ciple more evident than in considering the structure of the carboniferous area of the Mendip Hills, where enormous denudation had taken place long before the New Red Sandstone was deposited. How then could we ignore this operation in other parts of the country? As to faults, he submitted that their existence must be proved rather than assumed. Did they exist, they were not gaping fractures, but closed; and he regarded it as physically impossible for such hollows as those in which the lakes were found to be due to such causes. Even if fractures existed, they could only constitute lines of weakness, along which denuding agents might more readily work. As to the lakes on the summits of ridges, he would not pretend to account for what he had not seen; but he cited similar lakes on the Grimsel, which presented similar phenomena, and which he regarded as undoubtedly due to glacier action. Even on the top of *roches moutonnées* such basins were found; and though he might not know the exact circumstances under which they were formed, they were undoubtedly due to ice-action. If in Switzerland and other glaciated countries of the present day we find the configuration of the country presenting similar phenomena to those of Scotland, he considered that there was ample ground for attributing both to the same cause, and there was no need of invoking other causes. It was moreover to be borne in mind that though similar contorted gneissose rocks to those of Scotland occurred in several other countries, it was only in those which had been glaciated that such numerous lake-basins were to be seen.

The DUKE OF ARGYLL, in reply, agreed with Prof. Ramsay that it was not in all cases that the lake-basins were due to disturbance of the rocks; and indeed in some of the most contorted districts lakes were rarely present. All his contention was that whatever may have been the denuding agent, it was not in all cases ice.

2. DESCRIPTION of the SKULL of a DENTIGEROUS BIRD (ODONTOPTERYX*
TOLLIAPICUS, OW.) from the LONDON CLAY of SHEPPEY. By Professor
OWEN, F.R.S., F.G.S., &c.

[PLATES XVI. & XVII.]

AMONGST the additions to appear in the second edition of my 'British Fossil Mammals and Birds' I have anticipated the descriptions of certain species, as in the case of the gigantic Eocene bird, equalling in size the larger New-Zealand Moas†. The still more remarkable Ornitholite, also from Sheppey, which I am now about to describe, has stronger claims to be made known, without delay, on account of the transitional character which it manifests to the Pterosaurian order.

The fossil consists of a large portion of the skull, which, when the specimen was received in the British Museum, was more or less imbedded in the London Clay; the clearing out of the matrix by the

* Gr. *ὀδούς*, tooth; *πτερόν*, wing of bird.

† *Dasornis londinensis*, Trans. Zool. Soc. vol. vii. p. 145, pl. 16.

careful and skilful hands of Mr. Davies, Senior Attendant in the "Geological Department," brought to light the tooth-like processes of the alveolar borders of both upper and lower jaws, to which the uniqueness of this Eocene fossil is due; but the distinctive cranial characters of the warm-blooded feathered vertebrate are unmistakable.

The well-developed brain, expanding transversely in its posteriorly placed box (Pl. XVI. figs. 1-4, 3, 7, 11), making the base of a long cranial cone gradually tapering forward, the capacious lateral orbits (*ib.* figs. 1, 2, 4, 9, 10), and the single hemispheroid condyle (*ib.* fig. 3, 1) are avian: the large and long, freely articulated, dependent tympanic bone (*ib.* figs. 1, 2, 3, 28), the slender, straight and styloform zygomatic bar (*ib.* figs. 1 & 2, 26) received behind into the articular cup of the tympanic (*ib.* figs. 1 & 3, 4)—all the modifications, in short, that relate to the free and characteristic movements of the beak—are likewise here present.

Nothing in the fossil, at first apparent, could have led to a suspicion of the significant and well-marked modification of the mandibles which has suggested the generic name I have proposed for this extinct Eocene bird.

The occipital region (Pl. XVI. fig. 3) is broader than it is high; the occipital foramen (*ib.* ∞) partakes of the same proportion; the transverse diameter also exceeds in the condyle (*ib.* 1), of which hemisphere the upper part is truncate. The upper border of the foramen, through the posterior swelling of the cerebellum, slightly overhangs the condyle. The cerebellar protuberance (*ib.* 3) seems to have had a vertical median ridge, as it shows the broken or worn base of such a prominence. On each side of the cerebellar protuberance the occipital surface is smooth and moderately concave across; it is, in a less degree, convex vertically, until it bends in below to the upper border of the occipital foramen. The beginning of the subvertical exoccipital prominence (*ib.* 2), passing obliquely from near the side of the foramen magnum to the paroccipital wall (fig. 1, 4) of the tympanic cavity, is preserved; but the paroccipital itself is broken away. The upper transverse occipital ridge, low and linear, arches outward from the top of the vertical ridge (fig. 3, α, π) on each side down to the broken base of the paroccipital.

The depth (vertical diameter) of the occiput to the lower border of the condyle is $10\frac{1}{2}$ lines (0.022 m.), to the upper border of the occipital foramen $6\frac{1}{2}$ lines (0.015 m.); the extreme breadth (transverse diameter) of the occiput is 1 inch 3 lines (0.032 m.); the transverse diameter of the occipital foramen is 4 lines (0.008 m.).

The portion of the atlas (Pl. XVI. fig. 3, σ) preserved, as dislocated from the condyle below the foramen magnum, closely conforms to the avian type of that vertebra.

The parietal region (*ib.* figs. 1, 2, 3, 4, τ) slightly rises as it advances from the superoccipital ridge to the interval between the postorbitals, when the frontal surface passes forward with a slight convex curve to between the large orbits, and gradually sinks as it goes straight to the transverse fronto-nasal suture (*ib.* fig. 4, δ, η). The

parietal region (*ib.* 7) is smooth, transversely arched, and feebly impressed by the upper part of the crotaphyte fossa (figs. 1 & 2, *) opposite the middle of the occipital region.

The breadth of the cranium here is 1 inch 9 lines (0.045 m.); the length from the lateral occipital ridge to the hind margin of the orbit is $7\frac{1}{2}$ lines (0.016 m.). If a transversely curved fracture of the upper part of the cranium had coincided with a coronal (fronto-parietal) harmonia, the fore and aft extent of the coalesced parietals at their median (sagittal) suture would be $5\frac{1}{2}$ lines (0.012 m.). It is singular that a second fracture of the cranial roof should have commenced behind where the interfrontal suture terminated, and have extended forward to opposite the middle of the orbit; but this fracture soon quits the median line and inclines to the right; it is also complicated with a shorter posterior fracture starting from the transverse one simulating the coronal suture, but which curves unsymmetrically more forward on the left than on the right side.

The frontals, moderately convex transversely at their back part, become flat and then slightly concave in that direction as far as the fronto-nasal suture (Pl. XVI. fig. 4, 11, *f*, *n*); this is not a fracture, or but partially so at its outer ends.

The length of the frontal part of the cranium is 2 inches (0.050 m.); the least breadth of the interorbital tract is nearly 6 lines (0.012 m.); the extent of the frontal suture is 9 lines (0.020 m.). The antorbital process of the lacrymal (fig. 2, 73) is less mutilated on the left side of the fossil, which gives an appreciable idea of its size and shape.

Both fore and hind boundaries of the orbits (Pl. XVI. figs. 1, 2, 4, *o*) are partially broken away; but the antero-posterior diameter of those cavities seems to have been 1 inch 2 lines (0.030 m.); the vertical diameter is 1 inch 1 line (0.027 m.); they are of an oval form, with the small end forward. There is no trace of a depression for a superorbital gland; the upper border of the eye-chamber is thin, not to say sharp.

In the basal portion of the upper mandible here preserved (figs. 1, 2, 4, 15, 21, 22) there is no remaining trace of suture to mark the boundaries of the nasal, premaxillary, or maxillary bones.

An upper tract (fig. 4, 15), flattened at its hind part, is defined by two obtuse linear risings converging from the ends of the fronto-nasal suture rapidly, then bending forward, broadening and converging gradually till lost in a median transverse convex ridge or tract (22), 2 lines (0.004 m.) broad at the anterior fracture; the breadth of this mid tract, where flat, at the beginning of the lines of minor convergence, is 4 lines (0.008 m.).

The sides of the base of the upper mandible slope outward as they descend to a longitudinal groove (figs. 1 & 2, *g*), with a slight curve concave downward, below which the upper jaw-bone descends vertically to the alveolar border.

The extent, lengthwise, of the upper beak-bone here preserved is, on the left side (fig. 2), from the end of the fronto-nasal suture, 1 inch 6 lines (0.037 m.), on the right side (fig. 1) 1 inch 1 line (0.027 m.); the vertical diameter of the base is 9 lines (0.020 m.),

at the fractured end $7\frac{1}{2}$ lines (0·017 m.); the transverse diameter of the base, at the parallel of the fronto-nasal suture and at the alveolar borders, is 1 inch (0·025 m.), at the fractured end 9 lines (0·018 m.).

From the gradual loss of dimensions in the basal extent of the bony upper mandible here preserved, I estimate that the length of the beak from the fronto-nasal suture must have exceeded that (2 inches 5 lines) of the skull behind such suture, and that the total length of skull of *Odontopteryx* could not have been less than between 5 and 6 inches (see 'restoration' proposed in Pl. XVI. figs. 7 & 8). There is no trace of external nostril in the preserved extent (1 inch) of the upper beak-bone; a notch (Pl. XVI. fig. 2, *n*) at the fractured fore border, left side, may be part of such; but it is narrow, and is like a similar notch and obvious fracture situated further back, on the right side of the fossil. The malar zygoma (Pl. XVI. figs. 1, 2, 4, 26) is continued from the sublacrymal part (fig. 2, 73) of the base of the beak above the longitudinal lateral groove; below that groove the upper jaw appears to have terminated behind in a short free point (fig. 2, 21); but such, if it existed, has been broken away on both sides. The groove reappears on the zygoma, and indents the middle of its outer surface; the least vertical diameter, beneath the middle of the orbit, of the zygoma, is $2\frac{1}{2}$ lines (0·004 $\frac{1}{2}$ m.); toward the fore part of the orbit this diameter gradually augments; but the bone is broken away at the junction with the lacrymal, together with the lower part of that bone (fig. 2, 73); its conjunction and seeming continuation with the base of the upper beak-bone, above the longitudinal groove, is preserved. From this part, on the parallel of the fronto-nasal suture, an extent of 1 inch 5 lines (0·036 m.) of the left zygoma is preserved, and nearly as much of the right zygoma; both appendages diverge with a slight downward slope toward the zygomatic cup (*λ*) at the outer border of the tympanic (28) above its mandibular condyles.

The tympanic is preserved in its natural articulation with the mastoid on the right side (Pl. XVI. figs. 1 & 3, 28): it is $9\frac{1}{2}$ lines in length (0·020 m.), 3 lines (0·006 m.) in least breadth, $7\frac{1}{2}$ lines (0·015 m.) in greatest breadth at the lower articular end, including the zygomatic cup (*ib.* *λ*). Of the two condyles there, the outer one (fig. 3, 28 *i*) is a transversely extended convexity, the inner one (*ib.* *k*) is a narrower ridge-like convexity directed obliquely from behind inward and forward, where it slightly expands; a transversely concave groove or channel, in a similar oblique course, divides the condyles. A groove of a line breadth divides the outer condyle from the zygomatic (tympano-squamosal) cup (*ib.* *λ*). The shaft of the tympanic is triedral, with one margin slightly rounded, turned outward, another inward or mesiad (fig. 3 28), and with the anterior and internal sides converging upon, and extended into, the orbital process (fig. 1, *i*). The zygomatic cup is supported on a very short prominence, not produced forward so as to augment the fore and aft diameter of the distal end of the bone, which diameter is uniform and short in comparison with the transverse.

The articular end of each mandibular ramus (Pl. XVI. figs. 1 & 2, 30) is broken away: an impression on the matrix shows the vertical diameter of the ramus (fig. 8, 30), at the joint with the tympanic, to have been $4\frac{1}{2}$ lines (0·009 m.); in advance of this the preserved part rapidly gains depth and gives 8 lines (0·017 m.), where it is parallel (figs. 1, 2, 30, 31) with the fore border of the orbit. Here a fracture or suture runs from below upward and forward to beneath the hind point or end of the upper jaw (fig. 2, 21). If this be a suture, it divides the confluent angular (30), surangular (31), and articular elements from the combined splenial and dentary (fig. 2, 32). The latter element loses depth as it advances; the fore part is obliquely broken away nearly opposite the broken fore part of the upper jaw. The vertical diameter of the mandibular ramus is here reduced to 5 lines (0·010 m.); the portion of ramus preserved on the left side is 2 inches 5 lines (0·060 m.) in length; on the right side a corresponding portion of the ramus is preserved, 2 inches 2 lines in length, but with more of the lower border broken away. The course of what remains of the boundary between the dentary (fig. 1, 32) and hinder part (*ib.* 31) of the ramus corresponds so closely with that of the left ramus (fig. 2) as to add to the probability that it is a retained suture, or a yielding of the ramus along the line of, perhaps, a partially ossified suture.

The upper border of the mandible beneath the zygoma is moderately convex toward the orbit, but not partially produced as a coronoid process; the ramus here is thin transversely in proportion to its depth, its thickness not exceeding 2 lines.

The upper two thirds of the outer surface of this part of the mandible is feebly convex vertically, and is divided by a ridge due to the subsidence of the flat lower third part of the outer surface. The line of this ridge or subsidence slightly ascends to the suture with the dentary. From the part of the suture where such line terminates, a groove (Pl. XVI. fig. 2, *f*) begins, which traverses the outer surface of the dentary almost parallel with the alveolar border, and at 4 or 5 lines below it; the part of the outer surface of the dentary above the groove is rather more prominent than that below the groove.

The outer surface of both upper and lower beak-bones is sculptured by fine, irregular, subreticulate, seemingly vascular, linear impressions and foramina.

The alveolar border of the preserved hind part of the upper jaw-bone, an inch in extent on the right side (Pl. XVI. fig. 1), is produced into nine tooth-shaped processes, conical, subcompressed, sharp-pointed, slightly inclined forward. A view of this part of the skull, twice the natural size, is given in fig. 5. The hindmost tooth preserved is but a quarter of a line long, the next is about half a line in length, the third in advance is a little longer, the fourth a little shorter; the fifth (*ib.* *ib.* *a*) suddenly increases to a cone or triangle, $2\frac{1}{2}$ lines along its longer (hinder) side, 2 lines along its shorter (fore) side, and nearly as long across the base, which is confluent with the jaw. The alveolar border swells slightly where it forms

the dental base; the outer side of the tooth is sculptured like the rest of the bone, but in a less or finer degree (see the magnified view, fig. 5, *a*). At rather less than a line in advance of this tooth is a minute one like the fourth; in advance of this is the base of a larger denticle (*ib. b*), the fracture of which shows a cavity filled by pyritic matrix; and at a line in advance of this is the fractured hollow base of a smaller denticle: these hollows might at first sight be mistaken for sockets.

The alveolar border of the left side of the upper jaw (Pl. XVI. fig. 2, & fig. 6, magnified two diameters), continued further forward than that of the right side, shows, at a part wanting on the right side, a more advanced tooth (*c*), of the same shape as the fifth (*a*) from the hindmost on the right side, but somewhat larger; its apex is more obtuse and seems to have been worn. This tooth is also a direct continuation of the bone, with the osseous sculpturing more feebly marked than on the jaw, the tooth appearing smooth to the naked eye. The bases of two smaller denticles appear in the 3 lines extent of alveolar border in advance of this tooth.

Thus we have evidence of about twelve of the maxillary teeth or tooth-like processes—two large, divided by an interval of about half an inch, the rest small or minute—all compressed, triangular, pointed, arming the hinder inch and a half of the alveolar border on each side of the upper jaw.

This dental character is more distinctly displayed in the corresponding parts of the alveolar border of the lower jaw. On the right side (Pl. XVI. fig. 1), in an extent of 8 lines from the suture of the dentary (32) with the surangular (31), are five denticles (fig. 5, magn. 2 diameters): the hindmost is as minute as the one above; the next is somewhat larger; the third (*a*) is much larger, though not so large as the fifth (*a*) above, behind which the point of the third below projects. The fourth tooth below (counting forwards) is minute, the fifth (*c*) suddenly enlarged, especially in length, to 3 lines, with a breadth of base of 1 line; it is sharp-pointed, directed obliquely upward and forward. These teeth are processes of the bone; and the outward markings are strongest near the apex.

In the left dentary (Pl. XVI. fig. 2 & fig. 6, magn. 2 diams.), along an inch extent of the hind part of the alveolar border, are three of the larger laniariform teeth (*ib. ib. d. e. f.*), divided by intervals of from 3 to 4 lines, in which are minute denticles.

The lower laniaries are longer and more slender than the upper ones; they are similarly directed, with their summits slightly inclined forward.

On an estimate of the extent of the dentigerous borders of the jaws at 3 inches, and a conjecture that the larger teeth were continued at the same intervals (as shown in the fossil) to the ends of the restored jaws, there would be ten of these teeth on each side of both upper and lower mandibles; the intervening denticles would be about double that number (see conjectural restoration, fig. 8, Pl. XVI.).

The strictly avian character of the skull, on which this quasi-

reptilian one is grafted, shows profitable comparisons to be within the limits of the feathered class. The inference which has been drawn as to the length of the beak leads us first to compare *Odontopteryx* with those birds in which that part also exceeds in length the rest of the skull, which latter portion, bounded in front by the fronto-nasal suture, I shall speak of in the ensuing comparisons as the "cranium."

Such character is exceptional in the *Aves aereæ* and *Aves terrestres* of Nitzsch. The Hornbills, Toucans, a few Crows, certain Woodpeckers, Kingfishers, Cuckoos, Humming-birds, Kivis, Ostriches, manifest it, but with well-marked differential characters pointing to another road, for the closer affinity of which we are in quest.

A beak longer than the cranium is the rule in the *Aves aquaticæ*; but not any of the waders has the external nostrils so remote from the orbits as in *Odontopteryx*. This character of the fossil confines one to the Totipalmates and tubinarian Longipennates; but the Petrels, like the Albatrosses, Gulls, Terns, and Skimmers have other well-marked characters which remove them from the present extinct genus.

Indeed, the absence of the superorbital gland-pit in *Odontopteryx* limits the field of comparison to the Totipalmates and Lamellirostrals, in which, however, the Swan (*Cygnus olor*) and some Geese (*Cereopsis*) and Teal show traces, more or less definite, of the impression of such gland above and behind the rim of the orbit. There is no such trace in the Cormorants, Anhingas, and Gannets; and it is in these fish-eating sea-birds that an extent of upper beak-bone, free from narial vacuities, would be found corresponding with that which is preserved in the Sheppey fossil. But the Totipalmates have not the orbit bounded by a hind wall as in *Odontopteryx*; the super-orbital border is abruptly truncate behind by a wide and deep crotaphyte fossa, which in the Cormorant and Gannet ascends so as almost to meet its fellow upon the parietal region of the cranium.

In *Odontopteryx*, the parietal region is broadly and smoothly arched (Pl. XVI. fig. 4, 7); and the crotaphyte fossa (Pl. XVI. figs. 1, 2, *), very shallow, commences low down at the side of the arch (fig. 1, *), very little above the level of the foramen magnum. Now this is the character of the fossa in certain *Anatidæ*, the Goose (*Anser palustris*) e. g.; and in this family, also, the orbital wall is continued down the back part of the cavity as in *Odontopteryx*, but is there produced forward as a strong process, which seems not to have existed in the fossil. The hinder half, however, of the external nostril would have appeared in the base of the beak preserved in the fossil, if the bird it represents had partaken of the narial characters of the Lamellirostrals.

In most of these water-birds the coronoid border of the mandible is raised into a definable process; and where, as in *Mergus*, this is not the case, the outstanding tubercle is present, of which there is no trace in *Odontopteryx*, as there is none in the Totipalmates.

The hind half of the mandibular ramus resembles in its depth and thinness that part of the lower jaw of the Lamellirostrals more

than it does the same part in the Totipalmates, where it is thicker and shallower.

The outer surface of the dentary is divided into an upper and lower tract in Swans and Geese by a groove which, beginning near the trace of the suture with the angular and surangular elements, curves feebly downwards as it advances forward: *Cygnus Ruppelli*, in this character, nearly repeats that in *Odontopteryx*.

The upper beak-bone in *Anatidæ* does not show the longitudinal groove which impresses it in *Odontopteryx*. But this groove is present in *Sula* and *Phalacrocorax*. It commences behind, in these sea-birds, a little in advance of the outer end of the naso-frontal suture, and extends straight forward, about midway between the upper and lower borders of the upper beak, to near its pointed termination. The groove (Pl. XVI. figs. 1 & 2, *g*) has the same relative position on the sides of the upper beak in *Odontopteryx*; but it begins below the fore part of the zygoma, and rises with a curve convex upward, to midway between the upper and lower borders of the maxilla, along which it then runs straight as far as that bone is preserved.

The upper part of the upper beak in *Sula* is broad and arched at its base, the transverse convexity being more marked as the beak narrows and advances. In *Odontopteryx* an upper tract is pinched off, so to speak, from the sides, flattened above at first, and becoming transversely convex as it narrows and advances, the sides of the beak below this tract being transversely concave in a feeble degree before attaining the groove (*g*). This upper median raised tract recalls the more strongly developed one in *Procellaria*, and suggests the possibility of its having been prolonged, in *Odontopteryx*, to terminate forward, as in Petrels, in the outer opening of the tubular nostrils; but the mutilation of the beak in the fossil leaves this point purely conjectural; and in all other comparable characters of the skull the resemblances are found with the Lamellirostrals and Totipalmates, not with the Longipennate sea-birds.

Another character approximates the fossil to *Sula*; there is no trace of a mid notch at the fore part of the frontal, into which, in *Anser palustris*, the end of the nasal branch of the premaxillary is produced; the transverse fronto-nasal suture abruptly defines the cranium from the beak in *Odontopteryx*, as in the Totipalmates. But the transverse contraction of the interorbital part of the frontal is more considerable in the fossil, and the hind part of the nasopremaxillary tract is flatter, with other differences from the Gannets and Cormorants already noticed.

Thus *Odontopteryx*, independently of its teeth, shows, in the unique fossil representing the genus, its distinctness from all known existing genera of birds.

Of the species which have the bill armed with tooth-like processes, the enumeration is easy. The true Falcons have the single "tooth" on each side of the upper jaw; a like armature of the beak of the Butcher birds has suggested the term "dentiostres" for the tribe of Passerines including the *Laniidæ*. The male of one genus

of Humming-bird has the same character, whence the name "*Andrododon*." The Dodlet (*Dulunculus*), of the Samoan Isles, has been called the "tooth-billed Pigeon," because of the notches leaving three pointed horny processes in the sheath of the lower bill, beneath and just behind the hook-like production at the end of the upper one. The alveolar borders of the bill in *Anatidæ* and *Phænicopteridæ* are notched by transversely set laminae: and these are produced and pointed in their fish-catching allies, the Goosanders and Mergansers.

But in all these cases the "teeth" of the ornithologist or "tooth-like processes" are horny, are confined to the sheath of the bill, and *there are no corresponding productions of the supporting bone*, the alveolar borders of which are even, or but minutely indicative of the horny teeth. It is true, as Geoffroy St.-Hilaire first pointed out, the beginnings of the horny sheath are due in some birds (Parrots, *e.g.*) to detached papillæ occupying shallow cavities of the borders simulating sockets; but the primitive tubercles run into each other, and are ultimately confluent with the beak-sheath*.

Perhaps a nearer approach to a dental structure is made where the hardening salts are in such excess as to give the sheath the character of ivory, welded to the bone, as in some Woodpeckers.

The production of the alveolar border into bony tooth-like processes is peculiar, according to my present observation of birds, to *Odontopteryx*. The closest repetition of this structure which I have yet seen is in the Australian Hooded Lizard (*Chlamydosaurus*); but the teeth are small, save the two at the fore part of each upper jaw and the single one at the same part of each mandibular ramus. The smaller teeth are so closely confluent with the alveolar border of both jaws as to seem to be processes: the larger anteriorly terminal teeth, though ankylosed to the bone, have their base defined by a ridge, suggesting the outlet of a socket, which is best marked in the lower jaw. All these teeth are tipped or capped with hard dentine; but such is not the case with the bony tooth-like processes in *Odontopteryx*. These seem, moreover, to have been sheathed with horn, or to have supported tooth-like processes of the horny beak; and their outer surface shows, though more feebly marked, the linear and punctate indentations relating to the vascular attachment of the horny to the bony beak. There is no trace of alveoli, although the cavity in the base of what seems to be a broken-off tooth at the fore part of the right upper jaw might be mistaken for one. I have not been able to detect, by application of lenses of any available power to the teeth *in situ*, any indication of a dentinal cap or apex.

After having myself outlined the drawings (which were finished as in figs. 1-6, Pl. XVI., with the care and accuracy characteristic of the accomplished artist, Mr. Griesbach) I had a mould and cast taken of the unique fossil to represent its original condition, and then selected the dental process which seemed best to promise evidence of tooth-structure.

Of this tooth (Pl. XVI. figs. 1 & 5, *e*) a longitudinal slice was taken (as in Pl. XVII. fig. 1) and laid, with some loss of the apex, upon a

* *Anat. of Vertebrates*, ii. p. 145.

glass slide. It showed large vacuities, especially at the attached base, filled with pyritic matter; and in the body of the tooth this matter occupied and demonstrated part of the vascular canals. These show chiefly a longitudinal course (Pl. XVII. fig. 1, *a*), or in the direction of the tooth's axis, united by short cross branches of minor diameter (*b*), including oblong spaces (*c*). The general arrangement being thus reticulate as in bone, the vascular substance not having filled a basal conical cavity, like the dentinal pulp of a true tooth, a large proportion of the osseous tissue of the process was preserved, showing, under a magnifying power of 250 diameters (fig. 2), the bone-cells. These have the proportions of length and breadth characteristic of the bones of birds, and also of Pterodactyles. Many of the bone-cells were in the direction of the long axis of the process, as at *a, a* (fig. 2), and averaged in length $\frac{1}{300}$ of an inch; others, nearer the vascular canals, were arranged in a direction at right angles to the long axis of the process, as at *b, b*, *ib.*: these indicated a short or transverse diameter of the cell of $\frac{1}{300}$ of an inch. The canaliculi from the bone-cells were obliterated. Thus the microscopic test, in the degree in which I have been enabled to apply it, shows the osseous characters of the tooth-like processes, and adds to the probability of the conclusion drawn from the external vascular markings, that they were sheathed by hollow processes of the horny beak in the living bird.

With the exception of the better-preserved canaliculi in the microscopic sections of the bone-tissue of a fossil femur of a bird from Sheppey, figured by Quekett*, the size and shape of the bone-cells are much alike in that and the present fossil from the same formation and locality.

I conclude therefore that *Odontopteryx*, like *Archæopteryx*, was a warm-blooded feathered biped, with wings, and, further, that it was web-footed and a fish-eater, and that in the catching of its slippery prey it was assisted by this pterosaurioid armature of its jaws.

The cretaceous fossil skull, affirmed by Professor O. C. Marsh to be that of a bird with teeth, and which he proposes as the type of a genus under the name *Ichthyornis*, also of an order which he calls "*Ichthyornithes*," and of a new subclass of birds under the name "ODONTORNITHES" or "*Aves dentatæ*"†, differs from the Sheppey fossil in having "the eyes placed well forwards," in having "the lower jaw long and slender," in having "the teeth quite numerous and implanted in distinct sockets," and in the size and shape of such teeth. They are described as being "small, compressed, and pointed, and all alike," or "similar." "Those in the lower jaw number about twenty in each ramus, and are all more or less inclined backward." "The maxillary teeth appear to have been equally numerous and essentially the same as those of the mandible"‡.

* 'Histological Catalogue,' Museum of the Royal College of Surgeons, &c. 4to, vol. ii. plate x. figs. 34, 36.

† American Journal of Science and Arts, vol. v. 8vo, February 1873.

‡ *Id. ib.*

ODONTOPTERYX TOLIAPICUS.

Fig. 1.

Fig. 2.

D. Blair. del.

H. Ernst. imp.

C. Griesbach. lith.

CONDYPTERYX POLIAPICUS.
Mendocino Tooth.

When we are favoured with the description and figures of the *Odontornithes* by their accomplished discoverer we shall possess grounds for judging of the ordinal and higher relations of affinity between the Eocene toothed bird and the Cretaceous *Ichthyornis*. But the indications already vouchsafed by that active and indefatigable palæontologist suffice for an opinion of their specific and generic distinctness.

*Odontopteryx** has the orbits well within the limits of the hinder half of the skull; the lower jaw, though no doubt "long," has the rami too deep to bear the term "slender;" the teeth are separated by spaces which would not permit of their being reckoned as "quite numerous;" they are not implanted in sockets, but are represented by alveolar processes of the bone. It is true that some of them are "small," and all are "compressed and pointed;" but they are not "all similar" in respect of size: one, two, or three small teeth are interposed to the single, widely separated, large laniaries; finally, all the preserved teeth of *Odontopteryx* incline more or less forward instead of "backward."

EXPLANATION OF PLATES XVI. & XVII.

PLATE XVI.

- Fig. 1. Right-side view of the preserved part of the skull of *Odontopteryx toliapicus*, Ow.
2. Left-side view of do. do.
3. Hind or occipital surface, with right tympanic bone: *v*, portion of atlas.
4. Upper view of the preserved part of the skull of *Odontopteryx toliapicus*, Ow.

The above figures are of the natural size.

5. Preserved dentigerous parts of right side of both jaws; twice the natural size.
6. Preserved dentigerous parts of left side of both jaws; twice the natural size.
7. Outline of entire skull, conjecturally restored, from above.
8. Outline of entire skull, conjecturally restored, from the right side.

PLATE XVII.

- Fig. 1. View of a longitudinal section of the denticle, magnified 35 diameters and reduced one half.
2. View of a portion of the same section, magnified 250 diameters and reduced one half.

DISCUSSION.

Mr. SEELEY had given much study to the Pterosaurians, to which the author had indicated the affinities of *Odontopteryx*. He had in *Ornithocheirus Oweni* found what appeared to be identical structure with that of the bird; and it therefore appeared to form a new genus of Pterosaurians. Both in the frontal and occipital regions of the skull he recognized affinities to *Ornithocheirus*; but it presented even more distinctly marked reptilian affinities. The position of the brain was also quite as far back in the skull; and the quadrate bone also presented curious analogies, so much so as to be almost identical.

* I should have preferred the term *Odontornis* for my genus; but it is bespoken for Marsh's subclass.

The sutures presented characters similar to those exhibited by immature birds; and he thought that the separation of the bones in this example showed affinities to the anserine type. He was quite prepared to regard the fossil as that of a bird rather than of an Ornithosaurian. He inquired as to the character of the palatal bones.

Mr. CHARLESWORTH inquired as to the light in which this discovery would be regarded by evolutionists.

Prof. OWEN briefly replied.

3. CONTRIBUTION to the ANATOMY of HYPsilOPHODON FOXII. An ACCOUNT of some recently acquired REMAINS. By J. W. HULKE, Esq., F.R.S., F.G.S.

[PLATE XVIII.]

IN 1849 a block of sandstone containing a considerable portion of a reptilian skeleton was found by some labourers on the south-west shore of the Isle of Wight, near Cowleaze Chine. It was broken in two; and one piece passed into the collection of the late Dr. G. Mantell, the other into that of Mr. Bowerbank. Subsequently both pieces were acquired by the British Museum and reunited. Thus completed, the slab exhibits a continuous chain of some 18 presacral vertebræ, succeeded by the right ilium, the middle of which is crushed and hidden by an imperfect metatarsus. Below this are some long slender bones, which have received different interpretations from distinguished anatomists; and behind these are the left femur and a series of 12 caudal vertebræ. In 1855 a description of this fossil, illustrated by a plate, was given by Professor Owen, in his 'Fossil Reptiles of the Wealden Formations' (vol. 1855, Older Dinosauria, p. 2), where it is entitled "Part of the Skeleton of a young *Iguanodon*, *I. Mantelli*,"—a conclusion towards which the weight of evidence then seemed to incline. In 1867 Prof. Huxley, from a comparison of its vertebræ with those of *Iguanodon*, and from the presence of four metatarsals in the pes, concluded its generic distinctness from *Iguanodon Mantelli*; and in 1870 he made it the subject of a communication to this Society. Prof. Huxley prefaced this paper by a detailed description of a small reptilian skull discovered by the Rev. W. Fox in the same stratum from which the Mantell-Bowerbank fossil had been obtained. It had been previously exhibited by Mr. F. Fellows for Mr. Fox, at the Norwich Meeting of the British Association, 1868, when Mr. Huxley drew attention to the remarkable facts that the teeth contained in the posterior moiety of the pramaxilla were quite different in shape from the maxillary teeth, and that the anterior moiety of the pramaxilla was beak-like and edentulous. The maxillary teeth, though presenting a general resemblance to those of *Iguanodon*, at the same stage of wear, yet appeared, on close examination, so distinct as not to leave any doubt of the generic distinctness of this reptile; and Mr. Huxley proposed for it the generic name *Hypsilophodon*, and called the species *H. Foxii*, after its fortunate discoverer. The preservation of a vertebral