

ART. XIV.—*Note on the position of Amphibians among the classes of Vertebrates;* by JAMES D. DANA.

IN a recent article by the writer on the *Parallel relations of the classes of Vertebrates*,¹ Amphibians are made the inferior division of the class of Reptiles. The usual arguments against this view were not alluded to because they were believed to be familiar to all interested in the subject, and their discussion at the time seemed not to be required. A few words with regard to them are here added in order to set forth more distinctly the special value of the analogies appealed to in that paper.

The evidence in favor of separating the Amphibians from Reptiles as an independent *class* is undeniably of great weight. Their approximation to Fishes in embryological development and the corresponding divergence from ordinary Reptiles have the appearance of being decisive proof that they are as closely related to Fishes as to Reptiles, and, therefore, that they occupy an intermediate position between the two in classification.

The chemical researches on the composition of eggs by Fremy, made a few years since,² claiming to show among their results "the curious physiological fact that Amphibians, besides passing through an early condition of existence like that of Fishes, lay eggs which have the greatest affinity in chemical composition to those of Fishes," seemed to the writer, when they were first published, to carry the evidence to the most fundamental point in the nature of the species, even below that of embryological development. If the fundamental elements thus differ, should not the superstructures also, and far more widely?

But the question recurred whether in the subdivision of the subkingdoms of animal life into classes, it is not, after all, the more correct method to take note primarily of species in their finished or adult state; that is, whether adults do not express the true idea and nature of species, or the objects to be classified, rather than the special series of changes through which the adult characteristics are reached.

In favor of an affirmative reply to this question, the fact stands out prominently that, as regards the subkingdoms in animal life, embryology in the hands of the best embryologists has only sustained what Cuvier had derived from the study of the adult animals themselves; and in the hands of other embryological investigators, and some of the latest, even these great natural groups have not been left without mutilation. And as to the subordinate divisions under the subkingdoms there is not only great diversity in the different embryological systems, but violations of natural affinities in all. Professor Agassiz, in his *Essay*

¹ This Journal, [2], xxxvi, 315, November, 1863.

² This Journal, [2], xix, 38, 238, xx, 65, 1855, from the *Journ. de Pharmacie*, 1854.

on Classification,³ criticizes the systems of Van Beneden, Kölliker and Vogt, on account of their violating the structural affinities of groups, implying that embryological conclusions have to be tested by a reference to the natural types of structure. In nature a specific type is often expressed in a long series of species running through a very wide range of grade; and structures so diverse in grade as those of the higher and lower extreme groups are diverse in the nature of the changes which take place in the course of embryological development. Not appreciating this fact, embryological systemists have cut the series, and made bold demarcations between parts that are essentially one in type. Thus has resulted the separation of the class of Worms from Articulates by both Van Beneden and Vogt, and of the order of Cephalopods from Mollusks by the latter, etc.; and such errors will continue to attend upon the decisions of pure embryology until the precise value of its characteristics in classification is understood.

If, then, the structural relations of the developed animals are an authority to which embryology must appeal, the adult Amphibians may claim to be considered, on a question of their relations to ordinary Reptiles, even before their eggs and young. Embryology proves that Amphibians and ordinary Reptiles are *distinct groups*, as is proved also by structural considerations; but, in the present state of the science, it can hardly be said to demonstrate that these groups are *classes*, coördinate with those of Birds and Mammals;—and I venture to say, as regards the separation of groups, that, in no state, will it prove what the adult structures will not sustain.

But, further, if it were proposed to make a Reptilian whose early life should be aquatic, could it be accomplished by means of eggs having the same chemical constitution as those of ordinary or terrestrial Reptiles? The development, at each step, involves, and depends upon, chemical changes; and it is hence

³ See the first volume of his Contributions to the Natural History of the United States (pages 220 to 232). Even von Baer, as here quoted, in subdividing the placental Mammals, places in one group the *Carnivores, Insectivores and Rodents*, and in another *Man, Monkeys, Ruminants, Pachyderms and Cetaceans*. Van Beneden divides the Invertebrates into two groups, the *first*, including Insects, Myriapods, Spiders and Crustaceans, the *second*, the subkingdom of Mollusks, the *inferior part of the subkingdom of Articulates*, that is, *Worms*, together with the Radiates, Rhizopods and Infusoria; and his division of Polyps, among the Radiates, in his latest amendments of his system, *includes both Polyps and Acalephs*. Vogt makes three grand groups of animals: the *first*, including Vertebrates, and all Articulates *excepting Worms*; the *second*, Mollusks, Worms and Radiates; the *third*, Infusoria, and Rhizopods; and his division of Mollusks *does not embrace the Cephalopods*, while it does include a tribe of Acalephs. Recently, Prof. Huxley, in lectures before the Royal College of Surgeons, of which a report is given in the Medical Times and Gazette, for May, 1863, says, (page 555,) after discussing the importance of the placenta in Mammals as a basis of classification, that, in his view, there is no difficulty in the way of a classification which unites the Proboscideans with the Rodents rather than with Paridigitate and Imparidigitate Herbivores.

reasonable to infer that the egg which was to be developed when bathed in *water* should thus differ somewhat from one that was to be developed in the *air*; and also that such *aquatic* eggs should approach in constitution those of the true *aquatic* Vertebrates, or Fishes. We may safely conclude, further, that the method of development for eggs thus different in constitution, and at the same time of inferior grade, would necessarily differ from those of ordinary Reptiles, and differ by approximating to those of Fishes. Accordingly, in Amphibians there may be only that divergence from the method of making a Reptile that was required in order that a division of inferior Reptiles should exist characterized by a fish-like life in the young state.

The fact is that the *superstructures* (p. 184) do *not* widely differ. In the adult state the species are Reptiles in all essential structural characters:—they are air-breathing; they have imperfect circulation and, consequently, are cold-blooded; and outside or inside there are no fundamental differences in type that would require a separation from the Reptilian class. The divergence is small compared with that between typical Amphibians and Fishes.

Such considerations are sufficient to authorize the assertion that the evidence in favor of regarding Amphibians as Reptiles at least balances that on the other side, if it does not outweigh it.

Now add to the above the analogy drawn from other classes of Vertebrates, as presented in the paper referred to in the opening paragraph of this article:—that the class of Mammals has its *inferior* subdivision—the Oötocoids, or *semioviparous* species—intermediate between ordinary Mammals and the *oviparous* classes below; that the class of Birds, according to recent discoveries, has its *inferior* subdivision—the Erpetoids, or *Reptilian* species—between ordinary Birds and *Reptiles*; and that between ordinary Reptiles and the class below, or that of *Fishes*, there are the Amphibians, or *fish-like* Reptiles; also, that the grand distinction between semioviparous and ordinary Mammals is manifested in their *embryological development*, or their young state, as well as that between Amphibians and ordinary Reptiles; and the evidence becomes strong that if Oötocoids constitute a hypotypic subdivision of Mammals, so Amphibians constitute a hypotypic subdivision of Reptiles. It is not necessary to repeat at length the argument on this point, as the reader can easily refer to the former paper on the subject. This point is illustrated also in the following article in the same volume (Article I, On the Classification of animals based on the principle of Cephalization) by a wider range of analogies, showing that similar hypotypic groups constitute the lower subdivision in several departments of the animal kingdom.