be led to the conclusion that there is some radical distinction between plants and animals in these respects.

Many matters of importance are treated in the book, especially the vexed question of the nature of "mutations," to which no justice can be done here. All that can be now attempted is an outline of the essential discoveries. To some it may seem that the disposition of this article is towards undue scepticism. To doubt the theory of cross-overs, for instance, at this date is almost in effect to "draw an indictment against a nation," which we know on high authority is an impossible task. Let it then be explicitly said that not even the most sceptical of readers can go through the *Drosophila* work unmoved by a sense of admiration for the zeal and penetration with which it has been conducted, and for the great extension of genetic knowledge to which it has led—greater far than has been made in any one line of work since Mendel's own experiments.

W. BATESON

PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES

THE ninth number of Volume 2 of the *Proceedings of the National Academy of Sciences* contains the following articles:

The Mechanism of Diffusion of Electrolytes through Animal Membranes: Jacques Loeb, Rockefeller Institute for Medical Research, New York. For the diffusion of certain electrolytes through animal membranes there is required besides the osmotic pressure a second effect called the "salt effect" upon the membrane. This consists probably in an ionization of the protein molecules of the membrane.

The Rotation and Radial Velocity of the Spiral Nebula N.G.C. 4594: Francis G. Pease, Mount Wilson Observatory, Carnegie Institution of Washington. The radial velocity is + 1,180 km., in good agreement with the value found by Slipher. The linear velocity of rotation at a point 2 minutes of arc from the nucleus is over 330 km.

A Simple Method for Determining the Colors of the Stars: Frederick H. Seares, Mount Wilson Solar Observatory, Carnegie Institution of Washington. The method suggested consists in determining the ratio of exposure-times which is necessary to produce photographic and photovisual or more briefly, blue and yellow, images of the same size.

Studies of Magnitudes in Star Clusters, III. The Colors of the Brighter Stars in Four Globular Systems: Harlow Shapley, Mount Wilson Solar Observatory, Carnegie Institution of Washington. It is concluded that in all the clusters examined and probably in all globular clusters the volumes of the bright red stars are very great in comparison with the stars that are fainter and relatively blue.

The Effect of an Electric Field on the Lines of Lithium and Calcium: Janet T. Howell, Mount Wilson Solar Observatory, Carnegie Institution of Washington. Lithium and calcium were examined both for longitudinal and transverse effects.

A Proof of White's Porism: A. B. Coble.

A Contribution to the Petrography of the Philippine Islands: J. P. Iddings and E. W. Morley, Brinklow, Maryland and West Hartford, Conn. Six detailed analyses are given of rocks from Luzon, P. I.

Salt Antagonism in Gelatine: W. O. Fenn, Laboratory of Plant Physiology, Harvard University. The experiments on gelatine support the hypothesis that anions antagonize cations in their effects upon organisms. The hypothesis here developed resembles that of Clowes except that it requires that NaCl should antagonize any electrolyte which has either a strong anion or a strong cation. The point of maximum antagonism is an isoelectric point at which the amount of alcohol needed for precipitation is at a minimum, and the aggregation or amount of precipitation is at a maximum.

Similarity in the Behavior of Protoplasm and Gelatine: W. O. Fenn, Laboratory of Plant Physiology, Harvard University. A close analogy to Osterhout's experiments on the electrical resistance of *Laminaria* is found in gelatine (plus NaOH), if we assume that the effect of time in the *Laminaria* experi-

ments is to increase the concentrations of the salts in the cells of the tissue.

On Certain Asymptotic Expressions in the Theory of Linear Differential Equations: W. E. Milne, Department of Mathematics, Bowdoin College. Formulas more precise than those previously obtained by Birkhoff are given.

On Newton's Method of Approximation: Henry B. Fine, Department of Mathematics, Princeton University. A condition is given under which Newton's method of approximation for computing a real root of an equation, and the extension of this method used in computing a root of a system of equations, will with certainty lead to such a root or solution.

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SPECIAL ARTICLES

THE FUNCTION OF THE APYRENE SPERMATOZOA

Since the discovery of the dimorphism of spermatozoa in *Paludina* by von Siebold, 1836, numerous biologists have worked with this strange phenomenon without being able to find a conclusive explanation. On the one side investigators were found, like v. Brunn, who regarded the abnormal type of spermia as abortive elements without any function, whereas others, like Brock and Auerbach, thought it impossible that such typical elements could be produced regularly without being functional. It is well known how a new basis was given to these discussions, when Meves (1903)[1] worked out the details of the spermatogenesis of these two types of spermatozoa. He first proved that the atypical spermia in Prosobranchs contain only a small part of the chromatin of the cell and called them *oligopyrene* spermatozoa. He further discovered a similar dimorphism in some moths, but here the atypical spermia contain no chromatin at all, they are apyrene. Meves could get no evidence regarding the possible function of these elements, but he felt sure that they must have some function and pointed to the possibility of a fertilization by these elements, which would be interpreted as an "Entwicklungserregung." Since then much morphological work upon the structure and development of the atypical elements has been done, especially by Retzius, Kuschakewitsch, Reinke,[2] which, however, does not interest us here.

The interest in the possible function of these elements was awakened again, when the facts about the sex-chromosomes became known and their relation to the other kind of dimorphism of spermatozoa in insects and the mechanism of sex inheritance. The idea was promoted by R. Hertwig[3] that this dimorphism might also be connected with sex-determination and he tried to fit these possibilities into his general ideas of sex-determination, considering the possibility of fertilization by apyrene spermatozoa as a kind of male-producing parthenogenesis. These ideas were the starting point of some work which Popoff[4] did with *Paludina*. But he was unable to prove that the oligopyrene spermatozoa of that snail take any part in fertilization, although they are found in sufficient numbers in the oviduct. The only positive result was that in impregnated snails the oligopyrene spermia degenerate and die much earlier than the normal ones. Lamas,[5] who later studied the fertilization of *Murex*, was also unable to find any such spermatozoon inside the egg. On this point we have only a single positive observa-

[1] Meves, F., "Ueber oligopyrene und apyrene Spermien und ueber ihre Entstehung nach Beobachtungen an Paludina und Pygaera," *Arch. Mikr. Anat.*, 61, 1903. See there the quotations of the previous literature.

[2] Retzius, G., *Biol. Unters.*, N. F., Vol. 12, 13, 14, 1905–1909. Kuschakewitsch, S., "Studien über den Polymorphisms der männlichen Geschlechtselemente bei den Prosobranchia," *Arch. Zellforschg.*, 10, 1913 (complete literature). Reinke, E. E., "The Development of the Apyrene Spermatozoa of *Strombus tuberculatus*," Publ. 183, Carnegie Inst., Washington, 1914.

[3] Hertwig, R., "Ueber Correlation von Zell- und Kerngroesse, etc.," *Biol. Centrbl.*, 23, 1903.

[4] Popoff, M., "Eibildung bei Paludina vivipara, etc.," *Arch. mikr. Anat.*, 70, 1902.

[5] Lams, H., "Recherches concernant le dimorphisme des éléments sexuels chez le Murex," *Ann. Soc. Med. Gand.*, 89, 1910.