

book and mind enriched with all that he saw, so that the by-products may eventually outvalue the answer to his original problem. Mr. Gilbert well illustrated the geologist whose researches yielded so great a wealth of products, and in his work the line between pure geology and useful geology was not marked. In that type of geology, broad in scope and accurate in detail, by-products of high value can always be expected.

ZOOLOGY.—*The steps in the evolution of animals.*¹ AUSTIN H. CLARK, U. S. National Museum.

In the following dichotomous table are included all the essential characters of all the major animal groups, showing the successive steps by which the two most specialized phyla, the Vertebrata (in heavy-faced type) and the Arthropoda (in italics), have been evolved, and at the same time the relationship to the main developmental line of all the numerous off-shoots which have proved incapable of further evolution.

This table, which is based upon the body structure of adults, assumes the evolutionary course to have run as follows:

1. The formation of a multicellular body overcame the limitation in size inseparable from the unicellular body.

2. The appearance of quadrilateral symmetry (with a right and left side and a dorsal and ventral surface) and the correlated development of a head end overcame the inefficiency of a radially symmetrical body.

3. The development of a vascular and of a respiratory system facilitated the repair of waste and led to a marked increase in bodily activity.

4. The development of a skeleton enabled the muscles to function to better advantage, leading to a more perfect coordination of muscular action and greater perfection of bodily activity.

5. The appearance of gill clefts indicated the final stage in the centralization and perfection of the previously unorganized respiratory system.

6. The development of the dorsal nerve cords led to increased nervous efficiency through the unification and concentration of the nervous system.

7. The development, in connection with the last, of a definite head, was the final step in the centralization of the nervous control of the body.

¹ Received March 9, 1921.

Unicellular

Multicellular

Radially or bilaterally symmetrical

No definite organs nor body form

With definite organs and body form

Quadrilaterally symmetrical, with a head end

No vascular, respiratory or skeletal system

Without a special food collecting mechanism

Flattened

Cylindrical

With a special ciliated food collecting apparatus

With a vascular system and a respiratory system

No true skeleton

Unsegmented

Segmented

With a skeleton

Without gill clefts

Skeleton soft

Skeleton hard

Unsegmented externally

With a tentacular food collecting mechanism

Without a special food collecting mechanism

Segmented externally

With gill clefts

Nerves ventral

With a tentacular food collecting mechanism

Without a special food collecting mechanism

Nerves Dorsal

No definite head, and a special food collecting mechanism

Food collecting apparatus internal

Food collecting apparatus tentacular and external

With a definite head