collectors to the various aspects under which the higher *Crustacea* make their appearance in the oldest rocks at present known to contain them, that I venture to communicate the present notice to the Geological Society.

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4. *On the* PREMOLAR TEETH *of* DIPROTODON, *and on a* NEW SPECIES *of that* GENUS. By THOMAS H. HUXLEY, ESQ., F.R.S., Sec. G. S., &c.

[PLATE XXI.]

A SHORT time since, I was requested by Dr. Cotton, F.G.S., to examine a series of Australian fossils in his collection, which were procured by Mr. Isaacs from Gowrie, in the district of the Darling Downs in Queensland, the same locality from which other specimens in the Hunterian and British Museums were obtained. These fossils consisted of numerous teeth and fragments of jaws of *Macropus Atlas* and *M. Titan*; part of the upper jaw of a new species of Kangaroo, as large as these, but allied to *Lagorchestes* and *Hypsiprymnus*; with three lumbar vertebræ, a sacrum, portions of two innominate bones, three ossa calcis, and a right metatarsal of the great toe, belonging to these Marsupials. The metatarsal is remarkable for its short and stout proportions. But the most interesting among these remains were fragments of *Diprotodon*, comprising sundry molar teeth, a small portion of the right ramus of a lower jaw, and parts of the right and left upper jaws of two distinct individuals. Of these upper jaws, the former, which I shall call No. 1 (Pl. XXI. fig. 1), contained the premolar in place and the socket of the succeeding molar, with one fang in place. Fortunately, among the detached teeth, I found the crown and principal fang of this molar, and the premolar of the other side of the same skull. The other or left upper jaw, No. 2 (fig. 4), has a very different colour and texture, from the nature of the ferruginous matrix in which it has been imbedded. It retains a part of the palatine plate, and holds three teeth—the premolar and first and second molars. What (from its aspect and mineral condition) I do not doubt to be the fourth, or hindermost, molar of the same series was found loose among the other teeth.

The genus *Diprotodon* was founded by Professor Owen* upon part of a lower jaw, collected by Sir Thomas Mitchell, from a cave in the Wellington Valley. In 1845 further details were given by the same author†, who described two fragments of lower jaws, and all the lower series of teeth but the premolar. Of this tooth all that is said is, "its socket shows that it was implanted, like the other molars, by two fangs" (*l. c.* p. 214). A dorsal vertebra and a calcaneum, from the same deposits, are provisionally ascribed to the same genus.

* Mitchell's 'Three Expeditions into the Interior of Eastern Australia,' vol. ii. p. 368, pl. 9. fig. 1. 1838.

† Report of the Meeting of the British Association for 1844, p. 223; 'Report on the Extinct Mammals of Australia, &c.,' by Prof. Owen, F.R.S.

In the "Catalogue of the Fossil Organic Remains of *Mammalia* and *Aves* in the Museum of the Royal College of Surgeons" (1855), Professor Owen has given a fuller description, accompanied by figures, of the previously known remains of *Diprotodon australis*, and has added an account of some fragments of ribs, scapulæ, and limb-bones. No portions of the upper jaw, or of its teeth, are described in these successive communications; but in the paper "On some outline drawings and photographs of the skull of the *Zygomaturus trilobus*" (Quart. Journ. Geol. Soc. 1859, p. 168), it is stated of "*Zygomaturus*,"—"By the dentition of the upper jaw this fossil agrees in that essential character with the genus *Diprotodon*" (p. 173); and further, at p. 175, "The bony palate appears to have been entire or without any unusually large palatal vacuity, in this respect resembling the same part in *Macropus major* and *Diprotodon*;" and again at p. 175, —"In the cranium of *Diprotodon* in the Sydney Museum, of which photographs have been transmitted to me by Mr. George Bennett, the number of molar teeth is reduced to eight, four on each side; but it is by the loss of the first small molar; and from the appearance of that molar in *Zygomaturus*, I conjecture that it would also be shed in an older individual. But there are specimens in both the British Museum and the Hunterian Museum which demonstrate that the *Diprotodon* has five molar teeth developed on each side of both upper and lower jaws, as stated in my 'Report on the extinct Mammals of Australia.'"

I may remark, incidentally, that I am unable to find any reference to the upper jaw in the 'Report' here cited. In the passage which immediately precedes that just quoted, Professor Owen says,—"I have to state that the British Museum has now received ample evidence that the generic distinction which Mr. MacLeay believes to exist between that fossil (*Zygomaturus*) and *Diprotodon* is not present."

My valued friend Mr. MacLeay, however, by no means made the mistake here attributed to him, of establishing a new genus unnecessarily. "*Zygomaturus*" *is*, without doubt, generically distinct from *Diprotodon*: indeed, Mr. MacLeay's conclusion is implicitly admitted by Professor Owen in the paper which follows that cited above, and which is chiefly devoted to an attempt to prove the identity of *Zygomaturus* (MacLeay) with *Nototherium* (Owen); for the latter genus is regarded by Professor Owen as perfectly distinct from *Diprotodon*.

In the plate (Plate IX.) which accompanied that communication, the left penultimate upper molar of *Diprotodon* is figured (fig. 6); and the transverse direction of the principal ridges, as contrasted with their oblique direction in *Nototherium*, is noted.

I have now, I believe, adverted to all that has been written regarding the dentition of *Diprotodon*; and it will be observed that much remains to be learned respecting the premolar teeth and the dentition of the upper jaw generally. I shall proceed, therefore, to describe, at some length, the fossils noted above as Nos. 1 and 2.

No. 1 (Pl. XXI. figs. 1, 2, 3). This consists of so much of the right

maxilla of a *Diprotodon* as would lie between an anterior boundary-line, drawn through the anterior end of the infraorbital canal and the alveolar margin, half an inch in front of the premolar, and a posterior boundary-line, drawn at right angles to the alveolar margin, between the fangs of the first molar tooth. The superior limit of the fragment is the commencement of the lacrymal or antorbital prominence. The distance between the alveolar margin and the latter is 3 inches. The outer surface of the maxilla is strongly inclined inwards below the suborbital foramen, flattened or slightly convex from the alveoli of the premolar and molar to the level of that foramen, and slopes backwards and inwards, so as to be markedly concave, above that point. Although not more than an inch and a half of the infraorbital canal is preserved, its anterior end is fully half an inch below its posterior extremity, so strongly is it inclined downwards and forwards.

In all these characters the fossil agrees with *Diprotodon*, and differs from *Zygomaturus** ; in which latter animal the surface of the maxilla slopes directly outwards and backwards from the infraorbital foramen to form the prominent anterior margin of the orbit. In *Zygomaturus* the zygomatic process of the maxilla is given off at a point where the surface of that bone is quite smooth in the fossil before us.

Of No. 2 (Pl. XXI. figs. 4, 5, 6), a left maxilla, less of the upper and anterior, and more of the posterior and inner part, remain. The floor of the infraorbital foramen remains, and exhibits the same rapid slope as that of the other specimen. A strong horizontal palatine process is given off from the inner side of this fragment of the left maxilla. Its greatest breadth is one inch and three-eighths; and its inner boundary, rough and broken, presents no indication of a suture, so that the palate had more than double this width at this point. Opposite the interval between the first and second molars a small canal opens forwards, upon the under and anterior surface of the palate opposite the premolar. The palatine plate is three-eighths of an inch thick, and presents a flat external division, separated by a ridge from an inner part which slopes somewhat upwards; but behind the opening of the canal just mentioned, the under or oral surface rises both inwards and backwards; and, the upper or nasal surface falling in the same proportion, the palatine plate ends posteriorly and internally, opposite the interval between the second and third molars, in a thin edge, which, in this specimen, is nowhere completely entire. In a specimen of the right maxilla of *Diprotodon*, containing all the teeth save the premolar, in the collection of the British Museum (marked 32858), to which I shall have occasion to make frequent reference, the palatine plate is seen to end in a free, thin, rounded edge, and to become

* I employ Mr. MacLeay's generic name *Zygomaturus* for the fossil skull which he originally described, because, until a lower jaw has been discovered in connexion with such a skull, and that lower jaw turns out to be generically identical with the mandible upon which Professor Owen founded his genus *Nototherium*, the identity of *Nototherium* and *Zygomaturus* cannot be considered to be proved.

narrower from the level of the commencement of the third molar; so that, no doubt, a great palatine vacuity existed at this spot. This is the more remarkable, as, judging from a cast in the same collection, the palate of *Nototherium* was entire, and extended, as in the Kangaroos, behind the last molar tooth.

The molar teeth have the general characters of those of the lower jaw of *Diprotodon* already described by Professor Owen. Each exhibits two principal transverse ridges, with a posterior, almost obsolete, and an anterior, much more prominent and thick, but still low, basal ridge. The principal ridges are directed transversely to the axis of the palate and the alveolar margin, or have, at most, but a very slight inclination backwards and inwards. They are slightly concave backwards; and they wear down at first into two oval or elongate-reniform facets, separated by a deep valley, whose outer ends are, as usual, higher than the inner. The tooth becomes abraded faster in front than behind,—the anterior basal ridge contributing a single or double strip-like facet, which becomes connected in the middle with the worn face of the anterior of the two principal ridges. The latter also eventually unite in the middle of the tooth; so that, in much-worn teeth, the broad, four-sided field of dentine is surrounded only by a narrow band of enamel, the lateral portions of which present two sharply re-entering angles. There is no cingulum continued upon either the outer or the inner sides of the base of these teeth. The surface of the enamel has that sort of "reticulo-punctate or worm-eaten" look which is mentioned by Professor Owen as characteristic of the teeth in this genus.

The first molar is rather smaller than the second: the third is wanting: the fourth is considerably longer than the second, as the measurements given below will show, and has not the square outline of the first and second; but it diminishes posteriorly by the incurvation of its outer contour. Hence the posterior transverse ridge of the fourth molar is much smaller than the anterior. The tooth is not at all worn, and seems to have been but just cut. The principal crests are excavated from side to side posteriorly, and are correspondingly convex anteriorly. Superiorly they rise to a minutely ridged and forwardly curved edge, which is slightly concave upwards. The anterior basal ridge is sharply defined, but is not so thick as in the second molar.

Each molar tooth has a single posterior fang and two anterior fangs.

The premolar tooth (not more than half the size of the molar which succeeds it, and very much less worn) differs somewhat in its characters in the two fossils. I will first describe it as it appears in No. 1, where the premolar teeth of both sides are preserved. The tooth is implanted by two fangs, an anterior, smaller, and a posterior, larger; and its crown has somewhat the form of a tetrahedron with a truncated apex. The posterior side is flat, and slopes obliquely forwards to the roof-like summit of the tooth. The outer convex surface (fig. 1) is divided into three minor vertical convexities by two shallow grooves, which cease about halfway towards the base of the crown. The inner surface (fig. 3), less extensive than the

outer, is convex and triangular, being narrower towards the summit of the crown. It passes gradually into the anterior side, which is also triangular, but still narrower. From the vertical depressions on the outer surface two grooves extend inwards on to the crown, which is thus divided by two transverse valleys separated by elevations. Of these, the two posterior, broad and ridge-like, join internally to form the inner surface of the tooth; while the anterior, which has more the form of a cone than that of a crest, is not more than half as broad as the others, and terminates, internally, in a smoothly rounded convex pillar, which remains distinct to the base of the crown. From its anterior surface a ridge springs, which, gradually decreasing in height, skirts its base and then ascends, upon the inner part of the middle ridge, to form the anterior boundary of the inner face of the tooth. The posterior basal ridge is well marked and concave upwards; its inner and outer ends, as it were, ascending upon the postero-external and postero-internal angles of the tooth. The anterior, or mammillary, elevation is not at all worn in either tooth. The middle and posterior ridges are slightly worn, so as to give rise to two elongated facets, each not more than one-sixth of an inch wide, and passing into one another internally, being separated only by the posterior groove, which dilates somewhat suddenly at its inner end (fig. 2).

The premolar of No. 2 is constructed upon precisely the same general plan as that of No. 1, but differs in several details. Thus, it is slightly smaller, and the antero-internal ridge which skirts the base of the mammilla has a somewhat different form. But the most marked difference is offered by the outer surface of the tooth (fig. 4), which presents not merely three smoothly convex surfaces, as in the other specimen, but exhibits three well-defined vertical ridges, connected by prominent, curved, basal elevations. The premolar of this specimen is altogether somewhat smaller than that of the other.

That both these specimens are specifically distinct from the only species of *Diprotodon* known at present, viz. *D. australis*, appears likely, at first sight, from a comparison of the dimensions of the corresponding teeth.

In the maxilla of *Diprotodon australis* (British Museum, No. 32848), to which I have already referred, the socket of the premolar and the first and second molars occupy a space of 4½ inches in the alveolar margin of the maxilla: in No. 2 the same teeth occupy only about 3½ inches. The measurements of the individual teeth, given in eighths of an inch in the following table, present a nearly similar ratio.

	No. 2.		No. 1.		*D. australis* (B.M.).	
	Breadth.	Length.	Breadth.	Length.	Breadth.	Length.
Premolar	6½	7½	7	8	5	8*
First molar	9½	10	12	10	13	12
Second molar	11½	12			16	15
Fourth molar	13	16			17	20

* These are measurements of the alveolus and its contained fang. The crown of the tooth was doubtless much larger in each dimension.

From these measurements it would appear that No. 2 was about one-fourth smaller than *Diprotodon australis*, and that No. 1 took a place between No. 2 and the latter, but nearer No. 2. The question of the systematic value of the differences between No. 1 and No. 2, on the one hand, and between both of these and *Diprotodon australis*, now arises.

In No. 2, the outer surface of the premolar is ridged, and the crown of the first molar is not so broad as it is long.

In No. 1, the outer surface of the premolar presents simple convexities, without ridges, and the first molar is distinctly broader than long.

In *Diprotodon australis* the form of the premolar is not known; the first molar is somewhat broader than it is long.

I entertain no doubt that Nos. 1 and 2 are specifically distinct; and I propose for No. 2 the name *Diprotodon minor*. Whether No. 1 is specifically distinct from *Diprotodon australis*, or whether its difference in size is merely sexual, I cannot pretend to say, in the absence of any premolar teeth of undoubted *D. australis*.

From the very slight extent to which the premolar is worn while the first molar is so much abraded, I suspect that the former tooth must have persisted for a long while, instead of being pushed out at an early period as in many *Macropodidæ*. In form and pattern the premolar does not depart more widely than the molars themselves from the type found in some Kangaroos, such as *Halmaturus*; and the cast of *Zygomaturus* in the British Museum shows that the upper premolar in that animal had an essentially similar structure, though it seems to have been somewhat larger in proportion to the molars.

DESCRIPTION OF PLATE XXI.

Fig. 1. Part of the right upper maxilla of *Diprotodon* (*australis*?); viewed laterally.
2. The under or oral face of the same fragment.
3. A premolar tooth, apparently from the opposite maxilla of the same animal; viewed from the inner side.
4. Part of the left upper maxilla of *Diprotodon minor*; viewed laterally.
5. The under or oral face of the same specimen.
6. Fourth molar, probably of the same specimen of *Diprotodon minor*.

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5. *On the* Old Red Sandstones *of* Fifeshire.

By James Powrie, Esq., F.G.S.

Introduction.—In a paper which I communicated to the Geological Society last year*, I stated my belief in the conformability of all the Old Red Sandstones as exhibited in Forfarshire. In that paper as originally framed, I had even questioned the correctness of Sir C. Lyell's section of the Forfarshire rocks ('Manual of Geology'), in so far as this shows an overlying unconformable conglomerate at

* Quart. Journ. Geol. Soc. vol. xvii. p. 534.