THE COMMON FROG*

V.

THE third order of the class *Batrachia* is made up of a few creatures the distribution of which is limited to the warmer regions of the earth, where one of the genera (*Cæcilia*) comprising the group is distributed over both hemispheres, being found in India, Africa, and South America. Two other genera (*Siphonops* and *Rhinatrema*) are exclusively American, while a fourth genus (*Epicrium*) is only found in Asia. The order is called *Ophiomorpha*. These creatures are singularly unlike the frog in external appearance, as they are entirely destitute of limbs and have quite the appearance of earthworms, because they are not only very long and slender, but have also a skin which is soft and naked. By earlier naturalists, and even by Cuvier, they were classed with snakes.

In spite of this striking dissimilarity between the *Ophiomorpha* and *Anoura*, the former are really more like frogs than they are like efts in one important respect.

FIG. 22.—*Cæcilia.*

This is because, for all their elongated figure, the tail in them is quite rudimentary or altogether absent.

The *Ophiomorpha* would by many be supposed to present an analogy with serpents, from their long and elongated bodies, and from the utter absence of limbs.

There are, however, but very few snakes (the "rough-tails" *Uropeltidæ* and the *Tortricidæ*) which have long bodies and very short tails.

It is rather the singular family of lizards, *Amphisbenidæ* (with one exception completely limbless) that the Ophiomorpha resemble.

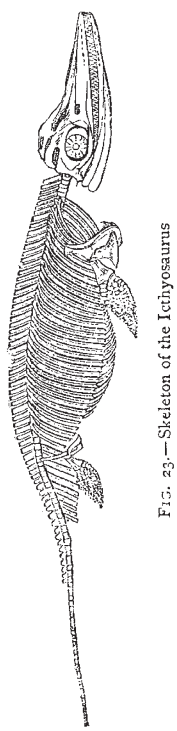

FIG. 23.—Skeleton of the Ichyosaurus

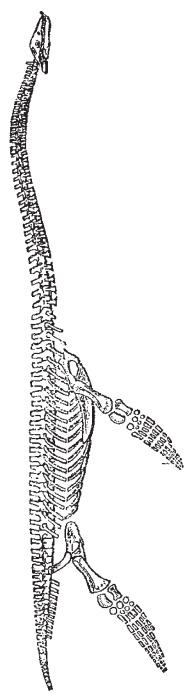

FIG. 24.—Skeleton of the Plesiosaurus.

These Amphisbenians have a softer skin than any other Saurians except chameleons. It is also marked in grooves which are arranged in transverse rings. They have an exceedingly short tail which is blunt, so that, the head being small, one end of the body is as large as the other.

The *Ophiomorpha* also have the body marked with numerous transverse grooves or rings; they are utterly devoid of limbs, and the head is scarcely, if at all, larger than the hinder end of the body.

These creatures burrow beneath the soil (which habit increases their resemblance to earth-worms) and feed on worms and other small animals and mould.

To turn now to another aspect of our subject, let us consider the relations of the Frog to past time. If, extending our survey over the records of past epochs, we search the tertiary and all other rocks above the Lias for fossil allies of our Frog, we shall (judging by what we yet know) fail to find any not at once referable to one or other of the three ordinal groups above enumerated.

Fossil frogs and toads have as yet only been found down to the miocene, the oldest being some found in the so-called "brown coal" which is not a carboniferous deposit at all. The remarkable thing, however, is that the difference between these oldest known Frogs and the existing forms is so very trifling. They are as complete and thorough frogs as any that live now.

FIG. 25.—Much enlarged horizonta section of the tooth of a Labyrinthodon

Again, the fossil Urodeles similarly resemble their existing representatives, and no one extinct species exhibits characters in any way tending to bridge over the chasm which separates the Urodela from the *Anoura*.

When, however, we descend to the Lias, Trias, and Carboniferous rocks, we come upon a rich variety of extinct species of animals evidently allied to those forming the three Batrachian classes already described. They form, however, an order by themselves, to which the term *Labyrinthodonta* has been applied, and thus our search into the past has brought us a rich and important harvest,

* Continued from p. 30.

and has introduced us to the fourth and last Order belonging to the frog's class of vertebrate animals. The Labyrinthodonts were creatures with long tails and mostly two pairs of limbs, but these members were always relatively small with slender toes. Some species attained a greater size by far than does any existing Urodele, even the gigantic Salamander.

To what existing animals can these huge monsters be considered to have affinity? It is impossible to say that they in any way bridge over the chasm separating the Frogs from the Efts. They appear indeed to have been almost equally removed from both—for the possession of short limbs and a long tail (characters common to so many widely different animals) cannot be regarded as any good evidence of affinity.

It is not improbable that they find their nearest allies in the existing insignificant *Ophiomorpha*. The latter, though apparently naked, have minute scales imbedded in the skin and arranged in rings at intervals, and the skull is provided with certain extra ossifications. The Labyrinthodonts have similar extra cranial ossifications, and though they have not rings of scales, the ventral region was protected by minute plates arranged in linear series converging inwards and forwards towards the middle line. Moreover, some forms appear to have been entirely devoid of limbs; at least no remnant of such parts has yet been discovered. Nevertheless the degree of development of the tail constitutes a marked distinction between the *Labyrinthodonta* and the *Ophiomorpha*.

Certain Labyrinthodonts had great formidable teeth in elongated jaws like those of crocodiles. Altogether these singular remains tempt us to speculate as to the succession of life upon this planet's surface. We know that as to the later secondary period that part in the life of the globe which is now played by beasts was then played by reptiles. Instead of the existing bats, Pterodactyles of all sizes flitted through the air. The ocean was peopled not by whales and dolphins, these had not yet appeared, but by huge Ichthyosauri and Plesiosauri. Reptiles of huge bulk (Iguanodons, Megalosauri, Notosauri, &c. &c.) fulfilled the parts of herbivorous and carnivorous beasts, and altogether the Mammalian fauna of to-day was represented by analogous reptilian precursors.

May it not have been similar in yet older periods with regard to animals of the Frog class? We have seen the possibility of aërial locomotion in even the existing *Rhacophorus*. It is true that all existing Urodeles are fresh-water forms, but it may well be that marine creatures once bore the same relation to them as the great marine *Ganoid* fish fauna bears to the few existing Ganoids* which now constitute a fresh-water group.

The great crocodile-like Labyrinthodonts must have been no ignoble predecessors of the rapacious reptiles which were to succeed them, and the fossil form *Ophiderpeton* suggests that the existing *Ophiomorpha* may be the last remnants of a race which preceded and represented the subsequently developed serpents.

This, however, is but a conjecture which future discoverers will probably ere long establish or refute.

The name *Labyrinthodonta* was bestowed upon the great fossil group on account of the beautiful and singularly complex structure of the teeth of some members of the order. These teeth are conical, and exhibit slight vertical grooves on their surface. A horizontal section shows that these surface-grooves are the external indications of deep indentations of the substance of the tooth. All these indentations converge towards the centre of the tooth, but not in straight lines, each indentation being elaborately inflected. Radiating from the centre of the tooth are a corresponding number of processes of the central pulp cavity—the radiating processes undulating like the converging folds.

* Existing Ganoids are the sturgeon, bony pike (Lepidosteus), mud-fish (Lepidosiren), and others as noticed earlier.

A similar structure of tooth is found in some Ganoid fishes, and an incipient stage (as it were) of the same condition existed in the Ichthyosaurus.

We have now reviewed the closest as well as the more remote allies of our Frog, and have seen how the Frog is a species of a group (*Anoura*) which is one of three existing and widely divergent orders, supplemented by an extinct ordinal group of the carboniferous period—the four orders (1. *Anoura*, 2. *Urodela*, 3. *Ophiomorpha*, and 4. *Labyrinthodonta*) being embraced in a higher unity termed a "Class," which is the Frog's *class*, as "Anoura" is his *order*. This class is with propriety spoken of as the *Frog's class*, since the Frog is the species from which its scientific derivation BATRACHIA is derived. This class may now be considered as a whole.

The Batrachians (of all three existing orders) are in the main aquatic animals, inasmuch as the greater number, even when adult, frequent, at least at intervals, ponds and streams, or delight in humid localities. Water also is necessary for the larval stages of almost all; and absolutely all, at one period of life, possess gills, while some (as we have seen) retain gills during their whole existence, and are permanently and constantly inhabitants of water.

The extinct forms (*Labyrinthodonta*) were, no doubt, also aquatic, as, besides their general relation to other Batrachians, traces or indications of the hard parts which supported the branchiæ of some Labyrinthodonts appear to have been actually found.

It is somewhat singular that in spite of this predominating aquatic habit, all Batrachians, both living and fossil, appear to inhabit, and to have inhabited, fresh water only. No Batrachian of any period is yet known to have been marine. This is the more remarkable since the most nearly allied class, that of fishes, is much more rich in salt-water than in fresh-water forms; while even existing *Reptilia* have (in the true sea-snakes and in chelonians) representatives which inhabit the open ocean, while in the secondary geological period marine reptiles (*Ichthyosauri* and *Plesiosauri*) abounded.

Indeed, of all classes of vertebrate animals, this aquatic class (*Batrachia*) has the least to do with the ocean, for many birds, and a still greater number of Mammals (*e.g.* the whales and porpoises), are constant inhabitants of salt water. All the adult Batrachians feed on animal substances, generally small worms, insects, or slugs, and animals allied to slugs. The larger Frogs and Toads will, however, as has been said, devour vertebrate animals, such as mice and small reptiles and birds. The existing large, tailed Batrachians devour fishes. The extinct tailed Batrachians, in their adult condition, were also undoubtedly animal feeders, but they may, in their young state, have been vegetarians. At any rate the tadpoles of the existing *Urodela* will eat vegetable matter, and indeed probably sustain themselves mainly upon it.

In cold latitudes the Batrachia, like the Reptilia, go into the winter sleep called *hibernation*, as also do the hedgehogs and bats amongst Mammals.

The Frogs and Toads sometimes hide and shelter themselves by creeping into out-of-the-way holes and corners, but more generally they (as also the Newts) bury themselves in mud at the bottom of ponds and streams. In hot latitudes, some forms pass the dry season in a similar state of lethargic inactivity.

Many beasts, birds, and fishes, range in flocks. The Batrachians, however, usually wander about in a solitary manner, and only congregate in the breeding season. It is then that their vocal powers find utterance, though only in the Anourous order; the tailed Batrachians never make more than a very feeble sound.

As regards the geographical distribution of the whole class, the northern hemisphere, and especially the American portion of it, is the more richly furnished. Africa, India, and Australia, are the most poorly supplied on the whole, because, though possessing very many kinds of

frogs and toads, the whole Eft order is unknown in those regions.

Our question "What is a Frog?" has now been somewhat further answered; but it cannot be completely so until the organisation of the animal has been more fully surveyed, and not only the relation of the frog to other Batrachians thus more clearly seen, but also the relations and affinities borne by the several orders of Batrachians and by the whole class to the other orders and other classes of the Vertebrate sub-kingdom.

Accordingly, we have now to make an acquaintance with more than those obvious and external characters which are found in the Frog, and to penetrate into its inner anatomy, surveying successively its bony framework and the various parts and organs which subserve the several actions necessary to its continued existence.

At the same time the more noteworthy resemblances presented by the Frog to other creatures will be pointed out. Thus we shall become acquainted with the relations existing first between the Frog and other members of its order; secondly, between the members of its order (*Anoura*) and its class fellows—*i.e.* other Batrachians; thirdly, we shall comprehend the degree of relationship existing between the Batrachia and the other classes of the Vertebrate sub-kingdom; and fourthly, we shall come to recognise certain singular resemblances which exist between the various groups of Batrachians (the Frog's order of course forming one), and some of the orders into which other vertebrate classes—especially the class of Reptiles—have been divided.

The skeleton of the Frog, both external and internal, naturally comes first as the support and foundation of the other structures. The internal skeleton (or *endo-skeleton*) will include the bones of the head, *i.e.* the skull, backbone (already referred to), and the bones of the limbs. The external skeleton (*exo-skeleton*) will consist of the skin only.

ST. GEORGE MIVART

(*To be continued.*)

ASTRONOMICAL ALMANACS*

V.—*The "Connaissance des Temps" under the continued direction of the old Academy*

LET us return to the *Connaissance des Temps* of the old Academy.

Jeaurat, who succeeded Lalande in 1775, adopted exactly the same principles as the latter; he, however, extended considerably the ephemerides of the moon, giving its declination for every six hours, to facilitate the calculation of the altitude, when at the same time only the distance could be observed. Méchain succeeded Jeaurat in 1788; he followed the example of his two predecessors, and like them, continued to take from the "Nautical Almanac" the distances of the moon, which Maskelyne had the kindness to send him even in manuscript.

Moreover, besides the ephemerides and the lunar distances, the *Connaissance des Temps* still contained observations, memoirs on various astronomical topics, an abridged notice of new books likely to be of interest to astronomers and navigators, and a brief history of astronomy during the past year, due to the skilful and well-informed pen of Lalande. This state of things continued until 1794, the year when Méchain left Paris, to take part in the meridian work. Soon after, the suppression of the academies having dispersed the astronomers, the *Connaissance des Temps* for 1795 was compiled and published by the temporary Commission of Weights and Measures. Finally, on June 25 of the same year, 1795, the publication of this work was placed under the eminent direction of the Bureau des Longitudes. Here we may conclude the first part of our account of the *Connaissance des Temps*—a work at first completely independent, then published with the approbation of the Academy, which included at the time nearly all those who were occupied with astronomy; and afterwards entrusted to the care of the Bureau des Longitudes, a commission which still continues to be charged with its publication.

* Continued from vol. viii. p. 531.

VI. *The "Connaissance des Temps" under the Bureau des Longitudes*

The first care of the Bureau was to entrust one of its members with the publication and direction of the *Connaissance des Temps*, thus showing, from the first, the true course which ought to have been adopted from the beginning, that a work of this kind demands strictly personal superintendence. Its choice fell upon Lalande, then Astronomer of the Observatory of *l'Ecole Militaire*. As to the calculations, however, the superintendence of this astronomer was more nominal than real; he was occupied mainly with the *Additions* which he had commenced in 1760, and towards which the bent of his mind,—"more of a collector than an inventor"—carried him. Thanks to the great quantity of material which he had acquired, he made of these additions a work really useful, for at this time periodic scientific publications were very rare. His *Journal d'Astronomie* (history of astronomy during the preceding year), contains a mass of information of great value, even at the present day, to all who take an interest in the history of the science of astronomy.

As to the calculations, they were made partly by Bouvard, whom Laplace had appointed adjoint to the Bureau des Longitudes, and partly in the bureau of the *Cadastre*, under the direction of Prony, its chief. It was in the office of this celebrated engineer that the distances of the moon from the sun and from the principal stars were calculated, distances which ceased from that time to be taken from the *Nautical Almanac*. Let us, however, add, that up to the year 1806 the greater part of the other calculations of the *Connaissance des Temps* were drawn from the *Nautical Almanac*, "with the view," according to the preamble, "of accelerating the publication." Despite this assistance, nevertheless, this work appeared only about a year and a half or two years in advance; it was then, at that time, completely useless to navigators who had to make a long round. The attention of the Bureau des Longitudes was not however turned in this direction. Its president was then the illustrious Laplace, one of the glories of the mathematical sciences, and who first knew how to deduce from the great discovery of Newton, all the consequences which it was calculated to yield.

Pierre Simon Laplace was born March 23, 1749, of a family of poor farmers of Beaumont-en-Auge (Normandy, Calvados). It is not known where he got the elements of his education, for when later he was raised to the highest honours, he had the weakness to wish to conceal his humble origin. Appointed in 1770, on the recommendation of d'Alembert, Professor of Mathematics at *l'École militaire* of Paris, he became in 1772 adjoint member of the Academy of Sciences, next succeeded Bezout as examiner of the pupils of the royal corps of artillery, and in 1785 was made titular Academician. During this time, his beautiful memoirs on which he founded his *Mécanique céleste*, succeeded each other almost without interruption. Finally, in 1795, he was nominated president of the Bureau des Longitudes, a position which he held till his death, March 5, 1827.

Under his leadership the Bureau was occupied mainly in perfecting and re-constructing the tables, by means of which are calculated in advance the positions of the different stars. The tables of Delambre (the sun, Jupiter, Saturn, Uranus and the satellites of Jupiter, 1792), of Mayer (corrected by Mason, 1787), for the moon, of