

ties of dogmatism on the one hand, and scepticism on the other, it came to be so thought, we need not here consider. Let us hope and confidently expect that it will not last; that the religious faith which survived without a shock the notion of the fixity of the earth itself, may equally outlast the notion of the absolute fixity of the species which inhabit it; that in the future, even more than in the past, faith in an *order*, which is the basis of Science, will not (as it cannot reasonably) be dissevered, from faith in an *Ordainer*, which is the basis of Religion."

My self-imposed task is ended—how imperfectly it has been fulfilled no one is more conscious than myself; but if I have by this means succeeded in attracting your attention to a few of the vast number of lines of scientific inquiry stretching into the universe around, along which the intellectual powers of man are striving to advance, and upon which we also may become travellers, I shall not have spoken altogether in vain.

II.—ON A NEW GENUS OF FOSSIL FISH OF THE ORDER *DIPNOI*.¹

By RAMSAY H. TRAQUAIR, M.D.,
Professor of Zoology in the Royal College of Science, Dublin.

(PLATE XIV.)

A GASSIZ, after describing the intermaxillary bone of *Megalichthys*, makes the following brief statement regarding the fossil which is the subject of the present paper: "M. König possède une pièce détachée qui paraît être le même os."²

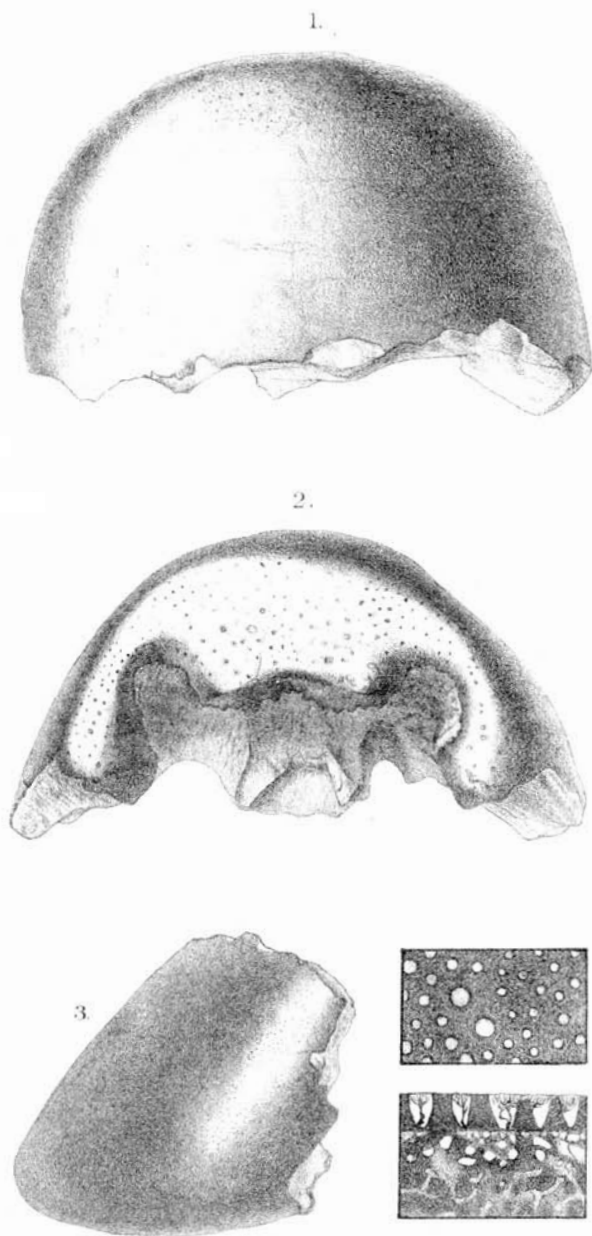
This "pièce détachée" is in the collection of the British Museum, and has lately been completely wrought out by removal of the remains of the matrix, in which it was imbedded. It was shown to me some time ago by my friend Mr. Henry Woodward, who expressed to me, at the time, his own opinion that it could not belong to *Megalichthys*, but that it was in all probability a new genus. In this opinion I entirely concurred, as it was at the first glance evident that it could not belong to the *Saurodipterine* group, of which *Megalichthys* is a member, although certain parts did exhibit a very brilliant punctated Ganoid surface, reminding us of the polished plates and scales of that genus. On the contrary, fragmentary as the fossil unfortunately is, its configuration shows that it must be closely allied to *Dipterus*, and must therefore be included in the order *Dipnoi*; the close relationship between *Dipterus* and the living *Ceratodus* and *Lepidosiren* having been already clearly shown by Dr. Günther.³

The specimen before us is, as aforesaid, only a fragment, measuring $1\frac{1}{2}$ inches in length by 3 in breadth, and is evidently the extremity of the snout of a very large fish, probably 4 or 5 feet long. It is of a somewhat semilunar form; showing a rough *posterior* margin where it has been broken off from the rest of the head; a *superior* arched ganoid surface, which has formed part of the upper aspect of the

¹ Read before the Royal Geological Society of Ireland, 14th May, 1873.

² Poissons Fossiles, vol. ii. part 2, p. 91.

³ Phil. Trans. 1871.



snout; an anterior margin forming the front edge of the upper lip; and an inferior excavated surface, which formed part of the roof of the mouth and nasal chambers. Placing the snout in its natural position, with the labial margin horizontal (Pl. XIV. Fig. 3), the superior surface is seen to slope downwards and forwards in the middle line at an angle of 45° , while towards the sides it is rounded off in an arched manner. This surface shows no trace either of sutures or of external nasal openings; it is smooth and ganoid, glossy and finely reticulate-punctate; near the labial margin, however, the minute punctures disappear, and are replaced by another set, which are larger, fewer, and further apart. Many of these larger punctures are also seen on the finely-reticulate surface above.

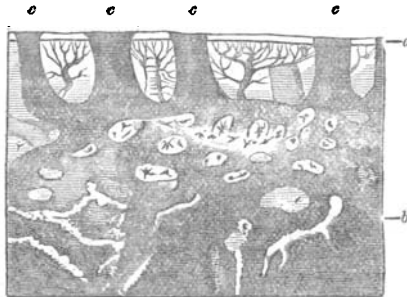
On turning up the fossil, and looking at it from below (Fig. 2), we see first a flattened margin, situated in front and laterally, which must have formed part of the upper lip, and which passes by a rounded edge over to the upper surface just described. This labial margin is brilliantly polished, and ornamented with the large scattered punctures already alluded to, and which average about $\frac{1}{50}$ inch in diameter. It shows also on each side and internally a pretty deep rounded notch, clearly indicating the position of an anterior nasal opening, which must thus have penetrated the upper lip as in the living *Dipnoi*. This arrangement also agrees perfectly with what is seen on the under aspect of the snout of *Dipterus*. The portion of the labial margin situated between the right and left nasal notches shows a faint median indentation, dividing it into two parts, and each of those parts, right and left, is set on its rounded posterior edge with a row of six small blunted tooth-like projections. Similar blunted tooth-like bodies are also seen on the inner aspect of the projecting portion of the labial margin behind each nasal notch.

Posteriorly and internal to this strange ganoid labial margin, the specimen is deeply excavated, and the surface here seen has evidently formed part of the roof of the nasal chambers on each side, and of the front of the roof of the mouth. The bone is here rough; no sutures can be distinguished; but the median longitudinal projecting portion evidently represents the front of the vomer, anterior to the attachment of the palato-pterygoid plates. No trace is seen of vomerine teeth, as in *Ceratodus* and *Lepidosiren*, nor of their places of attachment as noticed by Günther in *Dipterus*; if present in this fish, they must also have been posterior to the portion preserved.

The hinder margin, all the way across between the two posterior angles of the specimen, shows nothing but the rough fractured surface where it has been broken off from the rest of the head. However, we may see here that the bone, forming the surfaces just described, exists as a rather thin shell over an internal space once occupied beyond doubt by cartilage, now completely filled up by the stony matrix, a dull grey argillaceous limestone. But the part between the posterior angle of the specimen, on each side, and the boss-like dentigerous projection behind each nasal notch, shows a distinct articular surface looking backwards, and which may have been for a maxillary bone, or for a superficial facial bone if the

maxillary were wanting, as is the case in the recent *Dipnoi*, and apparently also in the fossil *Dipterus*.

A thin vertical slice, taken from the bone on the upper surface near the posterior external angle, displays microscopic characters essentially similar to those found in the scales and plates of many ganoid fishes, including also the scales of *Megalichthys*. The bone is here very thin, measuring only about $\frac{1}{10}$ inch in vertical section. Its microscopic structure is represented in the accompanying wood-cut. Immediately below the surface is an absolutely structureless layer of transparent ganoinæ about $\frac{1}{1000}$ inch thick. Through this



Vertical section of bone on the upper surface of the snout, magnified 48 diameters.

a Layer of ganoinæ.

b True bone.

c Punctures of the surface—opening into the canal system of the interior.

the punctures of the surface pass into a set of short vertical canals, each widening downwards so as to assume a rather conical figure. At their bases they are connected by horizontal tubes, and this system also communicates below with a close irregular network of ordinary Haversian canals, which ramify through the lower part of the section, and, becoming coarser below, cause the bone on its inferior aspect to assume almost a spongy appearance. The intervals between the set of short wide vertical canals, cup-shaped in the section, are seen to be each traversed by a vertical tube, which, coming up from the Haversian network below, soon divide in an arborescent manner into a great number of minute ramifying branches, which pass towards but not into the superficial layer of structureless ganoinæ. Adjacent trees of this kind also freely communicate with each other by means of arched branches, passing around and between the vertical canals between which their stems are situated. A beautiful kosmine-like layer is thus formed below the ganoinæ; it must be noted, however, that small lacunæ are occasionally seen among its minute tubules. In the true bone below, lacunæ of the ordinary type abound in the meshes of its Haversian network.

Unfortunately nothing is known regarding the geological formation, or the locality, of the fossil just described. To Mr. Davies, of the British Museum, I am indebted for the information, that it "formed part of the old collection of the British Museum, of which there are no records, hence its history as to from whom, and whence it came is wanting." Judging, however, from its general aspect, one might readily be tempted to infer that it was of Palæozoic age.

ANALYTICAL TABLE OF THE GENERA OF GRAPTOLITES.

By CHARLES LAPWORTH, F.G.S.

RHABDOPHORA—(Allman).

Hydroids in which the polypary is strengthened by a chitinous filiform virgula.

SECTION I. GRAPTOLITIDÆ.

Polypary developed from a true sicula.
Cœnosarc originating a single series of thecæ only.
Virgula dorsal, imbedded in a narrow groove on the exterior surface of the periderm.

MONOPRIONIDÆ (Hopk.).

Polypary having a unilateral arrangement of parts.

Fam. I.—*Monograptidæ*—

a. Polypary simple—

- i. Thecæ isolated.
- ii. " in contact or overlapping.

b. Polypary compound—

- i. Thecæ in contact.

1. Gen. RASTRITES (Barr.). Example (*R. peregrinus*, Barr.).
2. Gen. MONOGRAPTUS (Gein.). " (*M. priodon*, Bronn).
3. Gen. CYTOGRAPTUS (Carr.). " (*C. Murchisoni*, Carr.).

Polypary having a bilateral arrangement of parts.

Fam. II.—*Nemagraptidæ* (Hopkinson, MS.)—

Branches irregularly disposed.
Thecæ adnate to the periderm; in contact only.
Sicula persistent, axillary, major extremity forming the proximal end of the adult polypary.

a. Primordial buds developed from the major extremity of the sicula.

- (i.) Primary branches simple.
- (ii.) " compound.
- i. Giving off simple branches from both margins, in the neighbourhood of the initial point—usually in pairs.
- ii. Repeatedly and irregularly branching and rebranching.

b. Primordial buds developed from the central portion of the sicula.

- i. Secondary branches few, irregularly disposed.
- ii. Secondary branches numerous, sub-regular.

4. Gen. LEPTOGRAPTUS (gen. nov.). " (*L. flaccidus*, Hall, sp.).
5. Gen. AMPHIGRAPTUS (gen. nov.). " (*A. divergens*, Hall, sp.).
6. Gen. PLEUROGRAPTUS (Nich.). " (*P. linearis*, Carr. sp.).
7. Gen. NEMAGRAPTUS (Emmons). " (*N. capillaris*, Emm.).
8. Gen. CœNOGRAPTUS (Hall). " (*C. gracilis*, Hall).

Fam. III.—*Dichograptidæ*—

Species with regular branches.
Thecæ in contact throughout,—flattened rectangular prisms,—inner walls bent into a gentle curve.
Sicula persistent, minor extremity forming the proximal end of the adult polypary.

a. Polypary simple,—no funicle.

Having two simple branches only.

b. Polypary compound.

Major extremity of the sicula giving origin to a funicle.

- (i.) Funicle frequently subdividing in a dichotomous manner.
Polypiferous branches, simple, terminal, radially disposed, answering in number to the subdivisions of the funicle.
- i. Branches four in number.
- ii. " eight in number.
- iii. " sixteen to thirty-two.
- iv. " more than thirty-two.
- (a.) divisions distant.
- (b.) " closely approximate.
- (ii.) Funicle once divided, giving origin to four main, polypiferous branches, which form the complete polypary,—
- i. by continued dichotomous subdivision;
- ii. by giving off simple branches from one margin only;
- iii. " compound " " both margins.

9. Gen. DIDYMOGRAPTUS (M'Coy). " (*D. Murchisoni*, Beck).
10. Gen. TETRAGRAPTUS (Salt.). " (*T. crucifer*, Salt.).
11. Gen. DICHOGAPTUS (Salt.). " (*D. octobrachiatus*, Hall).
12. Gen. LOGANOGRAPTUS (Hall). " (*L. Logan*, Hall).
13. Gen. CLONOGRAPTUS (Hall). " (*G. flexilis*, Hall).
14. " " " (*G. multifasciatus*, Hall).
15. Gen. " (*Grapt. Milesi*, Hall).
16. Gen. " (*Pl. vagans*, Nich.).
17. Gen. " (*G. Richardsoni*, Hall).

MONO-DI-PRIONIDÆ (Hopk.).

Fam. IV.—*Dicranograptidæ*—

Branches only two in number,—free or partly coalescent.
Thecæ slightly overlapping,—distal portions isolated,—incurved.
Major extremity of sicula forming the proximal end of the adult polypary.

- (i.) Branches free throughout their whole extent.
- (ii.) Branches coalescent in the proximal portion of their length.

18. Gen. DICELLOGRAPTUS (Hopk.). " (*D. elegans*, Carr. sp.).
19. Gen. DICRANOGRAPTUS (Hall). " (*D. ramosus*, Hall).

DIPRIONIDÆ (Hopk.).

Fam. V.—*Diplograptidæ*—

Polypary duplicate: being essentially a dibrachiate monoprioidian polypary, whose branches coalesce by the whole of their dorsal surfaces.

Sicula imbedded: the major extremity forming the proximal end of the polypary.

- i. Thecæ perpendicular: without ornament, or furnished proximally with a single, median, marginal spine.
Polypary tapering; section circular or bilobate.
Thecæ free, section sub-oval.
- ii. Thecæ inclined: without ornament, or furnished distally with two lateral apertural spines.
- a. Polypary usually styliform, section concavo-convex.
Thecæ usually free, section sub-oval.
- b. Polypary frequently foliiform, or sub-fusiform: section variable.
Thecæ of the form of those of *Dichograptus*.
- c. Polypary short, triangular: section flattened.
Thecæ linear, tubular, few in number.
- d. Polypary long, prismoid: section square.
Thecæ flattened: section rectangular.

20. Gen. CLIMACOGRAPTUS (Hall). " (*Clim. bicornis*, Hall)
21. Gen. DIPLOGRAPTUS (M'Coy).
Sub-gen. *Glyptograptus* (Lapw.). " (*Glypt. tamariscus*, Nich. sp.).
Sub-gen. *Petalograptus* (Suess). " (*Pet. folium*, His. sp.).
Sub-gen. *Cephalograptus* (Hopk.). " (*C. cometa*, Gein. sp.).
Sub-gen. *Orthograptus* (Lapw.). " (*O. quadrimucronatus*, Hall, sp.).

TETRAPRIONIDÆ (Hopk.).

Fam. VI.—*Phyllograptidæ*—

Polypary composite: being essentially a quadribrachiate monoprioidian polypary, whose branches coalesce by the whole of their dorsal surfaces.

Sicula imbedded—the major extremity forming the proximal end of the adult polypary.
Thecæ of the form of those of *Dichograptus*.

22. Gen. PHYLLOGRAPTUS (Hall). " (*P. typus*, Hall).

SECTION II. RETIOLOIDEA.

Polypary never developed from a siculiform "germ."
Cœnosarc originating a double series of thecæ.
Epiderm more or less supported by a framework of chitinous filaments.

Fam. VII.—*Glossograptidæ* (provisional Family).

Virgulæ coalescent, placed centrally within the body of the polypary.
Angles of the walls of the thecæ partly strengthened by chitinous filaments, which are prolonged as distinct or anastomosing lateral processes.
Periderm continuous, thickened.
Polypary simple, usually furnished with two opposite, longitudinal rows of distant, isolated spurs or lateral appendages, developed along the median line of the periderm at right angles with the thecæ.

- (i.) Without extraneous meshes.
Thecæ resembling those of *Orthograptus*.
- (ii.) With extraneous meshes.
- i. Extraneous meshes formed by single, simple filaments, developed from the anterior margins of the apertures.
Thecæ resembling those of *Retiolites*.
- ii. Extraneous meshes formed by numerous anastomosing filaments, developed from simple spinous processes from the outer walls of the thecæ.
Thecæ resembling those of *Climacograptus*.

23. Gen. GLOSSOGAPTUS (Emmons). " (*G. ciliatus*, Emm.).
24. Gen. RETIOGRAPTUS (Hall). " (*R. tentaculatus*, Hall).
25. Gen. LASIOGRAPTUS (gen. nov.). " (*Las. costatus*, sp. nov.).

Fam. VIII.—*Retiolitidæ*.

Virgulæ separated and placed one on the obverse, the other on the reverse aspect of the polypary; and forming an integral portion of the filiform framework.
Epiderm stretched upon a complete skeleton framework of chitinous threads.

- (i.) Periderm excessively attenuated.
- a. Periderm reduced to a scarcely appreciable film.
- i. Polypary simple.
- ii. Polypary compound.
- b. Periderm punctate.
- Polypary simple.
- (ii.) Periderm reduced to a network.
- Polypary simple.

26. Gen. CLATHROGRAPTUS (gen. nov.). " (*C. cuneiformis*, sp. nov.).
27. Gen. " (*Ret. eucharis*, Hall sp.).
28. Gen. TRIGONOGRAPTUS (Nich.). " (*T. ensiformis*, Hall sp.).
29. Gen. RETIOLITES (Barr.). " (*R. Geinitzianus*, Barr.).

From the preceding description it is evident that the fish, to which this strange and beautiful snout belonged, must take its place, not among the Ganoids proper, but among the *Dipnoi*. Of fossil fishes hitherto reckoned with certainty to the last-named order, we have only *Cheirodus*, *Dipterus*, *Ctenodus*, and *Ceratodus*; the position of *Phaneropleuron* and *Tristichopterus* being still doubtful. Our fossil is certainly neither *Dipterus* nor *Ceratodus*; *Cheirodus* is known only by its teeth; and as to *Ctenodus*, the front of the head has not yet been discovered, so that all evidence is wanting to connect it with that genus. It seems therefore, in these circumstances, best to frame a new genus for its reception; I propose, therefore, to bestow upon it the generic term *Ganorhynchus* (γάρος, ῥινχος), coupled with the specific name of *Woodwardi*, in honour of the distinguished palæontologist who first directed my attention to the fossil.

EXPLANATION OF PLATE XIV.

- FIG. 1.—Upper surface of the broken-off snout of *Ganorhynchus Woodwardi*.
 FIG. 2.—Lower aspect of the same fossil, showing the ganoid and pitted labial margin, the anterior nasal notches, portion of the roof of the nasal chambers, and the broken-off vomer in the centre.
 FIG. 3.—The same fossil seen from the left side. At the posterior inferior angle is seen the articular surface referred to at page 553. Both of these surfaces, right and left, are seen in Fig. 2, at the posterior external angles.
 FIG. 4.—A magnified view of the smooth ganoid surface of the upper lip, showing the large scattered punctures or pits with which it is ornamented.
 FIG. 5.—A microscopic section of the ganoid bone on the upper surface of the snout. This drawing, executed in the absence of the author from Great Britain, does not convey a very accurate or intelligible idea of the microscopic structure; the woodcut, page 554, has therefore been substituted.

III.—NOTES ON THE BRITISH GRAPTOLITES AND THEIR ALLIES.

By CHAS. LAPWORTH, F.G.S.

1.—ON AN IMPROVED CLASSIFICATION OF THE RHABDOPHORA.¹
PART II.

THE accompanying analytical Table of the genera of the *Rhabdophora* which are especially treated of in the present paper is here offered as a first and suggestive sketch for an improved arrangement of these forms. The foregoing conclusions have been employed in its construction, and are embodied in the general scheme. See Table I.

Of the several families under Mr. Hopkinson's well-known plan of arrangement, the first (*Monoprionidæ*) comprises the whole of the species distributed among the first three families in the Table. The *Tetraprionidæ* and *Mono-di-prionidæ*, as finally interpreted by himself,² are identical with two of the new families. Thus the alteration in this section is more apparent than real. It is a great proof of the value of Mr. Hopkinson's original classification that subsequent research has necessitated such a slight change in this department. In his scheme, however, the families were each founded upon a single structural peculiarity. The corresponding nomenclature was so precise and inflexible that it admitted of no modification or intercalation. In the proposed arrangement, on the

¹ For Part I. See *Geol. Mag.* Vol. X. pp. 500–504. ² *Geol. Mag.* Vol. X. p. 231.