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BALFOUR'S "COMPARATIVE EMBRYOLOGY"

Mr. BALFOUR has brought out the second volume of his treatise with admirable punctuality, and zoologists will find it no less valuable than the first. Indeed it is in many ways more attractive than the earlier volume, on account of the fact that the developmental history of the Vertebrata is here dealt with, and has an interest for a large class of anatomists who are not addicted to the study of other organisms. Moreover, in treating of the Vertebrata (or Chordata, as he prefers to call them when the group is so extended as to comprise the Ascidians) Mr. Balfour has introduced a very considerable amount of original matter.

The structure of the Vertebrata is not only more complex than that of other animals, but it is also better known, and has been more minutely discussed by anatomists; and similarly the development of various Vertebrate types has been more keenly scrutinised than that of other forms. Amphioxus, the lancepody, the salmon, the dogfish, the frog, tadpole, and newt, the turtle and lizard, the common fowl, the guinea-pig, rabbit, bat, and even man, have formed the subjects of numerous memoirs devoted to one or other of their phases of development. This has been going on for many years, in fact ever since Remak and Kölliker laid the foundations of what may be called "cellular embryology." The chick, the frog, and the rabbit have during this period enjoyed the services of a class of workers differing from those who have studied other animals. The latter have been naturalists interested in the study of embryology as throwing light on the affinities and origins of animal forms; the former have been distinctively medical men, who have sought in the minute study of the origin of the tissues of man and other Vertebrate animals indications which may be of service towards attaining the great desideratum of modern medicine, viz. a thorough knowledge of the physiology (i.e. the working of the mechanism) of man. Accordingly, from an early period the methods of the histological laboratory have been applied to the study of the Vertebrate embryo, and that by a large number of accomplished investigators, whilst it is only quite recently that the naturalists, as distinct from the medical men, have learnt to apply the same methods to the study of all organisms. There is at the present moment a movement from both sides and a fusion of the hitherto separate streams of "zoological" and "medical" embryology, which is marked as an epoch in the history of science by Mr. Balfour's treatise.

The medical histologist and physiologist has learnt that if he would comprehend the process of the cleavage of the egg and formation of the blastoderm and primitive organs he must not confine himself, as hitherto, to the limited area of comparison offered by the chick, the frog, and the rabbit; he must make common cause with the zoologist, and embrace the whole animal series in his view. He will, I cannot doubt, also soon openly acknowledge that the application of elaborate instruments of measurement to the nerves and muscles of dogs, rabbits, and frogs has furnished what knowledge it can in reference to man, and that if physiology is to move out of a barren path the whole evolutionary series connected with man—the lowest as well as the highest—must be made the subject of experiment.

On the other side we find the field-naturalist—the lover of the forms and colours of animals—no longer content with a superficial study. To solve the problem which Mr. Darwin has succeeded in placing before him as the aim of his science, it is necessary that the minute structure of all animals—their cellular anatomy and embryology—shall be as accurately known as is that of the rabbit and frog to physiologists. Accordingly it is becoming more and more usual to find naturalists trained in the histological methods originated by the medical physiologists, and pursuing precisely the same inquiries as they do.

Since the germ-layer theory was shown to apply not exclusively to the Vertebrata, but, in a modified form, to the whole animal kingdom, embryology has become one body of doctrine equally significant for the practical ends of the medical man and for the speculative conclusions of the philosopher and naturalist. This fact is abundantly evident from Mr. Balfour's two volumes; in the earlier as in the present the chief aim is to trace the history of the units of structure known as cells from the parent egg-cell until the adult form is attained. The doctrine of cell-structure and that of evolution taken together serve to unite the interests of scattered and sometimes reciprocally contemptuous groups of scientific men—the physiologist and the naturalist will turn each with equal pleasure and profit to Mr. Balfour's treatise.

The embryology of the Chordata is first of all treated in the present volume, in zoological order. The terms Cephalochordata (for Amphioxus), Urochordata (for the Tunicata), and Cranialata, which were proposed as divisions of Vertebrata in my "Notes on Embryology and Classification," are used, with some modification, by Mr. Balfour. Instead of Cranialata the term Vertebrata is used, whilst in place of Vertebrata as formerly applied, the term Chordata is used. This change is open to objection, chiefly on the ground that it is more convenient to retain so well-known a term as Vertebrata for the more important group, and not to sink it in subordination to an unfamiliar term: also, as it seems to me, on the ground that the implication in both words "Chordata" and "Vertebrata," as used by Mr. Balfour, is delusive. All animals with a "chorda" would not necessarily take their place in the group of pharyngo-branchiate Chordata possessed of a tubular nervous axis and myelonic eyes, to which rather than Chordata the old name "Vertebrata" is appropriate—the Tunicata having been assimilated by the old-established group in the course of a natural process of the growth of knowledge.

The defence of the limitation of the term Vertebrata to the Craniate Vertebrates on the ground that they alone possess "vertebrae," raises the whole question of what we are to understand in the widest sense by the words "vertebrae" and "vertebrate." It seems to me to be difficult to construct a definition of either of these words
which will apply to structures present in the Lampreys, Sturgeons, Chimæra, and Dipnoi, and will not apply to structures present in Amphioxus. Gegenbaur’s conception of the inapplicability of the term Vertebrata to forms devoid of myomeres as are the Tunicata, is, it seems, more reasonable. But even this objection is removed by the fact that in the tail of some Ascidian larvae, and in Appendicularia, there are indications of segmentation of the muscular tissue.

However that may be, Mr. Balfour’s account of the developmental phenomena exhibited by the various groups is of the greatest value, because it possesses three characteristics which also marked his first volume: it is complete as an epitome of all the very numerous and important contributions to the subject due to the Continental and English embryologists who have written so abundantly of late years; it contains a large amount of the author’s original unpublished observations; and, lastly, it is no mere catalogue of the opinions of this and that authority, but is a critical treatise in which without arrogance, but with argumentative skill, a definite view as to the significance of the phenomena described, even when these are obscure and difficult of interpretation, is put before the reader. This latter feature gives Mr. Balfour’s writings a special value, as pointing out lines of research for future observers.

The chapter on the Elasmobranchii is chiefly based on the author’s original researches, which were published as a monograph. He has been extending his observations to the Cyclostoma and Ganoidei during the period in which he was also engaged in the preparation of the two volumes of the present treatise. Valuable original drawings (Figs. 38, 39, 40, 41, 45, 46 and 45) of sections of embryos of Petromyzon Planeri are given, and a correspondingly original account of the developmental history. Similarly the Ganooids, Accipenser, and Lepidosteus are illustrated by original drawings prepared from embryos supplied to Mr. Balfour by Prof. Salesky and Prof. Agassiz. In discussing the Amphibia much use has been made of the excellent figures given by Prof. Götze in his great work on the development of Bombinator igneus, but here again Mr. Balfour is able to rely upon original observations upon the newt, carried out in his own laboratory by Messrs. Scott and Osborn.

The fact that Mr. Balfour does not give us in a precise form a history of the development of the common frog from stage to stage, is explained by the special nature of his treatise, which aims at putting forward the generalisations of embryology and dealing with the developmental phenomena of the whole range of animal forms rather than providing the commencing student with a few selected examples of growth from the egg. Much is said about the common frog in the chapter on Amphibia, and from the general statements which it contains, in addition to the statements definitely relating to the frog, a nearly complete answer can be obtained to all questions which suggest themselves in relation to the main features of development in that animal.

The Birds are treated next in order after the chapter on Amphibia, and necessarily the common fowl—on which Mr. Balfour published some years since, in conjunction with Dr. Foster, a separate work designed for the use of junior students—is the source from the study of which his facts are derived. In this chapter, and in that on the Mammals, Mr. Balfour discusses the views of Kölliker as to the origin of the mesoblast from the epiblast of the primitive streak, and other interesting points raised, since his earlier work, by the observations of Braun on parrots and ducks, and of Gasser on geese.

The chapter on Reptilia is remarkably short, owing to the fact that very few observations have been made on members of this class, and that in many important points they agree with birds. Original drawings relating to Lacerta muralis and Chelone midas illustrate this section.

In dealing with the Mammalia Mr. Balfour has to depend chiefly upon the recent researches of Ed. van Beneden and of Kölliker, and his critical power and fair dealing is shown in the way in which he treats the points of disagreement between those two admirable investigators. The main outlines of our knowledge of the later development of the Mammalian embryo and its fetal appendages were laid down many years ago by Bischoff and by Kölliker; but Mr. Balfour has given a particularly interesting account of the various modifications of the structure of the placenta presented by different mammals, illustrating his statement with woodcuts from the works of Prof. Huxley and Prof. Turner. With regard to the evolution of the placenta and the phyletic connection of the several forms seen in different recent Mammalia, he has some important original suggestions to offer.

It is impossible to give any idea, in a review such as this, of the abundance of facts and the thoroughness of treatment to be met with in the portion of Mr. Balfour’s book which we have just noticed. It deals with the groups of Vertebrata one by one, and with the hundreds of questions which the greater or less knowledge of the particular group so far in the possession of embryologists, brings into existence in endless variety. The general results of such a method of exposition cannot be summarised in a review.

But such summarising has been to a very considerable extent carried out by Mr. Balfour himself in the latter two-thirds of the present volume, which will be found the most readable, and in some respects the most important, part of the whole work. We have a chapter on the comparison of the formation of the germinal layers and of the early stages in the development of Vertebrates, one on the ancestral form of the Chordata, and one treating of the mode of origin and homologies of the germinal layers in animals generally and of larval forms, their nature, origin, and affinities. To these chapters succeed twelve entitled “Organogenesis,” which actually constitute a treatise on comparative anatomy, based upon embryological data, under the headings (1) epidermis and derivatives; (2) nervous system; (3) organs of vision; (4) auditory organs, olfactory organs, and sense organs of the lateral line; (5) the notochord, the vertebral column, the ribs, and the sternum; (6) the skull; (7) pectoral and pelvic girdles and the skeleton of the limbs; (8) the body cavity, the vascular system, and the vascular glands; (9) the muscular system; (10) excretory organs; (11) generative organs and genital ducts; (12) the alimentary canal and its appendages in the Chordata.

In these chapters many of the facts which have been previously detailed in that part of the work devoted to the treatment of group after group are again brought forward.
and looked at from a new point of view in relation to the doctrine of evolution, and facts which did not find their way into the earlier portion of the work receive consideration. Especially in the chapters on organogeny we find the questions connected with the probable first origin and later modifications of the nervous system and of the organs of special sense dealt with so as to supplement the earlier zoological chapters. It is not possible to single out for special notice any one of the discussions which may thus be said to sum up and give the general results of Mr. Balfour's work. But among the more interesting, as dealing with burning questions, are those relating to the origin of the limbs of fishes (based upon the author's recent investigations), and the nature of the excretory organs found in the different groups of the animal kingdom. In reference to the latter point Mr. Balfour commences his discussion with a remark which may be taken as an example of the judicial style in which he handles such problems. He says, "although there is not a little to be said for holding all these organs to be derived from some common prototype, the attempt to establish definite homologies between them is beset with very great difficulties."

The present volume is illustrated by about four hundred woodcuts, and consists of more than six hundred pages of royal octavo size. The first volume was of very nearly the same size, and as copiously illustrated. Together they form a contribution to that science of Biology which our countryman, Charles Darwin, has refounded and reformed, of which English men of science may feel justly proud. No work of the kind exists in any language beyond and probably no such work would have been undertaken had not Mr. Balfour given himself to the task. Translations of Mr. Balfour's book are at this moment in course of publication both in Germany and in France. The thoroughness with which he has carried out the revision and incorporation of a few more than a thousand scattered memoirs by contemporary writers, and the excellence of his critical remarks and original observations and drawings, are all the more remarkable when it is remembered that only three years have passed since the work was commenced, and that during that time Mr. Balfour has been actively engaged in lecturing and teaching in his laboratory at Cambridge, has published several original memoirs himself, and has superintended the production of as many more by his pupils.

The University of Glasgow has recently recognised the importance of Mr. Balfour's labours in embryology by conferring upon him the degree of LL.D. honoris causa.

Cambridge men, and all who hope for the restoration of the English Universities to their legitimate place in the academic sisterhood of Europe, must feel proud of Mr. Balfour and the steadily working school of biologists which has risen around the Trinity Professor on the banks of the Cam. The Cambridge biologists are now a power in the scientific progress of the country, and it is from Cambridge that the new men come to fill positions as teachers of biological science in the colleges of Manchester, Birmingham, Dublin, Eton, and elsewhere. Few persons, however, know the smallness of the share which the University of Cambridge, as such, has had in this admirable development, and how necessary it is, if the present condition of activity is to continue within its boundaries, that adequate arrangements shall be made in permanence for the maintenance of the laboratories and for the salaries of those who are at present gaining honour for the University without receiving from it any return.

E. Ray Lankester

PRIMITIVE INDUSTRY

Primitive Industry, or, Illustrations of the Handiwork in Stone, Bone, and Clay of the Native Races of the Northern Atlantic Seaboard of America. By Charles C. Abbott, M.D. (Salem, Mass.: George A. Bates, 1881.)

This work is a valuable contribution to our knowledge of American archaeology. Dr. Abbott describes successively the principal types of stone, bone, and bronze antiquities, especially those of New Jersey. The work is illustrated by more than 400 woodcuts, and is divided into 33 chapters devoted to Stone Axes; Celts; Chisels and Gouges; Grooved Hammers; Semilunar Knives; Chipped Flint Knives; Drills; Awls or Perforators; Scrapers; Slick Stones and Sinew Dressers; Mortars and Pestles; Pottery; Sheathite Food-Vessels; Pitted Stones; Chipped Flint Implements; Bone Implements; Agricultural Implements; Plummetts; Net-sinkers; Spear-points and Arrow-heads; Flint Daggers; Grooved Stone Club-heads; Pipes; Disoidal Stones; Inscribed Stones; Ceremonial Objects; Bird-shaped Stones; Gorgets; Totems; Pendants and Trinkets; Copper Implements; Hand-hammers and Rubbing-stones; Shell Heaps; Flint Chips; Palæolithic Implements; The Antiquity and Origin of the 'Trenton Gravels.'

The number of stone implements which have rewarded Dr. Abbott's industrious search is really surprising. In New Jersey alone he has amassed no less than 20,000 specimens.

"From the great number of stone axes," he says "already gathered, and that remain to be gathered, from the area of the State of New Jersey, it is clear that this form of weapon or implement, as the case may be, was in constant and universal use among the Delaware Indians. In some localities, of several square miles in extent, there have been found from three to five axes in every one hundred acres, and still others are occasionally brought to light by the plough. Allowing but one-half the smaller number to have been left lying in every one hundred acres of the State's area, when abandoned by the Indians, there would remain, for the benefit of archaeologists, the enormous number of one hundred and twenty-five thousand stone axes."

Considering the great abundance of stone implements, the rarity of typical scrapers in the United States is an interesting fact. No doubt many of the stone implements were used as scrapers, but I have hardly seen any specimens from Eastern America of the true typical North European and Eskimo form. Some of those figured by Dr. Abbott, though they may have served as scrapers, certainly are not of this type; and although others may be so, for instance that represented by Fig. 107, p. 124, it is difficult to speak positively, because Dr. Abbott does not give sections of the implements, so that in many cases their true form is doubtful. We would suggest to him to supply this omission in subsequent editions of his work.

Perhaps the most characteristic of American types are