observed in the laboratory, and occurring in a similar way in nature.

The Importance of Nivation as an Erosive Factor, and of Soil Flow as a Transporting Agency, in Northern Greenland: W. Elmer Ekblaw, Crocker Land Expedition, American Museum of Natural History, and University of Illinois. Nivation and solifluction, characteristic processes of disintegration and denudation under subarctic or arctic conditions, appear to be of prime importance in the reduction of high relief of northern Greenland.

On the α-Holomorphisms of a Group: G. A. Miller, Department of Mathematics, University of Illinois. A solution of the problem: For what values of α is it possible to construct non-abelian groups which admit separately an α-holomorphism?

The tenth number of Volume 4 contains the following articles:

Measuring the Mental Strength of an Army: Major Robert M. Yerkes, Sanitary Corps, N. A. A review of the psychological undertakings in connection with the examination of the recruits for the U. S. Army.

Thermo-Electric Action with Thermal Effusion in Metals: A Correction: Edwin H. Hall, Jefferson Physical Laboratory, Harvard University. Supplementary to an earlier paper.

Invariants and Canonical Forms: E. J. Wilczynski, Department of Mathematics, University of Chicago. A general proof in the sense of Moore's general analysis of the fact that the coefficients of a unique canonical form are invariants.

Types of Phosphorescence: Edward L. Nichols and H. L. Howes, Department of Physics, Cornell University. Two types of phosphorescence known as *persistent,* and as *vanishing,* are distinguished and discussed. The types are apparently independent, and both may occur with a single source of excitation, and in a single substance.

The Smithsonian "Solar Constant" Expedition to Calama, Chile: C. G. Abbot, Smithsonian Astrophysical Observatory. A preliminary report on the aim and equipment of the Calama Expedition.

Maroon—A Recurrent Mutation in Drosophila: Calvin B. Bridges, Marine Biological Laboratory, Woods Hole.

Edwin Bidwell Wilson
Massachusetts Institute of Technology, Cambridge, Mass.

SPECIAL ARTICLES

ON THE NATURE OF THE PIGMENTATION CHANGES FOLLOWING HYPOPHYSECTOMY IN THE FROG LARVA

It has been shown by Smith[1] and by Allen[2] that the removal of the hypophysis fundament from the young larval frog is followed by a marked change in pigmentation. Within seven to ten days after the operation—which is most successfully performed when the larva is 3.5–4.0 mm. in length—the color of the tadpole changes from black to "silvery," or as Smith describes it, the larva becomes an albino.

Smith and Allen hold quite different views as to the nature of this pigmentation change. Smith thinks that the silvery appearance of the operated tadpoles is due to a reduction in the number of melanophores in the epidermis and to a loss of the individual pigment granules contained in these melanophores. He states that the melanophores are equally expanded in the albinos and in the controls, "consequently the lighter color of the albinos can not be due to the contracted condition of the chromatophores but must be referred, in part, to the reduced number of melanin granules in the pigment cells of the epidermis."

Allen, on the other hand, believes that the lighter color of the operated larvæ is due to the fact that the epidermal pigment cells have migrated to deeper positions and that the pigment cells are contracted throughout all parts of the body. He is convinced that "there is no disappearance and bleaching of pigment granules as asserted by Smith." Each of these observers, apparently, has based his conclusions upon the study of sections entirely. It will be recognized readily that in

[1] Smith, P. E., *Anatomical Record,* Vol. 11, p. 57, 1916.

[2] Allen, B. M., *Biological Bulletin,* Vol. 32, p. 117, 1917.

the study of such large cells as the amphibian chromatophores a much more satisfactory microscopic preparation may be obtained by mounting pieces of skin entire.

During the course of experimental studies on the relation of certain of the endocrine glands to pigmentation and growth changes in the frog, striking objective proof has been obtained that the "silvering" which follows hypophysectomy is due mainly to contraction of certain melanophores and not to any marked reduction in the amount of pigment material present.

The experiments to be described were performed upon larvæ of *Rana sylvatica*. This frog is very darkly pigmented in young stages and the "silvering" which follows hypophysectomy is consequently a very striking color change. The hypophysis was removed, following the methods of Allen and of Smith, at a stage just preceding the appearance of muscular activity. The operated larvæ were immediately returned to large crystallizing dishes containing city water (Ann Arbor, Mich.). Although this water is very hard and may contain traces of chlorine, there was not the high mortality among operated tadpoles which Allen noted. The characteristic silvering appeared from the eighth to the tenth day following the operation. As noted by the previous observers mentioned the operated larvæ were constantly smaller than controls of the same age and were somewhat more active.

When a length of from 12 to 14 mm. had been attained groups of the silvery larvæ were placed in a dilute extract of pars intermedia of beef pituitary or in an emulsion made by shaking a few mgm. of dried pars intermedia in 100 c.c. of distilled water. For each experiment a control group of larvæ was placed in an equal amount of distilled water. The larvæ placed in contact with the pars intermedia substance soon underwent a striking change from silvery to dark, in which condition they closely resembled the normal tadpole. This change began to be apparent in 15–30 minutes and attained a maximum in from one to three hours, depending on the strength of the extract or emulsion employed. When returned to fresh water the darkened larvæ soon regained their silvery appearance (one to three hours).

This experiment proves conclusively that the silvery appearance of the hypophysectomized larvæ is not due primarily to a loss of pigment substance. It indicates rather that it is due to a sustained contraction of pigment-bearing cells, which may be caused to expand again by suitable stimuli.

To test the validity of the latter assumption the experiment was repeated with the larvæ held in Clarke's observation chamber so that changes in the pigment cells could be watched under the microscope. In silvery larvæ the sub-epidermal melanophores were found to be contracted into dense spherical masses, whereas in normal larvæ the same cells were greatly expanded so that processes of neighboring cells were almost in contact. When a silvery larva was subjected to the action of an extract of pars intermedia the contracted pigment cells were seen to expand slowly. In one experiment a definite change in the cell under observation could be noted within eighteen minutes. The cell continued to expand slowly by sending out pseudopodia-like processes into which pigment granules could be seen to stream.

To further elucidate the nature of the pigment change *toto* mounts of pieces of skin stripped from normal and experimental larvæ after fixation in Bouin's fluid, were prepared, as follows: (*a*) normal, (*b*) silvery (hypophysectomized), (*c*) darkened silvery (hypophysectomized, under influence of pars intermedia extract).

In addition to the sub-epidermal melanophore with branches so numerous that a typical "mossy" appearance is presented, the skin of the normal frog larva contains another type of pigment cell, with relatively few branches, situated in the epidermis. The latter cells are said not to be contractile (Hooker[3]).

Skin mounts prepared from silvery larvæ show that the sub-epidermal pigment cells are

[3] Hooker, D., SCIENCE, N. S., Vol. 39, p. 473, 1914.

contracted, some completely so that they form dense spherical masses; others are only partially contracted. This is in accord with what may be observed in the tail of the living silvery tadpole. Another feature which immediately attracts attention is the apparent absence of the epidermal melanophores. Upon closer examination the faint outlines of a few such cells may be made out. The cells contain very few pigment granules. Whether the remaining cells have migrated from the epidermis to deeper parts, as stated by Allen, or whether they have become invisible from loss of pigment granules could not be determined. It is apparent, however, that those occasional epidermal melanophores which may be identified contain only a small proportion of the number of pigment granules to be found in the normal condition. Whether the pigment granules have been changed and absorbed or have left the melanophore to become more widely distributed likewise has not as yet been established.

When a silvery larva has been darkened by the action of an extract of pars intermedia the sub-epidermal melanophores are found to be expanded, thus approximating the normal condition. The epidermal pigment cells, however, are not restored.

It may be concluded, then, that the change in color which follows hypophysectomy in the frog larva is due primarily to a contraction of the sub-epidermal melanophores. Only secondarily is it due to a loss of pigment granules from certain of the epidermal melanophores, and to a possible migration or loss of other epidermal melanophores.

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THE PALEONTOLOGICAL SOCIETY

The Paleontological Society held its tenth annual meeting at Baltimore, December 28, 1918, meeting in affiliation with the Geological Society of America. The meeting was held in the civil engineering building of Johns Hopkins University, with an attendance of about forty members and visitors. Following the business session and the presentation of appreciations of the life and work of four deceased members, the reading of papers bearing upon the various branches of paleontology and stratigraphy was commenced and continued until late in the afternoon. In the evening the members attended the annual dinner with the Geological Society of America at the Southern Hotel.

Of special mention among the papers presented, listed below, was the address of the retiring president, Dr. F. H. Knowlton, on "The evolution of geologic climates," in which the evidence of paleobotany was the predominant theme, and the papers on the Philosophical Aspect of Paleontology and the Economic Value of the Science. Important stratigraphic and paleontologic results were announced by the members particularly regarding the Coal Measures of Maryland, the Oxfordian of Cuba and the Tertiary rocks of South America.

The following papers were read:

Paleontologic Papers

Relation of the Holochoanites and the Orthochoanites to the Protochoanites, and the significance of the Bactritidæ: Amadeus W. Grabau.

On the inclusion of the Pleistocenic period in the Psychozoic Era: Amadeus W. Grabau.

The philosophical aspects of paleontology: John M. Clarke.

Characters and restoration of Cope's Sauropoda: Henry Fairfield Osborn.

Camarasaurus and Amphicœlias from Canyon City: Henry Fairfield Osborn and Charles C. Mook.

Orthogenetic development of the costæ in the Perisphinctinæ: Marjorie O'Connell.

Discovery of the Oxfordian in western Cuba: Barnum Brown and Marjorie O'Connell.

A new Eurypterid horizon: George H. Chadwick.

The economic value of paleontology: Ralph Arnold.

Stromatopora growth on edgeon conglomerates from the Silurian: John M. Clarke.

Stratigraphic Papers

The age of certain plant bearing beds and associated marine formations in South America: Edward W. Berry.

The stratigraphy and correlation of the coal measures of Maryland: Charles K. Swartz, W. A. Price, Jr., and Harvey Bassler.

The typical section of the Allegheny formation: Charles K. Swartz and Harvey Bassler.

The Eocene divisions of California: Bruce L. Clark.

Some problems of the Adirondack Precambrian: Harold L. Alling.

Permo-Triassic of northwestern Arizona: Harvey W. Shimer.

The stratigraphy and structure of the Newark system in Maryland and its relation to the Newark system of eastern North America: George Edwin Dorsey.