On the Phenomena of Reproduction in Animals and Plants.

Antithetic Alternation of Generations.

BY

J. BEARD, D.Sc.

Lecturer on Comparative Embryology, University of Edinburgh.

A RECENT number of the *Annals of Botany* contains Strasburger's conclusions on 'the periodic reduction of the chromosomes in living organisms'¹. The paper, though largely based on facts of plant-morphology, is not without its special significance to the zoologist and animal morphologist. In the zoological world Strasburger's statements appear to have created more unrest than satisfaction, and they have already led to an elaborate and somewhat ingenious criticism² from the pen of V. Haecker³. And naturally so, even though it should subsequently become apparent that in this, as in so many other cases, Strasburger was mainly in the right in his

¹ *Ann. of Botany*, Vol. viii, 1894, pp. 281-316.

² Haecker, V., The reduction of the chromosomes in the sexual cells, *Ann. of Botany*, Vol. ix, 1895, pp. 95-101.

³ Haecker's objections are certainly weighty ones, and are only rendered in some respects nugatory by the acceptance of a very different view of the nature of animal development from that hitherto adopted.

contentions so far as these relate to plants. How could it be otherwise? Is not the zoologist as such concerned with processes in which an antithetic alternation of generations is only conspicuous by its absence? How then shall he of all men accept an explanation of the meaning and nature of a process in plants, when to what is, to all appearance, the corresponding phenomenon in animal reproduction the interpretation offered would seem totally incapable of application?

The zoologist in general, having as little belief in the occurrence of spore-formation in animals as in an antithetic alternation of generations, and being limited by a blind acceptance of recapitulation with 'direct development' or by a simple negation of any such theory, is hardly to be expected to admit that the botanists may have obtained a deeper insight into the phenomena of plant-development than he believes himself to have of those of animal-reproduction.

Haecker speaks in his behalf with no uncertain note. An explanation which does not fit in with the zoological facts is to Haecker's mind possibly dependent on a 'misinterpretation of the results obtained by the botanists,' and he seems to think it more fitting that these investigators should set their house in order in the light of the newer zoological facts. Apparently it does not occur to him that the something lacking to complete agreement might lie at the door of the zoologist himself.

The fundamental laws and principles of animal reproduction are practically assumed to be less open to emendation and repeal than those of plant-development. But is this really the case? What we are taught when we begin our zoological studies, provided it be contained in the text-books as well as in the professor's lectures, becomes almost of the nature of a superstition, and the essence of such is, as Huxley has, I think, remarked, that it is accepted on faith without evidence.

In zoological research there is also a fatal tendency to look upon all previous results, in so far as they are of general

import and not directly treating of the particular form under examination, as though based on revelation and not to be impugned. Thus the facts and factors pointing to heterodox conclusions are liable to be ignored, and the total of new knowledge gleaned falls readily into line with previous beliefs.

So opposed to tradition does a new view seem that, when the deciding fact in its favour is finally discovered, the whole thing is looked upon as little short of a miracle. There are plenty of apparently meaningless facts in the possession of zoological science; but the most insignificant fact has some meaning, and it may often happen that the explanation of it is not to be directly got at. Many ways lead to Rome, some directly, others by circuitous paths.

When some seven years ago I began to follow the history of a few insignificant ganglion-cells in *Lepidosteus* and other oviparous Ichthyopsida it never seemed in the least likely that the end of the chapter would be found in the processes which occur during oogenesis, spermatogenesis, and conjugation. Any connection with spore-formation and an antithetic alternation of generations, such as that found in the Metaphyta, would at that time, and long afterwards, have appeared to me to be utterly absurd and chimerical. The track from the start almost to the finish has been a complex and puzzling one. Often it has been dark and ill-defined, and the goal has kept itself concealed until well-nigh the journey's end.

When the 'supposed law of Metazoan development'¹ was written, the recognition of any very close similarity in the laws governing animal- and plant-development seemed somewhat remote. All along the desire has been to study the facts, to ignore none, and not to be biased by theoretical considerations. For a long time no decisive facts were unearthed; but, ultimately, putting together various facts concerning larvae and their fate, their morphology, and their

¹ Beard, J., On a supposed Law of Metazoan development. Anat. Anz. 1892.

transformations in allied forms, observations on the first appearance of sexual characters in the vertebrate embryo, the attainment of the adult form of body, the formation of the definitive nervous system in the fish-embryo, and comparing the appearance of these latter factors with the period of commencing degeneration of the transient nervous apparatus, it became evident that the initiation of degeneration was in association with a number of phenomena which could be nothing other than a metamorphosis. And it then began to dawn upon one that the development of a lower Vertebrate was in reality an alternation of generations in which the sexual form began to be formed upon an asexual foundation at a very early period. It was then recognized that the two could only co-exist as long as the sexual generation was, so to speak, merely dormant upon the asexual one, and that, as soon as the former began to manifest activities in its development, these led without fail to the suppression of the latter. Owing to complete want of homology between the parts of the two generations, as proved by their different nervous systems, and as further manifested by numerous types with larval development among the Invertebrata, it became obvious that Metazoan development was really bound up with an *antithetic* alternation of generations. This was the standpoint reached when I became acquainted with Bower's researches and results on Apospory in ferns¹. Then many things found their natural interpretation, for it was at once recognized that the conclusions previously arrived at pointed to a sort of Apospory in animal development. At the same time the problem of the nature of the reducing division intruded itself, thanks to a presidential address of Prof. Bower's² in which Strasburger's conclusions were discussed.

It seemed necessary to find the explanation of this in animals, if, as was more than suspected, there existed some

¹ Bower, F. O., On Apospory and allied phenomena. Trans. Linn. Soc. Ser. Bot., Vol. ii, Pt. 14, 1887.

² Botanical Society, Edinburgh. Nov. 1894.

deep fundamental similarity between the modes of reproduction and development of animals and of plants.

Although regarding Metazoan development as a sort of apospory, I did not at first foresee the obvious result of a suppression of spore-formation, and it is due to my pupil, Mr. J. A. Murray, B.Sc., to state that it was he who first recognized how the omission of a spore-formation in animal (i.e. Metazoan) reproduction would affect the position where a reducing division could take place. All that had been done in upwards of seven years was needful before this final comparison of animal- and plant-reproduction could be drawn, and the possibility of its accomplishment appears to me to form the crowning point which proves the edifice to be fairly complete. Not only that; the sequel will, I venture to think, show the foundation on which so much labour and time have been expended to be correctly laid. The main point, at which attack may appear to be still possible, will undoubtedly be the evidence on which the occurrence of an antithetic alternation of generations in animals is based.

Those who think no sort of proof is possible may perhaps be astonished to find how mistaken was their belief, when all the evidences are laid before them. In one paper, or indeed in half a dozen, this cannot be satisfactorily done. Life is too short and time too limited for the individual, overwhelmed with other duties, to entertain any hope of being able, from his own observations, to demonstrate such an alternation in every group of the animal kingdom.

My own investigations¹ have hitherto been almost exclusively limited to the group with which I am most familiar, and in which, as it happens, the evidences in current embryology are least apparent, viz. the Vertebrata. For other forms, in the meantime, recourse must be had to the work of others, and this, if too often deficient from my point of view, is the more valuable in that such observations as do

¹ A memoir, many of whose results and conclusions are assumed in the present paper, is now in the press.

appear to possess direct bearings on the problem have almost all been made without any idea that they tended in any such direction.

There is no wish to disparage the labours of authors of embryological text-books by the remark that such books have hitherto been more concerned with organogeny than with the development of animal organisms, and it is only rarely that the reader of them has his attention called to anything but the germinal layers and the structures which arise from these. Observations treating of degenerations and disappearances of structures during development, like those of my friend R. S. Bergh¹ on *Aulostoma*, are liable to obtain an incredulous reception and to be covered with ridicule because they do not conform to the Germ-layer theory, or because they furnish enigmas to the embryologist in quest of a theory of the mesoderm.

It would be possible to write a book on Comparative Embryology in which the modes of development of organisms as opposed to organs should form the main theme of the work. This I know to be so from lecturing experiences.

However, this is all wide of the subject to be treated of here. The object of the present writing is a totally different one. The problem for consideration is, assuming an anti-thetic alternation of generations to take place in Metazoan development with 'aposporous' formation of the sexual generation in most if not in all cases, to show what bearings such a conception may have on the interpretation of certain phenomena that occur in the maturation of the sexual products, and, as a corollary to all this, it has been deemed necessary to enquire into the nature of the processes involved in the conjugation of the Protozoa.

The sequel has culminated in a most surprising result, i.e. in the recognition of the prevalence of one primitive mode of reproduction for the whole of organic nature, and this is of such a character that an alternation of generations

¹ Bergh, R. S., Die Metamorphose von *Aulostoma gulo*. Arbeiten a. d. Zool.-Zootom. Inst. zu Würzburg, Bd. VII, 1885.

becomes absolutely essential to its being carried out. *A priori* it seemed quite hopeless to expect that our knowledge of the processes of conjugation in the Infusoria, which we owe so largely to the brilliant labours of Richard Hertwig and E. Maupas, would confirm the suspicion that existed of the occurrence of a spore-formation with reduction of the number of chromosomes after a conjugation or antecedent to a new one in this group, but, as will subsequently appear, the known facts readily allow of such an interpretation.

Beard, J. 1895. "On the phenomena of reproduction in animals and plants. Antithetic alternation of generations." *Annals of botany* 9, 441–447.
<https://doi.org/10.1093/oxfordjournals.aob.a090748>.

View This Item Online: <https://www.biodiversitylibrary.org/item/233478>

DOI: <https://doi.org/10.1093/oxfordjournals.aob.a090748>

Permalink: <https://www.biodiversitylibrary.org/partpdf/318387>

Holding Institution

Smithsonian Libraries

Sponsored by

Biodiversity Heritage Library

Copyright & Reuse

Copyright Status: Not in copyright. The BHL knows of no copyright restrictions on this item.

This document was created from content at the **Biodiversity Heritage Library**, the world's largest open access digital library for biodiversity literature and archives. Visit BHL at <https://www.biodiversitylibrary.org>.