1903. Bd. III., Lief. 14. Pp. 123. Pls. IX. Stockholm. 1913.

The recent renewed interest in Antarctic exploration, the discovery of the South Pole, the unfortunate fatality attending the English expedition, etc., have focused attention on this *terra incognita.* There is in this region so much in the way of possibility as regards the origins of floras and faunas, centers of distribution, and possible migration routes, that everything which tends to throw light on its past life is likely to prove of absorbing interest, and in this connection it is a pleasure to note the appearance of Dr. Halle's splendid memoir on the Mesozoic flora of Graham Land which is the first Mesozoic flora known from the Antarctic. Previous to the work of the Swedish South Polar Expedition our knowledge of the ancient Antarctic vegetation was extremely limited. The present report is based on a very large collection made, it is said, under conditions of the greatest hardship, by Dr. J. G. Anderson at Hope Bay, Graham Land. The material came from a single series of hard, dark, slaty rocks and is regarded as Middle Jurassic in age. The flora embraces 61 forms of which, however, nearly 20 have not been given specific names. They are distributed among the several groups as follows: Filicales 25; Cycadales 17; Coniferales 16; unknown 3. It is of interest to note that the Ginkgoales, which are so important and varied an element in the northern hemisphere, are entirely absent in the Antarctic, as indeed they are in the Gondwanas of India. *Podozamites,* which is so abundant and variable in the north, is absent from the Hope Bay collection and is represented only by fragments in the Indian localities. Cycads are abundantly present at Hope Bay but they are all small-leafed species, while the conifers were abundant in materials but not well preserved.

Although the author has made quite a number of new species—on the wise basis that it is better to give a new name that may ultimately become a synonym, than to lump doubtful material under an old name that later may have to be divided—there are no less than 22 species previously known. Of these, 9 species are common to the Lower Oolites of England, 8 to the Upper Gondwanas of India, and 5 to the Jurassic of California and Oregon, with others which are scattered at various well-known Jurassic localities. The close relation existing between the Jurassic flora of Graham Land and other contemporaneous floras is certainly remarkable when considered in regard to its remoteness from these floras. In the nearest continent, South America, there are no floras of any importance that can be considered contemporaneous with the Antarctic one. Dr. Halle concludes as follows: "Though the closest argument is with the Jurassic flora of England, the resemblance to the Indian Upper Gondwana flora is nearly as great. The Hope Bay flora tends thereby to lessen yet more the differences between these floras and thus becomes another important illustration of the uniformity and world-wide distribution of Jurassic floras. This uniformity is all the more striking because of the pronounced differentiation of the world's vegetation into two different phyto-geographical provinces at the end of the Paleozoic, which difference would appear to have become almost extinguished in Jurassic time."

F. H. KNOWLTON

SPECIAL ARTICLES

THE PHYSICO-CHEMICAL CONDITIONS OF ANESTHETIC ACTION. CORRELATION BETWEEN THE ANTI-STIMULATING AND THE ANTI-CYTOLYTIC ACTION OF ANESTHETICS

THE anti-stimulating action of lipoid-solvent and other anesthetics is well known. Irritable tissues become temporarily irresponsive when exposed to solutions of these substances in certain concentrations, which must not be too high—otherwise cytolysis results, or too low—in which case irritability may be increased instead of decreased. The precise nature of the change in the irritable elements conditioning the loss of irritability remains obscure. The Overton-Meyer theory refers anesthesia to a modification of the lipoids. But a reversible loss of irritability similar in all essential respects to anesthesia may be induced by substances which have no specific relation to lipoids—as salts of magnesium or calcium, acids in low concentration, non-electrolytes like sugar—and also by the electric current (anelectrotonus). From these facts we must infer that although a change of state in the cell-lipoids may induce anesthesia it is not the essential change. Some other more general process is involved. What is the nature of this process?

In studying the conditions of chemical stimulation in the larvæ of *Arenicola*—a free-swimming annelid trochophore, 0.3 millimeters long and abundant at Woods Hole—I was struck with the fact that solutions which stimulate the musculature powerfully, causing strong and persistent shortening to half the normal length, invariably cause an immediate and marked exit of pigment from the body cells. Among such solutions are pure isotonic solutions of sodium and potassium salts. The cells of the larvæ contain a yellow water-soluble pigment, which on death, or under other conditions associated with increased permeability of the plasma membranes (action of cytolytic substances, as saponin), diffuses into the medium and colors the latter a bright yellow. This pigment thus serves as a convenient indicator of permeability-increase. The strong stimulation caused by isotonic NaCl solution is thus associated with a marked permeability-increasing action. This is equivalent to a cytolytic or toxic action, for definite toxic effects, as shown by breakdown of cilia and failure of the larvæ to revive completely on return to normal sea-water, always follow even brief exposure to the pure NaCl solution. The stimulating, permeability-increasing and cytolytic actions of the solution thus show a definite parallelism.

Conditions that prevent the immediate stimulating action also prevent the permeability-increasing and toxic action. Addition of a little calcium or magnesium chloride, *e. g.*, to the NaCl solution has this effect. In such mixed solutions there is little or no immediate stimulation or loss of pigment and the toxic action is greatly diminished. Stimulation and permeability-increase, with the associated toxic or cytolytic action, are thus simultaneously prevented by the calcium or other antagonistic salt.

Similar effects are seen if the organisms are briefly treated with magnesium chloride *previously* to being brought into the NaCl solution. Isotonic $MgCl_2$ solution causes neither stimulation nor loss of pigment. The musculature is rapidly anesthetized in this solution, and the animals remain rigid and without contraction, swimming slowly by the cilia which remain active. If the larvæ are then transferred to $m/2$ NaCl no immediate effect is seen. Stimulation and loss of pigment are entirely absent, and correspondingly there is little immediate toxic action. The treatment with $MgCl_2$ has a protective or anti-cytolytic as well as an anesthetic or anti-stimulating (desensitizing) effect.

Similar effects are produced by lipoid-solvent anesthetics. Larvæ exposed to a 0.7 v. per cent. solution of ether in sea-water are rapidly anesthetized. If then they are brought suddenly into pure $m/2$ NaCl containing the same proportion of ether, no stimulation or permeability-increase is seen, and the toxic action is diminished as before; *i. e.*, recovery on return to sea-water is much prompter and more complete than after similar exposure to pure $m/2$ NaCl without previous anesthetization. Direct transfer from normal sea-water to ether-containing salt-solution also causes little or no stimulation or loss of pigment. The anti-stimulating action in this case also is associated with or involves a marked anti-toxic action.

I have performed similar experiments with a large number of other anesthetics with the same general results.[1] In those concentrations which in sea-water produce typical reversible anesthesia, the anesthetic checks or prevents the immediate stimulating action of the salt

[1] For a detailed account of these experiments *cf. American Journal of Physiology*, 1913, Vol. 31, pp. 264 seq.

solution, and also its permeability-increasing action as indicated by loss of pigment. A corresponding anti-cytolytic or anti-toxic action is invariably found to be associated with these effects.

The following anesthetics have been used in these experiments: *alcohols:* methyl, ethyl, n-propyl, isopropyl, n-butyl, n-amyl, n-capryl; *esters:* ethyl acetate, propionate, butyrate, valerianate, nitrate; *urethanes:* methyl, ethyl, phenyl; chloroform, carbon tetrachloride, nitromethane, acetonitrile, benzol, toluol, xylol, phenanthrene, naphthalene; ethyl ether, chloretone, chloral hydrate, chloralose, paraldehyde, phenyl urea, acetanilide, phenacetin, methacetin.

Almost all of these substances have also been used by Overton in his investigations of anesthesia in tadpoles. In the case of *Arenicola* larvæ the concentrations requisite for neuromuscular anesthesia are in all cases higher (usually from three to five times higher) than for the neuromuscular system of Vertebrata. Otherwise the relations observed in these experiments are closely similar to those found by Overton and other experimenters in this field. For homologous series (alcohols, esters) the anesthetic action increases regularly with the molecular weight—*i. e.,* with the lipoid-water partition coefficient. The anti-cytolytic or protective action always runs closely parallel with the anti-stimulating action. A well-marked protective effect is however often seen in concentrations which are insufficient for complete anesthesia.

The general fact that the anesthetic hinders or prevents increase of permeability indicates that the seat of its *essential action is in the plasma-membranes of the irritable tissue.* The characteristic permeability of the plasma-membranes of cells to lipoid-soluble substances furnishes strong evidence that these membranes consist largely of lipoid material. The lipoid-solvents alter the membrane by changing the state of its lipoid components; other substances may produce similar effects by changing the state of the other colloids of the membrane. In general these observations show that anesthesia is associated with an increase in the resistance of the membrane to the permeability-increasing action of the stimulating agency. I infer, therefore, that the essential condition of anesthetic action is a modification of the physical properties of the plasma membranes of the irritable elements, of such a kind that the membranes fail to undergo, under the usual conditions of stimulation, the increase of permeability essential to this process. This modification may be caused by lipoid-solvents, salts or other substances; also by altering the electrical polarization of the membrane by an external electric current, as in anelectrotonus. Apparently any condition that renders the membrane incapable of rapid and reversible changes of permeability renders the tissue refractory to stimulation. On this view the parallelism between the antistimulating and anti-cytolytic actions becomes intelligible, since increased permeability is the condition of cytolysis as well as of stimulation. Substances or conditions that prevent the one effect will also prevent the other.

These observations have a direct bearing on the general theory of stimulation. They support the view that an essential feature of the stimulation-process is a well-marked increase in the permeability of the limiting membranes of the irritable elements. It is obvious that the problem of the nature of anesthetic action involves the problem of the nature of the stimulation-process, and study of the action of anesthetics thus forms one means of attacking this wider problem. Any constant physical modifications caused in the irritable elements by the anesthetic, coincidently with the loss of irritability, must furnish indications of the nature of the processes concerned in the response to stimulation. The above observations thus agree with those of Nernst and his successors, which localize the primary or critical process in stimulation at the semi-permeable membranes of the irritable elements. They indicate further that in stimulation the permeability of these membranes is increased. But changes of permeability must involve changes in the electrical polarization of the membranes; and it seems probable that these variations in electrical polarization are more directly responsible for the characteristic special effects produced by stimulation—such as increased oxidation, contraction, and the other forms of response which vary from cell to cell.

RALPH S. LILLIE
UNIVERSITY OF PENNSYLVANIA

THE SOUTHERN SOCIETY FOR PHILOSOPHY AND PSYCHOLOGY

THE eighth annual meeting of the Southern Society for Philosophy and Psychology was held at the Johns Hopkins University, Baltimore, on Tuesday and Wednesday, April 8 and 9, 1913. Three sessions were held: one on Tuesday afternoon, one on Tuesday evening and one on Wednesday forenoon. On Tuesday afternoon at 5 o'clock the members of the society were invited to attend the university lectures on "Bergson's Doctrine of Time" given by Professor A. O. Lovejoy in the Donovan Room of McCoy Hall. The sessions were held in the lecture room of the biological laboratory, President R. M. Ogden presiding. The president's address, entitled "The Relation of Psychology to Philosophy and Education," was given at the session on Tuesday evening. Preceding this address, the local members of the society entertained the visiting members at a dinner at the Johns Hopkins Club, and after the address they entertained them at a smoker in the rooms of Professor Lovejoy. The following items were passed upon at the business meeting, which was held on Wednesday morning:

1. It was decided to hold the next meeting at Atlanta, Georgia, during the recess of the Christmas holidays, in conjunction with the meetings of the American Association for the Advancement of Science.

2. The following officers were elected for the year 1913: *President,* H. J. Pearce, Brenau College; *Vice-president,* A. O. Jovejoy, Johns Hopkins University; *Secretary-Treasurer,* W. C. Ruediger, The George Washington University; *Council for three years,* Bird T. Baldwin, Swarthmore College, and Josiah Morse, University of South Carolina.

3. The following were elected to membership: Professor W. H. Chase, University of North Carolina; Professor L. R. Geissler, University of Georgia; Miss H. B. Hubberd, Baltimore; Miss E. D. Keller, Baltimore; Dr. Frank A. Manny, Baltimore Training School; Professor Mark A. May, Murphy College; Father Thomas V. Moore, Catholic University of America; Mrs. Jacob Taubenhaus, Newark, Delaware; Mr. Jacob Ulrich, Baltimore; Professor H. H. Williams, University of North Carolina.

4. The accounts of the treasurer were audited by a committee of the council and showed a balance on hand, April 9, 1913, of $68.70.

5. Votes of thanks were extended to the authorities of the Johns Hopkins University for the use of the lecture room of the biological laboratory and to the local members for the dinner and the smoker.

W. C. RUEDIGER,
Secretary-Treasurer
THE GEORGE WASHINGTON UNIVERSITY,
WASHINGTON, D. C.

THE ZOOLOGICAL SECTION OF THE MICHIGAN ACADEMY OF SCIENCE

THE nineteenth annual meeting of the Zoological Section met in the zoological lecture room of the University of Michigan at 9 A.M. and 1:30 P.M. on April 3, with Vice-president Peter Okkelberg in the chair. The meetings were well attended and the following program was read. Dr. Bertram G. Smith, of the Ypsilanti State Normal College, was elected vice-president and chairman of the Zoological Section for the coming year. Hereafter the meetings will be held on the Friday and Saturday after Thanksgiving.

"Factors Governing Local Distribution of the Thysanoptera," A. F. Shull.

"Results of the Mershon Expedition to the Charity Islands, Lake Huron Coleoptera," A. W. Andrews.

"Types of Learning in Animals," J. F. Shepard.

"The Lepidoptera of the Douglas Lake Region, Cheboygan County, Michigan," Paul S. Welch.

"Check-list of Michigan Lepidoptera. II. Sphingidæ (Hawk-moths)," W. W. Newcomb.

"On the Breeding Habits of the Log-perch," Jacob Reighard.

"A List of the Fish of Douglas Lake, Cheboygan County, Mich., with notes on their Ecological Relations," Jacob Reighard.

"May the Remains of Adult Lepidoptera be Identified in the Stomach Contents of Birds?" F. C. Gates.