

fixed. The other initial number $2n$ being given the successive values 6, 8, etc., or

$$n = 3, 4, \dots, 14,$$

the formula gives, with $N = 109721.6$, all the twelve observed members of the series from $m = 2$ to $m = 13$, respectively, the first with a deviation of 5, the second within 0.7, and the remaining ten members within a fraction, ranging from 0.1 to 0.35 Å.U.

The possibility of reducing $4N$ to N , based on the fact that all numbers are even, is interesting, especially as it forces itself on us also in the case of the fundamental and the principal series of singlets, which, though less precisely but again orderly and without gaps, are represented by

$$v = 4N \left(\frac{2n}{6} \right) \equiv N \left(\frac{n}{3} \right), \quad n = 4, 5,$$

and

$$v = 4N \left(\frac{14 \cdot 2n}{8 \cdot 4} \right) \equiv N \left(\frac{7 \cdot n}{4 \cdot 2} \right), \quad n = 3, 4, 5, \dots, 14.$$

This reducibility (to *one* N), if interpreted physically, would mean that the helium nucleus attracts each of its electrons with only one-half of its total charge, as if its lines of force formed two bundles, each entirely engaged with one of the two trabants. Details concerning these three series and the last-mentioned possibility will be given at the coming Boston meeting of the American Association.

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December 13.

Echinoderm Larvæ and their Bearing on Classification.

MAY I ask your permission for a short space in which to reply to Dr. Mortensen's letter published in NATURE of December 16, p. 806, under the title "Echinoderm Larvæ and their bearing on Classification." The points which Dr. Mortensen raises are two—namely (a) whether the Echinoderm metamorphosis is a metagenesis, *i.e.* an alternation of generations, or not, and (b) whether the fixed stage in the life-history of Asteroidea is a reminiscence of an ancestral condition or a secondary modification of development. I shall deal with the second point first. Dr. Mortensen states:

(1) That the group Spinulosa among Asteroidea are not primitive but modified forms and that the Paxillosa are the more primitive group, and that in this view certain modern systematists whom he quotes agree with him.

(2) That since the Astropectinidæ (Paxillosa) do not have a Brachiolaria stage in their ontogeny, this stage is not primitive and ancestral but secondarily intercalated where it occurs in the development of Spinulosa and Forcipulata.

I must confess that I am unconvinced by Dr. Mortensen's arguments. In his original work, reviewed by Dr. Bather, he forgot that the Brachiolaria larva was found in Spinulosa but referred it to Forcipulata only.

The systematists whom he quotes are neither palæontologists nor physiologists but—for the most part—students of the external features of preserved specimens only. Koehler (one of them) regards Hudsonaster, one of the oldest Asteroids known, as "voisine des Astropectinides," and W. K. Fisher also states that "typical Phanerozonia such as the Astropectinidæ are more primitive than the Spinulosa."

Now what these specialists are impressed by is the "phanerozonte" character of the Astropectinidæ, that is, the edging of the arms with a series of broad

plates termed the "marginals." I have always protested against regarding this feature as a primitive character and in this protest I have the support of the best British authority on fossil starfish, W. K. Spencer. The fact is, the apparent marginals of these ancient starfish are not homologous with the marginals of the modern Paxillosa at all but are the adam-bulacrals. Reasoning from imperfectly described fossils and superficially described modern forms has completely misled the older systematists.

Ludwig, whom Dr. Mortensen quotes, was a worthy pioneer in the knowledge of Echinoderms, but he belongs in all his thoughts and views to another epoch. His classification, for example, of the Holothuroidea into Actinopoda and Paractinopoda has been completely disposed of by modern embryological research. In my letter of a year ago, I gave physiological and anatomical reasons for regarding the Astropectinidæ as Asteroids secondarily modified for a life on sand. I can only express the doubt whether Dr. Mortensen could have regarded the Astropectinidæ as primitive if he had ever thoroughly dissected one.

With regard to the homology of the stalks of the Brachiolaria larva of the Asteroid and the Pentacrinoid larva of Antedon, I should like to reiterate the following facts:

(1) The larvæ are, broadly speaking, comparable; in both there is a long præoral lobe, a ventral stomodæum, right and left posterior coelomic sacs.

(2) In both forms there is a fixing ("sucking") disc formed at *precisely the same spot*, and in both the præoral lobe is converted into a stalk.

Is it not infinitely more probable that the precisely similar stage of fixation is an original and ancestral feature in both ontogenies, and not as Mortensen supposes, ancestral in the Crinoid and secondarily intercalated in the Asteroid ontogeny?

Of course, the subsequent metamorphosis is very different in the two cases—but this difference I have correlated with the adoption of different feeding habits by two sections of the primordial Echinoderm stem. I have the support of Mr. Tate Regan, based on his study of a widely different group, that what he calls "habitudinal differences" are the basis of all differential evolution.

With regard to the "metagenesis" of Echinoderm larvæ, Dr. Mortensen states that in one species of Ophiuroid the whole larval body is reproduced by the remnant of the ciliated apparatus cast off at metamorphosis. This case is certainly unique among Echinoderm larvæ and I cannot accept it until Dr. Mortensen brings forward better evidence. In any case, it will not, even if true, alter our views as to the significance of the larva. May I remind Dr. Mortensen that Antedon among Crinoids and Amphiura among Ophiuroids can both eject their entire alimentary viscera and reduce themselves to a framework of arms with a nervous centre and yet regenerate all that is lost? Finally, in Dr. Mortensen's appeal to Dr. Bather, he forgets that what Dr. Bather objected to was my fathering of Dr. Mortensen's views on him. My friend Dr. Bather and I are in substantial agreement in our views on Echinoderms.

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DR. MORTENSEN (NATURE, December 16, p. 806) says that "... since the larvæ of the more primitive Asteroids (the Phanerozonia) are devoid of a Brachiolaria stage, the sucking disc ... must be a later specialised structure. ..." Surely the statement is an error, and (even if it were true) the conclusion unjustified. The Phanerozonia of Sladen