends on the configuration of the surface of unconformity,—a quantity which cannot be predicted with confidence. If the oyster bed be regarded as contemporaneous throughout, then sedimentation was faster to the north when the lower part of bed I was deposited, so that the bed might be expected to thin to the south. All the other beds seem to thicken slightly in that direction. Some evidence will be presented later to indicate the absence of bed I not many miles to the west of the Calvert Cliffs (locality 5).

Some of the upper "zones" of Shattuck can be found along the Calvert Cliffs,—although there seems too little reason for calling them by that name. "Zone 10" is plainly the thick sandy fossil bed which lies from 36 to 42 feet above tide at the north end of the Cliffs, disappearing a little more than 1½ miles below old Plumpoint wharf (locality 6). "Zones 11, 12, and 13" are the two prominent clay beds separated by a thin bed which has yielded so many vertebrate remains. This thin bed, which is never more than 2½ feet thick, lies from 46 to 48 feet above tide at locality 4 and disappears beneath tide approximately one-half mile south of the south side of Parker Creek valley (locality 7). "Zones 14 and 15" are believed to have been founded on insufficient evidence, although the writer has not a great many ready facts to support this statement. The higher beds are hard to study along the Cliffs, especially in the northern part. As one passes to the south there is an uncertain correlation, and the writer believes that Shattuck called the same material at one time "Zone 15" (Calvert) and at another time a part of the overlying Choptank formation (see below for this formation). At this time, then, the writer is able only to call attention to possible errors in the earlier work.

Distribution of the Calvert Formation

The two parts of the Calvert formation—lower and upper, or Fairhaven diatomaceous earth and Plum Point marls—show very different areal extent. The lower Calvert is widespread in southern Maryland, so that its limits may be taken roughly as the limits of the Calvert formation itself (3).

The Plum Point marls are not known definitely in any place other than the Calvert Cliffs. Shattuck stated that they were to be found on Patuxent River, and in the Nomini Cliffs on the Potomac (about 25 miles southwest of locality 9). Neither of these statements has had subsequent verification,—though neither has had direct refutation. The writer can offer nothing decisive in this matter. He does believe that these beds, if present, must be much reduced in thickness, since he has seen no sure sign of them in his cursory examinations along those rivers, with one exception:

Hollin Cliff (locality 5) offers probably the finest section of the lower Calvert formation in the State. From the level of Patuxent River to 52 feet above, the beds resemble those of the lower Calvert as displayed elsewhere. At the top is an indurated bed about 1 foot thick, which probably is the same bed found within a radius of 4 or 5 miles of Hollin Cliff. Overlying the indurated bed is a series of sands exposed for about 20 feet. A layer of *Ostrea percrassa* lies 2½ feet above the base of these sands, then comes 2 feet of broken shells, and then 1½ feet of very fossiliferous sand.

It is suggested that the *Ostrea* bed may be the same as the one at the base of the Plum Point marls on the Bay shore (locality 4), and that the overlying fossiliferous sands may correspond to "Zone 10." (In this case bed I would be missing from this section.) A very fossiliferous layer like this one has been found some six miles southwest of Hollin Cliff, in Charles County (locality 8). Since few or no fossils have been found in the lower Calvert of that county, it is assumed that this layer belongs to the Plum Point marls, and, probably, to "Zone 10." If this be the case—and further work should make it definite—then the Plum Point marls may be shown to extend, in this latitude, at least 10 to 15 miles back from the Calvert Cliffs section.

Relation of the Calvert and Choptank Formations

In the Miocene deposits of Maryland three formations—Calvert, Choptank, and St. Mary's, from oldest to youngest—are differentiated. The Calvert and Choptank are said to be unconformable. The evidence given is both stratigraphic and paleontologic. For example, Shattuck

says that "The best place to observe the unconformity is in that portion of the Calvert Cliffs just below the mouth of Parker Creek [locality 7]. Even here, the unconformity cannot be seen while standing on the beach, but may be observed from a boat a short distance from the shore." Additional proof is that "—the fossil bed which lies lowest in the Choptank formation rests on the Calvert, while at Mt. Harmony [locality 3] and northward the upper fossil bed of the Choptank rests on the Calvert formation. There are also certain differences between the fauna of the Calvert and that of the Choptank."

No one of these statements should be accepted without verification. The writer has been out in a boat at the place mentioned, and has been unable to see the unconformity. Furthermore, he has constructed a large scale cross-section of the stratigraphy of the Cliffs in that vicinity. In this cross-section he at first thought that certain of the beds of the Calvert were truncated by beds lying above,—which would be good evidence for the relation claimed. It has been found in later study that there is no truncation,—that in the region from ¾ mile to about 2½ miles north of Governor Run (locality 9) there is a "sag" or depression of all the strata, but that the upper beds do not lie on an erosion surface on the lower. It is believed that there is no stratigraphic evidence in the Cliffs to prove unconformity.

The two other lines of evidence quoted above are disparate in value. That of different beds of the Choptank lying on the Calvert formation need not be considered until exact localities are given, and until one can be sure that he can recognize the same bed of the Choptank formation in different places back from the Bay shore,—something that has not as yet been demonstrated.

That there may be differences between the faunas of the two "formations" cannot be disputed by the writer. Some have claimed that the faunas are quite similar, and that they may represent animals living under slightly different environmental conditions (5). In this case, and in the absence of any definite stratigraphic proof to the contrary, there seems no need to separate the Choptank from the Plum Point marls of the Calvert formation. The Choptank has just about the same distribution as the Plum Point marls. The more important break seems to be that between the lower Calvert (Fairhaven diatomaceous earth) and the Plum Point marls, and the formational boundary apparently should be drawn at that horizon.

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AIDS TO THE TEACHING OF HIGH SCHOOL BIOLOGY

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High School Biology is a subject which lends itself admirably to motivation by the introduction of extraneous material into the formal course. Each teacher has his own particular locality to serve and his own particular ideas to express. These two demands force him to exercise his ingenuity in an attempt to motivate the interest of the students in the study of living things. While under this pressure of necessity the writer has found the projects described below to be of considerable assistance to him in conducting such a course. None of them are entirely original, but the combination and use of them in high school work proves to be so satisfactory that it is desirable to commend their use to others.

Numerous methods, by means of which interesting and enlightening biological information may be brought into the regular course, are available. The field of Biology is so broad that one has little difficulty in satisfying the demands of his community and those of his own interests. Of the various available methods of incorporating particular phases of this vast field of information, the following prove to be exceptionally useful: long essays or research studies, construction of biological scrapbooks, and nature study projects.

Long Essays

The long essay, or term paper, might better be called a research study. In this connection the term research is meant to specify the acquisition of new knowledge only so far as the student is concerned. Such a study should be designed to involve the student in an extensive search for information on some selected subject. This search should lead him through reference books, periodicals, governmental or other pamphlets, and to his parents, friends, and other citizens of his community or even to those of other communities, thereby serving to associate the school work with everyday life. Probably no other project will so successfully

coordinate Biology and other school subjects. Home Economics, Shop Practice, Physical Education, Hygiene, the Geography of the lower grades, and even History may be called into use as sources from which to glean data for the study. Typing and English Composition will be essential aids in making the written report.

The individual teacher will need to follow his own inclinations in regard to making this essay a requirement or an optional addition to the Biology course. Whatever the decision in this matter, it is absolutely necessary that the student select his own topic, for he must have sufficient interest in it to spur him on to further study. It has been the experience of the writer that otherwise mediocre students will often respond to this method of instruction with surprisingly good results. It is necessary that all topics be selected early in the semester in order that the students have plenty of time in which to conduct their studies. It is also advisable to have frequent reports of progress by the people making these studies. The investigations should be completed and the reports submitted at the earliest possible dates so that all "last minute rushes" be prevented. A few of the innumerable topics are suggested below.

Suggested Topics for Research Studies

Beekeeping	Care of Pets
Raising and Breeding Rabbits	Varieties and Care of Canaries
The Cotton Industry	Tropical Fish
The Linen Industry	Poisonous and Harmless Snakes
The Paper Industry	Land and Water Turtles

Biological Scrapbooks

The construction of biological scrapbooks proves to be an interesting pastime which often serves to attract the attention of the listless student and certainly adds to the store of knowledge of everyone. The writer has found this to be a valuable first semester requirement. It seems advisable, however, that it be an optional activity for the second semester, and that it be restricted at that time to the collection of current material only. The daily newspapers, the weekly and monthly magazines, and many other publications contain pictures and short articles of biological interest which escape the notice of high school students unless they are especially on the lookout for such material. The instructor needs to impress upon the student the necessity for a systematic and neat organization of the material of which the scrapbook is made-up. A haphazard arrangement of clippings should be discouraged. In order that the

scrapbook be useful and valuable as well as interesting it should be indexed and arranged in sections. Such a well planned bit of work is one of which the student will be justly proud.

Nature Study Projects

It is a commonly accepted opinion that one should study nature rather than books about nature. However, the inflexible school program seldom leaves any room for extensive and frequent field trips in Biology. Even where such excursions are provided for, they are not always desirable. Too often class field trips degenerate into a mere escape from routine both for the students and the instructor. Another serious objection to the class field trip is the difficulty with which it is conducted. To conduct one of these trips successfully requires considerable planning and effort on the part of the teacher. The writer has found that the study of nature can be more readily and more satisfactorily done through the medium of individual nature study projects, supplemented by occasional class trips. Such projects permit the interested students to pursue their own selected phases of nature study. This method does require that the teacher be willing to give advice and guidance to the students involved in the study of projects, but on the whole it is more easily managed than a series of class excursions. A decided advantage of the individual project method is its adaptability to the urban communities where field trips are almost or even wholly impossible. In such situations certain outstanding students may be permitted to work on projects of a limited nature as, for example, the establishment and maintenance of a balanced aquarium or, perhaps, a study of the biology of a vacant city lot. Such school activities will often furnish the nucleus around which worthwhile hobbies will develop. Such hobbies in providing an outlet for excess energies are of definite value in keeping unemployed children and young people from wandering aimlessly in the streets and eventually coming into conflict with the law.

A List of Suggested Nature Study Projects

Establishing and maintaining a freshwater aquarium
Establishing and maintaining a terrarium
Preparing study skins of small mammals
Preparing skeletons for the school laboratory
Identification of the common wild flowers of the locality
Identification of the common birds of the locality
Identification of the trees of the locality

Preparation of an insect collection
Making leaf prints
The biology of a measured plot of ground

These selected aids to the teaching of high school biology have each proved their usefulness. If properly used they will not only aid the teacher but will instill the students with a new interest in the study of life and of living things. Probably the most important of all in this respect is the Nature Study Project.

HISTOLOGICAL EFFECTS OF X-RADIATION ON REGENERATING TISSUES IN THE URODELE, *TRITURUS VIRIDESCENS VIRIDESCENS*

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It has been shown previously (Crummy '35) that regeneration of the tail of adult Trituri is inhibited by exposure to a single large dosage of x-radiation (1704 "r" units during a period of twenty minutes). Curtis ('28) reported that x-rays destroyed the "formative cells" from which new tissues were developed during regeneration in planarians. Stone ('32) reported a similar effect on the "neoblasts" which give rise to new tissues during regeneration in the annelid, *Tubifex*. Butler ('33) claims that the "primary effect of x-radiation on regeneration appears to be an effect on differentiation." Edmondson ('36) suggests that the effect of x-rays may be a destructive action on mesoderm-forming cells. Histological studies of the irradiated tissues of the adult *Triturus* were made for the purpose of throwing more light on this baffling problem.

Histological observations of normal regeneration were made on tissues fixed immediately, 10, 20, and 100 days after amputation, respectively. These observations were then compared with similar ones made of x-rayed tissues. These studies were confined to those tissues which had been irradiated on the same day that the tail was amputated. Tissues to be studied were fixed in Bouin's fixative and imbedded in paraffin. Sections were cut at ten microns and stained in Mallory's triple stain for connective tissue.

Sagittal sections through the amputated stump of the tail, when fixed immediately after amputation show that the muscles have contracted to a certain extent, causing a slight projection of the vertebra beyond the surrounding tissues. Butler ('33), Herrick ('32), and others have mentioned the fact that the healing of the wound of amputation is ordinarily

rather rapid and that it is largely due to migration of epidermal cells rather than to cellular proliferation. This idea is substantiated by the fact that the wound appears to be completely healed over within a day and a half after amputation. The migration of epidermal cells results in a "piling up" as Herrick calls it, after the advancing edges of the wound come together.

Sections fixed five days after amputation show that wound healing is complete and that there is present between the epidermis and the underlying tissues a mesenchymatous matrix. Cutuly ('32) describes the development of this matrix rather thoroughly. In regard to the earliest observable beginning of the formation of this matrix, he says, "Shortly before the epidermal cells have completely covered the wound a mesenchymatous matrix can be seen in regions beneath the epidermal cells. Usually the matrix can be seen first where epidermal cells and connective tissues are in contact."

At ten days after amputation the mesenchymatous matrix has become considerably larger than it was at five days. However, it is still little more than a narrow band. The spinal cord is in contact with the epidermis. Melanophores in the regenerating region are, for the most part, contracted and lie beneath the epidermis, only a few being found in it at this time. Numerous mitotic figures are present in the mesenchymatous cells, or blastema. There is some dedifferentiation or disintegration of cartilage at this stage. Differentiation of skin glands seems to have begun already at this early stage, for numerous areas which appear to be gland anlagen are present, close underneath and in contact with the epidermis in the regenerating region.

Twenty days after the date of amputation, the mesenchymatous matrix has become a comparatively broad band, at least five times as broad as it was at ten days. Melanophores are numerous in the regenerating area and are greatly expanded. The mesenchymatous matrix is of a spongy nature, in that the cell nuclei are not closely compacted. Skin glands are definitely present at twenty days of regeneration. The spinal cord projects through the spongy matrix and closely approaches the epidermis. At this stage the blastema cells of the mesenchymatous matrix are being transformed into what appear to be cartilage cells just ventrad of the spinal cord, so that the matrix in this region is quite compact.

The regenerative processes are practically complete after 100 days of regeneration. Skin glands appear to be fully developed by this time in the regenerated part of the tail-tip. Cartilage formation has progressed to the extent that a cartilaginous spinal column extends from

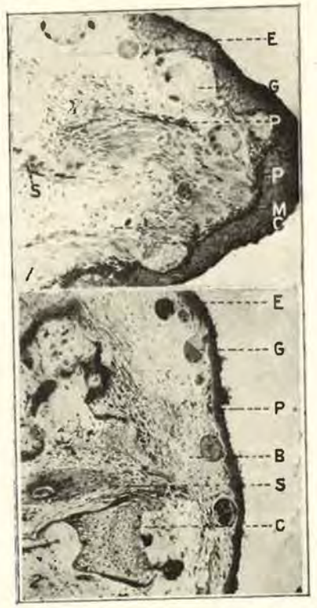

FIG. 1. Photomicrograph of enlarged sagittal section of the tip of a normally regenerating tail, fixed 100 days after amputation, showing fully developed glands, subepidemal pigment layer, and muscle tissue.

FIG. 2. Photomicrograph of sagittal section of tail in which regeneration has been completely inhibited. Fixed 100 days after amputation and irradiation.

B—blastema, C—cartilage, E—epidermis, G—skin glands, M—muscles, P—melanophores, S—spinal cord.

the level of amputation to the very tip of the tail. The spinal cord also extends to the tip of the tail. Striated muscles are present between the end of the spinal column and the epidermis, as well as in the other normal positions throughout the newly formed tail. The normal layer of black pigment beneath the epidermis has become fully formed by this time. Melanophores are also scattered throughout the epidermis, as well as the deeper tissues. All of the melanophores to be found are expanded to a greater or lesser extent. A mesenchymatous matrix can no longer be distinguished.

Histological examination of sagittal sections of x-rayed tails which had been fixed immediately after irradiation shows no observable differences between irradiated and non-irradiated tissues at this time. Even after ten days' regeneration, the histological pictures of the irradiated and non-irradiated tissues are but slightly different. The mesenchymatous matrix is approximately the same size in both, but it does seem to be more compact in the irradiated tail-tip. Melanophores seem to be somewhat less abundant in the x-rayed than in the normal tail, at this time. Furthermore, a higher percentage of the melanophores that are present in the irradiated tail-tips are in a contracted condition. Skin gland anlagen may be present in the wound areas of the non-regenerating x-rayed tails, as well as in the normally regenerating ones ten days after amputation, but they certainly are not as prominent as they are in the latter for none have been found.

The most marked differences between the irradiated and non-irradiated tissues, at twenty days after amputation, are to be found in connection with the melanophores. These bodies are much less numerous in the regeneration area of the irradiated tissues than in that of the non-irradiated tissues. The melanophores that are present in the "blastema region" of the irradiated tissues are definitely less expanded than in the normal regeneration bud. The mesenchymatous matrix may be somewhat more compact in the irradiated tail at this time but not unmistakably so. Cartilage cells are being laid down beneath the nerve cord much as in normal regeneration at this stage. Skin gland anlagen have definitely been found at this stage in the irradiated tails.

Upon microscopic examination of sagittal sections of non-regenerating tail stumps 100 days after amputation and irradiation, one finds that apparently fully developed skin glands are present here as well as in the tail stumps of normally regenerating individuals. There has, however, been no cartilage formation that was persistent for this long a time. Although differentiation of cartilage seems to have begun at twenty days after irradiation, it evidently does not continue or even persist for none is present beneath the epidermis at this later stage. No layer of black pigment such as is present beneath the epidermis in anormally regenerating tail at 100 days after amputation is to be found in sections of non-regenerating x-rayed tails at this stage. Only a few melanophores are to be found among the tissues of the regeneration area and those that are present are, for the most part, in a much contracted state. No muscles, or even muscle fibers, are present in the area of regeneration of the x-rayed tails. The spinal cord, like the vertebral column, shows no signs of regeneration. A region which might be compared to the mesenchymatous matrix is present. However, blastema-like cells are very limited in number.

In summarizing the foregoing histological observations it is interesting to point out that the most apparent difference between the irradiated and the non-irradiated tissues is in the relative conditions of the black pigment cells or melanophores. Exposure to this strength dosage of x-rays appears to affect these bodies severely. The presence of fully developed skin glands would seem to indicate that the primary effect of x-rays was not on differentiation, but rather on some other process of regeneration such as growth. The absence of regenerated cartilage and muscles in the final stages of the process, on the other hand, indicates a severe effect on differentiation of the mesodermal derivatives. However, the total inhibition of regeneration by this treatment seems to prove that the effect is primarily on the process of growth, although perhaps secondarily on differentiation.

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WILLIAM DARLINGTON, BOTANIST

By Walter J. Nickerson, Jr.

William Darlington was born on April 28, 1782, in the ancient village of Dilworth, then in Chester County but now in Delaware County. He was of good Quaker stock which formed in that southeastern corner of Pennsylvania a remarkably homogeneous society—industrious, prosperous, and in general without class distinction.

At the age of eighteen, being disinterested in the life of a farmer, he persuaded his father to let him study medicine; and accordingly he was entered as pupil with Dr. Vaughan of Wilmington, Delaware. In 1802, when yellow fever broke out in Wilmington, the only medical personages to remain in the town to render services were Dr. Vaughan and his pupil, Darlington.

During the winters of 1802–3 and 1803–4, William Darlington attended the medical lectures at the University of Pennsylvania, and in June, 1804, received the degree of Doctor of Medicine with high commendation from Dr. Benjamin Rush for his thesis. He was the first citizen of Chester County to receive the degree.

In the spring of 1804, upon the completion of his second course of medical lectures, Darlington attended the botanical lectures of Dr. Benjamin Smith Barton and thus made his first acquaintance with the science the pleasures and beauties of which caused him his greatest contentment and which became the basis for most of his fame.

After a trip to Calcutta as surgeon on an East-India merchantman, Darlington settled in West Chester where he made his home the remainder of his life. For five years he was a practicing physician, but was called in 1814 to represent his district in the Fourteenth Congress of the United States. Upon its completion he returned to West Chester but was reelected to serve in the Sixteenth and Seventeenth Congresses.

In 1826, with some friends, he assisted in organizing the Chester County Cabinet of Natural Sciences. He was president from its origin until the time of his death. The Cabinet encouraged the study of the sciences by giving popular and scientific lectures. Large collections of mineralogical and biological specimens were made which are now in the Museum of the State Teachers College at West Chester. As a contribution to the new Cabinet, Dr. Darlington published his first botanical work, "Florula Cestrica" dedicating it to Reverend Lewis D. von Schweinitz of Bethlehem, Pennsylvania, with the following inscription:

Dear Sir:

I am conscious that the dedication of a performance of this grade is but an equivocal compliment to a Botanist of your distinguished attainments; but I could not

forego the opportunity this presented, to testify the deep sense which I entertain of your kindness and liberality so repeatedly manifested in aiding me in the investigation of our more difficult plants. It is but justice to say, that whatever of accuracy there may be, in the determination of those plants, is mainly owing to your obliging revision of that portion of my Herbarium. As for the errors, deficiencies, and temerious innovations, which may be observed in this work,—it is perhaps needless to aid, that they are all my own.

The full title of the work is, "Catalogus of the Phanogamous Plants growing in the vicinty of the Borough of West Chester in Chester County, Pennsylvania, with brief notices of their properties, and uses, in medicine, rural economy, and the arts." Dr. Darlington was 44 years of age when this, his first work, was published but for some years had been recognized both in this country and abroad for his attainments as a botanist. This is witnessed by the act of Professor De Candolle, of Geneva, dedicating, in 1825, a genus of plants to his name.

Through a question of priority, the dedication of the genus did not prove permanent; subsequently Dr. Torrey, of New York, dedicated to him the genus *Darlingtonia* of the Pitcher-Plant Family, Sarracinaceae.

In the "Florula Cestrica" is a glossary of botanical terms, a description of each plant listed with common name and derviation of its scientific name, its uses in medicine and the arts, and some data as to its habitat.

A revised, enlarged, and much more elaborate book was issued in 1837, under the title "Flora Cestrica." In this work Dr. Darlington apologizes for retaining the "*Linnaean arrangement* when the modern botanical world has so generally abandoned it for the *Natural method,*" but he says, "I am fully conscious of the old-fashioned garb in which this work is arrayed, and have a thorough conviction of the value and importance of studying plants according to their natural affinities: But observing that the Natural method is kept, as it were, in a continual state of fermentation by the labors and researches of the great Masters in the Science—and feeling my inability to co-operate, or aid in adjusting its details—I thought it most advisable, in the present attempt, to adhere mainly to the Linnaean classification."

Dr. Darlington qualifies his apology by saying "in the present attempt," for in his correspondence it can be noticed that his expressed "inability to co-operate" arises, not from his limitations, but from his desire to check the flood of synonyms for plants mistakenly identified as new genera and species. In his Herbarium are sheets with as many as 25 synonyms listed for each specimen. It is thought that Dr. Darlington and his group in the Chester County Cabinet served as a clearing

house for botanists of the period for botanical nomenclature, and that they did much to keep the feet and the vocabularies of enthusiatic systematists on solid ground.

With the 1853 edition of "Flora Cestrica," the "natural system as illustrated by De Candolle, Hooker, and Gray" was introduced. All plants down to and including the Lichens that were known to be indigenous to the borough were described.

These three editions of Dr. Darlington's work were important to his pleas for an enlightened agriculture. He urged an accurate knowledge of the distinctive characteristics, and economic properties, together with a precise nomenclature of those plants that interest the cultivator of the soil. He emphasized the use of scientific names to obviate local customs in common names. Indeed, it is related, that it was once no uncommon thing for a traveller in the county to hear farmers denounce the abundance of *Taraxacum officinale!*

Dr. Darlington's Botanies served as guides in the education of children in scientific principles. He urged the founding of the fundamentals of science in all children that they might have a basis for self-culture. He observed that schools may not turn out philosophers but may instill the rising generation with the elements of truth and discipline them into habits of useful observation.

Dr. Darlington enjoyed to an eminent degree the friendship and correspondence of the foremost botanists of the day, De Candolle and Hooker in Europe, and Torrey and Gray in the United States. He received an honorary degree of Doctor of Laws from Yale, and was elected to honorary membership in the Botanical Society of the Netherlands at Leyden.

The contributions of Dr. Darlington seem to be of two natures. In his younger days with the publications of his first book, he was a pioneer. In his older days with the publication of later works, he was a clear-minded conservative. He opened fields which other men developed, for it must be remembered that little had been written in this country before his time.

NOTES ON THE LEAST BROWN BAT *MYOTIS SUBULATUS LEIBII*

By Charles E. Mohr
Reading Public Museum

In January, 1931, I checked through Miller and Allen's bulletin on "The American Bats of the Genus *Myotis* and *Pizonyx*" in an effort to learn just what bats might be expected to occur in Pennsylvania. I was surprised to find that a newly-described species, *Myotis sodalis*, had been "taken in February from a cave in Center County, Pa." Communication with Vernon Bailey, the collector, led me to believe the locality was Woodward Cave.

Accordingly, on January 28, 1931, I visited that cave, collected a dozen or so bats and brought them back to the zoology laboratory at Bucknell University. Hasty examination indicated that there were no *Myotis sodalis* among them. In the press of work the bats were neglected, several died, and later the mummified skins were carried along to the Reading Museum. There Earl L. Poole, assistant director, in looking over them recognized one of them as *Myotis subulatus leibii*, the Least Brown Bat, which, with the exception of a western *Pipistrellus*, is the smallest bat in North America.

This was the first record for Pennsylvania, and at the time of the report on its discovery,[1] the ninth specimen recorded in the literature.[2] In 1933, I made a careful check on museum and private collections, and although this species has been known since 1842, I learned of the existence of only 18 specimens.[3] Since then Vernon Bailey has reported finding it in Colossal Cave, in the Mammoth Cave area,[4] but has only a single specimen.

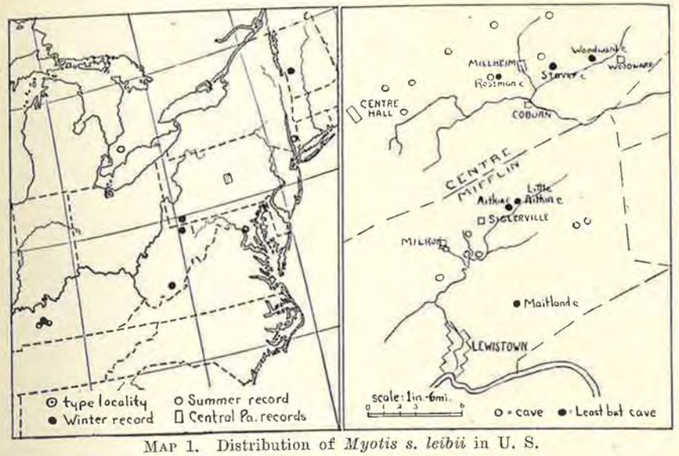
This apparent scarcity over the rather extensive range shown in Map 1 is in marked contrast with its abundance in a small area in Centre and Mifflin counties, in central Pennsylvania, where during the last five winters I have collected, or marked and released, 124 specimens. As can be seen from the map, this area lies close to the geographical center of the Least Brown Bat's known range.

[1] Mohr, Charles E., Myotis subulatus leibii and Myotis sodalis in Pennsylvania. Jour. of Mamm., XIII, 2, pp. 160–161, 1932.

[2] Miller, Gerrit S., Jr., and Allen, Glover M., The American bats of the genera Myotis and Pizonyx, U. S. Nat. Bull. 144, p. 172, 1928.

[3] Mohr, Charles E., Pennsylvania bats of the genus Myotis. Proc. Pa. Acad. Sci., VII, p. 42, 1933.

[4] Bailey, Vernon, Cave life of Kentucky. American Midland Naturalist, XIV, 5, p. 462, 1933.



Map 1. Distribution of *Myotis s. leibii* in U. S.
Map 2. Distribution of *Myotis s. leibii* in Pa.

As soon as it became apparent that the Least bat might be found with some regularity, I determined to mark individual bats. I used bird bands and ear tags the first year; but finding tags superior I have used them exclusively since then.[5] In the past five winters I have marked 84 bats, of which I have retaken 17, and of these, seven were observed more than once, one of them four times.

Observations made at the time of collecting or marking bats, and upon recovering marked bats, lead to some interesting conclusions regarding the Least Brown Bat. In the first place, its range in Pennsylvania seems remarkably restricted. Although I have visited almost 100 caves in Pennsylvania and West Virginia in winter, returning to most of them at least once, I have found the Least Brown Bat in only seven caves. With the exception of Dulaney Cave, where a single specimen has been taken, all these caves are located in Centre and Mifflin counties. Map 2 shows the proximity of five of them, Woodward, Stover, Rossman, Aitkin, and Little Aitkin caves. Indeed a circle with a diameter of about 22 miles would include the five. These caves harbored 120 specimens.

The two Aitkin caves and Stover Cave, which together contained over 100 Least bats, are located in heavy hemlock forests in the foothills of mountains which rise to 2000 feet. The other caves occupied are very

[5] Mohr, Charles E., Marking bats for later recognition. Proc. Pa. Acad. Sci., VIII, pp. 26–30, 1934.

close to such areas. The caves are usually small, and in the more extensive caves the Least bats are found close to the entrances.

The Least Brown Bat is rivalled only by the Big Brown Bat, *Eptesicus f. fuscus,* in its ability to withstand severe weather, and by its almost continuous activity throughout the winter. Although my cave visits in late fall have been comparatively infrequent, I am convinced that few Least bats enter caves before the end of November, while other bats have been there for a month or more. December 1, 1935, is my earliest record. In the same way they have departed from the caves while the colonies of *Myotis sodalis* and *M. l. lucifugus* are still quite torpid. April 9, 1936, is my latest record for the Least Brown Bat; other species remain in the caves for several more weeks.

Their rarity at certain times in midwinter, and their abundance at other times only two or three weeks apart suggests that they may wander outside of the caves during moderately warm winter weather, returning when it becomes colder. For instance, on March 8, 1936, after six weeks of unusually severe weather, I found about 25 Least bats in Stover Cave, concentrated largely in the most sheltered portions of this rather open cave. In Aitkin Cave also, the Least bats were farther back than usual, it being surprising to find them much more than 100 feet from the entrance.

The Least Brown Bat, along with other bats, shows a definite homing sense. Marked bats occur in the same cave in different seasons, or if removed to another, they return to their original cave. For instance, #293 was captured and banded at Aitkin Cave on March 19, 1933, but released in Little Aitkin Cave, a quarter mile away. During the following winter I recovered it three times, each time back in Aitkin Cave. The history of #310 is somewhat different. It was captured and tagged in Little Aitkin Cave on February 25, 1934, and retaken there in March and April. On December 30, 1934, I visited Aitkin Cave on a hurried night trip and to my surprise found #310 there. It was not until February, after I had found it again, that I learned that the entrance of Little Aitkin Cave had been completely closed by a rock slide which occurred during the previous November. Deprived of its winter roost, #310 hibernated in the nearest accessible cave, which happened to be Aitkin Cave.

Little has been learned regarding the breeding habits of this species. It is a solitary species, only once have I observed a cluster, and that contained only three individuals. The sexes are equally divided. Of the bats examined 60 have been males, 64 females; of those tagged, 33 were

males, 31 females. The fact that six males, but eleven females have been recovered might be interpreted as an indication that the females are less active and possibly stay nearer to the caves in summer. The only known summer records are from Sing Sing, N. Y., Plummer Island, Maryland, the Mammoth Cave area, Kentucky, and Mt. Bridges, Ontario. Only the last was a female.

Exactly half of the Least bats found in Pennsylvania, 62, have been found in Stover Cave. This cave is unique in the respect that in it the Least bats usually outnumber all other species. Solitary *Eptesicus f. fuscus, Pipistrellus s. subflavus, Myotis sodalis, M. l. lucifugus,* and rarely *M. keenii septenrionalis* occur, but seldom as many as half a dozen of any one species. In other caves where the Least Brown Bat occurs regularly there are large colonies of *Myotis l. lucifugus* or *M. sodalis.* A study of Stover Cave[6] leads one to the belief that the cave does not offer sufficient shelter for the social species, but provides enough protection for the hardy Least Brown Bat even in the coldest weather. The cave is just about 100 feet in extent, 15 to 30 feet wide, 6 to 20 feet high, and descends at about a 45° angle. It is rumored that the cave was once quite extensive but the fact that the bats are most numerous in severe weather indicates that they cannot retreat beyond the known passages.

The observations here presented permit the following tentative conclusions:

1. The Least Brown Bat is limited in its winter range to very definite ecological situations.
2. Ecological conditions being favorable, this bat may occur in considerable numbers.
3. This species spreads out during summer, down from the mountains and the caves in which it hibernates.
4. Even in winter the Least Brown Bat shows considerable activity, besides showing its hardiness by entering the caves late and leaving them early.
5. Individuals of this species winter in the same cave year after year, as shown by the recovery of marked specimens.

[6] Stone, Ralph W., Pennsylvania caves, 2nd edition. Topographic and Geologic Survey, Harrisburg, 1932. pp. 46–47.

SERICITIZATION IN THE PENNSYLVANIA HIGHLANDS

By Donald M. Fraser
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Abstract

Rocks rich in sericite are widespread in the Pennsylvania Highlands, where they occur in the Byram and Hardyston formations and in the pre-Cambrian schists. The occurrence and distribution of the sericite, the minerals replaced by it and the nature of the solutions and processes responsible for the alteration are discussed.

Introduction

Sericite-rich rocks from the Pennsylvania Highlands have been studied from the Easton, Allentown, Boyertown and Reading quadrangles. All the formations contain sericite, the fine scaly or fibrous variety of muscovite which Shannon[1] says "is distinguished by having less potash in many instances, and more combined water" than typical muscovite. The Paleozoic limestones commonly have scattered scales and fibers with a greater abundance of these in the shaly gradations. The Hardyston sandstone and quartzite, the pre-Cambrian schists[2] and the Byram gneiss commonly contain sericite as an alteration product of feldspar. Under at least two conditions however sericite occurs in these latter formations much more abundantly than merely as a product of the partial alteration of feldspar, in places making up fifty percent or more of the mass.

Observation and Discussion

Specimens of particular interest discussed below come from half a mile southeast of Blandon in the Reading Quadrangle 1½ miles northwest of Lower Saucon in the Allentown Quadrangle and south and east of Mt. Pleasant school and from the northeastern and southeastern side of Morgan Hill in the Easton Quadrangle.

These specimens illustrate the occurrences of sericite in abundance under two conditions,—

1. In the pre-Cambrian schists in those phases formerly rich in sillimanite.

2. In crushed and sheared zones.

The phases of the pre-Cambrian schists which were composed chiefly of quartz and sillimanite with smaller amounts of feldspar, in most cases

[1] Shannon, E. V.: U. S. Nat. Mus. Bull. 131, 1926, p. 367.

[2] Wherry, E. T.: Pre-Cambrian Sedimentary Rocks in the Highlands of Eastern Pennsylvania, Bull. G. S. A. vol. 29, pp. 375–392, 1918.

show a pronounced development of sericite. Except for the largest crystals, the sillimanite is completely replaced by aggregates of fibrous sericite (Fig. 1). In these rocks the feldspar, too, is almost completely replaced. Quartz is still widely distributed in the mass but shows embayments, veins and networks of sericite encroaching into every grain. It is interesting that the sericite replacing and in places forming aggregate pseudomorphs of the sillimanite is fibrous, that replacing quartz is commonly scaly, while both the scaly and fibrous types appear in the areas interpreted as having been formed from feldspar. In fact, this difference in the type of sericite together with the shape and distribution of the replaced areas constitutes part of the evidence that those areas were formerly feldspar. In other places however feldspar remnants give positive evidence of its former greater abundance.

The replacement of sillimanite has resulted in elongate brush-like areas with only occasionally a few needle-like or prismatic remnants of sillimanite distributed in the secondary sericite mass. The alteration progressed from the outside of the crystals inward and at the same time operated along the cleavage planes and the numerous fractures cutting the crystals perpendicular to the cleavage.

Wherry[3] recognized the general alteration of the minerals to sericite or aggregates of fine mica, some of which he designated as pinite and gives one analysis which shows quartz 52.6%, sericite 40.0%, sillimanite 6.8% with feldspar (altered), biotite, ilmenite and zircon together less than one percent.

Quartz is replaced by sericite along the margins of grains and along fractures. The more fibrous type of sericite replacing sillimanite is less abundant and the fine scaly form is the rule in the quartz areas. Where sillimanite was in contact with quartz the fibrous area of sericite pseudomorphous after sillimanite is bordered by a scaly zone of the fine mica extending into the quartz. It is thought that the alteration of the sillimanite progressed more rapidly than that of quartz, possibly occurring for the most part before much change had taken place in the quartz which altered somewhat later only with the continuation of the activity of the altering solutions. This is largely speculation but it is thought it would account for the distribution of the two types of the replacing mineral without much gradation between them.

A few smaller areas of sheaf-like aggregates of sericite associated with a little epidote and aggregates of minute limonite granules indicate the former presence of occasional flakes of biotite.

The second set of conditions under which sericite-rich rocks occur in-

[3] *Op. cit.*

cludes the more intensely crushed and sheared areas. In the Morgan Hill vicinity in the Easton Quadrangle, there are numerous examples of intense shearing in which there is abundant evidence of sericitization. The rocks affected are chiefly the Byram and the Hardyston with a greater abundance of the former. The sericite has developed in thin streaks, discontinuous bands, lenticular areas and irregular patches. (Fig. 2.) The elongated areas lie parallel to the sheared structures of the rock and the larger percentage of the sericite scales and fibers are arranged parallel to the same direction. Not infrequently however there are areas in which the scales have a heterogeneous orientation or are arranged transverse to the dominant rock structure. This would indicate the development of those areas following the dominant shearing. In addition there are numerous examples of partially replaced quartz and feldspar grains which exhibit slender arms or thin sheets of unreplaced material. (Fig. 3.) These would have been broken with the occurrence of any great amount of movement and it is thought therefore that they offer additional evidence that much of the sericitization followed the maximum shearing.

In these sheared rocks and also in the crushed specimens, a good example of which occurs southeast of Blandon in the Reading Quadrangle, the feldspars, quartz and biotite are more or less completely replaced. The alteration has progressed along the margins of grains, along cleavages and along fractures. In places only scattered remnants of the original minerals remain. (Fig. 4.) In a sense the alteration is small-scale rather than large-scale in that there are no areas of several feet or tens of feet entirely of sericite but in numerous outcrops a large volume of the rock is sericite.

In addition to the two distinct sets of conditions under which rocks with abundant sericite are found wherein the sericite has formed at the expense of minerals either of metamorphic or igneous origin, the occurrence of abundant sericite in the Hardyston should be noted. In this case the clay minerals of sedimentary origin have neocrystallized to produce the fine sericitic mass by which the quartz and feldspar are now surrounded. Mere neocrystallization of the clay and silt material is, however, not the whole story for one finds not inconsiderable amounts of the quartz and feldspar converted to fine scaly mica, indicating definite replacement of these minerals as an early stage in a process which, continued, would result in the sericitization of the mass.

Interpretation and Conclusions

As has been discussed above, the sericite in the sillimanite rocks has developed as a result of the breaking down and replacement of quartz and

sillimanite and a small amount of feldspar and biotite. In rocks of this type there is, of course, abundant silica and alumina for the development of sericite but potash must be brought in.

In discussing this subject Harker[4] says "A common retrograde transformation in thermally metamorphosed argillaceous rocks is sericitization of the aluminous silicates. . . . Sillimanite doubtless suffers a like change, (i.e., *alteration to fine scales of white mica*) though this cannot often be verified owing to the usual occurrence of this mineral in slender needles. These aluminous silicates do not, it is true, contain all the material for the making of a mica; but there is no need for the supposition, in itself highly improbable or in our view inadmissable, that the requisite potash is introduced from some extraneous source."

It is apparent that if the reaction suggested by Rastall,[5] for the conversion of potash feldspar into an aggregate of white mica may be accepted, some potassium is in excess in the form of KOH which may combine with alumina and silica to produce sericite. Rastall in referring to this reaction says,

"This can be expressed by the following rather less determinate equation, in which it is necessary to introduce an unknown factor x.

$$\text{"}K_2O \cdot Al_2O_3 \cdot 6SiO_2 + xH_2O - xKOH + (H, K)_2O \cdot Al_2O_3 \cdot 2SiO_2 + 4SiO_2$$

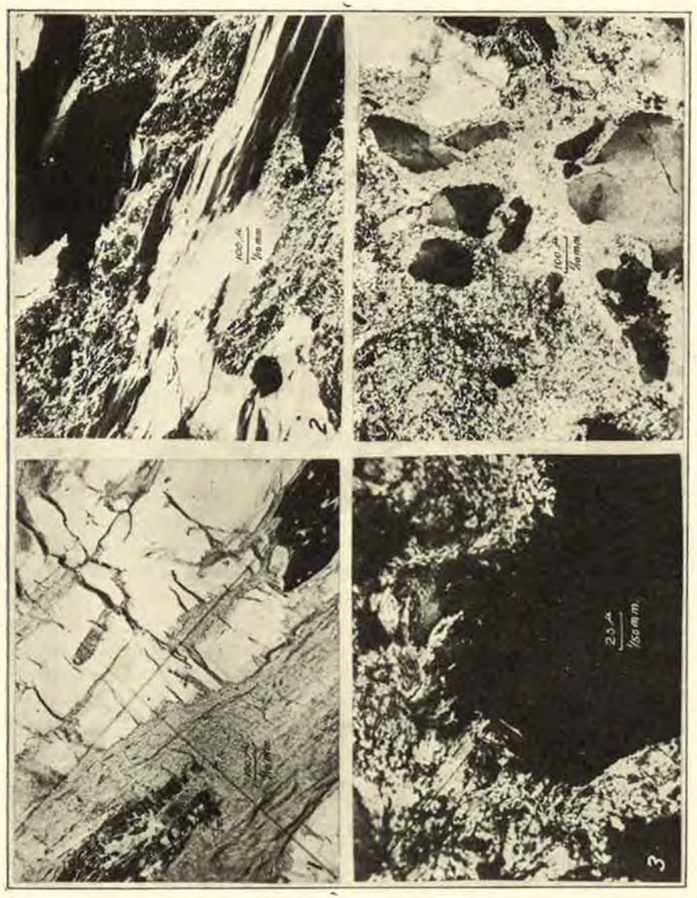
Here it is assumed that in muscovite hydrogen and potash are present in an indefinite ratio: this seems to fit the facts best, although some writers assign to muscovite the complicated formula $H_2O \cdot 3K_2O \cdot 4Al_2O_3 \cdot 8SiO_2$. There is little evidence in support of this and the hydrogen is almost certainly present as the OH group and not as H_2O."

It is likely that the potash that it is necessary to add to the quartz-sillimanite rocks in order to produce sericite could have been derived from the sericitization of nearby potash feldspar-rich rocks. The abundant sericitization of the crushed zones in the associated granite gneiss in which both orthoclase and microcline are important components may well have been the origin of the needed potash without the necessity of going to some "extraneous source" in the sense of postulating the introduction of potash by solutions of magmatic affiliations.

Inasmuch as it has been pointed out that the sericite is probably largely later than the shearing and crushing in the rocks showing such structures, it appears that the more abundant development of sericite in those zones

[4] Harker, Alfred: Metamorphism. Methuen & Co., Ltd., London, 1932, pp. 343–344.

[5] Rastall, R. H.: Physico-Chemical Geology. Longmans, Green & Co., London, 1927, p. 156.



Photomicrographs of thin sections showing occurrences of sericite.

than elsewhere in rocks of the same type is largely due to the ease of travel of the solutions responsible for the alteration. Whether these solutions were descending meteoric or ascending meteoric or magmatic of possibly higher temperature is not obvious. The rather intimate replacement and extensive and complete attack of all grains rather than the concentration of limitation of the alteration to more noticeably sheared or open fissures within the larger zone of shearing indicate the solutions were quite penetrating and probably were not merely percolating meteoric waters traveling along the channels of easiest passage.

Considering the sericitized crushed and sheared zones as well as the sericitized sillimanite rocks wherein we must introduce potash and in which specimens, too, there is evidence of a type of alteration which appears to be rather definitely hydrothermal, it is concluded that the development of sericite-rich rocks in the Pennsylvania Highlands was the result of two processes as indicated below:

1. The process resulting in the sericitization of the sillimanite rocks which likely was a hydrothermal action in which there has been a conversion of sillimanite and quartz to sericite and the governing factor was the chemical composition of the rocks affected. (Fig. 1.)

2. The process resulting in the sericitization of the crushed zones which may have been as closely related to weathering as to hydrothermal action and the governing factor was the structure of the rocks affected. (Fig. 4.)

Fig. 1. Quartz and sillimanite in a pre-Cambrian schist being replaced by sericite. Sillimanite is present only as a few small remnants in the darker area at the left in the gray sericite mass. Numerous fractures in the quartz (light area) have been invaded by the sericite. Larger areas parallel to the longer axis of the quartz area were formerly sillimanite, now sericite. In this specimen the sericitization was a selective process, the alteration being determined by the composition of the minerals in the rock. The dark grain in the lower right is magnetite. Plane polarized light.

Fig. 2. Sericite (gray speckled areas) replacing quartz and feldspar (elongated white and black areas) in a sheared phase of the Byram gneiss. Note the areas of sericite within the stretched quartz grains which cut the structure of the quartz. Crossed nicols.

Fig. 3. Sericite (speckled areas) replacing quartz (large black area) in the Byram gneiss. Note the encroachment of the scaly sericite along the borders and the apparently isolated sericite scales which may be connected with the main mass either above or below the plane of the section. Crossed nicols.

Fig. 4. Crushed Byram gneiss suffering sericitization. Note the isolated grains of quartz and orthoclase with serrated borders lying in a groundmass of sericite (speckled gray material making up a large part of the field). Here there is general sericitization of the minerals present but the nearby uncrushed Byram exhibits only minor alteration. The dominant control factor here was the structure of the rock mass. Crossed nicols.

SEISMIC STUDY OF LEHIGH VALLEY LIMESTONES

By Maurice Ewing
Lehigh University

Introduction

Measurements designed to give an accurate value of the velocity of elastic waves in limestone by means of the refraction seismograph revealed a region of marked irregularity in the limestone near the abandoned Industrial Limestone Quarry one mile northeast of Hanoverville, Pa. A charge of dynamite at the bottom of the water-filled quarry was used to generate seismic waves and also to cause a radio transmitter to emit a signal at the same instant. A sensitive portable seismograph and a radio receiver at a distant point recorded the radio signal and the seismic waves on a seismogram. From reference marks on the seismogram at intervals of one-hundredth of a second the lapse of time between the arrival of the radio signal and that of the seismic wave could be measured to a few thousandths of a second. This gave the travel-time of the seismic wave. Qualitative estimates of the amplitude of motion of the ground could also be made from the seismogram.

Fig. 1 shows the shot points and recording stations. It should be noted that the stations may be divided into a group lying approximately north of the quarry and one west of it.

Although it is frequently possible on a seismogram to identify several different waves which have travelled over paths requiring different travel-

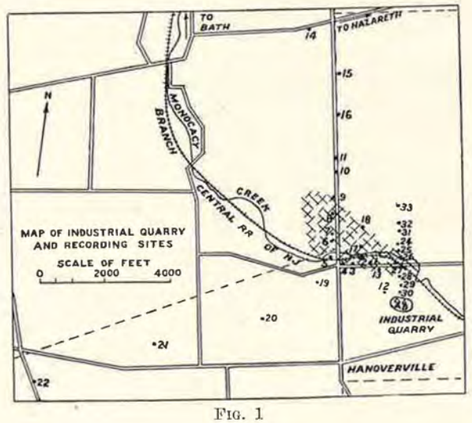


Fig. 1

times, it is obvious that the first wave to arrive may always be timed more accurately and identified more positively than any later arrival. These first arrivals definitely disclose the geologic feature under discussion.

Results from Time of First Arrival

In Fig. 2 the travel-time of the first seismic wave is plotted as a function of the distance travelled. It is seen that the points for all stations

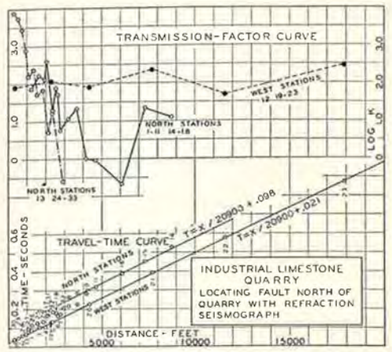


Fig. 2

west of the quarry lie near a straight line, the equation of which was found by the method of least squares to be $T = (X/20{,}900) + 0.021$, where T is travel-time in seconds and X is distance in feet. For stations to the north, say north of Monocacy Creek, the points on the graph lie above this line, indicating propagation of waves in this direction at lower average speeds.

It may be noted that the amount of extra time required remains approximately constant for stations north of station 10, indicating that beyond this station the waves travel with the normal velocity of 20,900 ft./sec. The loss of time occurs in a zone extending from about 1000 to about 4000 feet north of the quarry. If it is assumed that the total loss of time which is 0.077 sec. occurs uniformly over a space of 3000 feet, a velocity of 13,500 ft./sec. is obtained for this low speed zone. A more likely assumption, which is strongly supported by the data from stations 24–33, is that within the 3000 feet interval there are several irregular narrow zones of velocity about 6000 ft./sec., the velocity elsewhere having the normal value for limestone. This interpretation is put forward as

the most logical one for the data at hand, the narrow zones of low velocity being considered unconsolidated material along fault planes.

The failure of the line through the points corresponding to the westward stations to pass through the origin of the graph is due to the fact that the limestone was covered by an appreciable thickness of weathered or glacial material at all recording stations and that some time was lost at the shot point by the wave in travelling through water and broken stone before entering solid limestone. The zone in which faulting is considered to exist is cross-hatched in Fig. 1.

Results from Absorption of Seismic Energy

The energy from an explosion usually travels to a seismograph by a variety of paths. The magnifications of a seismograph for a transient vibration can not be determined precisely without great difficulty. The energy in elastic waves produced by a given charge of dynamite depends greatly upon conditions in the immediate vicinity of the charge. For these reasons it is difficult to measure accurately the absorption of seismic energy in the ground, and only rarely has it been possible to draw useful conclusions from a study of this factor.

In the present study the subsurface material is apparently homogeneous (except for the fault) so no great variety of paths is possible. Also the location of the dynamite charges at the bottom of a water filled quarry resulted in a minimum of variability in shot-point conditions. A transmission factor K has been defined and calculated with sufficient accuracy to show definitely that energy is transmitted more effectively westward than northward from the quarry. From the amplitude of first motion on the seismogram and the 30-cycle steady-state magnification factor of the seismograph, the amplitude of the first ground motion, A, at each recording station was calculated. The transmission factor K is defined by the following equation, under the assumptions (1) the seismic energy generated by the explosion is proportional to the charge Q of the dynamite used, (2) the intensity of seismic energy arriving at the seismograph is proportional to the square of the amplitude of first ground movement, (3) for normal transmission the intensity of seismic energy varies inversely as the square of the distance, X:

$$A^2 = K\ Q/X^2$$

The transmission factor for each recording station is shown graphically in Fig. 2. For the west stations the value of K is constant within the limit of accuracy of the measurement, indicating normal transmission. For the north stations 1–11, 14–18 the value of K is definitely lower, indicating poor transmission of energy through the zone cross-hatched in Fig. 1. For north stations 13, 24–33 a new shot-point within the quarry was selected which gave more effective transmission of energy into the rock resulting in high values of K for the short distances. The rapid decrease in the value of K indicates a very high degree of absorption along this line.

Conclusions

Professor B. L. Miller has pointed out that the presence of cement rock in the National Cement Company quarry about one mile east, indicates a fault in the same general vicinity as that given above. A magnetic survey of the region, now in progress, reveals a large linear magnetic anomaly with axis east-west, in the vicinity of the seismic anomaly. Thus all available evidence points to the existence of a large fault 1000 to 2000 feet north of the Industrial Limestone Quarry.*

The velocity of longitudinal waves in limestone was found to be 20,900 ft./sec.

Acknowledgments

Acknowledgment is made to the National Research Council for a grant-in-aid and to the officials of the Pennsylvania-Dixie Cement Corporation for permission to work on the property owned by the corporation.

A MUSEUM PRACTICAL FOR TEACHER TRAINING

By John E. Anderson
West Chester

There are two types of students in attendance at every college. One type is intelligent and quite readily trained or at least amenable to training. The other type is not only intelligent but in addition borders on the intellectual. The latter type is not satisfied with mere basic training but demands some freedom and facilities for exercising its own ingenuity in attacking current problems.

The trend in training schools for years has been toward the establishment of laboratories in the sciences but the movement has suffered so from inertia that only within the past ten years has much of anything been accomplished along that line. It still suffices in many places to teach any science out of books with some assistance from charts. Techniques are discussed with seriousness and at great length but few of them have been taught, particularly in the field of biological sciences.

* Note added June 13. For results of magnetic survey see Trans. Amer. Geophys. Union. 1936.

Also, the curricula are quite inflexible so that one can be certificated in fields by taking a woefully inadequate minimal program of studies. It is not until his senior year, when he goes out for his practice teaching that the student suddenly realizes his lack of preparation.

In spite of continuous efforts to raise the standards of preparation, curricular changes are not made rapidly. Recognizing this, an attempt has been made to do two things, *viz.*, supplement the factual knowledge of the ordinary student and to provide an outlet for the self-directed energies of the better student. Nothing furnishes more practical aid than a working museum.

No college service area, especially in the older part of the country, is so small or so devoid of amateur collections that a nucleus for a museum has not already been established. In Pennsylvania this certainly is true. A year ago I reported briefly on the collections at the State Teachers College at West Chester. The Darlington collection which forms the nucleus for the botanical work is only one of many others in various fields. Such collections are still available. We had no representatives of the marine algae, but during two years of cooperative search we unearthed a fine collection made in Florida and Australia waters. It had been made in the middle of the last century and was obtained at one of the ordinary sales. It is to be understood that none of the rare specimens are used by students. The main work consists of an attempt to duplicate, in so far as possible, the earlier sets.

Bird collections, insect groups and mineralogical specimens are to be had. The earlier naturalists were well trained and the result is that aside from obsolete terminology the identifications are reliable enough to act as starting points for the more interested student. No attempt should be made to build the museum as a competitive structure to those of universities and municipalities. As local sources are exhausted, gaps in any collection can be filled by exchange but it must be borne in mind that the museum is to be a workshop and not a show place.

Just what can be done with this type of museum? First, the orientation courses, such as Educational Biology and Physical Science are furnished with demonstration material. The courses in elementary botany and zoology can be given additional materials to supplement the purely morphological and taxonomic studies which comprise those courses. The ornithological collection can be used to illustrate studies in distribution. The ethnological exhibits, even if purely local, can add to any course in history or geography. The potentialities are quite unlimited even for the ordinary student.

The greatest value, however, accrues from the fact that the museum

offers facilities to the better students for individual, self-directed work. No credit is given for the work so it puts no time demand on the student. It is proper to assume that if a student is a science major he has some natural bent in that direction. That means that additional work is welcome to the average student if guidance is provided. The more scholarly student, who already has a natural curiosity regarding everything, will greet with pleasure any opportunity to satisfy it.

To illustrate this specifically, four average students with an enthusiastic embryo ornithologist have become quite adept at handling small exhibits of birds, have become acquainted with a relatively large number of local birds in the museum and outside and have, above all, discovered how to compensate for the lack of courses in bird study by systematically training themselves. Next year the same group plans to work on some other phase of biology. Another group has become interested in photography connected with museum lighting. Odd as it may seem, this interest has led to considerable work in photographing spider webs, bird nests, etc.

The better students, those who can initiate their own activities, have found various worthwhile outlets for their enthusiasms. Work with the old botanical collections has led one student into extensive biographical reading with reference to the collectors. Those of us who are interested in biography appreciate the possible ramifications of such reading. The hunt for old books has become a hobby with two other students.

It should be understood that what is being done is not research even in the loosest sense of the word. Since third and fourth grade youngsters do research these days a certain opprobrium attaches itself to the word. The additional work does do certain things very definitely and these in the science field are not only valuable but essential. Any student who has voluntarily made use of the museum has become aware of the value of the fundamentals involved in scientific work. Methodical approach, careful and thorough work, the necessity of time-consuming effort have become real to him. He sees the necessity of imagination, if not of vision, but above all he has discovered the imperative need of thorough basic groundwork as a stepping stone to real, solid, satisfactory achievement.

TWO CASES OF POLYDACTYLISM IN THE MANUS OF CATS

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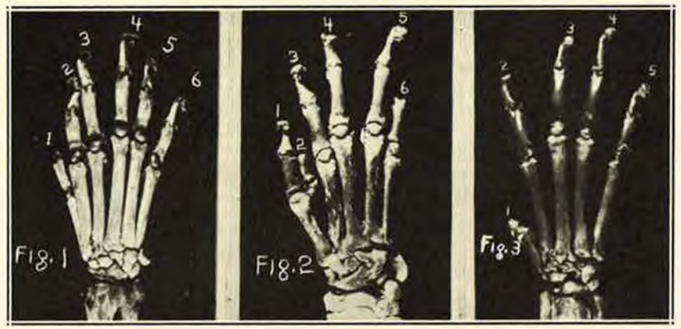
University of Pittsburgh and Albright College

The purpose of this paper is to give a general description of the arrangement of the bones in two types of polydactylism in cats.

The two pairs of forelimbs were given to me by Prof. Clarence A. Horn. Nothing is known of the manus of the ancestors, of the sexes, weights or ages of the cats from which the specimens were secured.

Six fingers are present on the both hands of the two cats. In each case, the right and left hands of the same cat exhibit identical polydactylism. All of the digits bear normal claws.

The chief distinction between the two types of abnormalities lies in the manner of origin of the supernumerary fingers. In Figure 1 there is an extra digit and metacarpal on each manus. In Figure 2 the number of metacarpals is normal but six digits are present. The extra digit arises as a bifiurcation on the distal end of the first metacarpal.



DORSAL ASPECT OF THE MANUS OF CAT
FIG. 1. With a supernumerary metacarpal.
FIG. 2. With a normal metacarpus but possessing a supernumerary digit.
FIG. 3. Normal.

It is difficult to determine which digit of Figure 1 is supernumerary. After an examination of the digits and the articulations of their metacarpals with the bones of the carpus, it is possible to restrict the probable supernumerary metacarpal to certain digits. The phalanges and metacarpals of digits number 3, 4, 5, and 6 have apparent normal articulations with the bones of the carpus, Figure 4, and their full complement of phalanges. If it is accepted as a temporary conclusion that the bones and their articulations of digits 3, 4, 5, and 6 are normal, the supernumerary digit must be one of the two remaining digits, number 1 or 2. The metacarpal of digit 2, Figure 1, which articulates with the trapezium, the place of articulation of the first metacarpal in the normal manus, however bears two phalanges exclusive of the claw which is the complement of phalanges present in every finger but the first in normal hands. Therefore it is not the normal first digit unless one of the phalanges itself is supernumerary. Digit 1 of Figure 1 has a metacarpal and only one phalange exclusive of the claw which is the number of phalanges in the normal first digit. The articulation of the first metacarpal with the carpus is anomalous. The first metacarpal of the normal manus articulates with the trapezium, Figure 6, but the first

FIGS. 4, 5, 6. Enlarged views of the carpi of figures 1, 2, 3 respectively.
FIG. 7. Enlarged view of first two digits of figures 2.

T —trapezium
TR—trapezoid
OM—os magnum
UN—unciform
CU—cuneiform
P —pisiform
SC—scapholunar

metacarpal of Figure 1 articulates with the scapholunar. At the first glance this abnormality would apparently eliminate digit 1 as the true first digit. It is quite possible, however, that the development of the metacarpal of the second digit of Figure 1 forced the proximal end of the metacarpal of digit 1 from the trapezium to the scapholunar. Therefore in view of these observations, it is tentatively concluded that digit 2 is supernumerary.

The metacarpus of Figure 2 is normal but the number of digits is anomalous. All of the digits except 1 and 2 are normally articulated with the metacarpus and bear their full complement of phalanges. In view of this observation it is digit 1 or 2 which is supernumerary. Each of these two digits, however, possesses two phalanges exclusive of the claw. The normal first digit possesses only one phalange exclusive of the claw. If either of the digits 1 or 2 is to be considered as the normal first digit then it must be allowed that one of the phalanges is supernumerary. The small proximal phalange of digit 2 might represent an overdevelopment of one of the small, paired sesamoid bones found on the plantar side of the articulation of the metacarpal with the phalange since only one of the sesamoid bones is present at this joint. Either one of these digits might be the true first digit and then again it is possible that neither is the case. From these observations, it is alone concluded that the manus is polydactylic.

Anomalies are frequently found in the human hand. Cases of syndactylism or web-fingered hands have been reported in the human manus. The absence of phalanges in the digits is known as brachydactylism. These abnormalities frequently follow "Mendel's Laws" of inheritance.

Polydactylism is not generally interpreted as a reversion to a six-fingered ancestor but as due to some disturbance of the normal embryological development of the pentadactylic pattern.

There may be many more types of polydactylism present in the manus of the cat than the two types reported in this paper.

In general, it is concluded from these observations that, at least, two types of polydactylism exist in the manus of cats, one of which involves an extra metacarpal and another which involves only extra phalanges.

THE INHERITANCE OF CROOKED LITTLE FINGERS

By V. Earl Light
Lebanon Valley College

Tomesku (1928) observed clinodactyly, an abnormal flexure, deviation or curvature of fingers, in a number of persons, and records members of four different, unrelated families. In every case observed he found that the malformation occurred in individuals that possessed black hair.

Figures 2, 3, and 4 in Tomesku's account show that the deformity is confined to the little fingers and appears to be in the joint rather than in a curvature of any phalanx. Figures 5 and 6 in his paper show a different type of deformity in which the curvature is in the phalanges and not in the joints, and curvatures are noticeable not only in the phalanges of the little fingers but also in the index and sometimes the middle fingers.

From the text of Tomesku's observations one can draw the following conclusions:

First, the malformation in the little fingers is confined to the end of each little finger.

Second, there is frequently a diminished development of the second phalanx of the little finger, the second phalanx being, sometimes, from one to three millimeters shorter than the terminal phalanx.

Third, the malformation is linked with black hair and is not found in individuals with blond or chestnut colored hair.

Fourth, crookedness in the little fingers is sometimes accompanied by crookedness in the index or even the middle fingers.

Fifth, crookedness is noticeable at birth, and becomes more pronounced during the growth period.

Glass and Magee (1935) report two families observed by them, but were unable to obtain a reliable family history of the one family. Unfortunately, too, no x-rays are given and therefore neither the type or degree of crookedness of the little fingers can be studied. An authentic family history of the other family shows the inheritance of the malformation through four generations. Four conclusions are presented from their observations:

First, the affection skipped the second generation in direct line, indicating that it is not always dominant in inheritance.

Second, the bend is in the third or terminal phalanx, not in the joint. No x-rays are shown to corroborate this.

Third, the second phalanx is shorter than normal, thereby corroborating the statement by Tomesku "that the second phalanx is frequently from one to three millimeters shorter than the third or terminal one."

Fourth, one individual in the fourth generation of known family history is red-haired, and one individual in the unauthenticated family history is a blonde. This does not corroborate the statement of Tomesku's observations "that all persons possessing the malformation are black-haired individuals."

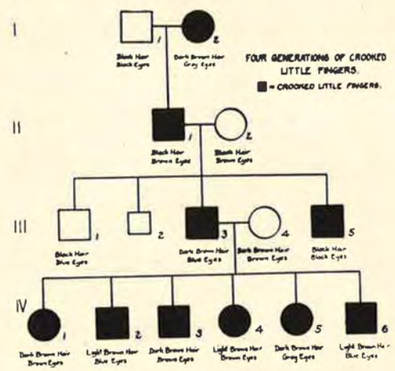
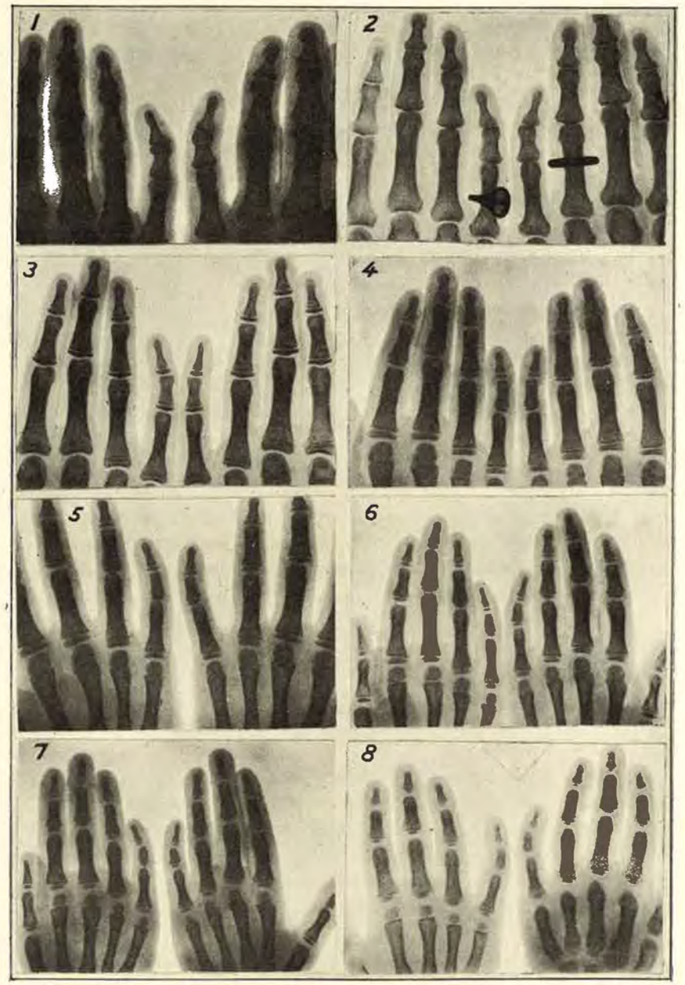


Fig. 1

The author presents the inheritance of crooked little fingers in his family unbroken through four known generations, consisting of ten individuals. The family tree of his family (Fig. 1) shows the malformation present in his paternal grandmother in the first generation; his father in the second generation; himself, and one of his brothers in the third generation; and each of his six children in the fourth generation. No record is available to show the type or extent of the malformation in the little fingers of his grandmother, but they showed a marked crookedness at the tips. Her hair was dark brown.

In all of the following figures the hands are shown crossed, so that the little fingers lie side by side. The right hand therefore is on the left, the left hand on the right.

An x-ray photograph of the hands of the author's father (Fig. 1) shows a marked malformation in the little fingers. The bending occurs at the joint by a shortening of the terminal phalanx on its inner (radial) side, not a curvature in the phalanx itself. Measurements of the second



Three generations of crooked little fingers. 1 Grandfather, 70. 2. Father, 44. 3. Daughter, 14. 4. Son, 12. 5. Son, 11. 6. Dughter, 8. 7. Daughter, 6. 8. Son, 4.

and third phalanges show them to be of approximately the same length. His age is 70, his hair color is black.

The author's hands are shown in figure 2. The type of curvature is similar to that of his father. Measurements show the second and third phalanges of the left little finger to be of the same length, while the second phalanx of the right little finger is a millimeter and a half shorter than the third or terminal phalanx. His age is 44, his hair color is dark brown.

The malformation in the hands of one of his brothers is the same type of curvature, but not as marked. His age is 33, his hair color black.

The little fingers of the hands of the oldest daughter in the fourth generation (Fig. 3) show marked deviations in the terminal phalanges. The type of deviation is the same as in the previous figures. Measurements show the second phalanx in each little finger a trifle shorter than the corresponding terminal phalanx. Her age is 14, her hair color is dark brown.

The little fingers of the twelve year old son in the fourth generation (Fig. 4) show less deviation than in the other children. The second phalanx of each little finger is longer than the terminal one. His hair color is light brown.

In the fingers of the eleven year old son (Fig. 5) the malformation is very pronounced. Curvature is in the same direction and of the same type as in the previous cases. Each second phalanx of the little fingers is shorter than the terminal phalanx. His hair color is dark brown.

The degree of development of the joints in the little fingers of the three youngest children is not sufficient to make accurate measurements and draw accurate conclusions. Figure 6 shows the condition in the eight year old daughter, hair light brown. The malformation is similar to the others and the second phalanges seem shorter than the terminal ones.

Figure 7 shows a marked curvature in the little fingers of the youngest daughter, age six. The terminal phalanges are longer than the second phalanges. Her hair is dark brown.

In the youngest son, age four, (Fig. 8) the deviation is also very marked. No accurate measurements of the phalanges can be made because of incomplete development of the joints. His hair is light brown.

The author intends to x-ray the hands of each of the children at about three year intervals in order to ascertain whether the statement of Tomesku is true or not that "deviations are noticeable at birth, and become more pronounced during the growth period."

Conclusions

These facts corroborate the statement of Glass and Magee that the condition of crooked little fingers is not in any way linked with hair color.

The affection does not necessarily skip a generation as found in the cases investigated by Glass and Magee, but it may be inherited directly through at least four generations.

There frequently is a diminished development of the middle phalanx.

The crookedness lies in the joints, conforming with the x-rays of Tomesku and not in a crookedness of the terminal phalanges as stated by Glass and Magee.

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OUR EXPLODING UNIVERSE—EXPLODED!

By Ruter William Springer
A.M., LL.M., Carlisle

The people of this planet have recently been greatly agitated by the news, vouched for by the most eminent astronomers, that our beloved universe is exploding, flying off in every direction and at inconceivable speed. And, like bad weather, it seems that nothing can be done by us, to prevent or stop it. But perhaps, though talking will not help the weather, a little discussion of this explosion situation may make it at least appear to be somewhat less serious than we have supposed.

Not being myself a professional astronomer or physicist, but what Huxley might politely call an *agnostic;* and others, more baldly, a *fool,* or, at least, an *amateur,* I may claim the right to "rush in, where angels (that is, higher mathematicians) fear to tread." Furthermore, Dr. Charles Lane Poor, Professor of Celestial Mechanics, Columbia University, has said[1] "The Einstein theory is the conclusion of a mathematical game, of no demonstrated significance outside the realm of mathemat-

[1] Nation, editorial, July 24, 1929.

ics." So, even if I had reached the very top round of the ladder of scientific fame, I would still be open to the very severest of criticism and interrogation.

Our sun and all the visible stars, including the Milky Way, form a great spiral nebula, formerly spoken of as "the universe," now better described as "our Galaxy," since we now know that there are many other similar spiral nebulae far beyond the boundaries of our Galaxy. The astronomical yardstick, called a "light-year," is the distance that light will travel in one solar year; or about fifty-seven hundred billion miles. The diameter of our Galaxy is about 200,000 light-years. The entire universe, probably comprising hundreds of spiral nebulae, is perhaps several billion light-years in diameter.

Light travels 186,284* miles per second; and its waves average perhaps one ten-thousandth of an inch in length. The red waves are longer, and therefore slower in vibration, than the blue waves. Just as the pitch of a locomotive whistle suddenly drops, as the locomotive passes us, giving us fewer vibrations of sound, so light from a moving source is found to be a little bluer when that source is approaching and a little redder when it is receding (This popular statement is not fully accurate): and the velocity of the source of light can be closely determined by measuring the change of color. Recently, Dr. Edwin P. Hubble, of Mt. Wilson Observatory, discovered, through this means, that all the great spiral nebulae seem to be receding from us at great speed; and that their velocity of recession increases in almost direct proportion to their distance from us. The entire universe is expanding, in every direction, with enormous velocity, just as the gas would in a rubber balloon expanding with heat. The rate of expansion is about one mile per second for every ten-thousand light-years of distance apart,—or from us. If we calculate backward, the date of the original explosion, when all the universe was collected at one central point, would appear to be about two billion years ago; but there is no imaginable force that could at that time have produced such a terrific explosion. Sir James Jeans suggests that the more distant nebulae may be receding with such enormous velocity, greater than the velocity of light, that the light proceeding from them could never reach us at all![2] The Dutch astronomer, de Sitter, said that such a cataclysm as this appears to be is so contrary to all known laws of nature that it "could only happen before the beginning or after the close of eternity;" but he suggested that, at such great distances, there might be a "reverse

* Recent experiments indicate a possible periodic variation of about 12 miles per second.

[2] Philadelphia Public Ledger, Sept. 30, 1931.

gravitation," that repels with a force increasing with the distance.[3] Dr. Walter S. Adams, Director of the Mt. Wilson Observatory, suggests that these confidently measured speeds may be illusory; and Dr. Harlow Shapley, the Harvard astronomer, says, "The measured velocity is probably not a measure of actual motion, but more likely a measure of crumbling space." In my own ignorant simplicity, I cannot see that this explanation, however, greatly clarifies the problem. But Sir James Jeans has shown, and others agree with him, that the present astronomical solar structure must have required five trillion years to evolve: so the only-two-billion-years-ago explosion seems to be pretty well exploded! Dr. E. A. Milne, of Oxford, has suggested that, instead of exploding from the said central point, these various great nebulae may have merely passed one-at-a-time, through or near this locality. Perhaps. But, since there may be hundreds of these nebulae, each averaging around 200,000 light-years in diameter, it must have taken perhaps a billion years for this great pageant to have passed the "given point;" and it must have been a wonderful sight to watch these huge systems rushing by, some of them probably breaking the speed-limit of 186,284 miles per second; and we cannot help thinking, in our simplicity, what a wonderful Traffic Policeman the Creator must be, to keep everything moving smoothly, in such a traffic jam as that, without a bad pile-up! It might be better, following Dr. Adams, to seek some *illusory effect,* rather than believe too strenuously in the "explosion" theory,—or the "expansion" theory, as some may prefer to call it; or in the "traffic jam" (!) theory of Dr. Milne.

It is very easy to formulate this newer hypothesis, now favored by many: *There is a distance-factor, which modifies this wave-length of light, which must be included in calculating the motions toward or from us of distant heavenly bodies, which otherwise would give an ILLUSORY effect of recession, and which increases regularly with the distance from the point of observation.* Of course, this is not at all an "explanation;" but only a formulation of our ignorance: but such a formulation is at least a good start, and indicates the correct line for our investigation. Since this illusion is in the light that comes to us, we should search in the nature of light itself for the answer; and, since it is in direct proportion to the distance that the light has traveled, the cause ought to be in the field traveled rather than in the light itself. Dr. William D. MacMillan, of the University of Chicago, ascribes this "distance-effect" to a slight loss of energy, on the part of light, during its long passage through

[3] Dr. Henry Norris Russell, Scientific American, June, 1929.

space; but Dr. Henry N. Russell, of Princeton and of Mt. Wilson, says,[4] "—Nor is there any evidence that light is weakened in its passage through space . . . no perceptible diminution after a journey of a million years." If we consider light as a vibration in the luminiferous ether, internal friction, in the course of millions of years, might well slow down the rate of vibration even more than the stated infinitesimal amount. But this internal friction should also operate to check the forward motion even more; and might cause a reversed "distance effect." Ether-friction offers no solution; and, ether being only an unproved hypothesis, to explain what it no longer explains, and being in many other ways now discredited, we might as well look for some more adequate theory of light propagation.

Newton conceived of light as composed of flying corpuscles; his contemporary, Huygens, as waves, the theory held until recently. Lately, more and more evidence has accumulated, to show that light must consist, somehow, of something that is both particles and waves. Drs. R. A. Millikan and G. Harvey Cameron[5] say, "Radiant energy can never escape from an atomic system without the disappearance of an equivalent amount of mass from that system." That is to say, energy is matter. Dr. Russell[6] says, "Radiant energy [that is, light] may . . . be arrested . . . and turned back into the equivalent of energy—material atoms. This is a bold speculation; but many distinguished mathematicians and physicists favor it." Reversing the process, is Jean's hypothesis,[7] "That in the stars matter is actually destroyed, as protons and electrons unite to form radiation." Professor George P. Thomson of Aberdeen University[8] says "Atoms can be made to emit light; and each atom emits its own characteristic wave-lengths." Dr. Millikan says,[9] "Although photons are not direct constituents of atoms, they are radiated whenever there is a loss of energy within the . . . structure." Dr. Russell well sums up these ideas:[10] "The stars may be regarded as heat engines. . . . They are drawing upon internal energy of some sort, transforming it into heat, and radiating it away into space. . . . May not the process of conversion of matter into energy be reversible, so that the diffuse energy of radiation ultimately becomes re-concentrated into atoms, starting a

[4] Scientific American, Sept., 1929.
[5] Scientific American, Aug., 1928.
[6] Scientific American, September, 1929.
[7] Quoted by Bishop Barnes, Scientific American, July, 1932.
[8] George Fisher Baker Lecture, Cornell University, 1930.
[9] Quoted by Jean Harrington, Scientific American, October, 1935.
[10] Scientific American, Aug., 1928.

new cycle of change; and so on, forever? . . . It may be that atoms are re-formed from radiation [that is, from light] somewhere in space."

It seems to me, in my ignorance as an outsider, that scientists have, thus far, at least partially overlooked two very important items: first, that the protons and electrons, especially those composing the simpler atoms, might be separated and thrown out as light particles, the electrons as ordinary light and the protons as Dr. Millikan's cosmic rays;[11] and, second, that an infinitesimal particle bearing a powerful charge of static electricity must be in some unique state of—let us not say, vibration, but —pulsation. Dr. Thomson says,[12] "The experiments I have described essentially involve the idea that the wave of the moving electron is spread over a number of the atoms" in the target. "The electron has not even an approximate boundary, as far as our present knowledge goes. It is more like a gas, which can expand" almost indefinitely. Sir Chandrasekhara Venkata Raman, winner of the 1930 Nobel Prize in physics, says[13] that "Light is like a string of base-balls, whizzing and curving as they speed ahead." He reports that he has discovered that these light-particles have a rotary motion, very much the same as rifle balls.

Let us now attempt a new, to me, at least, theory of light, which will explain the "distance-effect" with which we started. If we lay a series of billiard balls close together, in a straight line, along the cushion, and then roll another ball so as to strike one end of this line, in the direction of the line, this ball will come to rest, the shock will be transmitted as a vibration throughout the line, and the ball at the other end will fly off. Let us assume that light is a vibration transmitted through the atoms, or the electrons within the atoms, just as sound is a vibration of the molecules. The light, or energy, is generated in the interior of a star; and transmitted outward, as vibration. When this vibration reaches the outer limit of matter, at the outer part of the hydrogen super-atmosphere of the star, the last electron of hydrogen affected flies off, as a photon, or light-corpuscle, into space. When this light-electron, or photon, strikes

[11] The protons, said to be two thousand times as massive as electrons, might well, as held by Dr. Millikan, form these "cosmic rays," with 34 times the penetrative power of x-rays. Dr. Thomas W. Johnson, of Swarthmore, reporting to the Panama Canal Natural History Society, July, 1933, the results of his researches at the Barro Colorado Island Laboratory, Canal Zone, said, of the cosmic rays, "There is no indication whatever of any negative rays. . . . By far the greater part of the rays are positive. Measurements are complete enough to leave little room for doubt. . . . If these photons are produced, as Dr. Regener postulates, by the annihilation of matter, then these directional measurements show positively charged . . . fragments . . . with intensity of just about the right magnitude to correlate with the intensity of photons."
[12] An unusually valuable article, Scientific American, July, 1930.
[13] Philadelphia Public Ledger, June 27, 1931.

the outermost part of our atmosphere, it is stopped; but its impact is transmitted to us, as a vibration. This theory would explain many of the present problems of light: let us see how it jibes with the distance-effect.

We are told that light-rays may cross indefinitely, without affecting each other. This should be so, if light is vibratory; but not if it is corpuscular. Photons are very small; but they should occasionally strike one another and knock each other out of the procession. We might conceive of a beam of light as a long railway train of cars, the cars very small and very far apart. Occasionally, then, one of these cars is derailed and lost: what is the effect on the shape of the train? At first, nothing perceptible, since the gap is infinitesimal. Even a considerable number of such casualties would be imperceptible. But when this train is traveling on and on, for millions of years, the remaining electrons, being all charged with negative electricity and thus repelling each other, will tend to space themselves out, at equal distances; and the wave-length will be slightly increased. This is exactly the distance-effect for which we are looking; and our inquiry seems to be satisfied. If this "billiard ball," or vibro-corpuscular, theory of light should be found to be correct, the distance-effect, now interpreted as evidence of an expanding or exploding universe, is satisfactorily explained; and the "explosion" is exploded. If, as quite likely, this theory should be found not to be correct, we may still look for some other explanation apart from that of an exploding, or expanding, universe. If this or some similar theory of light is correct, parts of Professor Einstein's theory of relativity may also go into the discard: but that is another story.

Please pardon a momentary digression. Whenever I hear talk of "curved," "crumpled" or "warped" space, I am reminded of the story of the man who went into a cheap restaurant and ordered a cup of coffee "without cream." The waiter returned and said, "I am sorry, sir, but we are out of cream. Will you take your coffee without milk?" If space is just empty nothingness, it seems to me that the difference between curved, crumpled or warped, space and straight space is about the same as the difference between coffee without cream and coffee without milk. Of course, if all space is filled with luminiferous ether, and if the rays of light, in passing through that space are found to be crooked, we might be tempted to speak of "space," that is of the luminiferous ether, as "warped." But how can we know that the "space" is actually crooked, unless we run a straight line through it? and, if we can run a straight line through it, then the space itself cannot be curved, but only something lying in the space,— as the path of a ray of light. But what, in all creation is there that could warp that astounding paradox, the "luminiferous ether"?—that ether of which Lord Kelvin said that one cubic centimeter could not weigh more than one-quintillionth (.000,000,000,000,000,001) of a gram, while Sir Oliver Lodge insisted that this same cubic centimeter of paradox must have a mass (or weight) of one-quadrillion (1,000,000,-000,000,000) grams; and through which the earth and the sun rush at incalculable velocity without causing the slightest ripple; that luminiferous absurdity which, while affording us the logical phenomena of the aberration of light coming to us at right-angles to the line of our own local flight, and of change of color in light coming to us more nearly parallel to the line of our own flight or of the flight of the source of light, absolutely refuses to give us the slightest clue as to its own absolute motion or lack of motion,— as demonstrated by Michelson and Morley,—stubbornly refuses to tell us whether it is "without cream" or "without milk"? Why nothing can do all this,—*except NOTHING!* So that is the answer! I believe Professor Einstein has recently abandoned his former theory of curved space, though still believing in the expanding universe.

But, if we adopt the theory that interstellar light is corpuscular, we may easily imagine a train of photons, comprising a ray or beam of light, careening and staggering through space, inclining hither and yon as it enters one or another gravitational field of varying intensity and direction. Every gravitating body in the universe would be continually affecting and varying the direction of flight of every particle of light in the universe, in accordance with what we call Newton's laws. Yes, these gravitational fields would, in fact, make "space" appear to be very crooked indeed: though the space itself would be entirely neutral. But what is this gravitation; and how does it occupy all space? That, as I before said, is a very different story, and outside our present purview. At present, we are not studying gravitation, but light and a reputedly exploding universe. Nevertheless, this present study may help to clear up some outstanding difficulties of present theories concerning the nature of space.

Supposing that this theory should prove more or less correct,—we might, for a moment, stop to inquire what becomes of the light corpuscles sent out into empty space, which do not find any goal. The velocity of a body falling into the universe from an infinite distance depends upon the size and the mean density of the universe. We might hazard a guess, that that velocity is the velocity of light, 186,284 miles per second; and that this is the ideal velocity of the electrons in revolving around an atomic nucleus; and that this velocity has been attained by all electrons

by their falling back into the universe, after having flown out to the limit of their motion. As they drift back, they are continually forming new nebulae and new stellar systems. Such a light-particle might be a billion years in crossing the part of the universe which we know; it might pass on, for a trillion years, before it leaves the organized, central part of the universe; then out, and still out, through aeons of nebulous masses growing more and more tenuous; then still farther out, "a wandering star, for which is reserved the blackness of darkness" almost "for evermore." Finally, under the influence of gravitation, it comes to rest, in the infinity of infinities; and then slowly turns back again toward that distant center, gradually drifting toward other particles, to form the beginning of some new star-system. Finally, under enormous pressure, in the heart of some giant star, this electron may be forced into a heavy atom; and then torn loose again, to recommence its great round. Such a circuit is *one second of eternity.*

AN UNSTABLE GENE IN HABROBRACON

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In an experiment planned to obtain individuals mosaic for cantaloup and white—two eye color factors in Habrobracon—a number of wasps were found with small red spots in the eyes. Usually there was just one small spot in one eye though some eyes did have two or even three spots and, very rarely, both eyes were spotted. One hundred and four females, heterozygous for cantaloup and white, were bred. Ten produced one or more white-eyed males with a red spot.

The 104 females came from three or four mothers. It is reasonable to assume that one of these mothers carried the mutated gene for eye spotting and gave rise to the 10 females which produced the spotted-eyed males. Since so many daughters carried the mutated gene it is very probable that it was present, may even have arisen, in either the egg or the sperm which gave rise to the mother.

When the ratio in which spotted-eyed males appear is considered it is apparent that this character is different from any previously found in Habrobracon. The 10 mothers of the first spotted-eyed males produced 1230 sons of which 17 showed spots. Since the mothers were heterozygous and, therefore, half of the sons had black or cantaloup eyes, it is likely that other males showed the trait but in a masked condition. No record was made of eye colors so nothing can be concluded regarding the matter of spotted-eyed males in proportion to white-eyed males. It is

obvious, however, that this is the first unstable locus observed in Habrobracon.

Some of the original males were mated to white females as a means of preserving and studying the trait. Following this cross an inbreeding experiment was begun in an effort to increase the rate of appearance of the spotted-eyed individuals. In each generation some females were selected as virgins and mated to spotted-eyed males—brothers if possible—while other females were allowed to mate at random with a brother in the same vial.

Table I shows the results obtained in successive generations in two inbred lines. Two F_2 females were selected to start the lines and their

TABLE I

RESULTS OBTAINED FROM INBREEDING THE UNSTABLE GENE

Generation	Line I			Line II		
	White males	Unstable males	Percent	White males	Unstable males	Percent
F_4	315	35	10.0	185	29	13.5
F_5	1044	148	12.4	299	35	10.4
F_6	974	109	10.0	190	28	23.7
F_7	522	75	12.5	235	43	15.4
F_8	770	188	19.6			
F_9	844	181	17.6			

daughters produced the F_4 generations listed in the table. Inbreeding was continued in each generation following. In both cases later generations produced a higher percentage of spotted-eyed males than the early generations. There apparently are modifying factors present in the stocks which affect the mutability of the unstable gene and there has been some selection of those which speed up its mutation rate. Further proof of the above conclusion is provided when one late family is considered more closely. In the F_7 generation of Line I one mother produced 82 white males, 20 spotted-eyed males and 30 daughters—19.6 percent of the males were spotted. Five of the daughters when bred produced 463 white males and 132 spotted-eyed males in addition to the daughters—22.2 percent spotted males.

Since it is known that there are modifying factors which affect the rate of mutation of the unstable gene it was thought that outcrosses to unrelated stocks might introduce new modifiers. Spotted-eyed males were mated to stock 25 females. Table II shows the results in F_2 and F_3 of

TABLE II

RESULTS OBTAINED FROM AN OUTCROSS OF AN UNSTABLE MALE BY STOCK 25 FEMALE

Generation	Female No.	Type males	White males	Unstable males	Percent unstable
F_2	1	853	773	18	02.2
	2	408	420	12	02.7
	3	97	91	3	03.1
F_3	1	104	96	2	02.4
	2	423	587	32	05.1
	3	102	116	1	00.8

three such crosses. Modifiers in this case have lowered the mutation rate of the unstable gene. Other crosses of this sort need to be made and further counts considered.

The above experiment was discontinued because later results had to be neglected on account of a temperature effect. The wasps had been reared in an incubator at 30° C. but were moved and reared at room temperature for a while. It was found that this change had a marked effect on the mutation rate of the unstable gene. At first a few spotted-eyed males appeared but at later, slightly cooler, temperatures none appeared. As soon as wasps from the inbred lines were again reared in an incubator normal ratios of spotted-eyed males began to appear.

Since data were available it seemed worth while to consider whether age of mother was correlated in any way with mutation rate of this gene.

TABLE III

SUMMARY OF RESULTS WHEN GROUPED ACCORDING TO AGE OF MOTHER

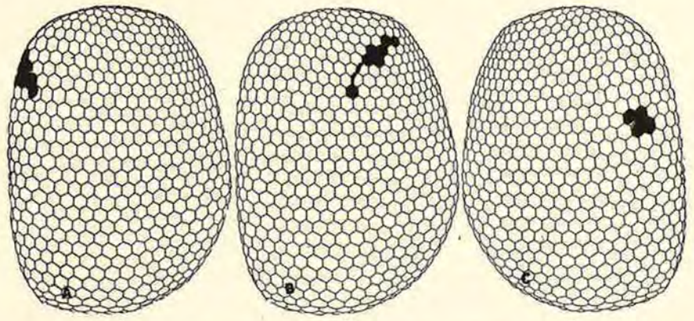
Vial	Normal	Unstable	Total	Percent unstable	Vial	Normal	Unstable	Total	Percent unstable
a	875	132	1007	12.1	g	387	61	448	13.6
b	896	163	1059	15.4	h	213	37	250	14.8
c	899	119	1018	11.7	i	202	30	232	12.9
d	904	111	1015	10.9	j	85	9	94	09.5
e	861	117	978	11.9	k	16	1	17	05.8
f	646	87	773	11.8					
					Totals	5984	867	6851	12.6

Table III shows the tabulated data. Females are normally transferred to new vials and given fresh caterpillars every third day. Thus vial A contains offspring from eggs laid the first three days after setting, vial B those laid on the 4th, 5th and 6th days and so on. A few of the females

were transferred 10 times though there was gradual dying off after the 5th vial. The highest percentage of spotted-eyed males appeared in the 2nd vial. There were almost as many, proportionately, in the 8th vial and only a few less in the 7th though, on the whole, the variations in numbers were not great. The mutability of this gene is evidently not greatly influenced by the age of the mother.

As was stated, the spots followed no definite pattern as to number per individual. The eyes of 112 males, having spotted-eyes, upon analysis showed 107 had one spot in one eye, five had one spot in each eye, eight had two spots in one eye and three had three spots in one eye. Later studies have brought to light other variations. Eyes have been found with as many as five spots.

The spots not only occur irregularly but they also vary a great deal in size and shape (Figs. A, B and C). Among 131 spots 74 were one



A B C

Eyes of Habrobracon showing the comparative sizes and shapes of the character, unstable.

to five ommatidia in size, 42 were six to ten ommatidia, 12 were 11 to 15 ommatidia while two affected 17 ommatidia and one colored 21 ommatidia. These spots consisted of clumps or streaks of ommatidia. The streaks might be one or two ommatidia in width and might run straight across the eye, up and down or at any angle. Some streaks zigzag, some are bent while some present almost unpigmented areas.

Another variable feature is the color. Some spots are very deep red with a slightly purplish cast and others are a light pink to lavender. Often one spot will show a number of shades of color. There may be some very dark ommatidia, some with lighter centers and some very light ommatidia in the same spot. It is of interest to note also that often only

one or two of the six walls of an ommatidium appear to be pigmented. Spots have been seen in which no one ommatidium had all its walls colored but two or more ommatidia had two or three or four walls darkened.

The pigment in these spots differs from any heretofore found in Habrobracon in that it is soluble in ethyl alcohol. In searching for a preservative it was found that the pigment also dissolved in formalin solution and in glycerin-water solution but that it did not dissolve in toluol.

Since the spots produced in the eyes are actually small in proportion to the size of the eye, since no male has ever been found with both eyes, one eye, half or even a fourth of an eye affected by this gene and since no male has ever produced a fraternity in which the unstable gene gave evidence of having mutated in the gonads, it is evident that this gene has a very limited time during as well as place in development at which it mutates. Also since females (diploid individuals) do not have spotted eyes, it is obvious that the mutated gene is a recessive.

Conclusions

A frequently mutating gene, unstable, has been found to cause red spots to appear in the white-eyed males of Habrobracon. These spots vary in number per eye, in size, shape and color. The ratio of spotted-eyed males in proportion to white-eyed was increased by inbreeding, no doubt because of selection of modifiers. An outcross to stock 25 introduced modifiers which decreased the mutation rate of unstable. Room temperatures keep the gene from mutating.

SOME THERAPEUTIC RESULTS WITH BACTERIOPHAGE

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In 1917, Felix d'Herelle (1) was trying to develop a more potent vaccine to treat troops afflicted with dysentery. He thought that by growing cultures in filtrates of previous growths, he might accomplish this. To his surprise, he found that the filtrates instead of increasing growth greatly lessened it, in some instances completely lysing or dissolving the cultures; tubes instead of growing cloudy became crystal clear. He filtered these newly dissolved tubes and found that the filtrate dissolved the cultures even faster. The process could be carried on endlessly, in some instances as many as a thousand generations, and always the product produced lysis. He tried dilutions of from one to ten, one to a hundred, one to a thousand, and so on to one to a trillion. The

phenomenon was just as effective in these tremendously high dilutions; furthermore he could take a tube diluted one to a trillion, re-dilute it after it had cleared, and repeat the phenomenon as before. He also found that this lytic agent was very specific; filtrates that might work very well against one organism would be powerless against another and those which were potent against the second might be futile against the first. Also, the virulence of the filtrate for a specific organism increased with repeated contacts; thus, at first, it might attack in dilutions of one to a thousand; filtrates against the daughter colony would work in dilutions of one to a hundred thousand; filtrates of that against the granddaughter of colonies, one to ten million, and so on.

D'Herelle realized that he had something new, something which grew and multiplied like bacteria yet destroyed bacteria; something which was highly specific, which would work in amazingly high dilutions, which increased in virulence toward a specific organism, and which would pass through filters ordinarily capable of withholding bacteria. To this substance he gave the name "Bacteriophage" or eater of bacteria.

Where did it come from? He began culturing the stools of patients suffering from dysentery. At first he found no trace of the phage. Then one day he would find it. He traced back to the clinical records of these patients, and noted that the day he found bacteriophage coincided with the beginning of improvement and convalescence. Thus phage seemed to be linked in some way with recovery from disease. The miraculous power of the Ganges River to cure disease has been known for centuries; individuals afflicted with all manner of horrible conditions bathe in its waters and are cured. D'Herelle filtered some Ganges water and found it teemed with phage. There was a village in India stricken with cholera. D'Herelle obtained phage from convalescents, prepared a large quantity of the material in his laboratory, and poured it into the village well. Immediately everybody recovered except a certain small group. He found these people were drinking from a different well; he poured phage into there, and quickly they, too, recovered.

What was it? D'Herelle conceived of phage as being a filterable virus akin to that causing sleeping sickness and infantile paralysis, save that instead of attacking people it attacked bacteria. Thus it was sort of a parasite of bacteria. He thought of disease as being a continuous battle between phage and the bacillus. If the phage won, the patient recovered; if the bacillus, the patient died; if they tended to balance each other and existed in a sort of symbiosis, then a chronic disease resulted. Bitter controversies arose in the scientific world as to D'Herelle's interpretation, many men believing that phage was an

enzyme or something else, but they all agreed on his observed facts; and the question is still in considerable dispute.

Five cases are being reported to give some idea of the therapeutic possibilities with bacteriophage. These cases may be considered as controlled in that all other treatment was stopped, the bacterioghage was made on the organism affecting each individual, and results were so prompt and consistent with similarly treated cases that a direct causal effect of the bacteriophage may be assumed.

Case 1. Chronic Furunculosis. Seven years before, a physician pricked himself with a needle. This was followed by a severe blood stream infection during which he almost died. He recovered, however, but since that time was afflicted with recurrent crops of boils, which were increasing in frequency and severity. He tried all of the prescribed treatments without success. In January 1934, bacteriophage was grown on organisms obtained from one of his lesions, and re-injected into him as a vaccine. Since that time, over two years, he has had no boils.

Case 2. Colitis. A woman of 35 had been afflicted with colitis for about 15 years. She had ten to fifteen bowel movements a day. Organisms were cultured from her stool, an autogenous bacteriophage prepared on them, and she was given a course by mouth and injections into the skin. Since November 1934, she has gained considerable weight, and now has only one or two movements a day.

Case 3. Septicaemia. A boy of 20 had an infected heel in October of 1935, the infection eventually entering his blood stream. On five separate occasions the organism was recovered from his blood. The prognosis in cases of this sort is almost 100% fatal. An autogenous phage was prepared and injected into the patient during a period of three months. Since January 1936 his temperature has been normal and repeated blood cultures have been sterile. Prof. Ward MacNeal (2) of the N. Y. Post-graduate Hospital, reports 100 similar phage-treated cases with a 25% recovery rate.

Case 4. Pelvic Infection. A woman of 35 had an abortion followed by a severe pelvic infection. It was of a spreading type, the patient grew progressively worse, and the outlook was very grave. Bacteriophage was injected, rapidly a sharply localized abscess formed, and from it organisms lysed by the bacteriophage were obtained. The patient is doing housework twenty months after her illness.

Case 5. Carbuncle. A man with moderately severe diabetes developed a carbuncle on his arm, the site being one difficult to treat surgically. There was a steady progression in its size and the development of

satellite pustules. Wet dressings of bacteriophage were put upon it, the infection was stopped, and the patient was able to leave the hospital in two weeks.

Summary

Results with bacteriophage grown on the infecting organism of a variety of human clinical conditions have resulted in good to spectacular results. In a series of 60 controlled cases, results have been good in approximately 70 per cent. Much work remains to be done, and only with a firm realization of the inherent difficulties in clinical evaluation and with adequate bacteriological control can definite progress be made in this potentially fruitful field.

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THE EFFECT OF X-RAYS ON THE CARCINOGENIC ACTIVITY OF A TAR EXTRACT

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Only limited attempts have been made to study the effect of local factors on tar as concerning its carcinogenic activity. Effects of heating and cooling, dilution of the tar, dialysis and electrolysis have been tested on only limited groups according to the summaries of Woglom (10), and Seelig and Cooper (8).

After some attempts to affect the carcinogenic incidence of tar by passing an electric current through the substance, Katzareff (3) reported an increase in incidence as well as rate of growth of tar tumors. Raposa (6) and others (8 & 10), however, demonstrated that the increase was probably due, not to any change of the tar as the result of the electric treatment, but to an increase in temperature, since an increase of the temperature was noted when the electric current was passed through the mixture.

A somewhat different attack was made by Bonne and Stoel (1). By x-raying the skin of mice and then painting with tar, they were able to induce cellular changes which seemed to hasten necrosis in the treated area, as compared to that in non-rayed but painted areas on other mice.

Castigliomi (2) treated 4 groups of mice, some tarred and radiated over the same site and others tarred over one site, and radiated over another. He concluded that the radiation in the painted area hastened the process of carcinogenesis through direct crippling of the local and general defense mechanism of the body. It would be difficult, however, to estimate to what extent the x-rays affected the direct action of the tar.

There have been a few other studies on local and general factors in tar cancer. Since light as well as x-radiation may play a part in carcinogenesis: the work of Neumann (5); Vles, de Coulton and Ugo (9); Schorr and Ssobolewa (7); and others (10 & 8) are of interest in this connection. Also, more recently, the study of light as a factor in carcinogenesis has been given much further attention. The workers listed above, however concluded, in general, that light is still a doubtful factor as affecting carcinoma.

In a series of experiments in which an attempt is being made to discover the effects of biopsy on tar-induced carcinoma of mice, a benzene extract of coal pitch (4) is being used to produce such tumors. The experiment being here reported was planned to run concurrently with the above, in which some of the tar extract used would be exposed to x-radiation.

Materials and Methods

The tar extract was kept in two wide mouthed two-ounce bottles which had been filled to a depth of approximately one-half inch with the extract. The extract in bottle A was subjected to x-radiation, bottle B was used as the control. During treatment bottle A was placed directly under the x-ray target so as to receive the maximum amount of the x-radiation. Exposures were made every two weeks under the following conditions: K. V. 90; M. A. 4: Distance 20 cm. unfiltered; dosage 500 R. U. for a total of 3000 R. U.

The treatment accorded all experimental mice was as follows: The interscapular area of the mouse was clipped and the tar extract applied every third day until a well defined upgrowth, 2–3 mm. in diameter, was noted.

From a group of 170 animals painted with the extract which had been exposed to x-radiation, 41 animals died during the painting period and 129 individuals developed ulcerated tumors. From the second group of 354 mice treated with the control extract, 104 animals died during the painting period and 250 animals developed tumors.

The results obtained are summarized in Table I. The animals exposed to the paintings with treated extract gave rise to tumors on an

TABLE I

Resulted obtained from animals treated with X-rayed and control extracts

	Number mice started	Number died during treatment	Average days produced death	Number mice developed tumors	Days required to induce tumors
X-rayed extract	170	41	138.8 3.62 S.D.	129	156.6 2.02 S.D.
Control extract	354	104	100.0 6.0 S.D.	250	137.7 2.31 S.D.

average of 153.67 days. The 250 animals exposed to untreated extract gave rise to original tumors in an average of 137.73 days. While a difference of 15.94 days in favor of the non-x-rayed group is noted, statistically this difference may be considered insignificant or due to chance sampling. No significant differences were noted when the two groups were listed according to sex. These results are given in table Ia.

TABLE Ia

Data obtained when animals were grouped according to sex

Extract	Number mice	Sex	Average number days require to induce tumor
X-rayed	58	Female	152.4 2.21 S.D.
"	69	Male	154.4 1.84 S.D.
Control	121	Female	133.9 2.19 S.D.
"	120	Male	138.1 2.49 S.D.

The 41 animals of the experimental group that died during the painting period lived, on the average, 138.85 days. The 104 animals from the control group that died during the painting period lived, on the average, 100 days. A significant differences of 38.85 days, indicates that animals painted with untreated extract were less affected by the painting and therefore had a longer survival period.

Conclusion

It may be assumed, from the data presented, that x-radiation of the tar extract does reduce its toxic or lethal effects upon the mice. However, the time required to induce carcinoma does not seem significantly

affected. It is not the purpose of this paper to attempt to analyze the direct effects of the x-rays on the tar extract itself, but it is believed that some ionic rearrangements do take place among the high boiling-point fractions or complex elements.

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FURTHER STUDIES OF LARVAL GRAFTS IN ADULT RED-SPOTTED NEWTS

By W. H. Wright and H. H. Collins
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Fragments of late premetamorphic larvae as large as the head and thorax are found to be viable as grafts, when implanted upon the adult body as well as similar grafts of much younger larvae used in earlier experiments. Functional hearts are found to be present in these grafts, more than seven months after implantation, and the grafts appear to be permanently adjusted to their hosts. Head grafts of this age, as in the younger head grafts previously studied, invariably become more or less amorphous masses of tissue when implanted on the ends of amputated host limbs, but the heart almost always persists. This organ displays a much stronger resistance to the factors as yet not understood, which bring about de-differentiation of other organ systems, present in the larval tissue at time of implantation.

Larval implants, in general, show great variation in form and rate of growth, although the fragments are identical in size and age at the time of implantation. In some experiments, head grafts, for example, have been placed in different locations on the body of the host. There are clear indications that some locations are more suitable than others for the best development of larval grafts. However, some of the widest variations

observed in the growth and form of larval implants are observed in identical grafts implanted in identical locations on the body of the host. These irregularities may be due in part to slight unobserved differences in operative technique. However, it is suggested that they may be largely due to variations in the intensity of tissue antagonism involved in the interactions between host and graft. The demonstration of the existence of individuality differentials in the red-spotted newt (the first case known in urodeles in general) by Anderson ('33) in his study of skin grafts and by Horowitz (mss. '36) in his work on subcutaneous muscle implants would seem to justify this hypothesis.

IMPLANTATION OF TESTES AND OVARIES IN THE RED-SPOTTED NEWT

By Edna Higbee
University of Pittsburgh

It was found in experiments on supersexing and implantation of testicular material into females that gonads may be successfully implanted in pockets under the skin or in the body cavity of the Red-spotted Newt. Also that there appears to be no such tissue antagonism as is shown in Pettinari's work on mammals. He used more than 350 animals and found first that "both autoplastic and homoplastic ovarian grafts take hold readily, with proper technique, but heteroplastic grafts become absorbed." Second that "for successful implantation the host must lack, absolutely or relatively, its sex hormones." Third "that the presence of an unsuccessful preceding graft of any type makes the animal refractory to succeeding grafts."

In the experiments carried out by the writer the methods of implantation were described previously by Higbee (34). 34 male animals were given extra testis grafts; 36 animals (males and females) were castrated and given either testis or ovarian implants depending on whether the host had been male or female at the beginning of the investigation (castrated males were given ovarian grafts, while castrated females were given testicular implants.) 10 females had one ovary removed and had 2 testes added to the body cavity. 12 males of the Red-spotted Newt (*Triturus viridescens viridescens* Rafinesque) were castrated and received testicular implants from *Triturus torosus*. All of these animals were kept in aquaria until death occurred and the information collected covers a period of from 2 months to 2 years.

It was found upon gross observation, that additional testis added to males not having had their own sex glands removed, took hold in the host's

body and were present in as healthy condition as those in the hosts which had had their sex glands removed. Also that testis grafts, in female hosts with only one ovary removed, were well established and did not seem to be affected by any antagonism from the remaining ovary. However, in 10 animals which had undergone a second set of supersexing operations some months following the first ones, antagonism was developed due to the presence of a too large amount of testicular hormone. The excess amount of hormone resulted in the destruction of the host's own testes in some cases as well as the complete disappearance of both grafts in other cases.

The results obtained tend to show that in the newt, at least, gonad material may be added in limited amounts without the complete removal of the sex hormones through castration as healthy implants were found upon autopsy to be established whether in a supersexed host or a castrated host.

THE EFFECT OF IMPLANTATION OF TESTES AND OVARIES ON THE CLOACAL GLANDS OF THE RED-SPOTTED NEWT

By Edna Higbee
University of Pittsburgh

In the normal Red-spotted Newt the cloacal eminence and the vent of the male is more prominent than that of the female. Internally in the male, the walls of the cloacal chamber rise into ridges which run caudad and ventrad toward the lips of the cloaca. A depression occurring on the dorsal side of the cloacal chamber, runs cephalad into a T-shape and becomes the direct continuation of the tubular portion of the cloaca. From the ventral wall of the cloaca, though in appearance from the dorsal side, a tongue-like elevation arises, which caudad becomes broken up into ridges on which the cloacal glands open.

Kingsbury (95) has shown that there are three groups of glands in the cloacal region of the male: "(1) the abdominal glands which extend from the cephalic part of the cloaca and open on finger-like papillae at its posterior end; (2) cloacal glands which form the bulk of the lateral walls of the cloaca and open on large villi along the sides of this organ; (3) pelvic glands, lodged anterior to the cloaca, which open mainly on its dorsal and dorso-lateral walls."

As has already been stated the cloaca of the female is much less prominent that that of the male; the vent is found on a ridge-like elevation. No papillae are found on the lips, which are simple in outline. The internal structure of the cloacal chamber is much simpler than in the male.

The low folds of the walls found here do not resemble those found in the caudal portion of the cloaca of the male. A ridge appears in the caudal end of the dorsal side of the cloaca, which increases in height to within a short distance of the oviducal papillae. At the cephalic end of the ridge a deep dorsal depression occurs. In this depression the papillae appear, which bear the mouths of the oviducts. The ventral portion of the cloacal cavity extends itself laterally and becomes the intestine. The bladder opens upon the ventral side of the cloaca just ventral to the intestinal opening and slightly cephalad of the oviduct papillae.

In males from which the testis had been removed these cloacal glands atrophy. In castrated males with ovarian grafts the glands are atrophied but to a less extent than those from which the testes had been completely removed and show a slight activity. The pelvic glands also maintain some activity. This is determined by the presence of some secretion in the lumina of the gland tubules. These results are comparable to those obtained by Adams 1933. In supersexed males as well as in viridescens castrates with torosus implants the glands of the cloaca increased in number. Transplanting of two testes into a castrated female caused a case of partial sex reversal in one animal, previously reported, Higbee (34), and caused the development of the three sets of male glands in the cloacal walls of the female. These results agree with those obtained by Noble and Pope (29) on Desmognathus. More detailed study will be made to determine which set of glands developed the best and if possible from what tissue they arose.

The experiments thus far completed show that cloacal glands in males and females are influenced by hormones produced by the gonads. Also that the female possesses latent possibilities for the development of cloacal glands of the male type and are only brought into expression by implantations of the testicular hormone.

ORGANISMAL DIFFERENTIALS IN A URODELE, *TRITURUS VIRIDESCENS*

By Norman Horowitz
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In a notable series of papers, Loeb and his associates have investigated the problem of individuality in the common experimental rodents by means of tissue transplantation. It has been the general opinion of workers in the field that organismal differentials are most pronounced in the higher mammals, becoming less distinct in the lower vertebrates, and that they are undetectable, except in extreme heterotransplantation,

below the Anura. This opinion is based largely upon the results of skin grafting in Urodeles and fishes, although recent work (Anderson, '32) has shown that differential reactions are demonstrable in Urodele skin grafts.

In order to test the validity of this conclusion, auto- and homografts of striated leg muscle were implanted subcutaneously, following the method of Loeb, in the Urodele, *Triturus viridescens viridescens* (Raf.). Heterotransplantations were made of the same tissue from *Triturus pyrrhogaster* to *Triturus viridescens*. Animals were killed at weekly intervals, and the grafted tissue was examined microscopically. The chief histologic changes observable over a period of 6–8 weeks were as follows:

Autografts: Beginning with the first week after operation, the graft was progressively encapsulated and infiltrated by fibrous connective tissue. This was accompanied by an invasion of the area by fibroblasts. Lymphocytes in small numbers were visible on the edges of the graft up to the third week after operation, but subsequently disappeared. At the end of six weeks, the grafted muscle was still alive and was well-vascularized, with fibrous tissue forming an interlacing network between the muscle bundles.

Homografts: The graft was rapidly invaded by fibrous tissue and fibroblasts. Invasion was accompanied by active replacement of muscle by connective tissue. Beginning with the third week after operation, lymphocytes appeared in the graft and rapidly increased in number; by the fifth week, the concentration of lymphocytes was extremely high, particularly in the regions where the muscle had not yet been replaced. During the sixth week the lymphocyte concentration began to fall off, and many large epithelioid cells appeared in the area. By the eighth week, the graft was completely destroyed.

Heterografts: Infiltration of fibrous tissue between bundles of the muscle graft was noticeable in the first week after implantation. A few lymphocytes and giant epithelioid cells appeared during the second week. Fibroblast and lymphocyte concentrations increased progressively up to the sixth week, at which time polymorphonuclear leucocytes appeared in the graft. By the end of the sixth week, the graft was completely destroyed.

These experiments show the presence of well-marked organismal differentials in Urodeles. The observed reactions agree to a remarkable extent with those described by Loeb and others for mammals. As in mammalian grafts, a fibroblastic is followed by a lymphocytic host reaction, resulting in eventual destruction of homo- and heterografts and their replacement by fibrous connective tissue. Autografts are preserved. As reported for mammals (Fleisher '18, '20; Loeb '30), these reactions are more intense in homo- than in heterografts. Polymorphonuclear leucocytes, furthermore, appear in the hetero-, but not in the homo- or autografts. Loeb ('30) reports the presence of giant epithelioid cells in homografts where tissue remains preserved. The present observations showed numerous giant epithelioid cells in the final stages of destruction of homografts, and a fewer number in the corresponding stages in heterografts. The chief difference between the reactions as described for mammals and those in *T. viridescens* is in the length of time required for destruction of the graft. Loeb ('30) gives 20–30 days after operation for homografts, and 14–28 days for heterografts, as the time required for destruction of the transplant. The present experiments showed 49–56 days for homografts and 35–42 days for heterografts as the time required for destruction of the transplant. This time difference may be due to less marked individuality in Urodeles than in mammals, or simply to differences in body temperature. The presence, however, in Urodeles of distinct auto-, homo-, and hetero-differentials cannot be disputed.

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A LARVAL GRAFT TO AN ADULT TRITURUS

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The observations reported here were made on a larval fragment consisting of head and trunk portions which had remained on the body of the host for five months. The larva from which the fragment was taken, at the time of transplantation, was equivalent to the 46 stage of Harrison for Amblystoma.

After transplantation, no exterior changes, beyond loss of external gills, were observable. Throughout it has maintained its normal bilateral symmetry.

Ten days after transplantation the graft exhibited a marked gulping reflex characteristic of the adult. This reflex has been maintained.

In twenty-one days the graft showed voluntary opening and closing

of the mouth accompanied by a quite obvious snapping reflex when the mandible was stimulated with a blunt probe. This reflex has diminished in intensity.

Thirty-seven days after transplantation the graft exhibited a slight movement of the head which was independent of the movements of the body wall of the host. This movement has gradually become more pronounced.

The eyes of the graft not only persisted but grew so normally that 41 days after transplantation, they exhibited a decided pupillary reflex. This optic reflex has persisted, without change, since the initial observation. The reaction to light stimuli has been accompanied by a nictitating reflex. At 8 months the eyes are post-metamorphic in gross structure.

At 8 months the graft shows the following additional characteristics:

1. The presence of a large pouch which is continuous with the mouth cavity, the function of which is apparently for the storage of gulped air.

2. Larvae comparable to the 46 stage of Harrison for Amblystoma show the presence of olfactory pits. This graft, however, has developed nasal passages which communicate with the mouth cavity, a typically adult condition.

On the basis of the observations recorded above, one can justifiably assume that the central nervous system of this graft has persisted and has undergone, to a considerable degree, independent and progressive development.

CENTRAL NERVOUS SYSTEM OF TRANSPLANTED LARVAL FRAGMENTS

By Henry Idzkowsky
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In this study, larval fragments of the newt, *Triturus viridescens viridescens*, were transplanted to the adult of that form. The larvae were of an age comparable to stage 46 of Harrison for Amblystoma. The observations recorded here were made on serial, histological sections of the transplants after they had remained on the body of the host twelve to thirty days.

Within a week after the larval fragments are transplanted, the brain, contained within most of the fragments, shows degenerative changes. The spinal cord persists, however, as a structure quite similar, histologically, to normal larval spinal cord.

In most cases were the spinal cord persists it is subjected to pressure by encroaching connective tissue. This pressure causes a dorso-ventral

flattening with respect to the original dorso-ventral axis of the cord. As the pressure increases it becomes localized at or near the center of the dorsal and ventral surfaces, at the periphery of the cord, so that continued pressure, acting simultaneously on both the dorsal and ventral surfaces, eventually sections the cord, longitudinally, into two halves. This sectioning begins at the end of the graft adjacent to the tissues of the host, which in all cases is the caudal portion of the cord, and proceeds toward the cranial portion. In all the sections examined the most cranial portion of the cord had not as yet been divided, so that the tracts of the two segments converged at this point.

The histological changes brought about by this connective tissue pressure, with consequent sectioning of the cord, are as follows:

1. At the onset of pressure, with consequent flattening of the cord, the central canal of the cord becomes correspondingly flattened so that the pressure which becomes localized at a central area causes the inner dorsal and ventral portions of the ependyma to come in contact with one another.

2. At the point of contact of dorsal and ventral ependymal cells, the original single canal becomes constricted into two independent canals.

3. Some of the ependymal, germinal and neuroglia cells at the dorsal and ventral portions of the two newly formed cords have moved into the contiguous sides of the cords so that a symmetrical arrangement of these cells is attained in both of the two segments. The arrangement and histological picture of the cells of these two newly formed cords is entirely comparable to that found in normal early larval stages of the newt, *Triturus*.

Of the conclusions which can be drawn from these observations, the most salient one is that the larval spinal cord at a stage of development comparable to the 46 stage of Harrison for Amblystoma, has, under the conditions stated, the potentiality to withstand the process of sectioning as brought about by encroaching connective tissue. And that this potentiality is accompanied by the power to reform, under such conditions, two complete spinal cords. Consequently, the cord, at this stage, may be considered to be a totipotent rather than a unipotent system.

DIFFERENTIATING IRON HAEMATOXYLIN STAINS

By Robert T. Hance
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In many laboratories in recent years difficulty has been experienced in securing the desired contrast when destaining that most useful of all cytological stains, iron haematoxylin. Frequently the cytoplasm retains sufficient stain to give it a muddy appearance.

Various methods have been suggested for correcting this difficulty, the best of which involve the use of saturated aqueous solution of picric acid in place of the usual iron alum solution. Though excellent results are obtained with picric acid, differentiation is a very slow process frequently requiring hours to accomplish.

Equally satisfactory, if not superior in end results and rapidity, is the technique we have been using recently. The slides are mordanted and stained in haematoxylin prepared by Hance's method and then partially destained in the usual ferric alum. From ferric alum the slide is placed for 5 to 10 minutes (longer if necessary) in the common three per cent hydrogen peroxide solution available in all drug stores. This bleaches the cytoplasm and removes the yellowish brown color that interferes with the desirable sharp contrast between the chromatin and other parts of the cell. Now wash the slide in running tap water for several hours and carry it through the usual dehydrating procedures. The addition of a trace of ammonium hydroxide or of sodium bicarbonate to the first wash water may serve to intensify the stain.

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CYTOLOGICAL STUDIES ON MAMMALIAN SALIVARY GLANDS

By Robert T. Hance and Students
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The interest aroused by the rediscovery of the enormously large chromosomes in the salivary glands of certain diptera has raised several interesting questions involving the cause for this size, the karyoplasmic relation in general, and the possible universality of this cytological phenomenon in other groups of animals.

Why do the cells and their nuclei in the salivary glands of certain insects grow to be almost a hundred times larger than the common cells of the body? Why do these cells not complete division? What chemical factors produce these results?

These questions bear definitely on the problems of growth, which are of interest not only on theoretical ground but because any knowledge gained may aid in the control of abnormal growths with which the human organism is so seriously afflicted.

A preliminary survey of the salivary glands of the pig (adult and several stages in embryonic development), rat, cat, guinea pig, mouse and man indicates the cells to be large, as most secretory cells are, but the nuclei appear normal in size. Dividing cells when found show chromosomes that are large but not exceptionally so. Accurate measurements of cell body, nucleus and of the chromosomes themselves may bring to light difference from normal and are now in the process of being made.

NUCLEAR CYTOPLASMIC RELATIONS IN HUMAN PHAGOCYTES

By K. W. O. Runser and Robert T. Hance
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Old problems, like chikens, have a tendency to come home to roost at recurrent intervals. The relationship of cytoplasm and nucleus, around which so much interest, study and speculation centered several decades ago, dropped from general attention, due largely to a temporary exhaustion of techniques for further investigation.

Out of the old studies came the general conclusions that there is a rough functional-size relationship between nucleus and cytosome.

As Boveri wrote, "the constant, which we must accept as something given and not at present analyzable, is the fixed proportion between nuclear volume and protoplasmic volume, namely the karyoplasmic ratio."

The irregularity of the nucleus in the phagocyte suggested it as possibly good material for study along these lines.

Our observations to date indicate that though the area of the nucleus is approximately a third of the cell as a whole there are differences between the cells of different individuals that seem significant. These preliminary studies point to the necessity for a thorough examination of the extent of this individual variation and of its possible correlation with the functional activity of the cell and perhaps even with that of the body of which the cell is a part.

THE CHROMOSOMES OF *VALLISNERIA SPIRALIS*

By Kenneth A. Bergstresser
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At the suggestion of Dr. Hance this investigation of the root-tip chromosomes of *Vallisneria spiralis* was started. Vallisneria is a common aquarium plant and is very easily grown in any laboratory.

The size of the roots in this plant makes the technique of handling and preparing the tips for cutting a rather delicate one. The root-tips were fixed in Flemmings from 8 to 10 hours and washed in running water for the same length of time. In order to facilitate dehydration the drop method was used which was found to be very successful. The tips were cleared in cedar oil followed by chloroform, and embedded in paraffin.

First observations revealed these chromosomes to be large and consequently excellent material for study and experimentation.

Jørgensen (1927) working in Denmark, described the chromosomes of two varieties of Vallisneria and according to his observations the number for *V. spiralis* is twenty.

According to my observations, the number seems to be eighteen. However, due to a tendency for certain chromosomes to adhere end to end it is impossible at present to make a definite statement concerning the number.

A longitudinal splitting is pronounced in most of the larger chromosomes in the metaphase stage and is visible at earlier stages. This splitting is seen at the distal part of the metaphase chromosomes.

Further investigation into this problem is now in progress.

A RAPID METHOD FOR MAKING PERMANENT SMEARS OF SALIVARY CHROMOSOMES

By Jane E. Frankston and George J. Dambach
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Many methods have appeared from time to time for making permanent smears with the aid of aceto-carmine. Belling (1921) worked out a method for plant cytology; McClintock (1929), Steere (1931) and Barrett (1932) improved Belling's method. Many of these methods have been tried on the salivary chromosomes of Diptera. Aceto-carmine when used alone gave a good stain although it was not permanent. Iron-aceto-carmine required considerable time, but was also a good stain. The present authors have found that by combining Belling's aceto-carmine method with Barrett's method a permanent slide of salivary chromosomes could be made in less than 15 minutes.

The material on which this method was worked out was the salivary glands of the larvae of the wild type of *Drosophila melanogaster*, studied so much recently by Heitz and Baur (1933), Painter (1934) and others. It was our experience that the chromosomes from larvae just ready to pupate held the stain more readily than younger larvae.

The salivary glands were dissected from the larvae with the aid of a binocular; they were translucent bodies with fat cells attached at the posterior end and on one side. A few drops of Belling's aceto-carmine stain were then placed on the gland and left for a period of five to ten minutes. The chromatin material stained a darker red than the surrounding cytoplasm. When sufficient time had elapsed a cover glass was placed on the glands and a smear made by pressing on the cover glass. The slide was then examined for chromosomes. If satisfactory, more stain was added and left for a few minutes until the cover glass automatically raised above the preparation. The cover glass was then removed and a few drops of Barrett's iron-hematoxylin was added. This was poured off at once by tilting the slide and a few drops of 70 per cent alcohol were added, followed by 95 per cent. The slide was cleared by means of xylol and mounted in balsam.

The swelling action of acetic acid on the chromatin material can be controlled by the alcohol which can be varied in the iron-hematoxylin to suit the desired amount of swelling.

It has been suggested by Marshak (1936) that either butyric acid or proprionic acid swell the salivary chromosomes to a greater degree, but the use of these acids takes as much as two to three weeks for satisfactory results.

A summary of these stains follows:

Belling's aceto-carmine
45 per cent acetic acid saturated with carmine, boiled for 10 minutes, filtered when cold.

Barrett's iron-hematoxylin
One part of the solution made of equal parts of 0.5 per cent hematoxylin and 4 per cent iron alum.
One part of 95 per cent alcohol.
Two parts of glacial acetic acid.
After the hematoxylin is dissolved a small quantity of sodium bicarbonate is added to hasten the ripening of the hematoxylin.

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ASYMMETRICAL GROWTH OF LARVAL GRAFTS OF *TRITURUS VIRIDESCENS VIRIDESCENS* RAFINESQUE

By Frank E. Bolden
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The purpose of this paper is to give the result of some observations pertaining to asymmetrical growth of a larval graft upon the adult host of the newt, *Triturus viridescens viridescens*. A homoio transplantation of a larval fragment containing the head and thoracic regions was effected upon the amputated forelimb of an adult host. Both the adult specimen and the larva were anesthetized with a Ringer chloretone solution for 15 to 20 minutes. The left forelimb of the adult host was prepared to receive the graft in the following manner. The digits were held with a pair of forceps, while a sharp scalpel was drawn entirely around the limb just above the elbow and the host's body. The soft limb tissues were severed to the bone and rolled up like a sleeve towards the host's body, thus exposing the humerus as far as possible. A pair of small scissors was used to excise the humerus, thus leaving only the boneless sleeve to receive the larval graft. The larval graft was prepared by severing the desired fragment with a scalpel. The margin of the skin pocket was held open and the graft inserted. The free margins of the skin pocket were neatly adjusted to its surface in order to prevent, if possible, the loss of the graft.

The graft healed in place within three days after operation and vascularization ensued within three to nine days. During the vascularization period, the larval head became quite large, and by the time the period had subsided, the fragment had lost all features of identity. The graft resembled a large blister-like mass, in which the tissue had become dedifferentiated. The color changed from dark red to light red, then pink and finally to the normal spotted pattern. It was further observed that the graft was resorbed by the host, but reappeared on the twelfth day. Histological study showed the appearance of a number of lymphocytes in the region of the graft during a period ranging from two to eight days. This feature is common to most homoiotransplantations.

A definite circulatory system was found to exist in the graft. The original larval fragment contained a heart, located in the ventral region directly between the gills. The graft was placed in such a position that the pulsations of the heart could be observed on the ventral side, without disturbing the host or larva. As previously described by Wright (34), the grafted heart beat was much slower than the normal larval heart beat. Also, the two separate and distinct blood circulations were in evidence, the slower system being associated with the larval graft, and the faster one with the adult. A particular and interesting feature, observed during the seventh week of the experiment, was the complete disappearance of the larval heart, and its corresponding circulatory system. Accurate study and observation showed the graft to be dependent upon the circulatory system of the adult host. Further studies are being made in an attempt to gather more specific and enlightening data as to the cause of the resorption of the heart.

The eye, mouth, and nasal orifices persisted longest during modification of the larval head. At the same time, differentiation of color on the dorsal and ventral surfaces of the graft could be discerned. Pigmentation became denser as the graft became older. The eyes persisted with features that, superficially at least, appeared to be normal. However, the eyes did not appear symmetrical. The right eye of the graft was larger than the left. The left eye still retains a thin membranous tissue over the entire structure. At present the eyes are non-functional.

Evidence of a mouth was shown on the thirteenth day by the appearance of a small aperture surrounded by cartilaginous tissue. Characteristic mouth modification was more pronounced on the eighteenth day. At this time, the mouth, deviating from normal larval mouth growth, was filled with a tissue growth, which prohibited articulation of the jaws. To date, the mouth persists in remaining open and filled by this tissue. During resorption and subsequent growth, the adult host tissue grew over the graft and filled in the mouth area. The graft was unable to inhibit the growth organizer of the adult host tissue.

The nasal orifices were present but gave no evidence of being functional.

Great variation in the size of larval limbs has been observed by Collins (32) and Wright (34). When the limb buds began to grow, a slight diminution in the size of the graft was observed. Where a right and left forelimb developed from the same graft, one showed greater development than the other. In this particular instance, after 102 days of growth, the right forelimb showed a length of 3.5 mm.; while the left forelimb attained a length of only 2.3 mm. Both limbs developed on the ventro lateral surface of the head graft. Each developing limb contained a different number of digits, as observed by Collins (32). The digits were not as fully developed as those of a regenerating adult form, being shorter and more blunt in form. The five digits on the left, short forelimb were arranged in two rows, the first row having two and the second row having three. The longer right forelimb had four digits arranged according to the normal amphibian pattern. Inhibition of the regeneration of the adult host limb by the larval graft, as studied by Collins and Wright, is still evident to date. Larval limb movement was shown to be independent of that of the host. Both larval limbs respond to stimulation, and move in specific directions. The shorter forelimb can move in both a vertical and a horizontal direction, while the longer forelimb is able to move only in a vertical direction. Adult host tissue appears to have grown over the longer forelimb at the elbow joint, thus inhibiting horizontal movement. The adult host uses the entire limb graft in locomotion, the graft substituting for the amputated forelimb of the host. Thus we have asymmetrical growth and independent locomotor responses in the adult host, and within the graft itself.

It is a well known fact that the adult host is a mosaic of regenerative territories, each having different morphological potentialities. Therefore, the question as to whether host tissue was organized by larval tissue or vice versa, enters into this problem of asymmetrical growth of larval grafts. No definite answer has been presented to date. An investigation with regard to this problem is now in progress.

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SEASONAL CHANGES IN THE HEDONIC GLANDS OF THE MALE VERMILION-SPOTTED NEWT, *TRITURUS VIRIDESCENS*

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In the vermilion-spotted newt, *Triturus viridescens*, the adult male and female possess hedonic or head glands, which structures are present through the year. These hedonic glands appear as minute depressions in the integument, or as pits. They are located directly behind and on the level with the eye, on each side of the head. The number of hedonic glands on each side varies from three to four in males and from one to four in females. In the adult male these glands are more conspicuous in appearance than in the female. They are functional in the male during the breeding season, secreting a substance which attracts the female and causes her to collect the spermatophores which are deposited in the water by the male.

As amplexus was observed frequently during the year, the study was undertaken to determine whether the adult male hedonic glands functioned continuously throughout the year, or only during the true breeding season.

Adult males were used for the study. The hedonic glands were removed from the side of the head, and histologic studies were made of the glands' activities. The studies were pursued through the year, and observation revealed the following:

The pits in the adult male are formed from simple depressions or invaginations of epithelium. They are lined with columnar epithelium, under which are the hedonic glands. The glands rest on a thin layer of connective tissue at the base of the pit. The fully developed gland appears as simple sacular, or slightly tubular, and having a small duct. These glands may have one or more lumens branching off from the main one.

When these hedonic glands are active they become enlarged, their epithelial cells become cuboidal in form, and their tubules possess large lumens. The active hedonic gland contains a colloid secretion, and its duct becomes enlarged. When the hedonic glands contain secretion their tubules usually appear empty. When all of the secretion is poured out from the glands the ducts close. All of the hedonic glands do not contain secretion at the same time. When the glands are not active their lumens become smaller, no colloid secretion can be seen, and the cells touch the center of the lumen.

The studies through the year revealed that the secretory functions of the hedonic glands were variable in time. In September, the glands were inactive and there was complete absence of any secretion in the glands or the ducts. No amplexus was observed at this time. The October series revealed secretion present in a few glands; this correlates with the beginning of the "false" breeding season, and amplexus was observed at this time. The term "false" is used in this connection, because although mating behavior is typical of the true spring breeding season, no eggs are deposited. The significance of this phenomenon in the life history is unknown. In December, the glands were active as they were almost filled with secretion, and their ducts were enlarged. At this time also the animals exhibited amplexus. In February the glands contained secretion, and their ducts appeared open, as though the glands were discharging their contents. Amplexus was observed frequently during February. During April the glands were very active, as they were filled with secretion and their ducts were enlarged and open. It appeared as though the glands were ready to discharge their contents. Amplexus was observed at this time, as well. In June the glands contained secretion, and their ducts were open. Amplexus was observed. Both the April and June series showed increased activity; this corresponds with the season, as "egg-laying begins about March thirtieth and continues until the middle or end of June" (Pope). The July and August series showed little secretion present in the glands, and the ducts were almost closed. At this time no amplexus was observed.

These studies demonstrate the fact that the hedonic glands do not function continuously throughout the year. They show heightened secretory activity during the true and false breeding seasons. The glands continue to be active for periods longer than the actual breeding seasons, perhaps representing the margin of safety, manifested in such a great variety of ways in the life of organisms in general.

TECHNIQUES FOR THE DEMONSTRATION OF NERVE ENDINGS IN THE INTEGUMENT OF *TRITURUS VIRIDESCENS VIRIDESCENS*

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In the literature, there are no satisfactory techniques for the study of nerve endings in the integument of Triturus. The immediate need for such a technique has been brought about by the investigations on larval grafts on adult Triturus hosts.

Since the literature did not reveal any particular techniques for nerve endings of Triturus, the various ones for amphibian as well as human material were used, such as Galigher's formic acid-gold chloride; Ranvier's gold chloride; Cajal's ammoniacal alcohol-silver nitrate; Cajal's pyridine silver nitrate; Garvin-Ranvier's gold chloride; Hardesty's gold chloride and Retzius' methylene blue methods. None of these techniques proved satisfactory when used on Triturus material. They were all given sufficient trial under various conditions and so the writer found it necessary to make modifications of the most satisfactory of these methods.

The adult animals were first anaesthetized by placing them in a solution of 0.6 per cent Ringer's chloretone for approximately 30 minutes. Then the skin was removed very carefully from the animal. The methods which seemed to be the most satisfactory were the writer's modification of Hardesty's gold chloride method and a modification of the Garvin-Ranvier gold chloride method.

The author's modification of the Hardesty gold chloride method is the following: The tissue was placed in a 10 per cent solution of formic acid for 20 minutes. After being removed from the solution, it was blotted on a paper towel to remove the excess solution and then placed in a one per cent aqueous solution of gold chloride for 20 minutes. After again blotting on a paper towel, the tissue was put in 10 per cent formic acid for 24 hours in the dark. When it was removed from the formic acid, it was washed in distilled water by dipping it up and down in the container for a few seconds. The tissue was then dehydrated by passing it through a graded series of alcohol for approximately 15 minutes in each grade except 95 per cent in which it was kept for one hour. The tissue was then immersed in a half-and-half mixture of 95 per cent alcohol and xylol for two hours followed by xylol for one hour. Then it was placed in a half-and-half solution of xylol and melted paraffin for one-half hour and then into melted paraffin for three hours. Finally the tissue was imbedded. After sectioning at 10 microns and the sections

fastened to the slides by albumin, the paraffin was removed by means of xylol and the cover slips mounted by balsam.

The second modification was that of the Garvin-Ranvier gold chloride method. Fresh tissue was placed in 10 per cent formic acid for 20 minutes, after which time it was blotted on a paper towel and placed in a one per cent aqueous solution of gold chloride for 20 minutes. After again blotting on a paper towel, the tissue was put in 10 per cent formic acid in the dark for 24 hours. It was then blotted at the end of this time and placed in glycerine for at least two hours and may be preserved in this until readly for use. When ready to be cut, the tissue was placed in water and frozen by the usual method using carbon dioxide gas. The tissue was cut at 30 microns and was mounted in glycerine and the edges of the cover slip rimmed with vaseline.

All the tissue was handled with paraffin-coated or bone forceps. The tissue which one is staining for nerve endings must never be touched by metal forceps as the impregnation of the gold and silver will be impaired.

In the skin we find many free nerve endings and some few encapsulated ones. Some of the myelinated fibers as they come near to the terminations divided many times. At first these branches retain the myelin sheaths, but after many divisions the sheaths and finally the neurilemma are lost and only the naked axis cylinders are left. These go to the integument, where after more divisions, they end among dermal or epidermal cells as free nerve endings. In the encapsulated nerve endings, the fiber loses its myelin sheath as it enters the core, through which it goes from end to end. However, this latter type is comparatively rare in the integument and the free nerve endings are the predominant type.

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ANOMALOUS EXPERIMENTAL RESULTS FROM A STUDY OF THE PIGMENTARY EFFECTOR SYSTEM OF *TRITURUS PYRRHOGASTER* (BOIE)

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In attempting to explain the reactions and movements of Amphibian melanophores under the influence of certain definite stimuli, various investigators have postulated the existence of pigmentary effector systems which govern the actions and motions of these pigment cells. Up to the present time two endocrine glands, the pituitary and adrenal, the nervous system and several sense organs, notably the eye and the lateral line organs, have been considered, either singly or in various combinations, as the controlling factors in melanophore reactions and, as such, called pigmentary effector systems.

The two principal movements of melanophores are known as "contraction" and "expansion" and the existence of a controlling mechanism is predicated on the ability of various reagents to cause either expansion or contraction of these pigment cells. An expanded melanophore is one in which the black granules of melanin pigment are somewhat evenly distributed, not only throughout the central cell body but also throughout the numerous threadlike and many-branched cell processes. In this condition the melanophore, under microscopic examination, is distinctly grey in color as contrasted to the deep black of a contracted melanophore. A contracted melanophore, on the other hand, is one in which all the black granules of melanin pigment are withdrawn from the cell processes and concentrated within the cell body. There is also some possibility that in a contracted melanophore the cell processes are also withdrawn and that the cell then becomes spherical in shape instead of the commonly seen amoeboid structure. In general, the degree of expansion or contraction of melanophores is directly responsible for the degree of darkness or paleness in the coloration of individual animals.

Hogben (22–24), Smith (20), Swingle (21) and others working with Anuran tadpoles and adults have presented a strong case for the view that pituitary secretion plays an important rôle in the regulation of Amphibian color response. In their experiments they found that injection of pituitary extracts caused extreme expansion of melanophores while hypophysectomy produced complete contraction. Subsequent injection of pituitary extract into the hypophysectomized animals produced expansion which lasted only until the effects of the injected extract had

worn off. Laurens (15–16), Hogben (22–24) and Atwell (19–21) working with Urodele larvae and adults, especially Amblystoma, obtained substantially the same results. It seemed, then, fairly well established that the pituitary gland was the factor controlling expansion in amphibian melanophores. The same workers in addition to others also established the fact that the secretion of the adrenal gland was the controlling factor in contraction of amphibian melanophores.

Various experiments, especially transection of nerves supplying definite areas of the skin, have failed to produce any definite evidence for placing amphibian melanophores under the control of the nervous system which was found to regulate color changes in reptiles and fish. Recently Miss Jane Frankston, a worker in our own laboratories has demonstrated nerve endings in direct connection with melanophores of *Triturus viridescens* and it seems almost certain that the nervous system must play some rôle in the regulation of melanophore responses.

On the above results Hogben and his associates were then enabled to postulate the existence of a pigmentary effector system for amphibian melanophores consisting solely of the two endocrine glands, the pituitary and adrenal and excluding the nervous system entirely. Until the present time no important variations from this system had been noted until Kelley (35) working with *Triturus viridescens* obtained results which disagreed with those of Hogben and his associates. The author working with *Triturus pyrroghaster* has uncovered discrepancies along the same general lines which form the basis of the present report.

Kelly (35) working with *Triturus viridescens viridescens* (Rafinesque) found that with injections of or immersions in "Anterior Pituitary Extract" (Lilly) no uniform results could be obtained on either adult or larval animals. Injection of a 1% suspension of whole pituitary gland extract (Parke, Davis & Co.) caused immediate contraction of melanophores in larval as well as in adult animals. Injection of a 0.1% suspension of "Infundin" (Burroughs Welcome) had no effect either on adult or on larval animals. It is interesting to note that Collins and Adolph ('26) found evidences of contraction of melanophores after injection of pituitrin in adult Triturus. The above results are directly opposite to those obtained by Hogben, Laurens, Swingle and others on the effect of secretion of the pituitary gland on amphibian melanophores.

The author in working with the pigmentary system of *Triturus pyrrhogaster* (Boie) has obtained results similar to those of Kelly, Collins and Adolph. Repeated implantation of fresh whole pituitary gland of the frog produced extreme contraction of melanophores while injection of .2 cc. of a 5% solution of Pituitrin (Parke, Davis & Co.) had the same

general effect. Thus work on two different species of Triturus has produced results which seem to indicate that the pigmentary effector system of the genus Triturus differs radically from those of other Amphibia.

The extent of the anomaly in these results is more apparent when we consider the effect of hypophysectomy on pigment response in the numbers of this genus. Our results have shown that implantation of fresh pituitary or injection of suspension or extracted products of the same gland produced complete contraction of melanophores. On the other hand removal of the pituitary, hypophysectomy, a diametrically opposite stimulus, produces the same effect, complete contraction of melanophores. This anomaly seems almost wholly inexplicable in terms of the pigmentary effector system advanced by Hogben and his associates and a satisfactory explanation must be given before a definite and certain system for the control of amphibian melanophores can be established.

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INDUCED OVULATION IN *TRITURUS PYRRHOGASTER* (BOIE) BY MEANS OF EXTRACTS AND IMPLANTS OF THE PUTUITARY GLAND

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Pituitary glands of *Rana pipiens* have been found to induce egg laying successfully in the newt, *Triturus pyrrhogaster*. Pituitary bodies were removed from Rana and implanted into a subcutaneous pocket made under the lower jaw of the Triturus. Two glands were implanted into each animal, the animal being kept in a moist chamber for several hours before being placed in aquaria so that the wound might heal sufficiently to prevent muscular contraction from pushing the implant out. Female frogs were found to be preferable as a source of pituitary as the glands are slightly larger. Egg laying was observed to begin, in some cases, as soon as 24 hours after initial implantation. In those cases where results were not obtained so rapidly, implantation was continued daily at the rate of one gland per animal, three such treatments, over a period of four days, being the maximum time required for induction. Egg laying was found to continue over a period of two to four days.

Frog pituitary glands were also extracted by crushing in sterile amphibian Ringer's solution, the concentrations being one gland: 1 cc. solution and 1 gland: 2 cc. solution. These extracts were injected intraperitoneally into the Triturus, the dosage being 1 cc. daily. The results were not as satisfactory as those obtained by using whole gland implants both as to rapidity of induction and quantity of eggs obtained. No difference was observed as to the effects of the different concentrations of extract.

The secondary sexual characters were neither intensified nor diminished by the added pituitary.

This method provides a means of readily obtaining eggs of *Triturus pyrrhogaster* out of normal laying season as this work was carried on during February and March. The necessity of sacrificing the stock of Triturus, as in methods where glands of Triturus are used, and the dangers of partial paralysis which occurs when Antuitrin-S is employed, are eliminated. Also, as frogs are relatively inexpensive, this method is satisfactory from an economical standpoint.

THE RHESUS MONKEY AS A SUBJECT FOR STUDENT DISSECTION

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During the year 1934–35 an embalmed specimen of the Rhesus monkey was ordered by the Department of Biology of the University of Pittsburgh, and used as a demonstration dissection in the course in Mammalian Anatomy, in which the student dissections are carried out on embalmed specimens of the cat. The demonstration dissection of the monkey aroused much interest in a number of last year's class in Mammalian Anatomy, and during the present year they asked if they might be permitted to take a course in the dissection of the Rhesus monkey. As a result of these requests it seemed feasible to organize a course in the Anatomy of the Rhesus monkey, and this is now well in progress.

While the course is primarily limited to the anatomy of the monkey, the students are asked to take advantage of the fact that the monkey is a fine subject for comparison betwen the cat and the human. Having had courses in Comparative Anatomy and Cat Anatomy as prerequisites, they are expected to develop the ability to work somewhat independently. With the aid of knowledge gained through previous dissections, it is felt that this is not too much to expect.

The entire dissections are performed on one animal, by following the regional plan of dissection worked out and used for a number of years in our laboratories in the dissection of the cat.

The cost of the material is by no means prohibitive, in view of the fact that we have found it perfectly feasible to have two students work on one specimen at the same time. The Rhesus monkey is usually larger than a good sized cat, and its muscles are in many respects better differentiated. The two students can compare their respective dissections at any time.

The text used in the course is the recently published book, "The Anatomy of the Rhesus Monkey" by Hartman and Straus. As the Rhesus resembles the human body in many respects, standard texts in Human Anatomy, such as Gray, and Young, are found to be of great assistance.

The authors feel that teaching the anatomy of the monkey has many advantages. Briefly the material is easily stored between laboratory periods, in moist-chamber tanks designed to hold cat material. The student, having previously studied Mammalian Anatomy, gains at least a thorough knowledge of the relationship of form and function; he learns to work independently of others; he learns to differentiate between the mammals in general, and the primates; and he is prepared for a better understanding of human anatomy, a knowledge of which will be of great value to him in his future medical studies.

VARIATION IN *MICROTUS P. PENNSYLVANICUS*

By Olive Bown
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This preliminary study was made on a series of over 100 specimens of the Pennsylvania Meadow Mouse, *Microtus p. pennsylvanicus,* collected at Pymatuning Swamp near Linesville, Crawford County, Pennsylvania. Only mature individuals were included in the series. External measurements were taken in the field, and cranial measurements made on the cleaned skulls.

A study of these measurements shows that those of the skull are less variable than the body measurements. They are therefore of greater diagnostic value in determining the species. The least variable skull measurement is the diastema, the distance between the incisor and molar teeth. The most variable is that for cranial capacity, for which a pellet of number 10 shot was used as the unit of measurement.

The measurements show a marked sexual difference, with most of those for the male series larger than those for the female series. On the

other hand, most of the female measurements gave a smaller coefficient of variability than the corresponding measurements of the male series. These findings are in accord with the results of biometrical studies on other forms of mammals in which the male is more variable than the female.

A study of the pelage showed that moult occurs apparently at all seasons of the year, and inasmuch as there is no definite breeding season, it is probably regulated by the age of the animal. No definite moult pattern was observed.

An examination of the teeth revealed a marked variability in the molar pattern, especially in the third upper molar. This tooth showed a series gradation from the normal type with but three inner re-entrant angles to a form with four well-marked re-entrant angles. This variation is a common one in the genus and has been noted by Miller in *pennsylvanicus* and by Howell in *Microtus montanus yosemite*. A similar variation occurs in the European form, *Microtus arvalis*. It is not a surface variation, disappearing with wear, but extends throughout the length of the tooth. Its exact significance has not yet been determined. It may represent an ancestral type of tooth pattern which has nearly disappeared in the species, it may be merely a chance variation with no phylogenetic significance, or it may foreshadow the future development of the tooth. The lack of adequate fossil material makes it impossible to determine what the course of evolution of the molar pattern of Microtus has been.

The anterior trefoil of the first lower molar is also very variable, although it does not seem to be changing in a definite direction as does the third upper molar. The second molars in both upper and lower jaw are the least variable of the teeth.

These studies show that a greater degree of variability than is usually suspected is to be found in these small forms. Studies of a similar nature on series of other forms will help to show the amount of variability which may be expected in a given subspecies, and thus throw some light on the difficult problem of speciation.

CELLULAR CHANGES IN HOMOPLASTIC BRAIN GRAFTS IN *TRITURUS VIRIDESCENS VIRIDESCENS* (RAF.)

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Introduction

Since the classic researches of Harrison on the origin of the nerve fibers and their growth in vitro, many lines of investigation have been undertaken with the view of studying the forces that bring about development of the normal architecture in the central and peripheral nervous system. Many attempts have been made to transplant nervous tissue. The subject of cellular proliferation of nervous tissue has received considerable attention by many American workers both by the direct observation and by the experimental method. No attempt will be made to discuss the vast amount of literature available on this subject.

Harrison was able to keep alive and show growth of nervous tissue in vitro. Ranson reported successful transplants of spinal ganglia into the brain. He found that transplanted nerve ganglia in the brain region remained nearly normal when the ganglia were transplanted within or adjacent to the choroid plexus. Ranson thinks this may be due to a more complete anchorage or to a more adequate supply of nourishment.

Miss Dunn in her work on transplantation of cerebral cortex in the very young Albino rat states that after many unsuccessful attempts, positive results were obtained by utilizing a thin covering of blood clot to retain the graft in position and the best nourished grafts were those which lay near the choroid plexus of the lateral ventricles. Extensive series of researches using the experimental approach to the problem of central nervous system proliferation is seen in the works of Detwiler. These experiments have shown cellular changes within the brain and within the cord following transplantation.

The site of tissue transplantation has received considerable attention. For the most part transplants have been made into the subcutaneous tissue. New loci for consideration have been introduced by the experiments of Shirai who has employed the brain as the locus for heteroplastic tumor transplants in which situation, according to him, grafted tissue grows as readily in an alien as in an homologous host.

The generalized nature and viability of the nerve cells in Triturus makes it excellent material for transplantation. The posterior choroid plexus of the hind brain, because of its elaborate blood supply, forms an excellent vascular bed for transplanted brain tissue.

Statement of the Problem

In pursuing a study of homoplastic brain grafts in *Triturus viridescens*, it is hoped that more facts may be learned of the phenomenon of regeneration in nervous tissue and the behavior of these cells in homoplastic transplantations. Further to study cellular proliferation and the organization of fiber tracts in homoplastic grafts with the purpose of finding out whether or not differentiation simulates, more or less completely, the normal morphology of the brain.

Materials and Methods

In making homoplastic brain transplants on *Triturus viridescens viridescens*, a triangular piece of skin and bone was removed from the host animal just above the posterior choroid plexus. Enough tissue was removed to expose the plexus and care was taken to prevent any injury to the host brain. Animals were operated upon at intervals of a few days. Into the posterior choroid plexus of the host animal various parts of Triturus brain were transplanted. More frequently, however, the two cerebral hemispheres were removed with the aid of scissors and section lifter and transplanted to the posterior choroid plexus. The plexus forms a very good vascular bed into which the transplanted tissue can be placed easily. The animals were then allowed to recover from the anesthesia and remain in a moist chamber for a few days until the graft tissue appeared to be attached solidly. All animals were examined by histological methods for stages in regeneration or degeneration of the transplanted tissue. Histological material was prepared at five-day intervals extending over four months. The sections were stained with haematoxylin and eosin and Mallory's phospho-tungstic acid haematoxylin. In all the work, only

Fig. 1. View of the head of *Triturus* showing the superficial appearance of the transplant after 2 months of growth.

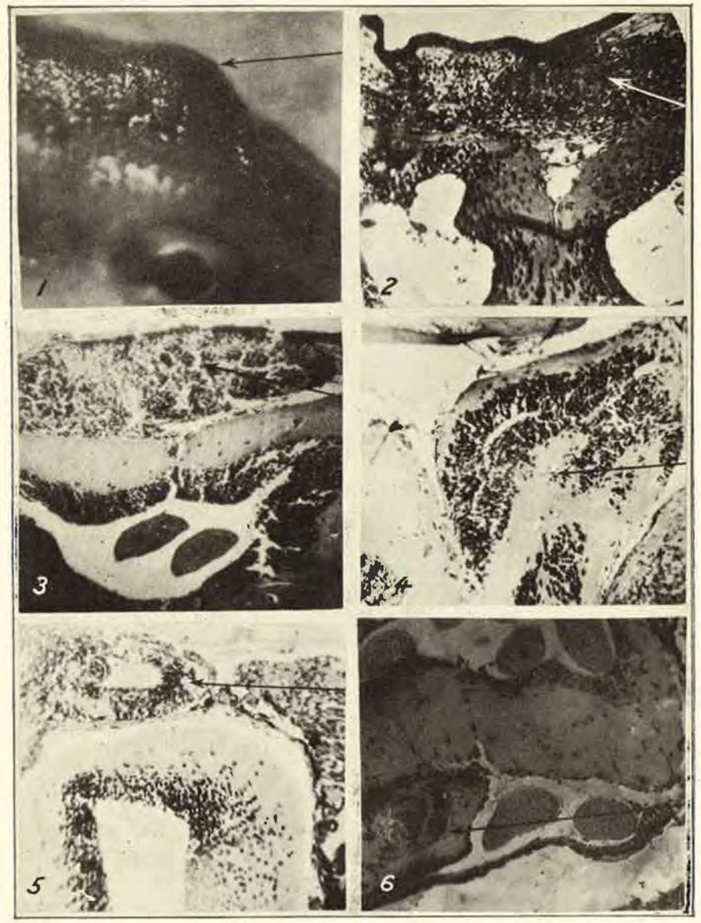
Fig. 2. Cross-sectional view of the head at the level of the cerebral hemisphere showing the early appearance of the transplant, after two weeks. The area does not show definite organization, the cell bodies are diffused with no central cavity.

Fig. 3. Cross-sectional view of the head at the caudal level of the cerebral hemispheres showing a rather well organized transplant, after 4 weeks. Cell bodies are aggregated around a beginning central cavities (lateral ventricles of brain.)

Fig. 4. Cross-sectional view of the brain at the level of cerebral hemispheres showing a well organized transplant with cavity and the periventricular arrangement of the cell bodies. Graft is becoming adherent to the host brain. After 6 weeks.

Fig. 5. Cross-sectional view of the brain at the level of cerebral hemispheres showing a highly organized graft, a miniature appearance of the original. After 2 months.

Fig. 6. Cross-sectional view of the brain at the level of the medulla showing a ventrally situated graft, well organized.



Cross-section of head of *Triturus* showing homoplastic grafts.

paraffin embedding was used. Experiments were carried out during the spring of 1935 and histological material prepared and studied during the summer at Woods Hole, Mass.

Results of the Study of Transplanted Brains

The posterior choroid plexus is a very favorable bed for the continuation of the viability of transplanted nervous tissue in homoplastic brain transplants. Early stages show no tendency to form structures resembling the other segments of the host brain, the transplants apparently undergoing de-differentiation. Later stages, however, do show some tendency to form a definite structural segment, i.e., the formation of a central cavity and periventricular localization of cell bodies of the neurones. There is no indication of the death of the transplanted neurones of the cerebral hemispheres, normal appearance and normal staining reactions, without fragmentation of the nucleus or a decrease in cell size, being indicative of this continued viability in homoplastic brain grafts.

In all transplants examined histologically the cell bodies of the neurones were like those of the host tissue. They stained in a similar manner and exhibited no indications of a nuclear disintegration at any place in the transplanted tissue. The early stages of the transplants showed no indication of a definite structural resemblance to other segments of host brain when the transplants consisted only of pieces of cerebral hemispheres. Later stages and especially at five and six weeks the transplants became well organized and became adherent to the host tissue. At places of union the scar tissue disappeared and the white area of the host brain became continuous with the white area of transplanted brain. The vascular bed of the posterior choroid plexus may have the same effect on the viability and growth of nervous tissue as a mass of differentiating or rapidly growing tissue. The mass of transplanted tissue in the choroid plexus did not alter the behavior of the animal during four months of observation previous to killing and fixing for histological study.

Conclusion

Brain tissue transplanted to the posterior choroid plexus retains its viability. It makes an attempt after about four weeks to organize itself after its original form. Studies made of the early and late transplanted brain segments showed that the cell bodies of the transplanted neurones were normal and like those of the host brain. There was no difference in staining reactions and no fragmentation of the nuclei of the transplanted cells which might have indicated disintegration. In many cases the fibers of the white area of the brain grew into the white area of the host brain and

became continuous with it. This is another evidence of viability and growth.

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A SIMPLE TIMELAPSE MACHINE

By L. K. Darbaker
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While in St. Louis some years ago, the writer became acquainted with Arthur C. Pillsbury, the famous lecturer and explorer in plant and animal life. At that time he was making timelapse pictures of the opening and closing of flowers. Such pictures form an important part in teaching but the expense of such a machine is beyond the means of the average teacher. Pillsbury's machine consisted of a large motor, connected to a special camera by a series of gears and was stationary.

I tried making such a machine which would be portable and inexpensive, by using alarm clocks for the timers and solonoid magnets to expose the film in an ordinary 16 mm Eastman motion picture camera. This machine produced pictures but the jar of the magnet would throw the pictures out of frame. Later the alarm clocks were replaced by telechron clocks.

Some time ago, the Radio Corporation of America placed on the market a remote control radio attachment, which permitted the selection of stations at a distance from the radio. This did not prove popular, probably because only six stations could be selected, with the result that these attachments were placed on the market at a low price. The motor and selector drum proved to be just what was needed in the timelapse

machine. All parts of the attachment were discarded except the transformer, the 23 volt motor and selector drum. The drum contacts were so arranged that when the motor circuit was closed, the motor would make one revolution, actuating a cam on the end of the drum shaft and causing the exposure of one frame of film. The contacts were also arranged so that the cam would not stop on the exposure point, thus causing more than one frame to be exposed. Other drum contacts were arranged to turn on the flood lights at the time of exposure.

The electric clock was changed so that when contacts were closed the motor circuit would be closed. These contact points were so arranged as to give various times of closing the motor circuit, by means of two 4-way 13-point switches. In this way intervals of 15, 30, and 60 seconds, 2½, 5, 15, 20, 30 and 60 minutes were obtained.

Such a machine is light in weight, portable, the cost is negligible and the camera is used without alterations.

FUNCTIONAL SCIENCE IN SECONDARY SCHOOLS

By William M. Martin
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This paper had its inception back in 1918–1920 at which time I was an assistant to Dr. S. H. Derickson, Lebanon Valley College, Annville, Pa. At that time the Pennsylvania Academy of Science was taking form in the mind of Dr. Derickson, as attested by his efforts and discussion of the subject three to five years before the initial assembly in Cincinnati in December, 1923. He conferred with Dr. Gress and others in the State Departments at Harrisburg on the subject. These facts prompt me to say I believe Dr. S. H. Derickson is the father of The Pennsylvania Academy of Science.

In his Presidential Address delivered to the Academy last year, Dr. Derickson made this significant summary of the purpose and objective of the Academy: *"The conception of our organization was the result of the consciousness of the need of conference with others in quest of truth."*

The inclusion of the secondary school teachers in the membership of the Academy was an initial provision in this plan of "Conference with others in quest of truth." This fact and the continued efforts to enroll membership from the secondary school group account for the wide range of outlook and interest of the membership of the Academy. This range from university specialist to instructor of adolescent youth presents some vital problems which must be faced if the Academy is to remain a *conference* of the original groups. The specialists outlook in research in pure science

and his presentation of papers have dominated the programs. The secondary school teacher who shares such programs is inclined to feel that he is a professional piker and is making no progress. Consequently, it is my opinion that a large number of the 66 per cent membership fatalities of the Academy are secondary school teachers. And as long as the prevailing membership range is desired, it will be profitable to include research in pure science plus research in the field of functional secondary school science and the study of same by adolescent youth. The Academy is the unique organization in Pennsylvania which can do effective conference work to the end of producing better qualified science teachers in secondary schools and better qualified graduates of the same secondary schools. I recommend this thought to the program committee.

The beginning secondary school science teacher is confronted with a task as gigantic as the ancient prophet. He must perform the miracle of articulation and of life upon the disintegrated fragments of college theory and experiences. To lay sinews upon dry bones, and cause flesh to grow over them, and cover all with skin, and give it spirit, and cause it to live, and thus be akin to living, adolescent youth—that is the present day miracle of adjustment facing the temporarily employed, the economically stranded, or the advanced trained beginning teacher as he comes out of *pre*-trade, *pre*-business, *pre*-technical research, *pre*-medicine, *pre*-etc., etc., college environment. Science research specialists, lectures, and subject professors, multiplied to cover all the specialized fields, which higher institutions of learning are trying to straddle, constitute the disintegrating factors which are basic to a secondary school science teachers training. He must experience a complete metamorphosis and cast off the invested college impedimenta before he can move in a functional realm.

A "quest of truth" on this vital subject of integration of college science designed to prepare teachers and functional science in secondary schools, discovers several significant trends:

(1) Dissatisfaction of secondary school administrators and teachers. Sixty-six county superintendents and assistant superintendents, representing 41 counties in Pennsylvania express themselves as follows:

(a) 69% say the subject matter of college courses is ill-adapted to secondary school science course opportunities;

(b) 98% say college science courses should include "methods" whereas few catalogues list such courses;

(c) 85% say college professors, who have not had recent experience or intimate contacts with high schools, are not qualified to train secondary school teachers;

(d) 90% say integrate science courses from grades up and not from college down;

(e) 100% say adapt high school science courses to the students and not to college entrance standards.

Thirty progressive secondary schools in the Middle Atlantic States have requested exemption from prevailing college entrance requirements, in order to perform an experiment in adaptation and integration and give life to their curricula.

(2) The new standards of accreditation for secondary schools shift the outlook from college entrance, subject matter, buildings, laboratories, experiments and equipment to the student. This new outlook considers not only the one in seven who anticipates college training, but the other six who will not go to college. The secondary school teacher must go to his experiences before entering college, on the farm, in industry, and in life apart from his college courses, for subject matter and outlook adaptable to the discovery of embryo scientists. Unrelated subject matter teacher training courses do not direct nor provide instruction materials nor experiences adapted to the task of the secondary school teacher.

(3) A third trend, which suggests departure from college domination and the inbreeding which has crept into the college-secondary school cycle, is in the college entrance examinations. This is the last year for specific examinations in botany and zoology. Comprehensive examinations on integrated physical sciences and biological sciences will be offered this year. And what is more significant, 280 colleges in the Middle Atlantic States area will admit students without entrance examinations and on the recommendation of school principals and a complete record of adapted curricular work completed in high school.

These trends are unmistakable. The common sense secondary school teacher is organizing his work on a functional basis and around the human interest problems which face the students in his classes. The student must have vital and honest experiences if his latent powers are to be released. The teacher's task is not the inculcation of certain blocks of subject matter, as inoculations to relieve inexperience and ignorance.

The following reel of motion picture will appear most unscientific to many of you, perhaps. The photography is poor or worse. There is no plot or continuity. Students exposed much of the film. The film does not reveal, but merely suggests, the hours of planning for field trips, the enthusiasm of the students, library work, socialized class periods, the follow-up laboratory and student research work, the great variety of discovery experiences in community, State and adjoining States, the fragrance of the out-of doors, the discovery adventures from mountain top to tide water, the noise of industry, the chill of coal mine, the organization of museums, the adapted science of farm, home, community,—the integrated chemistry and physics and biology of food, shelter, clothing, occupations, and leisure time activities.

No matter where you may be in your specialized research, the entire realm of science is virgin territory to the secondary school student, who, in cooperation with his teacher, is blazing trails and drafting road maps or air lanes. The Pennsylvania Academy of Science with its inclusive, cooperative membership may place college science departments along these main throughfares of tomorrow's traffic and at the same time direct that traffic in the direction of adapted objectives of college science departments.

THE DISCOVERY OF A MASTODON IN HUNTINGDON COUNTY

By Homer C. Will
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In the summer of 1935 newspapers reported the finding of mastodon remains in Pennsylvania. This interesting discovery was made at Saltillo, in Huntingdon County. Preliminary excavations indicated that the remains were intact. The removal of the skeleton may be started this spring as a WPA project, under the direction of Pa. State College. By late summer it may be possible to see an intact skeleton of a mastodon from Pennsylvania.

The discovery of the mastodon was made by Mr. Clair Cornelius, on his farm near Saltillo, while digging a ditch from springs in a marsh near his farm buildings. During the progress of the work, his pick struck the tusk of the mastodon. Lateral digging revealed molars. At this point operations ceased and experts were summoned. Then the discovery was announced.

The bones are very near the surface. Apparently the heavy animal was mired in the slough. This discovery indicates the incompleteness of our knowledge of extinct species and the element of chance in the discovery of fossils.

THE MYXOPHYCEAE OF A PENNSYLVANIA SULPHUR SPRING

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Until now, as far as the author is aware, no collections or determinations have been made of algae inhabiting sulphur springs in Pennsylvania. Some collections made during December, 1933, in northwestern Pennsylvania included material from the sulphur springs of Tamarack Swamp about seven miles northeast of Corry. The algae were present in the bricked-in, up-welling, sulphurous spring as a slimy, bright blue-green mass affixed to the sides for a depth of about half a meter. Remarkably enough, although the spring was icy cold, so that the hand of the collector became nearly paralyzed from reaching for specimens, more than seven members of the Myxophyceae were present, four of them in considerable numbers. Chlorophyceae were very rare, a few diatoms and a somewhat battered specimen of *Ulothrix* comprising the total.

Oscillatoria terebriformis (Ag.) Gem., gave to the sides of the spring a rich blue-green color and was most conspicuous microscopically of the forms present. This species, which is common to sulphur springs and hot springs, is characteristic in its appearance. The ends of the trichome, including the terminal 10–20 cells, are gradually constricted and at the same time spirally twisted; the cells are square to about one-half as long as wide and are (in this material) 4.5–6.5 μ in width. The end-cell is rounded; the filament is not constricted at the joints, and the adjacent walls of the cells are provided on the inner side with distinct granules.

Phormidium Treleasei Gom., known generally from hot springs and hot sulphur springs was perhaps next in quantity. The plants formed great flat masses of gelatinous blue-green material, and in the mucus were to be found some of the species mentioned below. The trichomes were 0.5 μ wide, with each cell about seven times as long as wide, and with no constrictions present in the filament. The color was a pale blue-green, and the cells were difficult to resolve individually even at very high magnifications. The filaments lay parallel in the mucus layer, which after having been mounted in glycerine jelly, often turned yellowish.

Oscillatoria limosa Ag., a cosmopolitan species, reported earlier from six different localities in this State,[1] was present in the collection in some

[1] Van Dersal, William R., and Cartledge, J. L., The Blue-Green Algae of Pennsylvania. Proc. Penna. Acad. Sci. 8: 84. 1933.

quantity, entangled usually with *O. terebriformis*. One thinks of this species as inhabiting stagnant or slowly-running water,[2] but it has been found rarely in this country in sulphur springs as noted by Tilden.[3] Its cosmopolitanism does not restrict it to fresh water, for according to Geitler[4] it may also be found in salt water. Geitler considers this form a mixture of several species (sammels-pezies). In the specimen examined the trichomes were 11–13 μ wide; the adjacent walls were heavily granulated; the end cells were rounded and possessed a thin membrane, while the other cells were about one-fourth as long as wide; no constrictions were evident between cells, and the filaments were very long.

Microcystis incerta Lemm., was mixed with the *Phormidium*. Cells were 1.5–2.2 μ in diameter, spherical, non-vacuolated, and pale blue-green. Colonies were nearly spherical, occasionally somewhat ragged, and were formed of cells very closely packed together. The mucilaginous tegument was colorless.

Microcystis firma (Breb. et Lenormand) Schmidle, occurred occasionally. The determination may be considered somewhat doubtful although the characters appear to fit the available descriptions. The spherical cells varied from 1.0–2.0 μ in diameter and were united in dense masses to form more or less spherical colonies some of which measured 30 μ across. The pseudovacuoles were quite distinct in each pale blue-green cell.

Chroococcus minor (Kutz.) Nag., appeared well-distributed in the mass. Occasional colonies of 6–8 members were uncommon; the usual occurrence of the cells was singly or in twos. Cells were 3.8–4.2 μ in diameter, of a decided bluish-green, and the gelatinous sheath was visible only rarely. This form is common on stones, wet wood, and very wet soil.

Oscillatoria amphibia Ag., was present as discreet strands, usually intermixed with the *Phormidium* or the other species of *Oscillatoria*. This form is generally to be found in stagnant water, hot water, soil, and rarely in brackish water. Its presence in sulphur springs is of interest although it has previously been noted as cosmopolitan,[5] and has been reported for this State by Lord.[6]

In addition to the above species, colonies were present which would

[2] Fremy, P., Les myxophycees de l'Afrique equatoriale française. Arch. de Bot. III, Memoire no. 2, p. 212. 1930.

[3] Tilden, Josephine, Minnesota Algae, Vol. I. p. 55. 1910.

[4] Geitler, L., in A. Pascher's Susswasser-Flora Deutschlands, Osterreichs und der Schweiz, Heft 12, Cyanophyceae, p. 358. 1925.

[5] Fremy, P., *loc. cit.* p. 213.

[6] Van Dersal, W. R., and Cartledge, J. L., *loc. cit.* p. 84.

seem to fall in the Genus *Gloeocapsa,* but the indistinctness of the sheath and the small size of the cells (less than 1 μ in diameter) made a precise determination difficult. The cells resembled the gonidia (nannocyten) of certain forms.[7,8]

All of the seven species noted except *Oscillatoria limosa,* and *O. amphibia* are new for the State. The addition of five species brings the total known from Pennsylvania to 153 species, which is estimated to be about half the number undoubtedly present. All the material is preserved at the herbarium of the Carnegie Museum, and it is to be hoped that further work can be done, particularly with forms collected in sulphurous waters.

BOGS AND SWAMPS NEAR CORRY, PENNSYLVANIA

By William R. Van Dersal
U. S. Soil Conservation Service

From 1933 to 1935 the author, in company with various members of Carnegie Museum, visited Corry, Pennsylvania, at intervals, particularly to investigate the bogs and swamps of the surrounding region. The discovery of several stands of balsam fir (*Abies balsamea*) and two small bogs of unusual interest stamps this area as a promising territory as far as species of boreal plants are concerned. After the large-scale disturbance of Pymatuning Swamp,[1] it is considered of distinct value to call to the attention of biologists these bogs, more representative of Canadian fauna and flora than any other locality in western Pennsylvania.

The town of Corry (see the Corry quadrangle of the U. S. Geological Survey topographic sheets) is five miles south of the New York line, about 30 miles west and slightly north of Warren, Pennsylvania. Numerous bogs and swamps occur within a 15-mile radius of the town. The best of these, botanically, are Benson Swamp, Tamarack Bog, including Possum and Sulphur Springs ponds, and Bear Lake.

Sulphur Springs Pond

This small oval pool, less than 300 feet long and only half as wide, gets its name from a sulphur spring some 200 yards east of it. The odoriferous overflow of the spring drains away north into Tamarack

[7] Geitler, L., *loc. cit.* p. 91.

[8] West, G. S., Algae, Vol. I, Myxophyceae, p. 25. 1916.

[1] Netting, M. G., and W. R. Van Dersal. The Future of the Ecology of Pymatuning Swamp. Cardinal 3: 151–161. 1934.

Swamp, so called, possibly, because it formerly may have contained tamarack. The pond itself supports on its edges a mat of floating vegetation, and is surrounded by forest. Soundings indicate that water extends under the vegetation for at least 50 feet from the apparent edge of the pool.

The pond is shallow enough to permit the watershield (*Brasenia Schreberi*) and spatterdock (*Nymphaea polysepala*) to grow around the edges and occasionally in the center. Surrounding the pool is a zone from 15 to 40 feet wide consisting mainly of cassandra (*Chamaedaphne calyculata*) growing in a thick mat of sphagnum moss. In this zone grow thousands of plants of the insectivorous sundew (*Drosera rotundifolia*) and the less common pitcher plant (*Sarracenia purpurea*), cranberry (*Vaccinium oxycoccus*), and cotton grass (*Eriophorum virginianum*). All of this zone, which sinks and undulates as one walks out upon it, is actually a mat 2 to 3 feet thick floating over 6 to 12 feet of water. At the very edge of the pond great chunks of the shore-mat break away and sink into the water. This process helps to fill up the pond with debris, forecasting the time when the pool will become covered entirely with vegetation, eventually drying up completely to permit later stages of succession to occupy the territory.

Labrador tea (*Ledum groenlandicum*) forms a concentric ring around this open cassandra-sphagnum zone, and mixed with it are many other Canadian plants, such as the shrubs andromeda (*Andromeda glaucophylla*), narrow-leaved laurel (*Kalmia polifolia*), blueberry (*Vaccinium corymbosum*), the snowberry (*Chiogenes hispidula*), nemopanthus (*N. mucronata*), and young trees of the tamarack (*Larix laricina*). The chokeberry (*Aronia melanocarpa*) and wild holly (*Ilex aquifolium*) occur in this dominantly shrub zone, and wintergreen (*Gaultheria procumbens*), and occasionally young white pines (*Pinus strobus*) may be noted.

From the edge of the pool, shrubs gradually increase in height toward the surrounding forest. The pioneers of the swamp forest are the tamarack and white pine. The farther back one goes, the less sphagnum one sees. In the forest white pine and hemlock (*Tsuga canadensis*) are the dominant trees, substituting here for the spruces and fir of the regions farther north.

Many trees and shrubs found in this forest differ from those common on the hills close about because of the moist substream. The azalea (*Azalea nudiflora*) blossoms in June while lady's slipper (*Cypripedium acaule*) reflects, as it were, the same flower color from the ground. The wild lily-of-the-valley (*Maianthemum canadense*) forms

a ground cover, often in mixture with *Polytrichum commune*. Many viburnums (*Viburnum dentatum*), (*V. alnifolium, V. prunifolium*) carry the blue, red, or black "nanny-berries" in the fall. Cinnamon ferns (*Osmunda cinnamomea*) crowd into the few open spaces and here also, as well as in the shadier portions, *Trillium undulatum* occurs in scattered clumps.

The pond formerly extended nearly a quarter of a mile southward as indicated by the vegetation and low-lying position of the land. Gradually the trough, at least 600 ft. wide at the pool, narrows and shallows until it merges imperceptibly into the country beyond. The natives speak of taking 60 bushels of blueberries (*Vaccinium corymbosum* and *V. atrococcum*) out of this small area in a season, and indeed, the bushes are very plentiful. Some talk of using the little basin as a source for peat has come to the writer's ears, but while samples have been taken, people in the region appear to know nothing about the matter.

Possum Pond

Possum Pond, half a mile to the southwest of Sulphur Springs Pond, is at least half again as large as Sulphur Springs Pond. The depth of the pool is much greater and very little watershield and no spatterdock succeed in growing in it. The open water is very closely surrounded by a swamp forest.

The zone of cassandra mixed with sphagnum moss and cranberry and containing pitcher plants, sundew, labrador tea, and cotton grass, is here too. The pool is first bordered by "stools" of the swamp loosestrife (*Decodon verticillatus*), a plant of distinctly southern affinities. The cranberry (*V. macrocarpon*) is a different species from the one at Sulphur Springs Pond. The wild flag (*Iris versicolor*) is found here also, and with it many other types of plants of non-boreal affinity, including certain rushes, (*i.e., Dulichium arundinaceum,* and *Juncus effusus*). Even the bracken (*Pteris aquilina*) manages to hold its own in the acid sphagnum mat. The cassandra-sphagnum zone is much looser and more open than at Sulphur Spring Pond and extends 20–50 feet from the shore-line. It merges abruptly into a tall shrub border on the landward side. In a few places, the chain fern (*Woodwardia virginica*) forms a transition, but usually the tall shrubs border directly on it. The chokeberry is very plentiful here, and mountain holly (*Nemopanthus mucronata*), wild holly (*Ilex verticillata*), and several species of nannyberries form the most of the zone, which at this pond is rarely more than 15 feet wide. The shrubs are very closely set together, making it difficult to travel through, except on the side farthest from the water.

At the line of transition between the shrub zone and the trees, the wild calla-lily (*Calla palustris*), sometimes claimed to be the rarest flower in Pennsylvania, is to be found sparingly. White pine and hemlock are the dominant members of the forest pressing in on the zones of lower vegetation around the pool. Red maple and yellow birch are found rarely at first, but as one walks away from the pool, more of these trees are encountered. In the deep forest which has comparatively little undergrowth, the cinnamon fern forms gigantic hummocks 5–6 feet high.

Cattle are watered on the southwest side and some disturbance of the various plant zones has resulted. Here are the greatest number of plants of southern affinities.

Tamarack Swamp

This swamp, reminiscent of much of Pymatuning,[2] consists of a large alder thicket surrounded by a swamp forest. Along the eastern edge between the alders and the forest is a peculiar scrub consisting of dwarfed hemlocks and yew (*Taxus canadensis*) with an understory of *Polytrichum commune, Gaultheria procumbens* and sphagnum moss. Although the topographic map indicates open water in the central part, careful quartering of the swamp has failed to reveal it.

The alder thicket consists of closely placed specimens of *Alnus incana,* 12–15 feet high. Under the canopy formed by its foliage may be found such plants as skunk cabbage (*Symplocarpus foetida*), cowslip (*Caltha palustris*), swamp violet (*Viola palustris*), meadow rue (*Thalictrum polygamum*), cascara (*Rhamnus alnifolium*), a clump-forming carex, and others. No tamarack is present anywhere in the swamp.

Surrounding the alder-filled center of the swamp, and merging into the alder, except in the scrub region on the west side, is a forest composed mainly of hemlock (*Tsuga canadensis*), yellow birch (*Betula lutea*), white pine (*Pinus strobus*), and a scattering of red maple (*Acer rubrum*). In places the Canadian yew grows on shaded hummocks formed of sphagnum. Cinnamon fern, swamp goldenrod (*Solidago patula*), various viburnums, and witch hazel (*Hamamelis virginiana*) are found in some abundance. Cattails (*Typha latifolia*) are present in wetter places.

Open fields border most of the swamp, but on the southern end a sample of the sugar-maple-beech forest persists. This forest is confined to the higher land, and formerly contained much hemlock which has

[2] Van Dersal, W. R., Ecological Study of Pymatuning Swamp. Univ. Pittsburgh Bull. 30: 4. 1933.

been cut out. The specimens of beech and sugar-maple are, however, very large.

The presence of sphagnum may indicate a former occupation of this area by boreal species. Some disturbance has permitted the area to be colonized by its present flora, which, in the case of the alder, may soon disappear as the substratum is apparently being rapidly built up.

Benson Swamp

This area, a few miles south of Tamarack Swamp, is farther along toward the climax forest of the region. It consists essentially of a swamp forest in which the substratum is much less moist than that in Tamarack Swamp, especially at the eastern end. Two plants mark it as formerly supporting a boreal flora; in four places in the swamp there are small stands of balsam fir, and very rarely old sphagnum hummocks may be discovered.

A railroad runs in an east-west line through the south central part, and in the ditches on either side of the right-of-way, and all along the southern edge of the swamp, an open cattail growth with occasional clumps of osier (*C. stolonifera*), willows, and some *Acorus calamus,* has become established. It is on the north side of the track that the more interesting parts of the swamp lie.

The swamp forest here consists of a mixture of white pine, hemlock, yellow birch, and red maple. Black ash (*Fraxinus nigra*), hop hornbeam (*Ostrya virginiana*), witch hazel (*Hamamelis virginiana*), highbush cranberry (*Viburnum opulus americanum*), wild holly, and rarely trembling aspen (*Populus tremuloides*) are mixed in a miscellaneous way with the above trees. Balsam, when it occurs, grows with the rest of the trees without apparent regular distribution. The ground cover consists of yew, sarsparilla (*Aralia nudicualis*), Clintonia (*C. borealis*), and royal and cinnamon ferns (*Osmunda regalis, O. cinnamomea*). In parts *Iris versicolor* may be observed. Cascara is nearly as rare as the clumps of sphagnum.

Bear Lake

This small lake, fed by underwater springs on the north side, with about 38 feet as its greatest depth, has been much modified by recreation seekers and fishermen. The northern and eastern sides are the more interesting. According to natives, balsam fir occurred at the north end, but was cut about 50 years ago. The butts, we are told, were 18–24 inches in diameter. At the present time no evidence of such stumps is to be found. Cassandra, locally called Bearberry (hence Bear Lake) covers a large area, and a few poor specimens of tamarack appear near the shore, a little way out from which Decodon occasionally is found.

The forest on the east side consists of red maple and yellow birch with considerable Nemopanthus near the shore. Large clumps of cinnamon fern are found beneath the trees. On the west side cranberry (*V. macrocarpon*) occurs. The entire locality has been so modified by grazing, farming, lumbering, swimming, and fishing that little of what was probably a "boreal island" like Possum Pond is left.

From these brief descriptions, it may be seen that there still exists in western Pennsylvania an area containing perhaps the choicest representatives of the Canadian flora in the State. Unless steps are taken to preserve it for future study, the bog flora in this State, already a "vanishing species," may eventually be exterminated.

Apparently none but biologists appreciate the value of undisturbed areas such as bogs, where study of the competition of Canadian and Alleghenian floras may lead eventually to a better understanding of ecological principles, and seemingly none but they will ever attempt to preserve such areas.

COLORATION OF LAND SNAILS

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In making a survey of the entire animal kingdom, we seldom place our finger upon any group of animals in which color does not exist in one form or another. This coloration ranges from the simple red and yellow lipochrome pigments of the protozoa, which are mostly plant-like pigments, to the larger array of colors and patterns in the higher animals, especially those found in birds.

The mollusca are especially remarkable for the number and brilliancy of their pigments. These occur in the mantle and other soft parts, in the shell, and in the secretions. In this paper we are concerned only with those colors that occur in the shell of the land snails.

In the terrestrial Gastropoda the coloring matter resides, in the main, in the superficial layer of the calcareous part of the shell, the periostracum or epidermis. The difference in the colors is largely due to the nature and tints of the epidermis. It seems probable that the primitive molluscan shell was horn-colored, after which white or a whitish color was evolved. But we lack sufficient proof for this statement, as the color of the fossil ancestors is rarely preserved. Exposure to the weather and the subsequent burial tend completely to obliterate the color of the epidermis.

In some of the recent shells there are present spots or bands of color. The true formation of these is not entirely known, as banding is considered the coalescence of points or spots, while the formation of spots is considered as the breaking up of bands. This breaking up is due to the presence of striae, which usually only obscure the bands underlying them.

In the land forms we find two divisions of coloration:

1. Oligochromatic approaching polychromatic, and
2. Monochromatic, the prevailing form.

In the former class, perhaps, two explanations are possible: 1. The snail has retained the pigmented shell which was of use to it in the sea. But this seems improbable, because the useful colors in the marine habitat would hardly have remained the same while its internal organization was undergoing such extensive modifications. 2. The snail had acquired its colors, the migrating species having either been colored or uncolored.

The monochromatic species, if descended from colored forms, have become so as they lead a distinctly quiet and retired life. The brightly colored species all live a more exposed and active life than the dull ones. Among the bright colors of shells shades of red, orange, and yellow are perhaps the most common, but blue and green also occur.

Albinism may be due to environmental conditions brought about by a chemical or physiological condition existing in the habitat of the snail. Some authors believe that this condition is a reversal to the primitive coloration. In many land snails albinism exists only as a much lighter color than that of the typical shell, but not as white; or in the banded forms, as a lighter coloration and an absence of the bands. Whether or not albinism is inherited will only be answered through further investigations along this line. And until such a condition can definitely be proven hereditary, it cannot be used as a basis for the construction of a new subspecies, as many authors have already done. It will be noted that most albino forms are not found along a continuous line of distribution, but are mainly found in localities far removed from each other, sometimes as much as a thousand miles.

Color, to a certain extent, is derived from the food of the snail, for food has an important effect upon the coloration of many animals. Increase in the deposition of a pigment may lead to an alteration of color, whether it is the basic color of the shell or the spots or bands. There is also evidence that various substances when taken into the body do influence the amount of secreted matter.

Fannie Hele[1] has made experiments with the influence of food upon

[1] Hele, Fannie M., 1884, Influence of Food upon Coloration. Deutsches Malakozoologischen Gesellschaft, Nachrichtsblatt, vol. 16, p. 109.

coloration of snails and has discovered that when *Helix aspersa* was fed exclusively on lettuce, the orange took on a dirty-gold shade and became always gradually darker.

C. C. Ormsbee[2] has made some interesting observations upon the color of *Anguispira alternata* with relation to its food. The shells of this snail differ in shade and resemble that of the wood in which they are found, and which forms a part of their food. Those found in maple are almost black; those in elm are dark brown; those in ash are light brown; those in beech are still lighter; and those in birch have a reddish tinge.

The coloration of land snails has played an important part in the study of Genetics, especially with the banded forms. Most of these experiments and observations have been made upon *Helix* and *Partula*. A. G. Mayer[3] and H. E. Crampton[4] have made extensive observations on *Partula* on some of the "high" islands of the Pacific on account of their geographical isolation.

The species of *Partula* are very variable and give rise to numerous color-sports. These color-sports tend to breed true and therefore to originate new color-forms and finally new species. This tendency, however, is held in check by frequent intercrossings with the parent stock and becomes effective only when the color variety is isolated or when it displays a remarkably strong tendency to breed true.

The production of these diverse color-types of *Partula* can scarcely be attributed to the action of the identical external influences in the same area. It would seem that the hereditary qualities of the earlier inhabitants or of the first immigrants are the real determining causes of the character of their descendants, which might vary subsequently, but in no discernible way on account of the qualitative effect of the environment.

Coloration has been used as a basis for the creation of species, subspecies, and varieties by taxonomists, but this boundary has been overstepped by a few workers in this field.

Since food plays an important part in the coloration of snails, then the variation in the shell color and color-pattern, bands, and spots, cannot be used definitely as a criterion for the separation of a species into a true

[2] Ormsbee, C. C., 1896, Influence of Environment upon the Form and Color of *Helix alternata*, Nautilus, vol. 10, pp. 63–64.

[3] Mayer, A. G., 1901, Some Species of *Partula* from Tahiti. Memoirs Museum of Comparative Zoology, Harvard College, vol. 26, pp. 117–35.

[4] Crampton, H. E., 1917, Studies on the Variation, Distribution and Evolution of the genus *Partula*. Carnegie Institute, Publication No. 228, 311 pp.

———, 1932, Importance of the genus *Partula* for the Problem of Hereditary and Environment in Nature. Proceedings Sixth International Congress of Genetics, Ithaca, N. Y., p. 31.

variety or subspecies, but only into a color variety, which, to my viewpoint, does not hold such an important position in taxonomy as a true variety, form, or subspecies. This is plainly illustrated by *Liguus*. A few conchologists during the last 35 years, having become "intoxicated" by this particular genus, have scrutinized very closely each specimen for the least difference in the color pattern in comparison with the type specimen for the sole purpose of creating new subspecies. These subspecies, as I have pointed out above, are merely color varieties. This same fate has befallen *Helix nemoralis* and *hortensis*. In these two species the number of bands and the variation in the thickness of the respective bands has been used to break up these two species into numerous subspecies.

If we are prone to accept such as albino forms and color varieties as true subspecies, then we are justified in making an abnormal specimen into a subspecies, as this too, is the result of environmental influences and also, perhaps, to injury. Therefore, we must take into consideration such influences as food and external stimuli on coloration and the hereditary possibilities of these changes before we become too hasty in determining a new subspecies, form, or variety.

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A RAPID METHOD FOR MAKING PERMANENT SMEARS OF SALIVARY CHROMOSOMES FROM GLANDS OF DIPTERA

By George J. Dambach and Jane Frankston
University of Pittsburgh

Many methods have appeared from time to time for making permanent smears with the aid of Aceto-carmine. Belling (1921) worked out a method for plant cytology. McClintock (1929), Steere (1931) and Barrett (1932) improved Belling's method. Many of these methods have

been tried on the salivary chromosomes of Diptera, although Aceto-carmine when used alone will give a good stain, the same for Iron-Aceto-carmine. The former is not a permanent stain, the latter requires a considerable time. However, the authors have found that by combining Belling's Aceto-carmine method with Barrett's method a permanent slide of salivary chromosomes can be made in less than 15 minutes.

The material on which this method was worked out was the salivary glands of the larvae of the wild type of *Drosophila melanogaster,* so much studied of late by Heitz and Baur (1933), Painter (1934) and many others. It was the experience of the present authors that the chromosomes from larvae just ready to pupate were found to hold the stain more readily than younger larvae.

The salivary glands are dissected from the larvae with the aid of a binocular and the glands removed from the body. The glands are clear translucent bodies with fat cells attached at the posterior end and on one side. A few drops of Belling's Aceto-carmine stain are then added and left for a period of 5 to 10 minutes. The chromatin material will stain more dark red than the cytoplasm as seen under the low power of the microscope. When sufficient time has elapsed a cover glass is placed on the glands and a smear made by pressing on the cover glass. The slide is examined for chromosomes. If satisfactory more stain is added and left for a few minutes until the cover glass automatically is raised above the preparation. The cover glass is then removed and a few drops of Barrett's Iron hematoxylin is added. This is poured off at once by tilting the slide and a few drops of 70% alcohol is added. The 70% alcohol is run off immediately and 95% alcohol is added. The slide is cleared and mounted in balsam.

The swelling action of acetic acid on the chromatin threads which is desirable, can be controlled by the alcohol and can be varied in the Iron-hematoxylin to suit the desired amount of swelling.

It has been suggested by Marshak (1936), that butyric acid and proprionic acid swells the salivary chromosomes to a greater degree but the use of these acids takes as much as 2 to 3 weeks for satisfactory results.

A summary of these stains follows:

Belling's Aceto-carmine.
45% acetic acid saturated with carmine, boil for 10 minutes, filter when cold.

Barrett's Iron hematoxylin.
1 part 0.5% hematoxylin and 4% iron alum (equal parts of each), 1 part 95% alcohol and 2 parts glacial acetic acid.

After the hematoxylin is dissolved a small quantity of sodium bicarbonate is added to hasten the ripening of the hematoxylin.

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THE WHITE BLOOD CELL CHANGES IN SPLENECTOMIZED RATS

By Clarence A. Horn
Albright College, Reading

A report was made in this journal, that the lymph and haemolymph nodes of splenectomized rats became hyperplasic. In this study, we wish to show that the white cells of the peripheral blood which are formed in these lymph structures take part in the immunity against *Bartonella muris*.

Review of the Literature

Jordan and Speidel (1923) and Jordan (1935) state that small lymphocytes pass from the nodules and grow into large lymphocytes, some of which get into adjacent venous sinuses, where they differentiate into erythrocytes, and in the extravascular system differentiate into granulocytes. Cannon and McClelland (1929) showed that when the lymph system (Reticulo-endothelial system) was blocked with India ink, the rat developed anemia. They believed the macrophages were not able to function as phagocytes. Perla and Marmorston (1935) believe that the compensatory mechanism established by the lymph system following

splenectomy are diffuse hyperplasia and increased activity of the endothelial cells of the lymph nodes and haemolymph nodes and hyperplasia of the hemocytoblastic tissue of the bone marrow. They believe there is an intimate relation between the spleen and the macrophage system in general, and that the resistance is primarily localized in the macrophage tissue of the pulp and not in the lymphoid tissue. The importance of the free and fixed reticular cells of the spleen in natural resistance is shown by the phagocytic ability of these cells in the removal of bacteria and foreign matter. They also suggest some chemical interrelationship with these tissues.

Procedure in the Investigation

Blood smears, stained with Wright's blood stain, were made of two groups of over 2,000 animals, every 30 days. The first group consisted of 30 normal rats and the blood cells were counted for 600 days. The

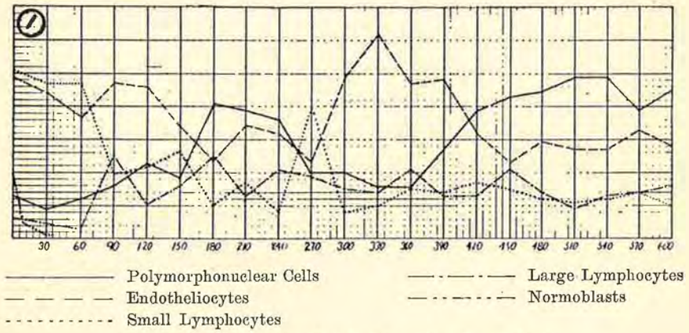
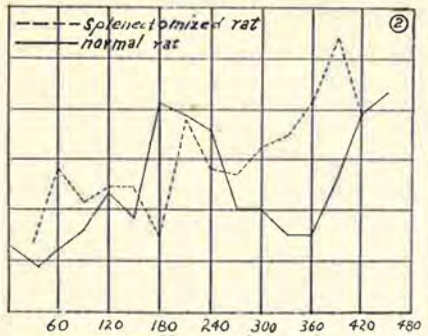
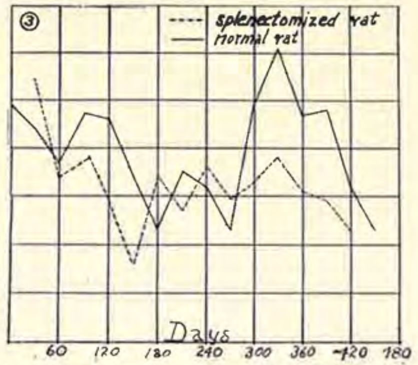
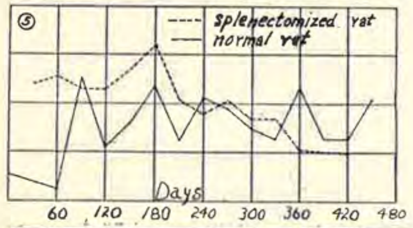


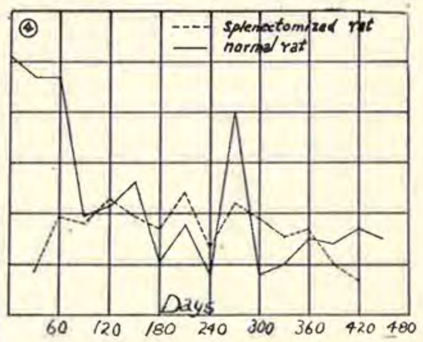
Fig. 1. Average white blood cell count of normal rats.

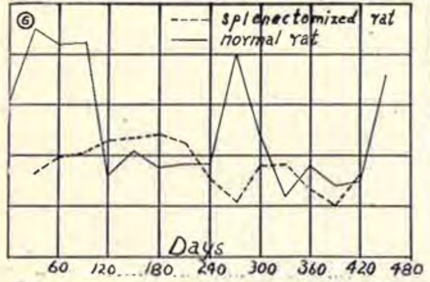
blood cells of the splectomized rats were counted up to 420 days. Figure 1 shows the percentage numbers of cells of the normal rats. It is significant to note that there were only 13% of polymorphonuclear cells on the first day after birth, but these gradually increased to 45% on the 600th day. The small lymphocytes and the endotheliocytes had a high percentage on the first day, 51% and 49% respectively. The endotheliocytes remained at 28% and the small lymphocytes decreased to 10% on the 600th day. The large lymphocytes remained between 10% and 30% during the entire life of the normals. There were also found at birth 19% normoblasts, which rapidly decreased in number, so that on the 32nd day, no more were found.

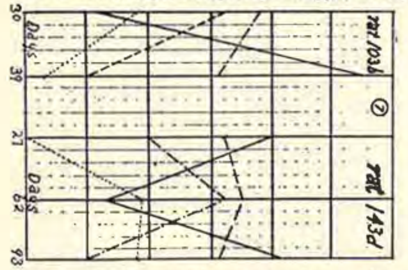












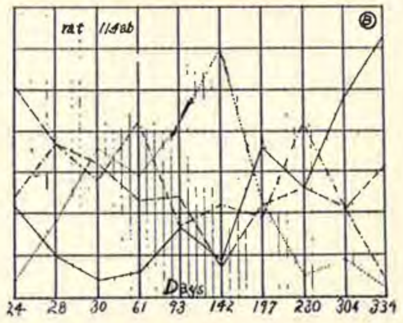


FIG. 2. Comparison of polymorphonuclear cell counts of a normal and splenectomized rat. FIG. 3. Compsrison of endotheliocyte counts of a normal and splenectomized rat. FIG. 4. Comparison of small lymphocyte cell counts of a normal and splenectomized rat. Fig. 5. Comparison of large lymphocyte counts of a normal and splenectomized rat. FIG. 6. Comparison of total lymphocyte counts of a normal and splenectomized rat. FIG. 7. White blood cell counts of two splenectomized rats which died of anemia. Legend for Figs. 7 and 8:

——— Polymorphonuclear Cells - - - - - - - - - - Small Lymphocytes

— — — — Endotheliocytes —·—·— Large Lymphocytes

In figures 2, 3, 4, 5, and 6, the polymorphonuclear cells, endotheliocytes, small lymphocytes, large lymphocytes and total lymphocytes of the normal blood cells were compared with the same kind of cells of the splenectomized animals. In all cases, the cells of the splenectomized rats show a more even curve than the normals, although, in general, they follow the course of the normal blood cells.

The changes in the percentage of white cells in splenectomized animals which died of anemia following an infection with *Bartonella muris* were noted. Figure 7, rat 103b, shows the first symptoms of anemia 30 days after splenectomy, when there were 12% polymorphonuclear cells, endotheliocytes 32%, small lymphocytes 18%, and large lymphocytes 38%. On the 39th day after splenectomy or 9 days following the infection, when the rat died, the polymorphonuclear cells increased to 55%, the endotheliocytes decreased to 10%, the small lymphocytes decreased to 3% and the large lymphocytes to 31%. In rat 143d, slight symptoms of anemia were noticed 27 days following splenectomy when the polymorphonuclear cells were 40%, the endotheliocytes were 32%, no small lymphocytes were seen, and 20% of large lymphocytes were found. Sixty-two days following splenectomy when the rat had fully recovered from anemia, the polymorphonuclear cells decreased to 13%, the endotheliocytes increased to 31%, the small lymphocytes increased to 19% and the large lymphocytes increased to 32%. Severe symptoms of anemia were again observed 93 days following splenectomy, and the rat died the same day. At this time the polymorphonuclear cells increased to 41%, the endotheliocytes decreased to 31%, the small lymphocytes decreased to 18% and the large lymphocytes decreased to 10%. The results of all the blood counts made of animals which died of anemia following splenectomy were always the same, namely, a decrease of lymphocytes below 40% with a corresponding increase of polymorphonuclear cells and endotheliocytes, or a very slight decrease of the endotheliocytes. The decrease of lymphocytes was always very marked.

Figure 8 shows the graph of rat 114ab which showed symptoms of anemia 24 days following splenectomy. The symptoms disappeared 6 days later, with a corresponding increase of lymphocytes. The small lymphocytes gradually increased to 60% on the 142d day following splenectomy. The animal did not show any further symptoms of anemia. Difficult breathing was observed in 230 days after splenectomy for the

FIG. 8. White blood cell counts of splenectomized rats which recovered from anemia and died of lung abscesses. 24, no symptoms; 28, severe symptoms; 30, no symptoms; 230, moderate polychromasia and difficult breathing; 304, difficult breathing; 334, entire lungs filled with abscesses, tumors on both uteri.

first time, and the blood picture had changed completely. The polymorphonuclear cells had increased to 42%, the endotheliocytes which were 52% at the time the first symptoms of anemia were observed gradually decreased to 26%. The small lymphocytes decreased to 5% and the large lymphocytes increased to 41%. The rat died of lung abscesses 334 days following splenectomy. At this time the polymorphonuclear cells increased to 63% and the endotheliocytes increased to 31%. The small and large lymphocytes decreased to 2% and 4%, respectively.

Conclusion

This study of the white blood cell changes following splenectomy shows that the lymphocytes play a very important rôle in the establishment of immunity against the *Bartonella muris*. On several occasions the endotheliocytes or endothelial cells of the lymph glands mentioned by Perla and Marmorston, or the macrophages of Cannon and McClelland, were seen engulfing red cells. It appears the lymphocytes play the major rôle in building immune processes against *Bartonella muris*, but that in the infection resulting in lung abscesses, the polymorphonuclear cells and endotheliocytes are the chief factors in immunity.

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THIRD ANNUAL MEETING
PENNSYLVANIA JUNIOR ACADEMY OF SCIENCE

State Teachers College, Indiana, Pa.
APRIL 10–11, 1936

The third annual meeting of the Pennsylvania Junior Academy of Science was called to order by President Harry Gross, of Reading, April 10, 1936, in the Science Building of the Indiana State Teachers College, Indiana, Pa.

Dr. Edgar T. Wherry, President of the Pennsylvania Academy of Science, welcomed the group and Harry Gross responded.

The following clubs answered roll call: Altoona Jr. Academy of Science; Reading H. S. Nature Club; Steinmetz Scientific Society, Upper Darby H. S.; Mount Union H. S. Biology Club; Punxsutawney H. S. Science Club; Bangor H. S. Science Club; and Indiana Jr. H. S. Science Club.

Dr. John C. Johnson, West Chester State Teachers College, gave an illustrated lecture on "Animals and Plants of the Rocky Mountains" and Dr. Norman H. Stewart, of Bucknell University, spoke on "Chasing Death."

Student papers were then presented from 3:45 to 5:00 o'clock at which time the first day's adjournment was declared.

With Vice-President Dolores Boland, Altoona, presiding, the second session of the Junior Academy was called to order Saturday, April 11 at 8:30 A. M. Following two hours of student papers a business meeting was held.

The minutes were read and approved and committee reports were made.

The Advisory Committee presented the following recommendations:

1. That the Advisory Committee be a standing committee with the sponsor of the President Club as an ex-officio member.

2. That the Advisory Committee be composed of Walter E. Hess, Dept. of Public Instruction, Harrisburg; Charles E. Mohr, Reading Sr. H. S.; Chelsey G. Remley, Upper Darby Sr. H. S.; J. C. Stone, Mt. Union H. S.; Mae Weber Smith, Taylor Alderdice H. S., Pittsburgh; H. C. Wimmer, Altoona H. S.; and Karl F. Oerlein, Chairman, State Teachers College, Indiana.

3. That a bulletin including complete information on the Pennsylvania Junior Academy of Science be published by October 1, 1936.

4. That a 300-word report of the meeting be sent to the Illinois Junior Academy for inclusion in its publication.

5. That dues be $1.00 straight per year.

6. That the fiscal year for the Junior Academy extend from September to September.

This report was accepted.

Mr. Remley, chairman of the Resolutions Committee, reported as follows:

1. That we extend our appreciation to Indiana State Teachers College and to those fraternities of the college which housed the Junior Academy for their hospitality and kindness.

2. That we thank Dr. John C. Johnson and Dr. N. H. Stewart of the Senior Academy for their interesting scientific talks.

3. That we thank all those who participated to make the annual program a success.

4. That we thank Mr. K. F. Oerlein for his enthusiastic support of the Junior Academy work.

The report was accepted and Mr. Wimmer, chairman of the Nominating Committee, presented its selection of officers for the following year. The president to come from Altoona, vice-president from Bangor and the secretary from Reading. This report was then accepted.

Mr. Mohr, chairman of the Membership Committee, next reported that the dues thereafter would be $1.00 per year for each club, and the Department of Public Instruction would be used to contact high school science clubs in the future. He also reported that membership blanks would be issued in the fall along with the bulletin.

Following the acceptance of this report and there being no further business, the meeting was adjourned.

The following papers were presented:

Friday Afternoon, April 10, 1936.

1. Collection and study of moths, Irving Adams, Baird Natural History Club, Reading Sr. H. S.
2. Vacuum pump (demonstration), Harold Smith, Altoona H. S.
3. Transmission of sound on a light beam, Otto Keser, Steinmetz Scientific Society, Upper Darby H. S.
4. My experiences as a taxidermist, Leonard Schwartz, Altoona H. S.
5. Interesting bits of science (demonstration), Edward Cox, Altoona Sr. H. S.

Saturday Morning, April 11, 1936.

6. Alloys of metals and synthetic precious gems, John Kinginger, Bangor High School Science Club.
7. Geology of Pennsylvania, Ray Johnston, Baird Natural History Club, Reading Sr. H. S.
8. Women Scientists, Nancy Ann Cockerill, Altoona Sr. H. S.
9. Discovery of rare gases, Daniel J. Miller, Bangor H. S.
10. Experiences with tropical fish, John Lingenfelter, Altoona Sr. H. S.
11. Chemiluminescence, Lester Guy, Steinmetz Scientific Society, Upper Darby Sr. H. S.
12. Beetles, destructive and beneficial, Harry Gross, Baird Natural History Club, Reading H. S.

Respectfully submitted,

JOHN CLOKEY.