VI.—Note on the Classification of the Ichthyopterygia (with a Notice of Two New Species).

By R. Lydekker, B.A., F.G.S., etc.

HAVING devoted several weeks to the study of the magnificent collection of the remains of Ichthyopterygians preserved in the British Museum (Natural History), I purpose on this occasion to give a brief notice of some of the conclusions at which I have arrived, since a considerable interval will elapse before the publication of that part of the Museum "Catalogue of Fossil Reptilia" in which my observations will be more fully recorded.

Exclusive of the genus *Cetarthrosaurus*, which is referred by Mr. Hulke to the *Mosasauridæ*, four genera of Ichthyopterygia have hitherto been described; viz. *Ophthalmosaurus*, Seeley, *Baptanodon* (*Sauranodon*), Marsh, *Ichthyosaurus*, König, and *Mixosaurus*, Baur. Since, however, there appear to be no characters by which *Baptanodon* can be generically separated from *Ophthalmosaurus*, I am inclined to follow the suggestion made by Dr. Baur, and unite the two; thus reducing the number of genera to three. With regard to *Ichthyosaurus*, it has been suggested by more than one writer that this genus is susceptible of division into two or more genera; and there is much to be said for this view, since there is an extraordinary amount of structural difference between many of the forms. If, however, the species be arranged in their natural relationship, which corresponds to a great extent with their distribution in time, it will be found that these distinctive characters tend to shade more or less completely into one another. Since, moreover, the skulls of all the species seem to be so nearly alike in general structure that it is very improbable that good generic characters could be drawn from them, I have come to the conclusion that it will be more convenient to the palæontologist, and most certainly to the pure geologist, to retain the genus in its original wide sense. I intentionally use the term convenient in this conjunction because I am glad to see that Prof. Flower,[1] in his recently published memoir on the Liberian *Hippopotamus*, has expressed his opinion very clearly that the restriction or multiplication of generic terms is purely and simply a matter of convenience; and that their multiplication rather tends to make us lose sight of the mutual relationship of allied forms. I am further convinced of the advisability of retaining the original use of the term *Ichthyosaurus*, because if we once begin to subdivide it, it will be almost impossible to know where to stop.

Dr. Baur, who adopts the view of the advisability of splitting up the type genus, makes the three above-mentioned genera the types of three distinct families; but if the term *Ichthyosaurus* be employed in the sense indicated above, it appears to me that the whole three genera may be conveniently included in a single family—the *Ichthyosauridæ*.

The last-mentioned writer has shown very clearly that while *Ichthyosaurus* occupies the middle position, *Ophthalmosaurus* is the

[1] P.Z.S. 1887, p. 614.

most, and *Mixosaurus* the least, specialized genus; and I find that while among the Liassic species *Ichthyosaurus communis* in the structure of its limbs makes the nearest approach to *Ophthalmosaurus*, *I. tenuirostris* and its allies are the forms most nearly allied to *Mixosaurus*. Now the pectoral limb of the generalized *I. tenuirostris* having only four digits, while in the more specialized species the number is greatly increased, it may be inferred that Ichthyosaurs have descended from a tetradactylate ancestor, or at least that only four digits have been primarily modified into the Ichthyosaurian paddle. A comparison of the pectoral limb of *I. tenuirostris* with that of *Chelydra* has moreover led me to conclude that the four digits there found correspond to the 2nd, 3rd, 4th, and 5th of the typical manus; the 3rd arising in the same way from the intermedium, and the 4th and 5th conjointly from the ulnare. The primary grouping of the genus which I have adopted is mainly based upon the simpler or more complex structure of the pectoral limb; and I may add that in those forms where the original four digits have become split up it is evident that the presence of two centralia in the carpus is an acquired and not an inherited character. This classification is in the main a modification of the one proposed by A. Wagner, and subsequently extended by Col. Kiprijanoff in the Memoirs of the St. Petersburg Academy for 1881. It is briefly summarized in the following table, which contains a synopsis of all the named species with which I am acquainted. The specific names applied by Hawkins to several of the English Liassic species are, however, omitted. In cases where the generic position of species is uncertain a note of interrogation is placed after the generic name; and when the serial position is provisional an asterisk is prefixed :—

I. Genus OPHTHALMOSAURUS, Seeley (*Baptanodon* = *Sauranodon*, Marsh).—Humerus articulating distally with three bones.

1. OPHTHALMOSAURUS ICENICUS, Seeley. Oxford and Kimeridge Clays, England.
2. OPHTHALMOSAURUS NATANS (Marsh). Up. Jurassic, N. America.
3. ,, DISCUS (Marsh). ,, ,, ,,
4. ,, CANTABRIGIENSIS, n.sp. *nobis*. Cambridge, Greensand.

II. Genus ICHTHYOSAURUS, König.—Humerus articulating distally with only the radius and ulna, which are short and in close apposition.

A. Latipinnate Group.—Pectoral limb with the third digit (that arising from the intermedium) containing two longitudinal rows of bones and two centralia; radius very short, with entire anterior border.

a. Campylodont subgroup.—Roots of the teeth enveloped in cement; humerus with prominent trochanteric ridge.

a. Femur very short, with trochanteric ridge enormously developed.

5. ICHTHYOSAURUS CAMPYLODON, Carter. Up. Cretaceous, Europe.
*6. ,, INDICUS, *nobis*. Up. Cretaceous, S. India.
*7. ,, STROMBECKI, Meyer. Neocomian, N. Germany.
*8. ,, POLYPTYCHODON, Koken. Neocomian, North Germany.

β. Femur longer, with trochanteric ridge less developed.

*9. Ichthyosaurus (?) ovalis, Phillips. Kimeridge Clay, Eng.

*10. „ (?) thyreospondylus, Phillips. Kimeridge Clay, England.

Syn. (?) *I. brachyspondylus*, Owen.
(?) *I. thyreospondylus*, Owen.

11. Ichthyosaurus leptospondylus, Wagner. Kimeridgian, Bavaria.

12. Ichthyosaurus entheciodon, Hulke. Kimeridge Clay, England.

13. Ichthyosaurus trigonus, Owen. Kimeridge and Oxford Clays, England.

Syn. (?) *I. posthumus*, Wagner. Kimeridgian, Bavaria.

*14. Ichthyosaurus (?) dilatatus, Phillips. Kimeridge and Oxford Clays, England.

*15. Ichthyosaurus hildesiensis, Koken. Neocomian, North Germany.

b. Typical subgroup.—Roots of the teeth without cement; humerus without prominent trochanteric ridge.

16. Ichthyosaurus communis, Conybeare. Low. Lias, England.
17. „ breviceps, Owen. „ „
18. „ Conybeari, n.sp., *nobis*. „ „
19. „ intermedius, Conybeare. „ „

B.—Longipinnate Group.—Pectoral limb with the third digit containing one longitudinal row of bones and a single centrale; radius nearly square, and usually with notched anterior border.

a. Acutirostrine subgroup.—Teeth small and cylindrical, coracoid without posterior notch; head of humerus oblong.

20. Ichthyosaurus integer, Bronn. Up. Lias, Würtemberg and (?) England.

21. Ichthyosaurus acutirostris, Owen. Up. Lias, Europe.

Syn. *I. longipennis*, Mantell.
I. microdon, Wagner.
I. quadriscissus, Quenstedt.
I. Zetlandicus, Seeley.
I. longifrons, Owen.

b.—Tenuirostrine subgroup.—Teeth small and cylindrical; coracoid with posterior notch; head of humerus triangular.

22. Ichthyosaurus tenuirostris, Conybeare. Lias, Europe.

Syn. *I. grandipes*, Sharpe.

23. Ichthyosaurus latifrons, König. Lias, England.

Syn. *I. longirostris*, Owen.
(?) *I. longirostris*, Jäger.

c. Platyodont subgroup.—Teeth large, either cylindrical or carinated; coracoid without posterior notch; head of humerus triangular.

24. Ichthyosaurus lonchiodon, Owen. Low. Lias, England.
25. „ „ platyodon, Conybeare. Low. Lias, England.

Syn. *Ichthyosaurus giganteus*, Leach.

26. Ichthyosaurus trigonodon, Theodori. Up. Lias, Bavaria.

III. Genus Mixosaurus, Baur. Humerus articulating with the radius and ulna, which are elongated and separated by an interval.

27. Mixosaurus cornalianus (Basani). Up. Lias, Italy.
Syn. *Ichthyosaurus cornalianus*, Basani.

The forms indicated by the under-mentioned names cannot be classified, and it is probable that several of them are synonyms of those already mentioned.

28. *Ichthyosaurus æqualis*, Phillips. Kimeridge Clay, England.
29. „ „ *angustidens*, Seeley. Up. Chalk, England.
30. „ „ (?) *atavus*, Quenstedt. Mid Trias, Germany.
31. „ „ *australis*, Hector. (?) Trias, New Zealand.
(?) = *Mixosaurus*.
32. „ „ *calorodirus*, Seeley. Kimeridge Clay, England.
33. „ „ (?) *carinatus*, Sauvage. Up. Trias, France.
? = *Mixosaurus*.
34. „ „ *coniformis*, Harlan. ? Lias.
35. „ „ *crassicostatus*, Theodori. Up. Lias, Bavaria.
36. „ „ *gaudensis*, Hulke. Reputed Miocene, Malta.
37. „ „ *hexagonus*, Theodori. Up. Lias, Bavaria.
38. „ „ *hygrodirus*, Seeley. Kimeridge Clay, England.
39. „ „ *ingens*, Theodori. Up. Lias, Bavaria.
40. „ „ *macrophthalmus*, Theodori. Up. Lias, Bavaria.
41. „ „ *megalodirus*, Seeley. Oxford Clay, England.
42. „ „ *Nordenskiöldi*, Hulke. Trias (?), Spitzbergen.
43. „ „ *planartus*, Theodori. Up. Lias, Bavaria.
44. „ „ *polaris*, Hulke. Trias (?), Spitzbergen.
45. „ „ (?) *rheticus*, Sauvage. Up. Trias, France.
(?) = *Mixosaurus*.
46. „ „ *triscissus*, Quenstedt. Up. Lias, Würtemberg.

The name *I. latimanus*, as will be noticed below, must be discarded. The names *I. Bonneyi*, *I. Doughtyi*, and *I. platymerus*, Seeley, and *I. advenus*, Phillips, are merely MS. ones; the first three being applied to specimens from the Cambridge Greensand, and the fourth to vertebræ from the Stonesfield slate. *I. Walkeri*, Seeley, has been made the type of *Cetarthrosaurus*.

In regard to the two new species above mentioned *Ophthalmosaurus cantabrigiensis* is founded on a small humerus from the Cambridge Greensand in the British Museum (No. 43989), which differs from that of *O. icenicus* in having the three distal facets of nearly equal dimensions. The name *Ichthyosaurus Conybeari* is applied to an imperfect skeleton of a small Ichthyosaur in the same collection (No. 38523) from the Lower Lias of Lyme-Regis, which differs from *I. communis* in the notching of the anterior border of some of the phalangeals of the pectoral limb, and in the relatively longer skull; while it is distinguished from *I. intermedius* by the greater width of the pelvic limb. It is possible that *I. latimanus*, Owen, may be

identical with this form, but since, as I shall show on a subsequent occasion, that species appears to have been founded by mixing up the characters of two specimens, which are apparently specifically distinct, the name must be abolished.

It is not improbable that one or more of the Kimeridgian species mentioned in the Campylodont subgroup may be referable to *Ophthalmosaurus*, and I think there is considerable probability of this being the case with *Ichthyosaurus* (?) *ovalis*, in which the contour of the vertebræ differs considerably from that obtaining in Kimeridgian species undoubtedly belonging to *Ichthyosaurus*. It may therefore prove that *Ophthalmosaurus icenicus* is even specifically identical with this form. In respect of other species, I have great doubt whether *I. entheciodon* is distinct from the continental *I. leptospondylus* of the same geological horizon, but since I cannot certainly say that the two are identical, it is preferable to allow both names to stand for the present. I find by a comparison of the type skulls of the so-called *I. Zetlandicus*[1] of the Upper Lias of Whitby, and *I. longifrons* of that of Normandy, that these two are evidently closely allied forms; and since certain differences in the arrangement of the bones of the quadratic region do not appear to me to be, at the most, of more than racial importance, I am inclined to refer both forms to a single species. A comparison of the pectoral limb of the Normandy form with that of the Whitby *I. acutirostris* shows, moreover, that both are of the same structural type; and since other Upper Liassic skulls from Whitby, which are indistinguishable from the type of *I. Zetlandicus*, agree equally closely with that of the former, I am disposed to unite both *I. Zetlandicus* and *I. longifrons* with *I. acutirostris*. I find, moreover, that skeletons from the Upper Lias of Würtemberg in the Museum, which agree with the one figured by Renevier in the "Bull. Soc. Vaudois" for 1885 as *I. quadriscissus*, Quenstedt, and also with those from the same region figured by Prof. Seeley in the "British Association Report" for 1880, without specific determination, present all the characters of the present species. And I am confirmed in this conclusion by finding it stated by Theodori in his Monograph of *I. trigonodon* that *I. acutirostris* is the most common form found in the Upper Lias of Bavaria and Würtemberg. The sketch of a skull from the Upper Lias of Banz, in Bavaria, made by Theodori and presented by him to Sir R. Owen, which is preserved in the British Museum, also affords important evidence in this direction, since it shows that the premaxilla and lachrymal did not unite below the nares to exclude the maxilla from that aperture;—a feature which is characteristic of the skulls described as *I. Zetlandicus* and *I. longifrons*.

I may observe also that, as Mr. W. Davies first pointed out to me, *I. longirostris*, Owen, appears to be identical with *I. latifrons*, König. The former name was, however, originally applied by Jäger

[1] I am glad to take this opportunity of thanking Prof. T. McKenny Hughes, of Cambridge, for his courtesy in permitting the type skull of *I. Zetlandicus* to be sent to the British Museum for comparison.

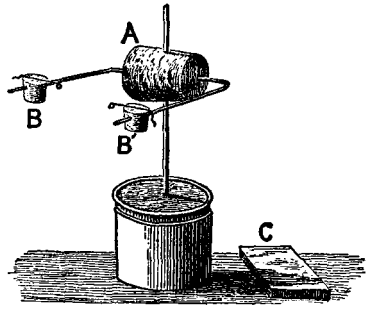
to specimens from the Upper Lias of Würtemberg which are probably also specifically the same.

In conclusion it will be interesting to draw attention to a pectoral limb of *I. acutirostris* (*quadriscissus*), figured by Dr. O. Fraas in the Jahresh. Ver. Nat. Württ., 1888, pl. vii., in which the contour of the integument is perceived. It appears from this figure that the integuments were produced a considerable distance on the posterior border of the paddle so as to form a large fold in the axillary region.

VII.—On Simple Apparatus for Use in the Observation of Flame-Reactions.

By Grenville A. J. Cole, F.G.S.

GEOLOGISTS, who are again and again forced to deal with the most minute or fragmentary specimens, and who find it impossible to cultivate, during their surveys of the earth, the methods perfected by the mineralogist in his learned leisure, have fully recognized the importance of Prof. Szabó's tabulation of the flame-reactions of the felspars. Since the accuracy of the results obtainable depends largely upon the position of the mineral-particle in the flame, I venture to call attention to a form of support that has proved in practice as convenient and efficient as it is simple.



Following a long way in the wake of Prof. Miller's ingenious goniometer, the materials of this little instrument are essentially wire and cork. A small gallipot, such as is used for Liebig's extract, forms a base that is clean, strong, and adequately heavy. A brass wire, about 5 mm. in diameter, passes through the cork of this, and rises 15 centimetres above it, carrying a stout cork A, which can be slid up and down to any level. A steel wire or knitting-needle, some 25 cm. long, is pushed horizontally through A, the last 7 cm. on either side being then bent forward at right angles. Two small corks, B and B′, are carried by the parallel arms thus formed, and support, by means of a knife-slit in the top of each, the fine platinum wires employed. B can be slipped off the steel wire, the mineral fragment can be attached, with Prof. Szabó's precautions, to the platinum loop, and the carrier replaced without fear of loss by jarring. B′ can be used for a type-specimen to be compared with that under examination, the wires on both corks being