12 Alban Doran, Esq. &c. &c.

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with the Author's compts.

DESCRIPTION

OF THE

SKULL OF A DENTIGEROUS BIRD

(*ODONTOPTERYX* TOLIAPICUS*, 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; πτέρυξ, 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, o, o), 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 styliform zygomatic bar (*ib.* figs. 1 & 2, 26) received behind into the articular cup of the tympanic (*ib.* figs. 1 & 3, *k*)—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.* *m*) 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, *x*, *x*) 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 10½ lines (0·022 m.), to the upper border of the occipital foramen 6½ 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, *v*) 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, 7) 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, *f. n*). The parietal region (*ib.* 7) is smooth, transversely arched, and feebly impressed by the upper part of the crotaphyte fossa (figs. 1 & 2, *s*) 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 7½ 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 5½ 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 7½ 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 2½ lines (0·004½ 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 (*h*) 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 9½ lines in length (0·020 m.), 3 lines (0·006 m.) in least breadth, 7½ lines (0·015 m.) in greatest breadth at the lower articular end, including the zygomatic cup (*ib. h*). 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. h*). 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, *l*). 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 4½ 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, 2½ 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 hindermost 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 hindermost is as minute as the one above; the next is somewhat larger; the third (*d*) 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 (*e*) 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 tubinarial 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 superorbital 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, 8), very shallow, commences low down at the side of the arch (fig. 1, 8), 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 Ruppelii*, 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 naso-premaxillary 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 "dentirostres" for the tribe of Passerines including the *Laniidæ*. The male of one genus of Humming-bird has the same character, whence the name "*Androdon*." The Dodlet (*Didunculus*), 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 *Phœnicopteridæ* are notched by transversely set laminæ: 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 anchylosed 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 $\frac{1}{800}$ 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 $\frac{1}{3000}$ 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 pterosauroid 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.*

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.

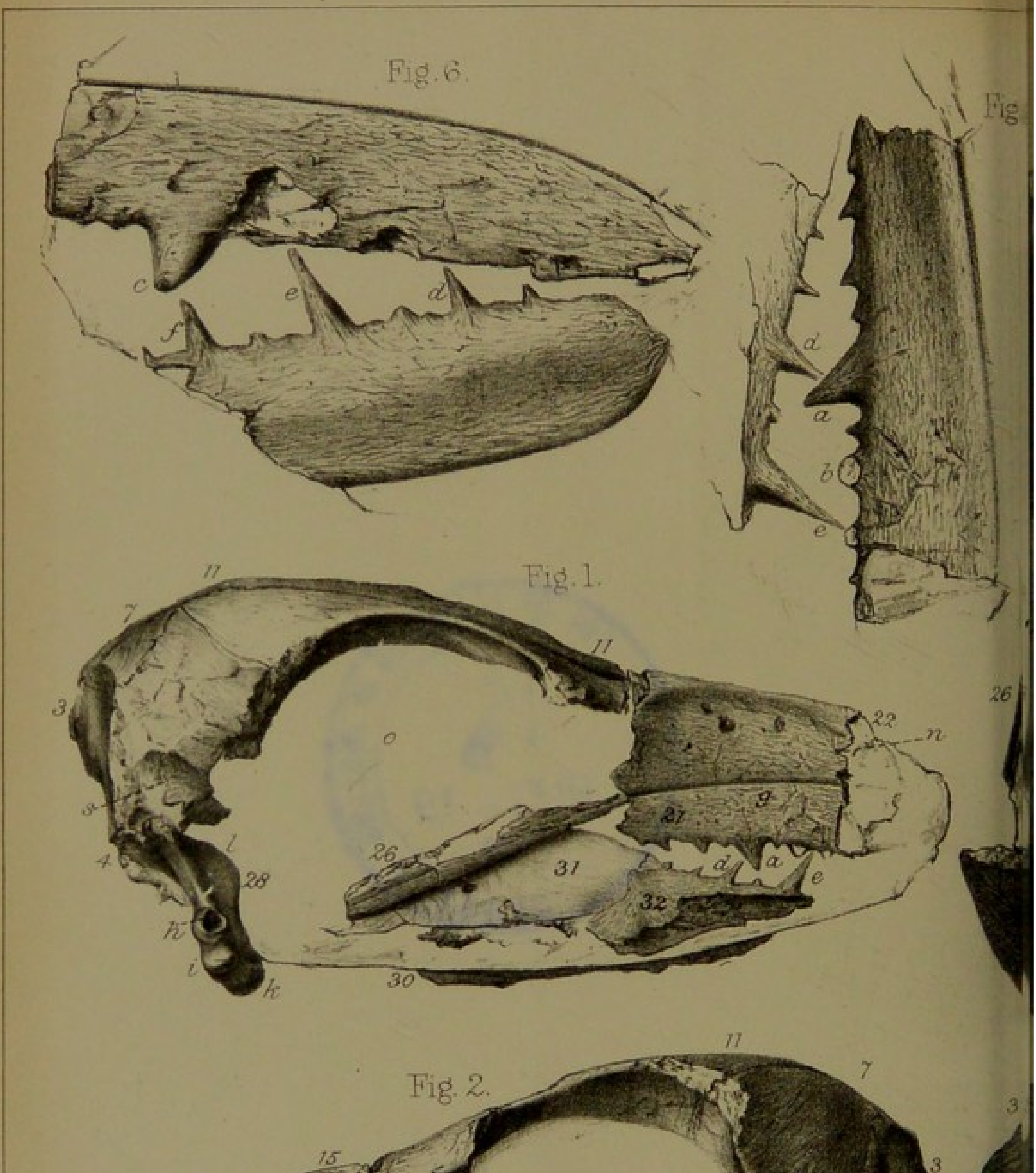
Mr. Seeley had given much study to the Pterosaurians, to which the author had indicated the affinities of *Odontopteryx*. He had in *Ornithocheirus Oweni* found what appeared to be identical structure with that of the bird; and it therefore appeared to form a new genus of Pterosaurians. Both in the frontal 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 bespoke 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.

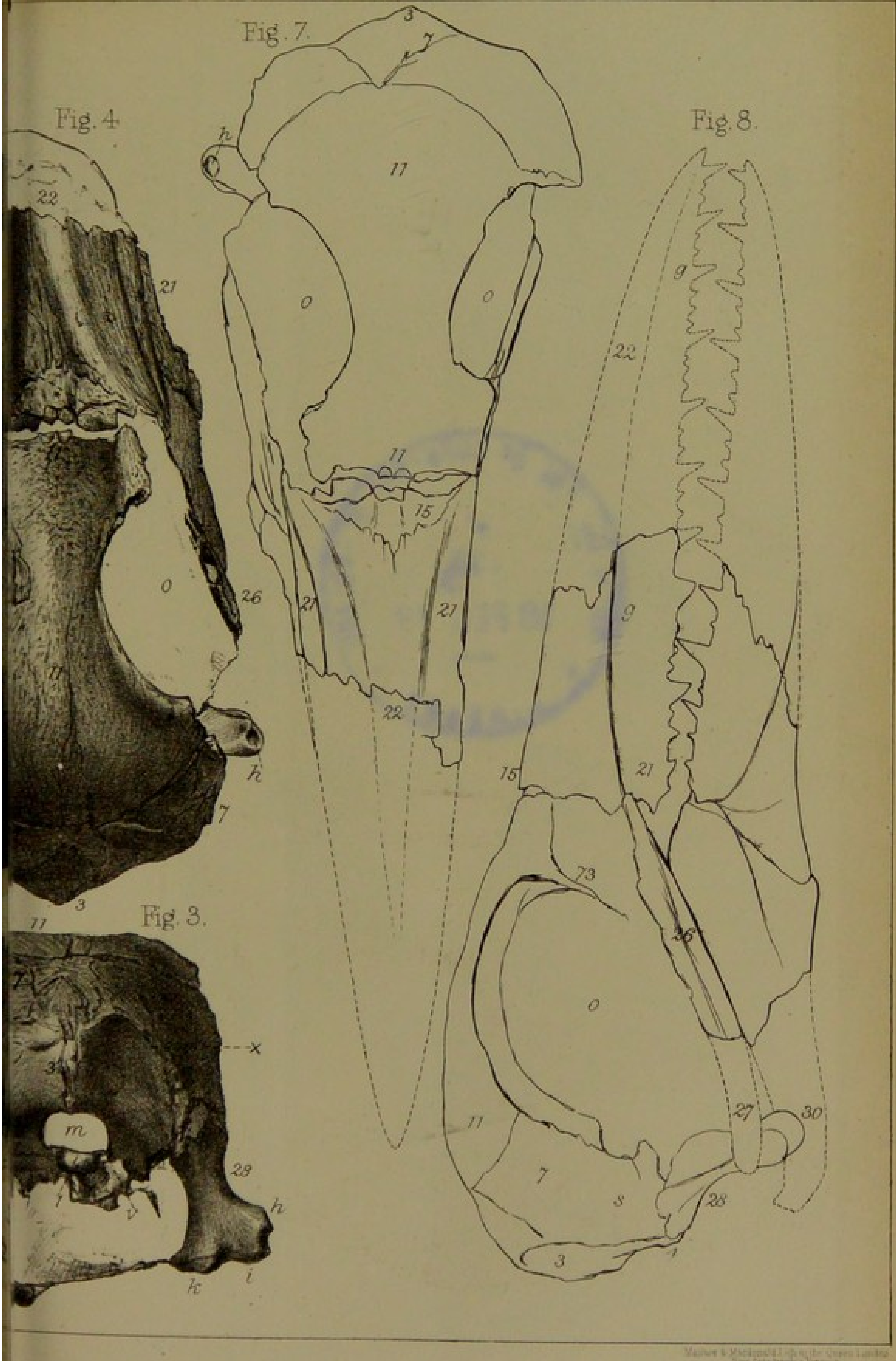
Mr. CHARLESWORTH inquired as to the light in which this discovery would be regarded by evolutionists.

Prof. OWEN briefly replied.



R.O.Del

ODONTOPTERY

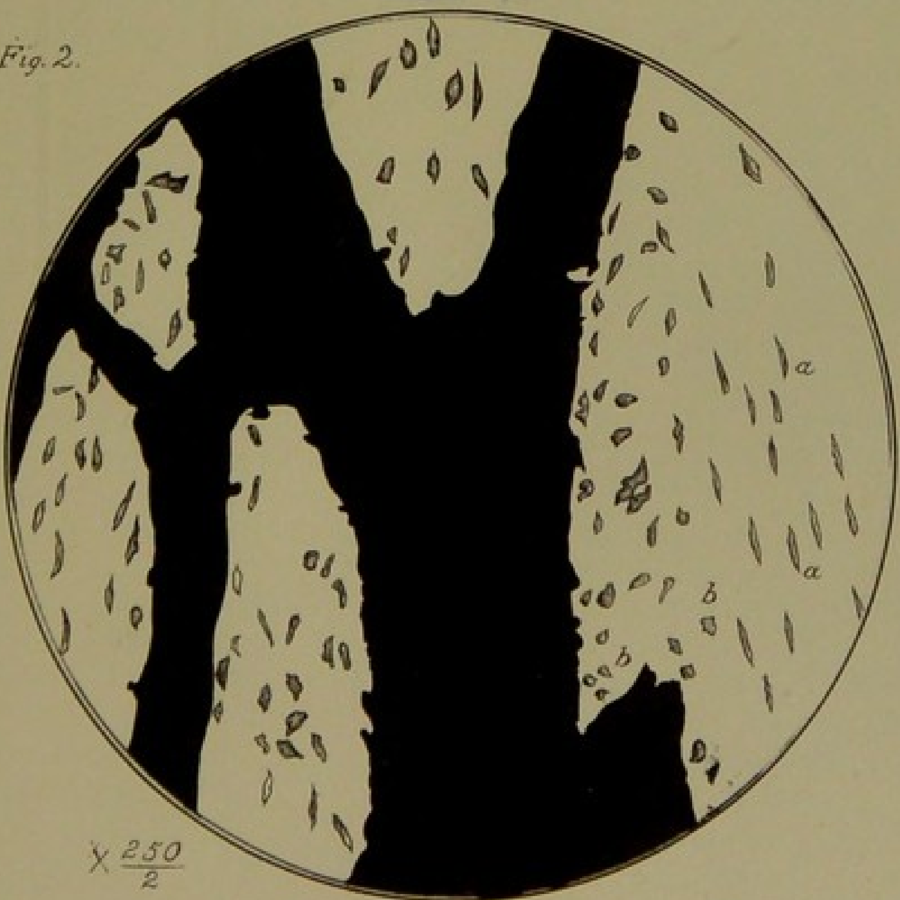


TOLIAPICUS.

Fig. 1.

× 35/2

Fig. 2.



× 250/2

D. Blair. del. | Hanhart. imp. | C. Griesbach. lith.

ODONTOPTERYX TOLIAPICUS.

Mandibular Tooth.

rately made. In the cists, those found in the chambered sepulchres were beautifully finished; the arrow-heads were exceedingly fine and delicate and of somewhat different shapes. The scrapers from the other chambered tomb were also very well made and of various shapes, so that I cannot suppose that "shape" had any thing to do with the period of deposit. The people seemed to have used any likely bit of flint; for we have found pieces of flint of no regular shape, but yet nicely chipped on the edges, and bearing marks of having been used. Those in the commoner cists are very rough, and seem to have been made for the occasion, for form's sake, hardly fit for use.

I should mention that *unburnt* cows' teeth are nearly always found in the cists, and in such positions as to show that they were placed there at the time of burial; they are not found among burnt bones of animals, as if a part of a funeral feast, but as a part of the ceremonial.

A lump of white quartz is another article nearly always found; the people here still use this for striking fire when flint cannot be obtained. The frequency of this gave us the impression of its being also a part of the ceremonial, perhaps an emblem of fire.

The urns do not vary much. One type is the commonest, in shape somewhat like an old-fashioned finger-glass; they are better baked and in better preservation than most of those found by Canon Greenwell. The roughest and the unusual shapes are found in solitary cists, without cairns, and one from a rough cist in a circle of earth.

Discussion.

Dr. Nicholas observed that the *menhirs* (long stones) described in the paper differed from those which he had examined in Brittany in one very striking respect; for, judging from the transverse sections given on the diagram-board, they had evidently been formed by human labour into a regular shape; and it was difficult even to imagine the amount of labour it required, with such tools as were then in use, and the hard materials to work upon, to bring those great masses of rock into any regular form. The menhirs of Brittany (he referred especially to that wonderful assemblage of them at and near Carnac) had been erected as they were found, as great boulders or masses of dislocated rock. No effort had been made to give them any uniformity of shape. But he observed on many of them certain striæ, which were not the effects of the action of glaciers or icebergs, but seemed to be the work of human hands. It was observable that this paper confirmed the conclusions of Dr. Lukis as to the sepulchral character of most of these gigantic monuments; but this was by no means inconsistent with the idea that they had also a religious significance.

Ordinary Meeting, Feb. 22nd, 1870.

Professor Huxley, LL.D., F.R.S., *President, in the Chair.*

New Member.—Edward Backhouse, Esq.

The following note was read by the author:—

XVIII. Supplementary Remarks *to a* Note *on an* Ancient Chinese Calva. By George Busk, Esq., F.R.S.

Since my former communication was read* I have been favoured through Mr. Mummery with some additional information on the subject of these prepared skulls from China, derived from Mr. W. Lockhart and Mr. Swinhoe, both authorities of the greatest weight in matters connected with Chinese customs.

In a letter to Mr. Mummery, Mr. Lockhart observes that he has been informed by his friend Mr. Wylie that the frontal letter is the Tibetan character for the vowel sound *a* as in *father*, and that it is also used as a numeral for thirty. The trefoil symbol he regards probably as an emblem of the Buddhist Trinity. Mr. Wylie is of opinion that the skull is of Mongol origin, and was taken from a lama temple near Peking.

Mr. Lockhart himself is acquainted only with the *lamas* among the Mongols and Tibetans at Peking; and says that the cadets of the families of the Mongol Princes are often made into *Lamas* or Priests, and retained at Peking in monasteries at the public expense as hostages for the fealty of the other members of the family.

As Mr. Wylie's opinion, above cited, appeared to cast some doubt upon the statement that the gold-mounted calva had been taken at the sack of the Summer Palace, I endeavoured to ascertain from Mr. Lockhart the probable grounds upon which it was founded, and he was good enough to procure from Mr. Swinhoe the following interesting particulars.

Mr. Swinhoe writes, "that when the British army was lying off the North Wall of Peking, the military train were housed in the 'Hih-Sze' (a Lama Temple). I went there," he says, "and saw in the inner shrine *two* of the gold-mounted *calvariæ* in question. Each was a skull of itself, without the lower jaw and the teeth of the upper. The skull was cut in two, so that the crown lifted off; and both the upper and lower portions of the skull thus divided were lined with gold. This temple was a purely Tibetian one, where the priests spoke no Chinese, and I could get no information from them. It was full of designs of skulls and bones on hanging cloths ranged round the Central Hall, and was filled with 'Avenging Gods;' and I was of the

* Journ. Ethn. Soc. vol. ii. p. 73.

opinion that the skulls were those of enemies slain by the Tibetans. The *calvariæ*, so far as I could learn, were used for pouring libations into the fire which was kept burning before the shrine*. I heard of other *calvariæ* being found in other parts of the same temple; but I myself only saw the two above mentioned. As soon was it as discovered that they were lined with the precious metal they became objects of theft and concealment, so that there was no seeing any more of them. I did not hear of any having been found in the 'Yuen-ming-yuen.' The gold-mounted ones would probably be the skulls of prominent enemies, whilst those lined with copper might be those of inferior chieftains."

From the above description of the two gold-mounted skulls seen by Mr. Swinhoe in the Buddhist temple, it would appear scarcely probable that either of them could have been that which was exhibited on the last occasion, and which consisted solely of the *calva* or upper portion of the skull. Consequently, if Mr. Swinhoe in his, perhaps hurried, view was not deceived in what he saw of the mounted skulls, and did not mistake the gold lid or cover for a second portion of the *calvaria*, it would appear that the Tibetan or Chinese Buddhists are in the habit of preparing skulls in two different manners. But it seems to me, in the absence of further evidence to the contrary, more probable that Mr. Swinhoe may have been deceived, and that the specimen exhibited in 1862 was in all probability one of those seen by him in the temple of "Hih-Sze."

Mr. Lockhart has also been kind enough to afford me the opportunity for exhibiting a second *calva* prepared in the same way as the former, and like that, as I am informed, mounted on a tripod stand and furnished with a lid. There is, however, this important difference, that the lining and rest of the mountings are of copper instead of gold, and that neither the metal nor the bone is sculptured. The skull itself in the present instance is rather larger and considerably thicker, and with stronger muscular impressions than the former one, but otherwise of the same shape and proportions.

The following paper was then read by the Assistant-Secretary:—

XIX. *On* Discoveries *in* Recent Deposits *in* Yorkshire. By C. Monkman, Esq.

The following paper contains a record of discoveries of the later prehistoric period in Yorkshire. The districts, lying

* This is in curious accordance with what Livy states respecting the *Boii.*

wide, are taken in separate sections, viz.—I. The Kelsea-Hill Clay; II. The York Sands; and, III. The Vale of Pickering.

I. *The Kelsea-Hill Clay.*

The discovery of "struck-off" flints, since 1864 (some of which show chipping and sign of use), in the clay of Kelsea Hill (then supposed to be the postglacial "Hessle" clay), in the East Riding of Yorkshire, has lately aroused considerable attention. The occurrence of the flint flakes and tools in this early clay was first observed by Mr. J. R. Mortimer, of Fimber; but it was not until midsummer of 1868 that a systematic search was instituted. In December of the same year I accompanied Mr. Mortimer to the place, and we were rewarded by the discovery of "hand-struck" flints, protruding from the clay at various depths. One implement was half of a "finger-flint" or "flaking-tool," chipped finely along the edges, and smoothed at the end by use (Pl. XV. fig. 1). This was picked down from the face of the clay cliff by Mr. Mortimer, who, as well as I, saw it protruding at a depth of fully five feet from the surface. This is the best chipped tool yet found, the remainder being cores, one of which shows seventeen facets (fig. 2); and struck-off flakes of all shapes, from the most delicate to the coarsest, some of which latter have been worked into "scrapers" (figs. 3, 4, 5). It is to be regretted that Kelsea Hill, near Keyingham, in Holderness, where the flints are found, is fast disappearing, the North-Eastern Railway Company's ballast-pit being there. The flints have become rare, the main yielding site having been already taken away.

The "Hessle clay," of which the flint-yielding deposit at Kelsea Hill was at first supposed to be a part, is so named from the evidence furnished at Hessle on the Humber, near Hull, of the overlap and unconformity of this clay to the true boulder-clay of Holderness; and the world is indebted to Mr. Searles V. Wood, jun., F.G.S., and the Rev. J. L. Rome, F.G.S., for the knowledge of its existence as a separate and distinct deposit, and of its position, relative to the glacial series, as a postglacial formation *.

The fact that the flint-bearing clay of Kelsea Hill was not a member of the Hessle-clay series, which clay caps the hill, was completely made out on the occasion of the visit of Sir Charles Lyell, Bart., to the East Riding, in the spring of 1869. Previously the Rev. J. L. Rome had paid a hurried visit to the pit, in company with Mr. Symonds; and the aspect of the cliff suggested a suspicion that the stiff, flint-yielding clay which remained on the west side of the pit was quite different from

* See paper in Quart. Journ. Geol. Soc. Lond. vol. xxiv.

Mr. HYDE CLARKE said, with reference to the age of the kitchen-midden in Guernsey, that it did not follow, because the pottery was of the class called by us Samian, that the period was Roman. He had found the like pottery in the kitchen-midden pointed out by him on Mount Pagus, at Smyrna. It was possible that the pottery might have been imported earlier than the Roman period. He thought it very desirable that the theoretical matter in the paper should be turned to account. He considered the Council might endeavour to get the States of the Islands to extend their protection to public objects, and to give greater facilities for the conversion of these monuments into heirlooms. With regard to the favourite assignment of these megalithic remains to the Celts, he knew of no justification for it. Their distribution is not conformable to the Celtic area, and the Celtic nomenclature is not distinctive or historical, but meaning only "long stones," "great stones," &c., which forms usually imply that the monuments belonged to a much earlier population.

Col. A. LANE FOX observed that he had found hand-bricks of the same kind as those mentioned by Mr. Flower in a pit near St. Peters, Broadstairs, associated with Roman pottery and with evidence of the fabrication of flint implements: the contents of this pit had been described in the first number of the Society's Journal for the year 1869. He did not concur with Mr. Hyde Clarke in thinking that Samian pottery, in this country, could be attributed to pre-Roman times. He thought that the occurrence of Samian ware, wherever found, might be regarded as a proof of Roman occupation. It was not, however, to be inferred from the presence of this class of pottery in the kitchen-middens referred to by Mr. Flower, that other kitchen-middens were Roman, but only those in which the Roman pottery occurred. A kitchen-midden might be of any date; the period could only be determined by the characters of the associated remains; and many were proved to belong to the early stone age. At Richborough, in Kent, examples of kitchen-middens might be seen belonging exclusively to the Roman age.

ORDINARY MEETING, DECEMBER 21ST, 1869. 13,

PROFESSOR HUXLEY, LL.D., F.R.S., *President, in the Chair.*

New Members.—Rev. JAMES SIMPSON; GEORGE CAMPBELL, Esq.; Dr. THOMAS NICHOLAS, M.A., F.G.S.

The following paper was read by the author:—

VIII. DESCRIPTION *of and* REMARKS *upon an* ANCIENT CALVARIA *from* CHINA, *which has been* SUPPOSED *to be that of* CONFUCIUS. By GEORGE BUSK, Esq., F.R.S.

AMONGST the various curiosities of the Great Exhibition of 1862, there was scarcely any more striking and interesting, of its kind,

SOME IMAGES/IMAGE TEXT FALL INTO GUTTERS

IRREGULAR PAGE NUMBERING