cent crinoids generally has ever been given before.

There is not space to review the questions of zoological relationships discussed—some of which are speculative, and will doubtless meet with criticism—nor the many new discoveries touching the structure and characters of the crinoid organism, which testify to the industry of the author. Among the more general conclusions to which these researches have led, the following may be mentioned:

1. The Crinoids of the recent seas are far more numerous, both in individuals and in species, than is commonly supposed, and their relative importance does not fall short of that of the other echinoderm groups.

2. The Crinoids, after a paleontological record almost without a parallel for duration and for variety in development, are represented in the recent seas chiefly by two highly aberrant types, viz: (1) the Pentacrinites, which have departed widely from their prototypes by enormously increasing the length of the column through the indefinite reduplication of the first stem joint, or proximale; and (2) the Comatulids, which have departed just as widely by discarding the column and compressing what is virtually the entire column of the pentacrinites within the compass of a single highly cirriferous proximale. Thus while the two groups are parallel to each other, and are descended from the same ancestral stock, and represent the same phylogenetic stage, during their development they have diverged from their phylogenetic mean in exactly opposite directions; and both groups are therefore far removed from the direct line representing the progressive development of the class.

3. These two aberrant types dominate the recent seas to such a degree that in comparison with them all the other types become relatively insignificant. The comatulids, although in their relation to the fossil crinoids merely an inconspicuous family, far outnumber all of the other existing crinoids taken together, at the same time extending through a much wider geographical, bathymetrical and thermal range. They exist in a vast array of diverse forms, none of which depart in any great degree from the general structure of the group, so that their classification necessitates the creation of numerous subfamilies, and families, and higher groups, which are not systematically comparable to similar groups in the stalked crinoids.

4. Among the Recent Crinoids the calyx, usually reduced to insignificant proportions, is of comparatively little systematic value—the classification being placed chiefly upon the column (or homologous structures), and the proximal pinnules. This is, broadly speaking, the reverse of the conditions in the fossil forms, and this fact involves the recognition of characters for the differentiation of species and genera wholly different from those employed in dealing with the fossils. The application of these criteria to the study of the collections and material above mentioned has resulted in the proposal of nearly 100 new genera, and the description of several hundred species new to science, among the comatulids alone, the systematic treatment and illustration of which are to follow in a succeeding volume.

5. The author believes the echinoderms to be a highly abberrant offshoot from a primitive crustacean stock, and that they are far from being the anomalous creatures they are commonly considered.

The thanks of all students of the echinoderms are due to the authorities of the National Museum for their liberality in facilitating the publication of the results of these researches in so thorough and comprehensive a manner, and in thus giving to the scientific public a work which is destined to take rank with the great monographs following the *Challenger* Expedition—a series which in its entirety stands as one of the finest contributions to the knowledge of marine zoology ever produced.

FRANK SPRINGER

THE PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES

THE eighth number of Volume 1 of the *Proceedings of the National Academy of Sciences* contained the following articles:

1. *Weber's Law and Antagonistic Salt Action:* Jacques Loeb, Rockefeller Institute for Medical Research, New York.

The author had shown that the ratio of the concentrations of antagonistic ions must remain within certain limits for the normal functioning of an organism. It is here shown that these limits remain approximately constant as the concentration of one of the ions is changed.

2. *The Polarized Fluorescence of Ammonium Uranyl Chloride:* E. L. Nichols and H. L. Howes, Physical Laboratory, Cornell University.

The remarkable fluorescence spectrum of this salt is described in considerable detail; observations being made at $+20°$ C. and $-185°$.

3. *The Linguistic Classification of Pottawatomi:* Truman Michelson, Bureau of American Ethnology, Washington.

By study of the so-called "verbal pronouns," which afford most satisfactory classificatory criteria, it is shown that Pottawatomi belongs to the Ojibwa Group of Central Algonquian dialects.

4. *The Light Curve of XX Cygni as a Contribution to the Study of Cepheid Variation:* Harlow Shapley and Martha Betz Shapley, Mount Wilson Solar Observatory, Carnegie Institution of Washington.

The form of the maximum of brightness in XX cygni is variable from period to period and thus suggests the hypothesis that the periodic light and spectrum variations in this and other Cepheid variables should be ascribed to internal vibrations producing irregularities in luminosity instead of to double star phenomena.

5. *The Feebly Inhibited. III. Inheritance of Temperament; with Special Reference to Twins and Suicides:* C. B. Davenport, Station for Experimental Evolution, Carnegie Institution of Washington.

A statistical study of 89 family histories, affording 147 matings, leads to the conclusion that temperament is inherited as though there were in the germ plasm a factor *E* which induces the more or less periodic occurrence of an excited condition and its absence, *e*, which results in a calmness; also a factor *C* which makes for normal cheerfulness and its absence which permits a more or less periodic depression, the factors behaving as though in different chromosomes, so that they are inherited independently.

6. *Second Type Stars of Low Mean Density:* Harlow Shapley, Mount Wilson Solar Observatory, Carnegie Institution of Washington.

Because of its bearing on the question of the order of stellar evolution, the density of stars of the second spectral type is discussed from the standpoint of the dependability of the observation and theoretical work that is the basis of the derivation of occasional extremely low values.

7. *On the Pathological Action of Arsenicals upon the Adrenals:* Wade H. Brown and Louise Pearce, Rockefeller Institute for Medical Research, New York.

That arsenicals of diverse chemical constitution exert pronounced pathological action upon the adrenals has not been generally recognized. It appears from these observations that the adrenotropic action of arsenicals is one of the most constant and important features of arsenical intoxication, and it is suggested that therapeutic doses of some arsenicals may be found to produce definite stimulation of the adrenal glands.

8. *Variations in the Character and Distribution of the Renal Lesions produced by Compounds:* Louise Pearce and Wade H. Brown, Rockefeller Institute for Medical Research, New York.

Not all compounds of arsenic produce vascular lesions; some are capable of producing tubular nephritis; the difference in the pathogenic action being explainable only upon the basis of the chemical constitution of the different compounds of arsenic.

9. *Seven Points on a Twisted Cubic Curve:* H. S. White, Department of Mathematics, Vassar College.

If seven points on a twisted cubic be joined,

two and two, by twenty-one lines, then any seven planes that contain these twenty-one lines will osculate a second cubic curve.

EDWIN BIDWELL WILSON

SPECIAL ARTICLES

PRELIMINARY STUDIES ON INTRACELLULAR DIGESTION AND ASSIMILATION IN AMPHIBIAN EMBRYOS [1]

BY means of a double stain of janus green and neutral red in an isotonic salt solution, the initial dilution of each stain being about 1:10,000, the yolk globules in the living cells of *Amblystoma* embryos may be differentiated into two types, which, for convenience of description, I designate as "alpha" and "beta" globules. The alpha globules stain selectively with janus green, at first greenish blue and then pinkish, presumably upon reduction of the dye. The beta globules stain selectively with the neutral red, and are by far the more numerous in the cell. When the same dyes are used singly in a dilution of 1:30,000 the alpha globules are relatively inert towards the red, and the beta globules are not stained by the green. In smears of living embryos which have been fixed upon the cover glass with the acetic-osmic bichromate mixture and stained with acid fuchsin according to the method of Bensley,[2] for mitochondria, the beta globules stain a deep, brilliant red while the alpha globules take on a duller tint, bordering on purple. The two types of globules may be similarly differentiated in sections prepared according to this method.

In smears of living cells which have been stained in janus green, alpha globules may be found here and there with deeply stained, blue excrescences upon their surface. These structures may be described as "alpha bodies." These are particularly distinct after the globule on which they occur has begun to take on the pinkish tint. They frequently appear as rows of slightly elongated masses connected by slender threads of the same kind of substance. In optical section some of them seem to dip into the substance of the globule while others project in varying degree above it. Some even have a very slight attachment to the globule. In other instances similarly staining substance is arranged in relatively coarse bands with ragged outline, a condition to which I shall refer again in considering the toxic action of the dye.

The different forms of alpha bodies I regard as indicative of different stages in their development. I have seen them in numerous cases arranged in rows over the surface of the globule as separate and distinct bodies. In this condition they have the form and color of mitochondria in the same preparation. In one instance, in fact, after I had begun to draw a globule with these separate and distinct alpha globules on its surface, I observed that some of the alpha bodies were changing their position relative to each other, and, giving continuous and close observation to those bodies, I saw some of them break loose from the globule and become indistinguishable in form and color from mitochondria which appeared elsewhere in the same preparation. Alpha bodies are visible also in smears and sections made according to Bensley's method for mitochondria as noted above.

Similarly there appear on some beta globules structures which may be called "beta bodies." These stain a deep red in contrast with the more delicately tinted body of the globule. In some respects they resemble in general structure the alpha bodies, but they are of a coarser nature. In some instances there is a hull of this substance around the greater part of the globule. Upon other globules it appears in ridges or as a chain of angular bodies. In smears of living cells I have seen beta bodies,

[1] When this paper was written I was not acquainted with the contribution of C. Saint-Hilaire: "Ueber die Veränderungen der Dotterkörner der Amphibien bei der intracellulären Verdauung," *Zoologische Jahrbücher, Abt. f. Allg. Zool. u. Physiol.*, B. 34, Heft 2. After a careful study of his results I am convinced that Saint-Hilaire has not seen my "alpha bodies." Otherwise, my observations, in many respects, are in striking agreement with his. The differences in matters of interpretation can not be discussed here.

[2] Bensley, R. R., "Studies on the Pancreas of the Guinea Pig," *American Journal of Anatomy*, Vol. 12, No. 3.