

ART. LIII.—*On the Fossil Reptilia of New Zealand.* By JAMES HECTOR, M.D., F.R.S., Director of the Geological Survey of New Zealand.

Plates—XXVII.—XXXI.

[*Read before the Wellington Philosophical Society, 13th October, 1873.*]

THE first notice of the occurrence in New Zealand strata of representatives of the Reptilian fauna characteristic of the mesozoic epoch, was made in 1861, when Professor Owen communicated to the British Association a brief description of certain fossils that had been discovered by Mr. T. H. Cockburn Hood, F.G.S., and presented by him to the British Museum. These fossil remains were obtained by Mr. Hood in a ravine on one of the tributaries of the Waipara River, at the northern extremity of the Canterbury plains. They comprise the vertebral centra, ribs, and coracoid bones, all belonging to the same individual which Professor Owen referred to a new species—*Plesiosaurus australis*.*

No further discovery of Saurian remains was made till after the occurrence of a great flood, in 1868, when Mr. Hood again obtained a large collection, and shipped it to England, unfortunately, by the ship "Mataoka," which was lost on the homeward voyage. Dr. Haast, however, communicated a short account of this collection to the Philosophical Institute of Canterbury,† and states that he "made drawings and took measurements of all the more important specimens, so that, in case the collection should not reach its destination, the information, at least, will not be altogether lost to the scientific world." This foresight was most fortunate, as, notwithstanding the great number and variety of the remains since found, that collection appears to have contained the only skull fragment, with jaws and teeth, of a true Sauropterygian that has yet been discovered.

In 1867 I had visited the locality‡ along with Mr. W. T. L. Travers, and obtained only a few fragments of these fossils; but after Mr. Hood's second discovery I sent Mr. R. L. Holmes, provided with the requisite appliances, to obtain a more complete collection for the Colonial Museum. Drawings of these, forwarded to Professor Owen, enabled him to add two new species, which he named *Plesiosaurus crassicostatus* and *P. hoodii*.§

In the following year Dr. Haast made a detailed survey of the district, and obtained a large series of Saurian and other fossils, which are now in the Canterbury Museum.||

Mr. John Buchanan, of the Geological Survey Department, having some years previously discovered the existence of Belemnite beds at the Amuri Bluff, a locality on the East Coast fifty miles north of the Waipara,¶ Dr. Haast's

* Trans. Brit. Ass., 1861, p. 122, *et seq.*

† Trans. N.Z. Inst., Vol. II., p. 186.

‡ Prog. Rep. Geol. Surv. N.Z., 1868, p. 9.

§ Geol. Mag., Feb., 1870, Vol. VII., p. 49, pl. 3. || Rep. Geol. Surv. N.Z., 1870, p. 5.

¶ Geol. Rep., 1867.

survey was extended in that direction in the summer of 1869, and resulted in finding several localities extremely rich in Reptilian remains. These are described in his report,* and his collections, having been forwarded to the Colonial Museum, form part of the material of the present communication.

In 1871, Mr. H. H. Travers made a further exploration at the Amuri Bluff; and during the early part of this year the relations of the different formations have been studied by Captain Hutton†; and a skilled collector, Mr. Alexander McKay, has also been employed to make an exhaustive collection of the Reptilian remains and associated fossils.

These different explorations have led to the accumulation of several tons of blocks of cement-stone containing fossil bones, and during the last three months these fossils have been worked out of the hard matrix by Mr. McKay. The general result is, that portions of 43 individual reptiles, mostly of gigantic size and all of aquatic habits, and belonging to at least 13 distinct species, have been discovered. These species represent two distinct groups, the first, with flat or slightly bi-concave vertebræ, being true Enaliosaurians, belonging to the genera *Plesiosaurus*, *Mauisaurus*,‡ (gen. nov. allied to *Elasmosaurus* of Cope), and *Polycotylus*, Cope; and the other having procœlian vertebræ, as in most recent Lacertilia and Crocodiles, but provided with swimming paddles, and therefore representing probably the order Pythonomorpha of Professor Cope.§ This order is represented in the collection by two distinct genera, *Liodon* (Owen), and *Taniwhasaurus*,|| (gen. nov. allied to *Clidastes* of Cope).

In addition there are several fragmentary remains, which, for the present, I only venture to place provisionally under one or other of these groups, and two vertebræ, which appear to belong to an exceptional form of the genus *Crocodylus*.

Lastly, from the lower mesozoic strata of Mount Potts, in Canterbury, a single vertebra was collected by Dr. Haast,¶ which I refer to the genus *Ichthyosaurus*.

The following is a schedule of the different Saurian remains referred to in this paper, with the localities where they were found, and the names of the collectors. When not otherwise stated the specimens are in the Colonial Museum at Wellington:—

* Rep. Geol. Surv. N Z., 1870-71, p. 25.

† Geol. Rep., 1872-73, p. 36.

‡ After *Mauī*, the traditional discoverer of New Zealand.

§ "On the Fossil Reptilia of the Cretaceous Rocks of Kansas," by Professor E. D. Cope. Preliminary Rep. on Geol. of Wyoming, F. V. Hayden, 1871, p. 385. I have not been able to refer to the original paper, by Professor Cope, in the Trans. Amer. Phil. Soc., 1868-70, for the definition of this order.

|| After the *Taniwha*, or fabled sea monster of the Maori.

¶ Rep. Geol. Surv., 1873, p. 6.

No.	NAME.	NATURE OF SPECIMEN.	COLLECTOR.	Amuri.	Cheviot.	Waipara
1	<i>Plesiosaurus australis</i> (Owen)	a. Vertebræ and extremities (in British Museum)	Hood			*
		b. Posterior trunk and limbs	McKay	*		*
		c. Trunk (in Canterbury Museum)	Haast			*
		d. Vertebral centrum	Haast		*	*
2	<i>Plesiosaurus crassicostatus</i> (Owen)	a. Thorax, neck, and humerus	Holmes			*
		b. Humerus and ribs	McKay	*		
		c. Cervical vertebræ	Haast	*		
		d. Vertebræ, coracoid, and humerus (in Canterbury Museum)	Haast			*
3	<i>Plesiosaurus hoodii</i> (Owen)	a. Cervical vertebra	Holmes			*
		b. Three vertebræ	Holmes			*
		c. Three vertebræ	McKay	*		
		d. Vertebra and thirty connected phalanges	McKay	*		
4	<i>Plesiosaurus holmesii</i> , n. sp.	a. Eleven lumbar vertebræ	Holmes			*
		b. Coracoid and part of humerus	Holmes			*
		c. Part of humerus	Holmes			*
		d. Humerus	McKay	*		
		e. Vertebra	Haast	*		*
		f. Vertebræ (in Canterbury Museum)	Haast			*
5	<i>Plesiosaurus traversii</i> , n. sp.	a. Nine vertebræ	H. Travers	*		
		b. Four vertebræ and teeth	McKay	*		
		c. Four vertebræ and chevron bones	Haast	*		
6	<i>Plesiosaurus mackayi</i> , n. sp.	a. Three vertebræ, part of coracoids, humerus, and clavicle	McKay	*		
		b. Paddle bone (in Canterbury Museum)	Haast	*		
7	<i>Polycotylus tenuis</i> , n. sp.	a. Vertebral centrum and humeri	McKay	*		
		b. Vertebræ and limbs	McKay	*		
		c. Vertebra and pelvic arch	McKay	*		
		d. Pelvic bone	Haast	*		

No.	NAME.	NATURE OF SPECIMEN.	COLLECTOR.	Amuri.	Cheviot.	Waipara
8	<i>Mauisaurus haastii</i> , n. sp.	a. Coracoids, scapula, and paddles	Haast		*	
		b. Four vertebræ, ribs, humerus, and paddles	H. Travers	*		
		c. Vertebra	H. Travers	*		
		d. Paddle	McKay	*		
		e. Four Vertebræ	Haast	*		
		f. Thirteen cervical vertebræ	H. Travers	*		
		g. Vertebra (in Canterbury Museum)	Haast			*
		h. Cast of jaw fragment and teeth (?)	W. Travers			*
9	<i>Mauisaurus brachiolatus</i> , n. sp.	a. Humerus	Haast	*		
		b. Humerus and other paddle bones (Canterbury Museum)	Haast			* ?
10	<i>Liodon haumuriensis</i> , n. sp.	a. Jaws with teeth	McKay	*		
		b. Caudal vertebræ and chevron bones	McKay	*		
		c. Eight cervical vertebræ	McKay	*		
		d. Ten lumbar vertebræ and ribs	Holmes			*
		e. Seven true ribs, also abdominal ribs and phalanges	Holmes			*
		f. Caudal vertebræ	Haast	*		
		g. Lower jaws, with teeth	Haast	*		
		h. Jaws and vertebræ	McKay	*		
11	<i>Taniwhasaurus oweni</i> , n. sp.	i. Vertebræ, etc. (in Canterbury Museum)	Haast			*
		a. Lumbar vertebræ, spines, and ribs	H. Travers	*		
		b. Paddle and pelvic bone	H. Travers	*		
		c. Head, lower jaw, and teeth	H. Travers	*		
		d. Jaws and teeth, with fragments	Haast	*		
		e. Pelvic and paddle bones, and ribs	McKay	*		
		f. Three vertebræ	McKay	*		
g. Vertebra	Haast	*				
12	<i>Crocodylus</i> ?	a. Cervical and dorsal vertebræ	McKay	*		
13	<i>Ichthyosaurus australis</i> , n. sp.	a. One vertebral centrum	Haast			Mt. Potts (triassic)

Not having examined the Amuri district, where the best sections of the formation containing Reptilian remains are exposed, I will not, at present, discuss their stratigraphical position, but refer to the reports of Dr. Haast and Captain Hutton, already quoted. That they belong to the upper part of the mesozoic period, representing the horizon of the cretaceous period of Europe, is rendered pretty certain by the associated fossils, which belong to the following genera :—

Ammonites, Scaphites, Nautilus, Belemnites (three species).

Turbo, Neptunæa, Aporrhais, Conchothyra, Sclaria, Natica, Pleurotoma, Dentalium.

Terebratula.

Panopæa, Cytherea, Lucina, Eriphylla, Protocardium, Crassatella, Astarte, Crenella, Myacites? Trigonía (three species), *Cucullæa, Axinæa, Leda, Pecten, Radula, Plagiostoma, Inoceramus* (four species), *Mytilus, Chama, Gryphæa, Ostrea, Aucella.*

Teredo, Pentacrinus, Corallines, Foraminifera, fish teeth and scales.

With the view of assisting collectors in determining the portions of Reptilian remains which are most likely to be found, I offer the following artificial diagnoses of the genera in which they have been provisionally placed:—

SAUROPTERYGIA.

Vertebræ with both ends flat, or concave.

Teeth curved, with striated, sharp-pointed crowns; are found in the rock matrix free from the jaws.

A—PLESIOSAURUS.

Centrum of dorsal vertebræ short as compared with its width, which is greater than its height; flat, or only slightly concave at both ends. Humerus prismatic, with a round proximal surface; distal end expanded and flat.

B—POLYCOTYLUS.

Centrum of dorsal vertebræ nearly equal in length to its diameter, constricted, articular surfaces circular, concave, with an elongated tubercle in the centre of the depression. Humerus slender and long in proportion to the size of the vertebræ, with two articular facets on the proximal end.

C—MAUISAURUS.

Centrum of dorsal vertebræ equal in length to the diameter, with smooth, concave sides, and an inferior mesial ridge; articular facets circular, flat, with a deep pit in the centre. Humerus with a large tuberosity.

D—ICHTHYOSAURUS.

Vertebræ consist of deeply biconcave disks.

PYTHONOMORPHA.

Vertebrae concave in front, and convex behind. Teeth firmly attached to the jaw ; never occur free in the matrix, except when broken off.

A—LIODON.

Dorsal vertebrae subprismatic, cup and ball of equal diameter. Teeth conical, curved, with thick enamel, pulp cavity constricted at base.

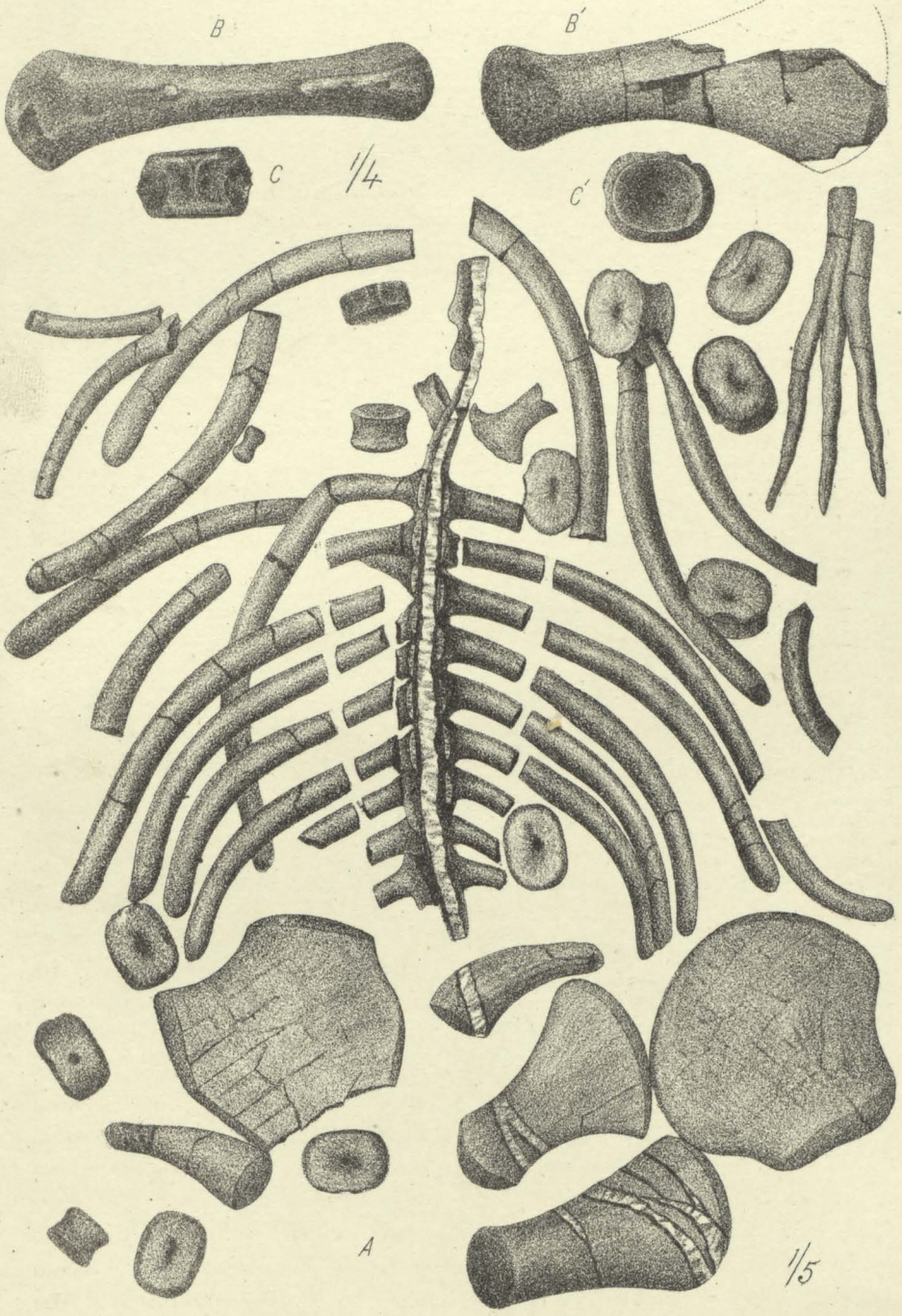
B—TANIWHASAURUS.

Dorsal vertebrae with the cup end expanded, and tapering obliquely to the ball end. Humerus very short, wide, and with powerful muscular crests. Teeth conical, with pulp cavity expanded at base.

1. PLESIOSAURUS AUSTRALIS, Owen. Proc. Brit. Assoc., 1861, p. 122.

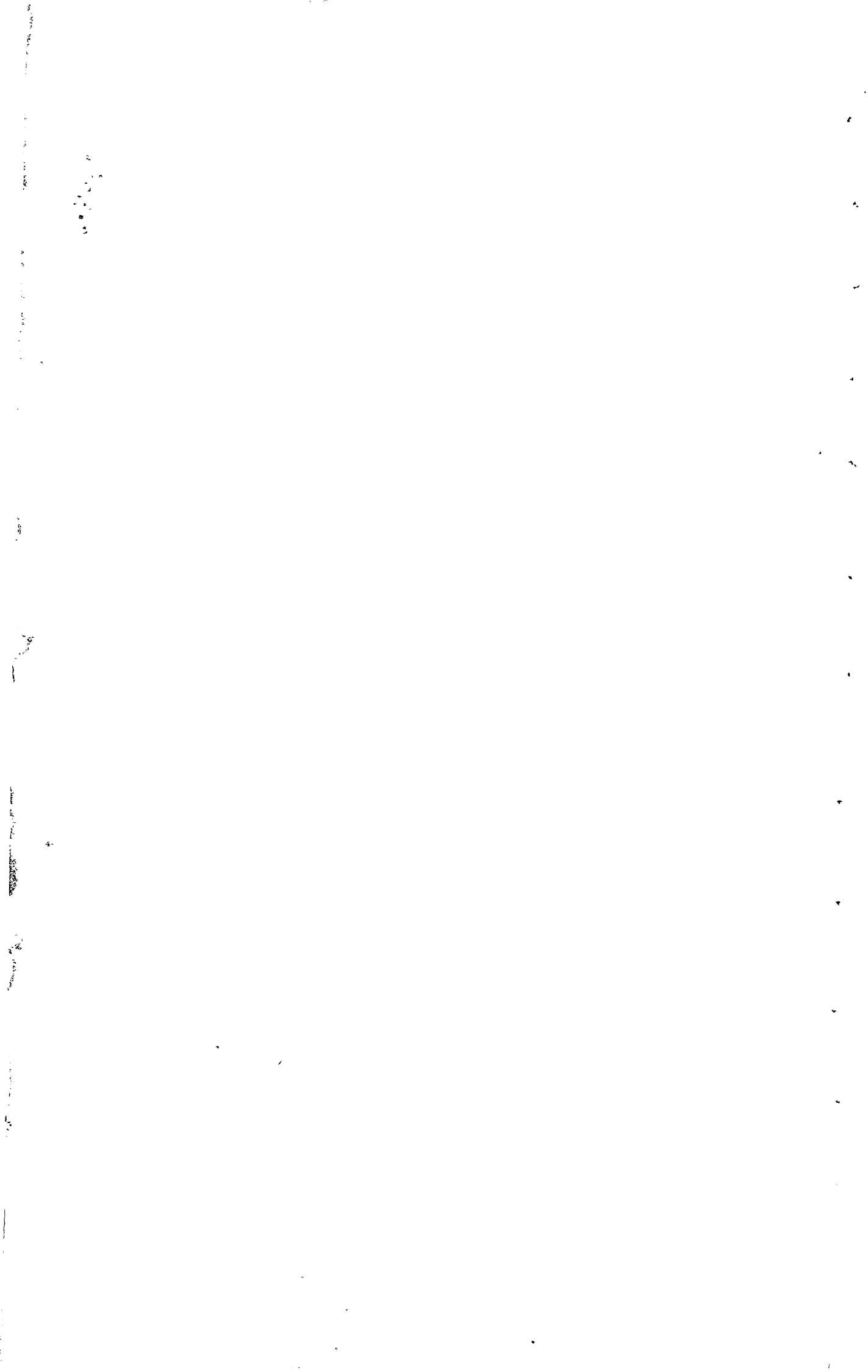
As Professor Owen's description of the specimens on which he founded this species is not accessible to many in the colony, I quote it at length.

The specimens "consisted of two vertebral bodies or centrums, ribs, and portions of the two coracoids of the same individual, all in the usual petrified condition of oolitic fossils. Their matrix was a bluish-grey clay-stone, effervescing with acid ; the largest mass contained impressions of parts of the arch, and of the transverse processes of nine dorsal vertebrae, and of ten ribs of the right side. Portions of five of the right diapophyses and of six of the ribs remained in this matrix. The bones had a ferruginous tint, contrasting with the matrix, as is commonly the case with specimens imbedded in the Oxfordian or liassic clays. The impression of the first diapophysis and of its rib, show the latter to have been articulated by a simple head to its extremity, as in the Plesiosaurus ; but the succeeding rib had been pushed a little behind the end of its diapophysis, and the same kind of dislocation had placed the five following ribs with their articular ends opposite the interspaces of their diapophyses. The ninth rib had nearly resumed its proper position opposite the end of the diapophysis, but at some distance from it ; the impression of the tenth rib shows the normal relative position of the pleur- and diapophyses. The ribs are solid, of compact texture, cylindrical, slightly curved, the fragments looking more like coprolites than bone ; they are about an inch in diameter, with but small intervals of, say, one-third of an inch, slightly expanding as they recede from the transverse process, and slightly contracting to the lower end. The first, terminating in an obtuse end of $\frac{1}{2}$ an inch diameter, is 7 inches long ; the second is 8 inches long ; the third is $8\frac{1}{2}$ inches ; the fourth rib is 9 inches long. The extremities of the others are broken off with the matrix. The separated fossils sent from New Zealand included the mesial coadjusted ends of a pair of long and broad bones, thickest where they were united, and



A. PLESIOSAURUS AUSTRALIS.
B.B' C.C' POLYCOTYLUS TENUIS. n. sp.

J.B. del. et lith.



becoming thinner as they extended outwards, and also towards the fore and hind parts of the bone, both of which ends were broken away. On one side the surface of the bone is convex lengthwise, and slightly concave transversely. On the opposite side the contour undulates lengthwise, the surface being concave, then rising to a convexity, where a protuberance has been formed by part of the coadjusted mesial margins of the bone; transversely this surface is slightly concave. A similar, but less developed, median prominence is seen at the middle of the medially united margins of the coracoids in the *Plesiosaurus hawkinsii*, and the author regards the above described parts of the New Zealand fossils as being homologous bones. But a more decided evidence of the Plesiosaurian nature of this antipodeal fossil is afforded by the vertebral centrums. They have flat articular ends, with two large and two small venous foramina beneath. The neurapophysial surfaces, showing the persistent independence of the neural arch, are separated from the costal surfaces by about half the diameter of the latter. These are of a full oval figure, 1 inch 3 lines in vertical, and 1 inch in fore-and-aft, diameter. On one side of one of the centrums the rib has coalesced with the costal surface. The following are the dimensions of this centrum:—Length 1 inch 9 lines, depth 2 inches 2 lines, breadth of articular end 3 inches 6 lines. The non-articular part of the centrum offers a fine silky character.”*

To this same species I refer the specimens marked No. 1 *b* and *d* in the collection of the Colonial Museum.

No. 1 *b*.—This consists of the thoracic segment of the trunk of a young individual. The dorsal surface of the animal has been worked out of the hard matrix of the slab so as to expose ten posterior dorsal segments with ribs. No vertebral centra are exposed *in situ*, but scattered on the slab among the ribs are four belonging to the dorsal region, and about twelve to the caudal, together with the smaller bones of the paddles. The thoracic ribs, a few abdominal ribs, and the dislocated bones of the pelvic arch and appendages, complete the specimen, which measures 2 feet square. The matrix is the usual grey cement stone, containing an excess of lime, which is crystallized out in cracks, the vertebræ, for instance, being split through the neural spines by a thick vein of calcspar that traverses the entire length of the column, and is continued so as to intersect the femur, of the right side. The neural spines project 1.5 inches above the transverse processes. They have rounded tips, are 1.3 inches in antero-posterior width, with zygapophyses projecting .4 inch. The transverse processes are 1.7 inches long, cylindrical, and of the same size as the ribs, to which they are attached without any expanded facet, either on the process or the head of the rib.

The ribs, which are directed backwards on the spine as they lie in the

* Owen, Proceedings of Brit. Assoc., 1861, p. 122.

specimen, are cylindrical, the most anterior being the largest, viz., 9 inches in length by .8 inch in diameter. They are closely packed, and, from their irregular curvature, seem as if they had been soft and flexible at the time they were imbedded in the calcareous mud. The largest caudal centrum has its transverse diameter 2 inches, and its vertical diameter 1.5 inches. The articular surfaces are nearly flat, with obtuse margins, and a distinct central pit. Their antero-posterior length is .8 inch, with a single inferior venous foramen. Similar centra occur, of various sizes down to .7 inch transverse diameter. None of the vertebral centra have attached processes, but some have distinct pits, to which the neural arch had its attachment. The dorsal centra are slightly longer, being 1.3 inches, and have a distinctly constricted form, their articular surfaces being a full oval, 2.3 inches by 1.6 inches, with sharp edges. On the ventral surface are two pairs of small foramina. The abdominal ribs are irregular in shape, tapering to both ends, and bound together, in groups of two or three, by their middle. Their greatest length is 10 inches.

The femur is 7 inches in length, proximal end rounded, 2.5 inches in diameter, distal end flattened and expanded to 4.5 inches. The pubic bone is rhomboidal, slightly concave, 6 × 6 inches, with only one well-marked elongated articular margin 3.5 inches in length. The ischium, of which only one is present, is more concave on the inner than the exposed surface, 2 inches wide at the articular extremity, 4.5 inches at the mesial, and 6 inches in length. The ilium has an irregular conical form, tapering, and slightly curved; its length is 4 inches, and its articular end, which is convex, is 2 inches in diameter. The paddle bones are flat, with slightly concave surfaces, and irregular outline. The phalanges are cylindrical, and much constricted in the middle.

Although the dimensions differ from those of the bones described by Professor Owen, which are common to the two specimens when allowance is made for the immature condition of the Amuri specimen, there is sufficient evidence to warrant their being placed in the same species. The characters on which I place most reliance are the coprolite-like form of the ribs and the silky texture.

No. 1 *d* is a vertebra found by Dr. Haast in a soft clay matrix, at the Cheviot Hills, along with the paddle of *Mavisaurus* (8 *a*), but is placed here on account of its remarkably Plesiosauroid character, the neural arch showing a distinct suture, though perfectly ankylosed to the centrum. This suture divides the articular surface for the head of the rib into two rough facets, the upper on a short transverse process, and the lower on the side of the centrum. The proportional length of the centrum of this vertebra exceeds that of any other Plesiosauroid in the collection, as will be seen from the following

dimensions:—Antero-posterior length 2·7 inches, transverse diameter 3·2 inches, vertical 2·8 inches, diameter of neural canal ·75 inch.

No. 1 *c.*—To this same species Dr. Haast has referred a fine specimen, which is exhibited in the Canterbury Museum, obtained at Boby's Creek, at Waipara. It is only partially worked out from the matrix, but shows the ventral aspect of the greater part of the trunk and tail of a Plesiosaur that measured probably 10 feet in length, the distance between the anterior margin of the thorax and the pubic arch being 4 feet. The portions of the skeleton which are visible are thirty-five vertebræ belonging to the dorsal and caudal regions, the scapula and pelvic arches, with appendages, and both vertebral and abdominal ribs. The transverse diameter of the vertebral centra is 2·15 inches, being greater than the vertical, while the length is only 1·7 inches. The height of the neural spines and the length of the transverse processes is about equal to the height of the vertebral centrum in the middle part of the back. The caudal vertebræ diminish rapidly in diameter and length towards the extremity of the tail. The coracoids form a very wide, compressed, bony plate, not much longer than the width in the middle, but constricted posteriorly, their length being equal to about six thoracic vertebræ. The ribs are slightly compressed, and do not agree well with Professor Owen's description of the type of the species to which this has been referred. The form of the vertebral centrum also exhibits so marked a difference in the proportion of the transverse diameter to the length, as to lead to the belief that it must have been a very different animal; but until it has been more clearly worked out from the matrix this cannot be well decided.

2. PLESIOSAURUS CRASSICOSTATUS, Owen. Geol. Mag., 1870, p. 52.

No. 2 *a.*—This fine slab, collected by Mr. R. L. Holmes at Boby's Creek, Waipara, exhibits the left side of the thorax and neck of a well-grown animal. A full-sized drawing of the specimen sent to Professor Owen enabled him to name this species; but, as the bones have since been more completely worked out from the matrix, and three dorsal centra discovered and extracted from beneath the ribs, I am able to add some further particulars regarding this interesting specimen.

Professor Owen remarks:—"Whoever may glance at a specimen or figure of a similarly-preserved trunk of a *Plesiosaurus* will appreciate the generic character of the ribs in the New Zealand fossil. They are robust, subcircular in section, expanding somewhat, or thickening, at their middle, obliterating there or leaving very little of intercostal space, at least in the collapsed condition of the chest. They are likewise solid."

The portion of the neck which has been preserved consists of seven cervical centra, each 1·4 inches in length, with 2·5 inches transverse, and 1·3 inches vertical

diameter. They are deeply excavated beneath, with two venous foramina. The articular surfaces are elongated transversely, forming a constricted oval, and only moderately concave, with rounded margins. The dorsal centra are more circular in form, the transverse and vertical diameters being 3·5 and 2·8 inches respectively, while the length is nearly 2 inches. They are much constricted on each side, and expanded at the ends to form a smooth, slightly concave articular surface, with a central tubercle ·5 inch in diameter. The neural processes are detached, their height, including the neural canal, being 4·5 inches. The lateral processes are flattened, but expanded at the tip, to form roughened circular facets for the rib articulations. Their length is 3·5, and width 1·3, inches. The ribs, twelve in number, are well preserved. They are flattened, with sharp anterior margins, slightly expanded towards the vertebral column, then constricted, and flattening out again at the centre, where they make an obtuse forward angle. The length of the first rib preserved is 12 inches, and of the eighth, which is the largest, 19 inches. The total length of the specimen is 3 feet, and, judging from the proportional length of the thorax in the long-necked Plesiosaurs, must have belonged to an animal at least 10 feet in length.

A portion of a humerus, belonging to this specimen, was also described (from a drawing) by Professor Owen, who points out that "it shows the hemispheroid articular head, coarsely pitted by characteristic circular depressions, with slightly raised margins. The degree of contraction of the shaft to the broken, and the indicated retention of a subcylindrical shape of shaft, are incompatible with any known modification of an Ichthyosaurian humerus or femur. These are more angular and transversely oblong at the proximal end, and more rapidly compressed and expanded in the distal one, in the fish-like sea-lizard. The fragment of limb bone in the Museum at Wellington is plainly Plesiosaurian. The long diameter of the head of the bone is 3·5 inches, the short diameter 3 inches. The peripheral contour is flatter or less convex on one side than the other, as it is in the same part of the femur of *Pleiosaurus portlandicus*, in which the small crateriform pits of the articular surface are shown; but their character is common to *Pleio-* and *Plesiosaurus*."

No. 2 *b* is a slab showing a humerus and a few broken ribs, identical with the above in their characters, obtained at the Amuri Bluff.

No. 2 *c* shows a few cervical vertebræ obtained by Dr. Haast at the same locality, which serve to confirm the occurrence of this species at both these localities.

No. 2 *d*, in the Canterbury Museum, are a few vertebræ, a coracoid bone, and humerus, from the Waipara, which also belong to this species.

3. PLESIOSAURUS HOODII, Owen. Geol. Mag., 1870, p. 51.

Professor Owen named this species from the drawing of a single cervical vertebra (3 *d*) obtained by Mr. Holmes at Waipara. These vertebrae, of which several other specimens have since been obtained (both from the Waipara, 3 *b*, and the Amuri Bluff, 3 *c* and 3 *d*), are easily distinguished by their peculiar characters, which are thus described, from the first discovered specimen, by Professor Owen:—"It is broad and flat on the under surface of the centrum; the sides also of which, between the terminal articular surface, are more flattened than usual, and converge towards the neural surface, giving somewhat of a triangular figure to the vertical transverse section of that part. The pleurapophyses come off from the lower part of the sides, and are confluent therewith, like transverse processes. The characteristic pair of venous foramina open upon the middle of the under surface. This vertebra most resembles one from the bone bed of Aust-Cliff, near Bristol, described in my 'Report on British Fossil Reptiles,' 1839, p. 78, and referred, with a note of interrogation, to the *Plesiosaurus trigonus* of Cuvier. The articular surface of the centrum is moderately concave, with a transversely oblong depression in the centre, and the margin rounded off. The neural arch is ankylosed to the centrum. The neural canal is contracted, as usual in cold-blooded air-breathers, and shows the ordinary proportion of that in *Plesiosaurus*. The pleurapophyses are short and thick; the fore and aft diameter of their base equals two-fifths of that of the entire centrum; they are somewhat inclined downward. A distance of twice their vertical basal diameter intervenes between them and the ankylosed base of the neurapophysis.

"This vertebra gives the following dimensions:—

Length of centrum	...	...	...	2 inches 1 line.
Breadth of articular end of centrum	...	...	...	2 " 2 "
Height of articular end of centrum, at middle	1	"	7	"

"The New Zealand specimen shows an exceptional form among the extensive series of modified Plesiosaurian cervical vertebrae already defined or recognized. Moreover, it is that form which hitherto, from British deposits, has not been met with associated with other parts of the frame, yielding the characters of proportionate length of neck; proportion of head to body; shape and number of teeth; form, structure, and proportions of limb-skeletons, either in relation to the trunk, or in that of the pectoral pair to the pelvic pair. In short, materials have been wanting for assurance that the degree of modification of the cervical vertebra may not have been associated with so much modification of the rest of the skeleton, as to warrant a generic section of *Sauropterygia*, or a subgeneric one in the Plesiosaurian family."

The proportions of the specimen given above agree well with the cervical vertebrae since obtained, although the actual dimensions vary somewhat. Thus,

in specimen 3 *c*, the length of the centrum is 2 inches, while the transverse and vertical diameter are 3 inches and 2·3 inches respectively. In specimen 3 *d* a posterior dorsal vertebra, without the neural spine, is recognized as belonging to this species, by the transversely elongated tubercle and the character of the articular facet. One end of the centrum has been broken off, so that its length cannot be ascertained, but it measures transversely 4 inches, and vertically 3·3 inches. The lateral processes spring from the side of the centrum, and not from the inferior third, as in the cervical vertebræ; and the neural spine, though broken off, has been distinctly continuous without any suture. This fusion of the neural arch, both in the anterior and posterior parts of the column thus indicated, confirms the suspicion that this species should be placed in a genus distinct from *Plesiosaurus*. On the same slab with this vertebra are thirty-two phalanges, exposed in their natural position in continuous rows; the largest about 2·7 inches in length, cylindrical, and only moderately constricted at the middle.

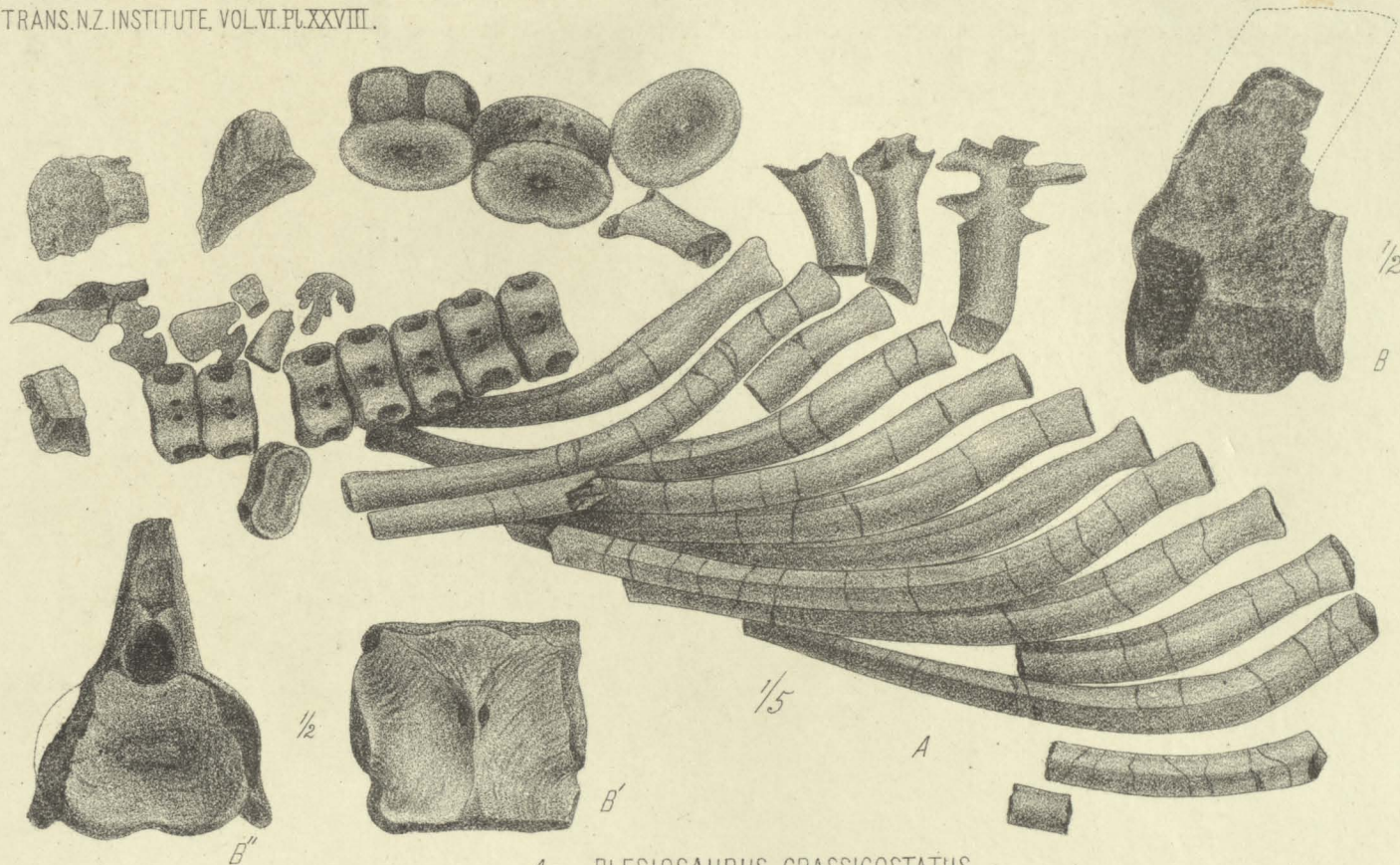
4. PLESIOSAURUS HOLMESII, n. sp.

This species is allied to *P. hoodii*, in the trigonal form of the vertebral centrum and the strong wedge-shaped neural spine continuous with the body of the vertebræ. They are, however, at once distinguished by their flat, smooth, articular surfaces, and the absence of the elongated tubercle in the centre. Eleven posterior cervical vertebræ (4 *a*) have a length *in situ* of 2 feet. They were found on the exposed surface of a slab, and are therefore water-worn, so that their transverse dimensions obtained are not trustworthy, but they appear to have been about 3 inches in diameter. In the same slab is a fragment of a shaft of a humerus, and the margin of a coracoid (4 *b, c*), with a scapulo-humeral articulation, which seems to have resembled closely that of *Mavisaurus*. The proximal end of a humerus (4 *d*), found by Mr. McKay at the Amuri Bluff, has been referred to this species on account of associated vertebral fragments. The articular head of the bone is peculiar, being divided into two portions by a bicipital notch, not a groove, as in *Mavisaurus*. The external part of the facet is a square, flat-topped, trochanter-like process, but continuous with the curve of the inner portion, which is nearly circular, convex, and deeply pitted, in the manner of *Plesiosaurus*. It is not improbable that both this and the last-mentioned species should be referred to Professor Owen's genus of *Pleiosaurus*.

5. PLESIOSAURUS TRAVERSII, n. sp.

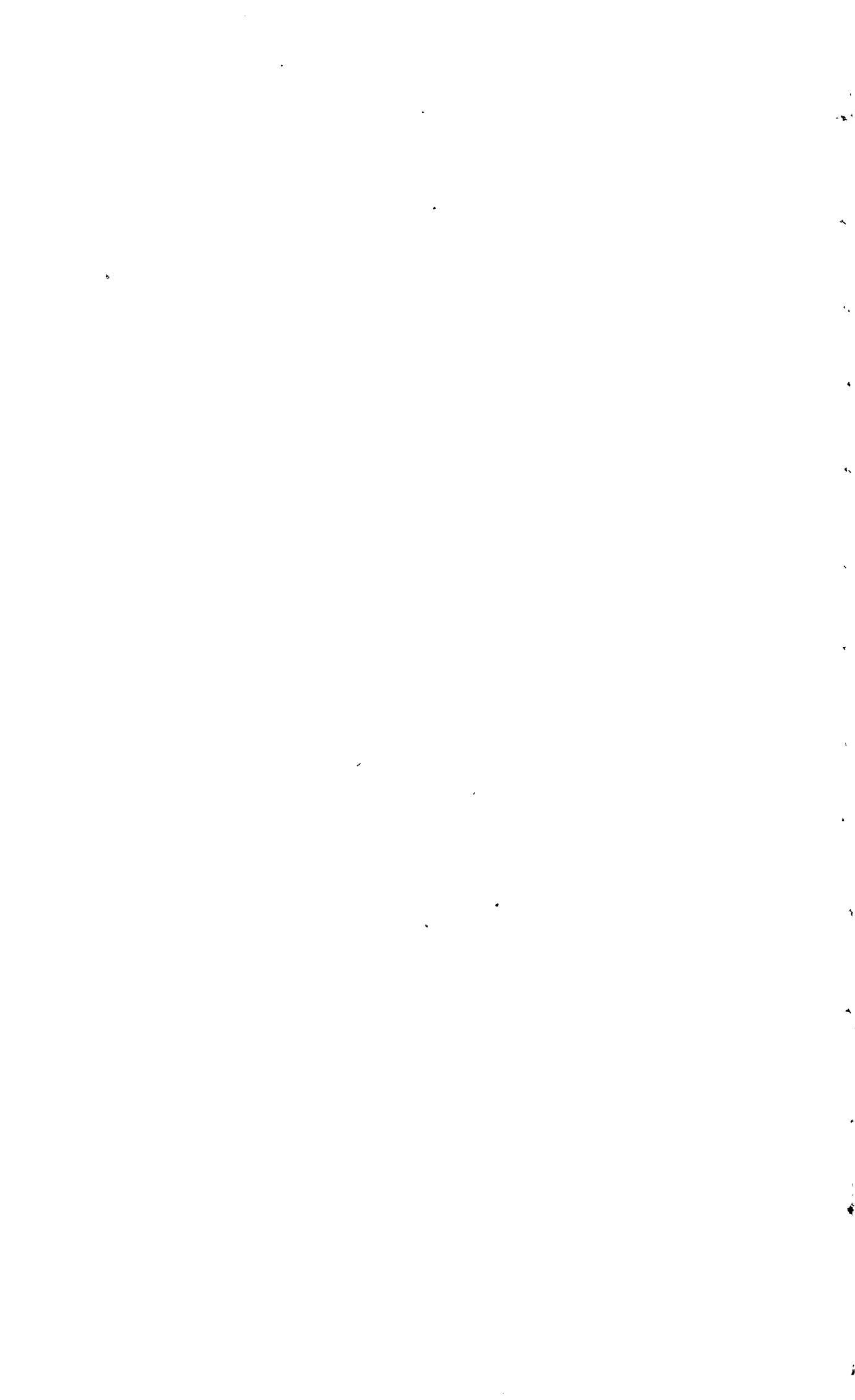
This is a very marked species, easily distinguished by the large quadrate centra of the vertebræ, that always show a tendency to split into four parts in the line of the venous foramina, and a constriction of the lateral border.

No. 5 *a*.—Nine cervical vertebræ, much water-worn, but showing the



A. PLESIOSAURUS CRASSICOSTATUS.
B. B' B''' " HOODII.

J.B. del. et lith.



peculiar character of the species. Transverse diameter of the centra 4 inches, vertical diameter 3·5 inches, antero-posterior length 2 inches. The neural spines are 1·7 inches in antero-posterior width, 4·5 inches long, leaving only a very narrow space between, and this is deeply notched by a bold zygapophysial articulation 1·3 inches in depth.

No. 5 *b*.—Is a slab with several vertebræ, and also obscure fragments of the lower jaw, among which is a single tooth *in situ* (Pl. XXIV., fig. H). This tooth is 2·2 inches long, and ·3 inch in greatest diameter, which is at the base of the crown, at 1 inch from the tip. It is a curved, flattened, produced cone, without any sign of a sharp ridge like that seen in the supposed tooth of *Mauisaurus*, to which, however, the species has some affinity, but is easily distinguished by the shorter vertebræ and the quadrate, not circular, form of the articular facets.

6. PLESIOSAURUS MACKAYII, n. sp.

This species is not unlike the last described in the form of the transverse section of the centra of the vertebræ, but their length is very different, being almost equal to the vertical diameter, as in *Mauisaurus*. But it is distinguished readily from that genus by the form of the humerus (*6a*), which is dilated at the distal end with a rounded articular extremity, and at the proximal end is feeble. The shape is somewhat prismatic, but the bone has been a good deal water-worn before being imbedded in the matrix. The clavicular bone is slender, with a well-marked oblong articular surface. A fragment of the coracoid bone shows this apparatus to have been very powerful, the width being about 7 inches, with a very strong symphysial surface. The articular surface at the angle of the bone for receiving the humerus is elongate and narrow, being 1·7 inches wide at the middle, and tapering both ways, to a length of 4 inches. The vertebral centra preserved, which belong to the dorsal region, have the following dimensions:—Antero-posterior diameter 3 inches, transverse 4 inches, vertical 3·2 inches. The humerus measures 13·5 inches in length, and is 8 inches wide at the dilated extremity.

7. POLYCOXYLUS TENUIS, n. sp.

This genus, according to Professor Cope, has close affinities to *Plesiosaurus*, but is distinguished by short deeply-concave vertebral centra, the concavity not, however, being of an open conic form, as in *Ichthyosaurus*, but distinctly flattened at the fundus. The limb bones are remarkable for their size compared with the vertebral column, indicating powerful natatory capacity. To this genus, under the above specific name, I provisionally refer the specimens marked 7 *a*, *b*, *c*, and *d*, all of which were obtained at the Amuri Bluff. The first consists of two slender paddle bones and one centrum, probably cervical. The length of each paddle bone (humerus?) is 9 inches,

the proximal end is slightly expanded, 2·5 inches in diameter, and presents two distinct regularly convex articular surfaces. The distal extremity is compressed, but, unlike *Plesiosaurus*, the compression is at right angles to the greatest diameter of the other end of the bone, and is 4·5 inches in diameter, by 1 inch in width. The vertebral centrum is circular, with two very distinct inferior foramina. There are four articular facets, two on the upper and two on the lower quadrants, for the neural arch and the costal processes respectively. The articular surfaces of the centrum are deeply excavated and concentrically striated, but with a well-marked central elevation and pit. The diameter of the centrum is 1·9 inches, its length 1·2 inches, and the thickness between the conical excavations of the articular facets is ·7 inch.

No. 7 *b*.—This specimen is associated with the above on account of the double facet on the proximal end of the humerus, which is 10 inches long. The vertebræ included in this slab are proportionately larger but not so concave as in the type. They are from the posterior dorsal region, and measure 2·5 inches in length by 3 inches in diameter.

No. 7 *c*.—The occurrence of a vertebral centrum, having the character of this species, connects with it provisionally a fragment of a pelvic arch contained in another slab. It consists of a hatchet-shaped pubic bone of the right side, articulated to a portion of the corresponding bone of the left side by a symphysis 4 inches long. Where these bones unite they are thickened so as to form a wide triangular surface of attachment.

8. MAUISAURUS HAASTII, n. sp.

The Sauropterygians referred to this genus are easily distinguished from *Plesiosaurus* by the character of the coracoid and the elongated vertebræ. In the latter respect it approaches the genus *Elasmosaurus* of Cope, but differs from it in the scapular arch, and particularly in the powerful muscular attachments evidenced by the humerus.

The huge reptilian distinguished by the above name is only represented in the collection by vertebræ, paddle bones, and coracoids, and a few rib fragments, of at least three individuals, obtained from the Cheviot Hills and the Amuri Bluff. No skull fragments or teeth have been found which can be referred to this animal, unless it be three teeth and a matrix cast of a portion of the jaw of a specimen (8 *b*) obtained at Boby's Creek, Waipara, by Mr W. T. L. Travers, and which is reported to be a fragment of the same block that was lost in the Matoaka, that contained the fine jaws and teeth described by Dr Haast.*

One of these teeth has been figured (Pl. XXIV., G *a, b, c*). It has a compressed, conical, slightly curved form; the crown is of dense black enamel, with a slightly swollen ferruginous base that is obliquely truncate and

* Haast, Trans. N.Z. Inst., II., 186.

excavated by a shallow pit. The enamel layer is seen, in the section (a), to thin out on the cement, and is not reflected to line a pulp-cavity, as in *Leiodon*. The external surface is very slightly rugose, and has a single ridge on the convex, or anterior, surface. The length is 1.5, and diameter .5, inch.

No. 8 a.—The total stretch of the scapular arch and anterior limbs could not have been much less than 9 feet from tip to tip of the paddles. The coracoid bones resemble *Ichthyosaurus* in form, being each 12 inches wide by 15 inches long. They are attached by a strong articular surface for 14 inches in the middle line, the thickened margin of the bone having been supported by strong ridges.

In this fine specimen, which was obtained by Dr. Haast in a soft matrix of blue clay shale in the bed of the Jed River, in the Cheviot Hills, twenty miles south of the Amuri Bluff, the coracoids were found attached along the mesial line by a thick massive suture, but thinning posteriorly, the middle portion of each bone being very thin, so that it could not be preserved. There are, however, at least two stout transverse ridges. The external anterior angle presents two articular facets, the anterior being one-third less than the posterior, and apparently articulating with the scapula, while the posterior formed two-thirds at least of the glenoid cavity.

The general form given to the coracoids is from the sketch taken before the bones were removed from the soft matrix in which they were found to be imbedded, but the attempt to restore it from the fragments has not been successful.

DIMENSIONS OF THE CORACOID.

	Inches.
Anterior margin	8
Anterior articular facet	3.5
Posterior articular facet	4.5
Posterior margin	14
Mesial articulation	15
Greatest thickness	3
Thickness of articulation of glenoid	3

Scapula.—Of this bone only a proximal fragment, 6 inches long, has been preserved. It presents a quadrate articular surface, 4 inches along the diameter for attachment to coracoid, and a rough deeply-grooved articular surface forming part of the glenoid cavity, the groove corresponding in position with the bicipital groove on the humerus. The bone appears to taper rapidly, the diameter where broken across being only 2 inches, while that of the articular end is 4 inches.

Humerus.—This is well preserved in 8 a, b, and d, in every case presenting nearly the same dimensions and character. It is greatly thickened at the proximal end to form a hemispherical articular surface and an expanded trochanter-like process, which are separated by a deep bicipital groove,

giving it more the look of a cetacean than a reptilian limb-bone. The distal extremity is flattened at right angles to the greatest expansion of the proximal, and has two distinct, slightly concave, articular surfaces to receive the ulna and radius. The plantar surface is smooth and slightly concave. The palmar surface slightly convex, and has a bold, rugose tuberosity in the middle to receive the attachment of the bicipital tendon, indicating powerful rotatory movements of the limb.

DIMENSIONS.						Inches.
Length	...	...	...	...	...	11.5
Diameter—articular surface	...	...	...	...	...	5
Diameter—neck	...	...	...	...	...	4
Length—trochanteroid surface	...	...	...	...	...	4.5
Width	...	...	...	...	...	2.5
Width—middle of bone	...	...	...	...	...	4.5
Thickness	...	...	...	...	...	2.5
Width—distal extremity	...	...	...	...	...	9
Thickness	...	...	...	...	...	2.5

Radius.—A pentagonal bone, with thin external margin and convex articular surfaces, and with a notch on the surface in contact with the ulna. It has two carpal articulations.

						Inches.
Length	...	...	...	...	...	3
Width	...	...	...	...	...	2.8

Ulna.—A hexagonal bone, with convex articulation.

						Inches.
Length	...	...	...	...	...	3.5
Width	...	...	...	...	...	4

Carpals.—The radial is cuneiform, with three articular surfaces and a bevelled external.

						Inches.
Length	...	...	...	...	...	2
Width	...	...	...	...	...	3

The *intermedium* is pentagonal.

						Inches.
Length	...	...	...	...	...	2.5
Width	...	...	...	...	...	2.5

Ulnare is hexagonal, with five articular surfaces.

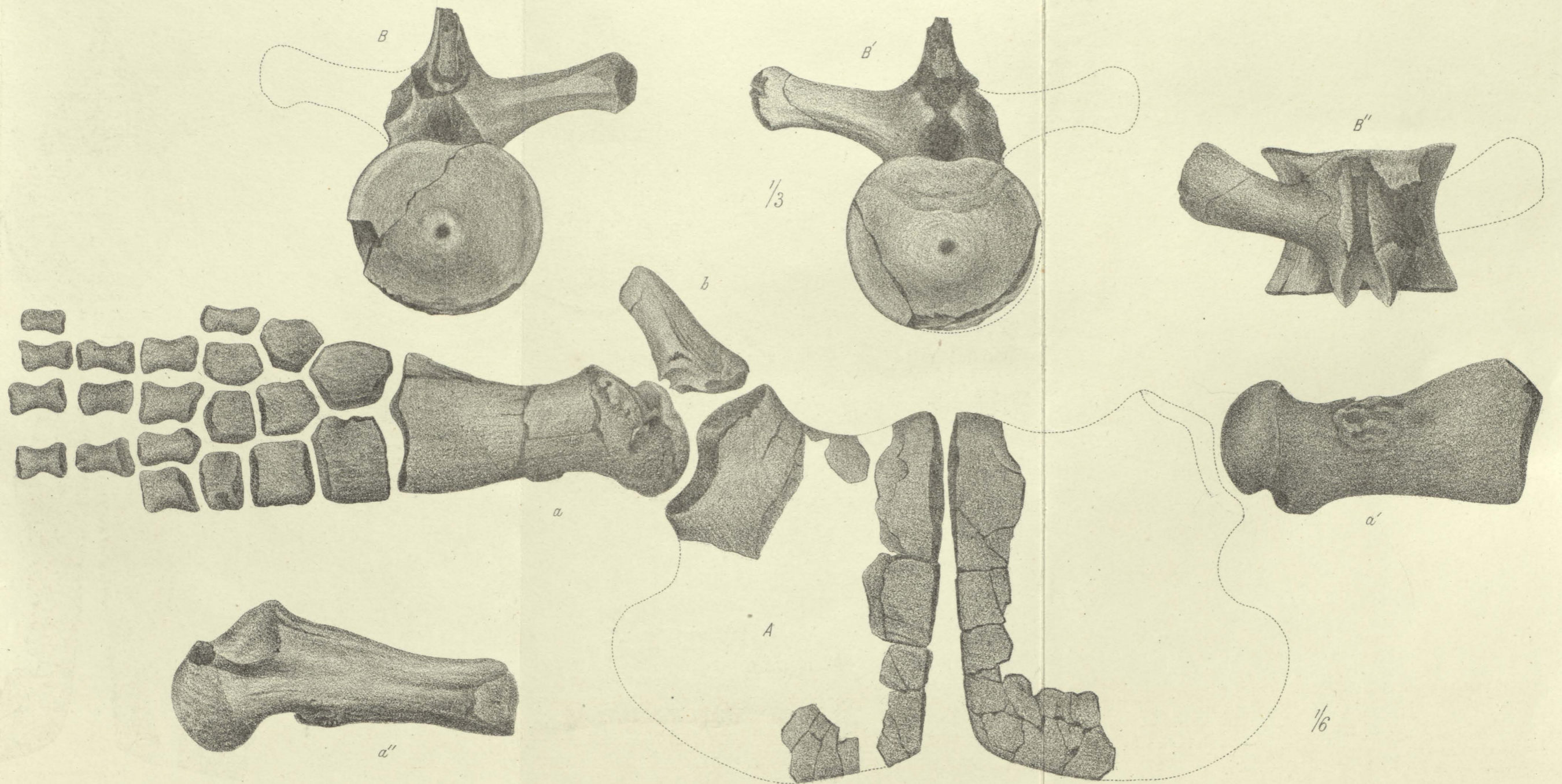
Distal Carpals.—1st has four articular surfaces, is rounded, and channelled externally.

						Inches.
Length	...	...	...	...	...	1.5
Width	...	...	...	...	...	2.5

It articulates with two phalanges.

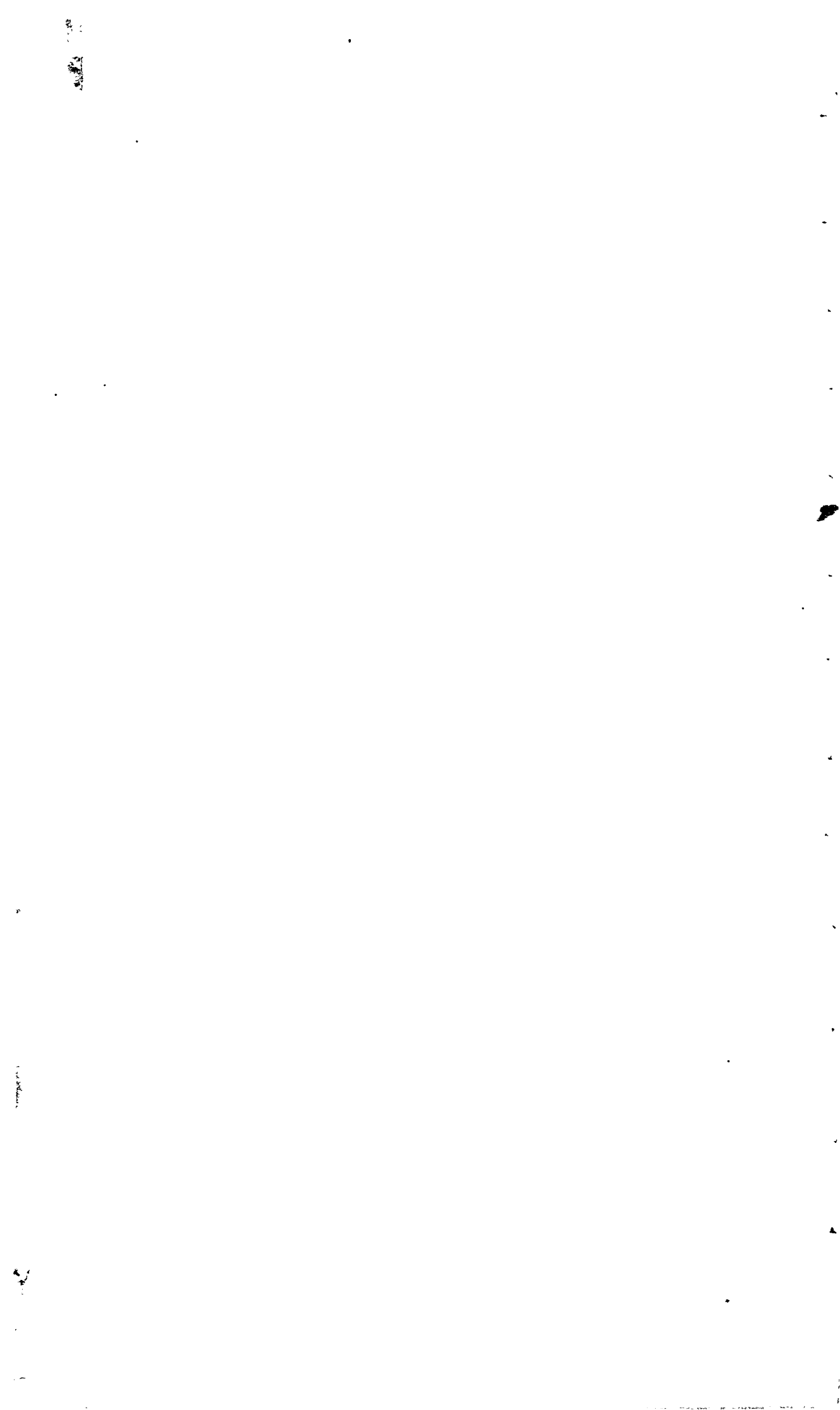
2nd also articulates with two phalanges, having, in all, five articular surfaces.

3rd is also pentagonal; articulates with only one phalange and the *ulnare*; the other surfaces not having perfect articulations.



MAUISAURUS HAASTII. *n. sp.*

J.B. del. et lith.



The quadrate character of the radius and carpal bones, and the grouping of the digits into three radial and two ulnar, indicates a difference from the ordinary Plesiosauroid.

The digits, however, are distinct, the phalanges being subcylindrical, compressed in the middle, and with distinct terminal articular surfaces. The proximal phalanges are 2·7 inches in length, and the 5th row are 2 inches.

As the smallest phalanges which have been obtained—1 inch in length by ·25 inch in diameter—still have articular surfaces and a constricted form, the digits must have been enormously prolonged to produce such attenuation. The total length of the paddle was probably not less than 5 feet.

No. 8 *b* is a slab got by Mr. H. H. Travers from the Amuri Bluff, in which were obtained, in addition to paddle bones and two cervical vertebræ, several rib fragments, which show that the rib had a wide, expanded, articular capitulum, which was apparently convex. The rib is rather sharply bent, with a thin inner edge, and a flattened, channelled surface, the cross section being a constricted oval.

No. 8 *c*.—Anterior dorsal vertebra, also collected at the Amuri Bluff by Mr. H. H. Travers, is a very finely-preserved specimen that has been worked out successfully from a hard matrix.

Centrum nearly circular, each vertebral diameter nearly equal to height, constricted one-fifth of the full transverse diameter at the middle part of the bone, where it is also compressed inferiorly. Articular facets very slightly concave, with central pit, on a raised tumid tubercle. Neural canal small, one-fifth the diameter of articular facets. No neural suture, the neural arch being simply a reflection of the lateral surface of the centrum, rising in the middle and supporting a large diapophysis, then springing from two ridges that bound a wide, shallow, smooth depression. The base of the diapophysis is trihedral. The upper surface is horizontal, and the lower, which is vertical to the centrum, is oblique, and excavated by a groove.

This process is expanded at the tip, with a slightly convex articular facet for the rib attachment. The length of the process is nearly equal to the height of the centrum.

The præzygapophyses are one-fifth the height of centrum in length, and one-eighth in width; being very feeble in proportion to the size of the bones. Their convex articular surface is deeply emarginate.

Post-zygapophyses are broken off. Neural spine equal to half vertical diameter of the centrum in length at base, and one-fifth the same in width.

The full height of the vertebral segment is 9 inches, or nearly twice the vertical diameter. Inferior surface has a bold mesial ridge separating venous foramina one inch apart.

DIMENSIONS.				Inches.
Height of centrum	...	...	...	5
Transverse diameter of centrum	..	...	...	5·5
Length of centrum	...	...	...	4·2
<i>Præzygapophysis</i>	...	...	...	1·3
<i>Diapophysis</i> —length	...	...	...	4·5
" width at base	...	...	...	1·6
" articular facet	...	...	...	2

No. 8 *b*.—This specimen, already referred to, also has two similar vertebræ, but less perfectly preserved, the dimensions agreeing exactly, so far as can be ascertained.

A centrum of a similar vertebra was found with the paddles at the Cheviot Hills, but as its length is one-fourth less, and the other dimensions are proportionately small, the Cheviot Hills specimen, notwithstanding its vast size, must have been greatly surpassed by those from the Amuri.

No. 8 *d*.—A paddle, also from the Amuri Bluff, the only divergence from the foregoing character being in the form of the ulna, which is decidedly more Plesiosauroid.

No. 8 *e*.—Four vertebræ, having the characters of the foregoing, but of smaller diameter, and without the long lateral processes; are, probably, from the anterior dorsal or cervical region of an individual of this species.

No. 8 *f*.—This is a large slab, which measures 4 feet in length, containing vertebræ which I refer to this species, showing that the neck had enormous proportions, the transverse diameter of the centrum being 4 inches, vertical 3 inches, and the length 3·5 inches. The neural spines are immensely elongated and closely interlocked, having a height of 5 inches, and a width of 2·7 inches. Thirteen vertebræ have been preserved in a continuous series, having a length of 3 feet 6 inches. The neck has been curiously twisted, so that the anterior four vertebræ have the ventral surface reversed in relation to the others. The four posterior vertebræ have hatched-shaped transverse processes. They resemble the description of the cervical vertebræ of *Elasmosaurus*, but present a marked difference in having the width of the centrum greater than its height, while the proportional length of the centra, and the large, firmly-anchylosed neural arches separate it from *Plesiosaurus*.

No. 8 *g*.—Several dorsal vertebræ belonging to this species are in the Canterbury Museum.

9. MAUISAURUS LATIBRACHIALIS, n. sp.

No. 9 *a*.—This specimen, obtained at the Amuri Bluff by Dr. Haast, is the proximal portion of a humerus of much larger size, and differs in its proportions from any of the foregoing, the width through the tuberosity being as 7 to 4, and also, at the same time, being so much compressed as to indicate a decided specific difference.

9 *b*.—A humerus corresponding with the characters of this species, but having also the ulna or radius, and some of the smaller paddle bones, is in the Canterbury Museum, according to Mr. A. McKay, who thinks the specimen came from Heathstock, in the Waipara.

LEIODON, Owen.

This genus was distinguished from *Mosasaurus* by Owen, by the form of the teeth, which are smooth, curved, and slightly compressed, so that in section they show an ellipse sharply pointed at both ends, and also by the mode of attachment of the teeth to the jaw bone. According to Professor Cope, it is abundant in America, being a characteristic fossil of the cretaceous formation, four species having been obtained from the western, four from the eastern, and two from the southern, cretaceous rocks of the United States; while the only other known species is represented by the jaw fragments found in Europe, and described by Professor Owen. The characters of the vertebræ show it to have been an exceedingly elongated reptile, one of the American species, the individual bones of which are not larger than those now to be described from the Amuri, having belonged to an animal which was not much short of 100 feet in length.

10. LEIODON HAUMURIENSIS, n. sp.

No. 10 *a*.—This is a portion of a skull of a gigantic species, which I refer to this genus on account of the character of the teeth. It consists of the whole tooth series of the upper jaw and the corresponding portion of the lower jaw of the right side, and the anterior half of the lower jaw of the left side, which was worked out from the lower part of the slab. There are 15 teeth, averaging two inches apart, above and below; the mature teeth rising from a distinct elevated crown of cement—characteristic of this genus—while the immature teeth push their way through the cement, generally alongside or slightly internal to the base of the old teeth. The largest mature teeth have a black enamelled crown 1.5 inches in length, slightly curved outwards and backwards, compressed laterally with an obtuse anterior ridge, and more rounded but still slightly angulate behind, the surface being irregularly striate but not channelled. The long diameter of the base is about .9, and the short diameter about .6, inches. Pulp cavity is filled with rock matrix, and the section shows it constricted where implanted in the dental cement. The internal cavity of the tooth shows more lateral compression than the external surface. It is lined with a black layer, between which and the enamel the dental substance is yellowish white. The total length of the tooth series is 26 inches; the jaws are quite straight and not curved towards the symphyses, and appear to have been set at a moderate horizontal angle, so that the muzzle must have been long and narrow.

Both jaws are prolonged as blunt processes for 2 inches beyond the tooth series, and show no sign of terminal teeth. The height of the lower jaw at first tooth is 2·5 inches, and at the tenth tooth 3·5 ; and the upper jaw appeared to maintain its width in the same remarkable way.

No. 10 *d*.—A string of 10 lumbar vertebræ, from the Waipara, appear also to belong to this genus. They are procelian and subprismatic in section. The neural spines are not well preserved, but were attached along the whole length of the vertebræ. The lateral processes (*pleurapophyses*) are short stout cylindrical tubercles, 1·5 inches long by 1·3 inches in diameter, with rounded extremities, received into distinct articular surfaces on the heads of the ribs. The surface of the bodies of the vertebræ is roughened and striated. They slightly expand towards both articular extremities, therein differing from another genus to be described. The articular surfaces are smooth, and the posterior extremity is marked by the peculiar epiphysial ridge shown in the drawing of *Mosasaurus* vertebræ in Mantell's "Fossils of Sussex."

The neural spines are remarkable for their great breadth, being 2·5 inches long and 3 inches high, and also for the very strongly striated surface, which character appears to be common to nearly all the flat bones of this reptile.

The dimensions of the vertebræ are :—

						Inches.
Transverse	...	...	...	...	...	3·5
Height	...	...	...	...	...	3
Length	...	...	...	...	...	3·5

No. 10 *e*.—I refer to this species 7 ribs, which are flattened and channelled deeply on the internal surface, and very much expanded towards the head, where they have well-developed articular processes, which are irregularly cup-shaped, with thin margins. They taper very much in the other direction.

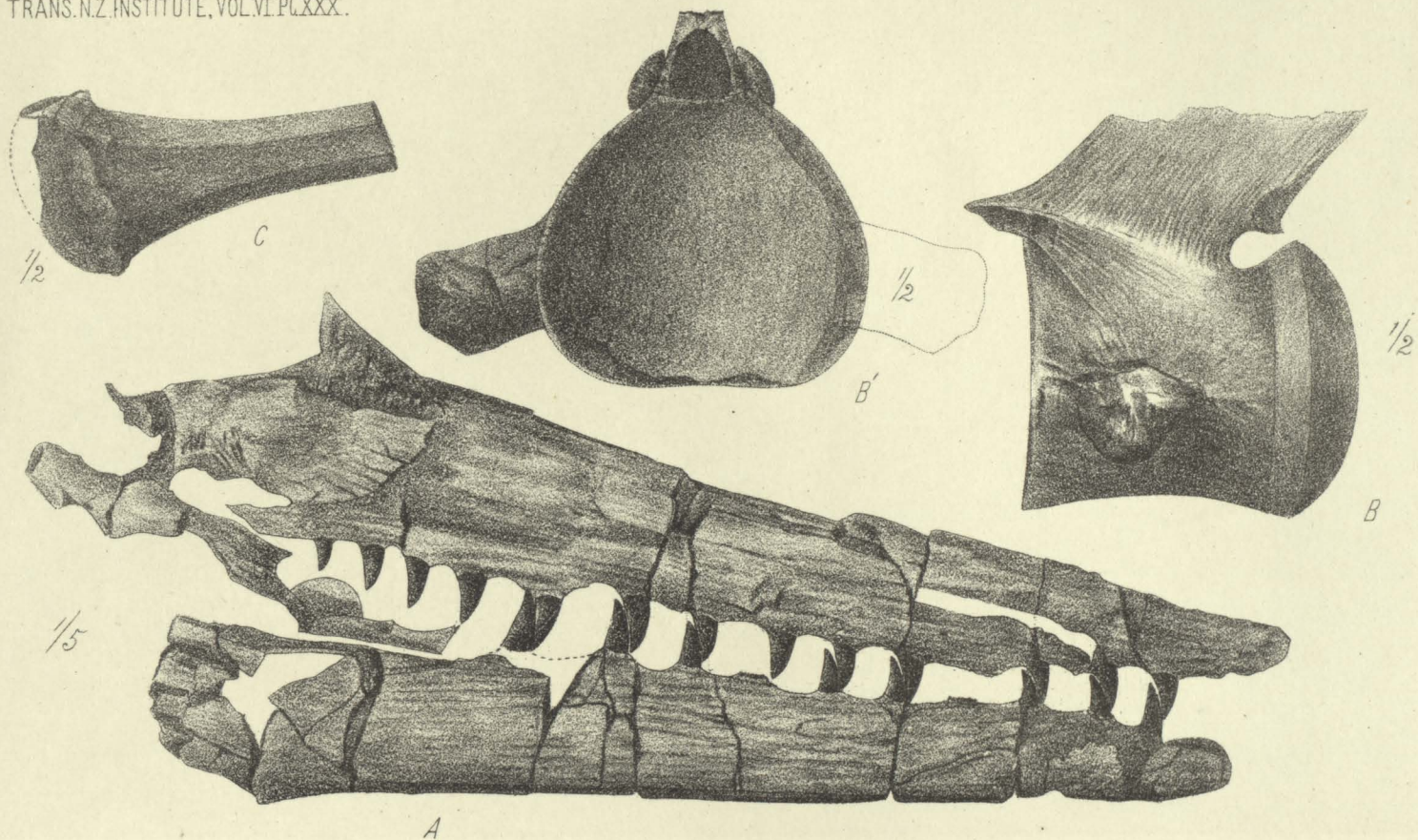
Longest rib, of which there are 8, is 18 inches ; also two abdominal ribs and three phalanges.

These were found in a slab at the Waipara, close to the vertebræ (10 *d*), and the evidence for connecting them with this genus is afforded by the peculiarly-excavated form of the head of the rib, which appears to fit the articulated surface on the tubercle, and also their striated surface ; and, further, certain fragments of spinous processes intermixed with the ribs also assist in this determination.

No. 10 *f*.—Three caudal vertebræ, from the Amuri Bluff, evidently belong to the same species with the above, and form one of the most important links in connecting palæontologically these widely-separated localities.

No. 10 *g*.—A slab of 20 caudal vertebræ, chevron processes, and neural spines, which also belong to this species. Obtained from the base of the boulder bed at the Amuri.

The most anterior vertebra is 2·3 inches in diameter, whilst the last



LEIODON HAUMURIENSIS.



vertebra of the string has its centrum 2 inches in diameter. There is, however, one detached vertebra of minute size, the centrum being only .75 inch, which would apparently indicate that the diameter of the caudal vertebræ either diminished suddenly, or that the number must have been very great. The length of the centrum is 1.5 to 1.2 inches, while that of the single small vertebra is only .5 inch.

They are all proœelian, quadrilateral in section, with a small triangular neural canal, enclosed by a stout spinous process 3 inches in height by 1 in width.

The chevron bones are 5.5 inches in length, the bifurcate processes 1.5, articulating with facets on the lower aspect of the centra, and obliquely directed backwards, in the same way as the first of the series of chevron bones in the Tuatara.

No. 10 c.—Eight vertebræ from another slab, also from the Amuri Bluff, probably from the cervical portion of the column. They are connected with the foregoing, from the striated character of the spines and the proœelian form of the centra. The inferior surface of one is well preserved, and shows a width between the insertion of the lateral processes of 1.7 inches, or about the same as that of the anterior articulations. The excavation on the inferior surface of the centrum, beneath the lateral process, corresponds closely with that observed in 10 d.

No. 10 g.—Jaws and teeth of a fine specimen, collected by Dr. Haast at the Amuri Bluff, but still imbedded in the blocks of matrix, appear to belong to this species.

No. 10 h.—Lower jaws of both sides, with the tooth series exposed, but in a very broken and displaced condition. The jaws appear to be curved and set at a wide angle, resembling the figure of *Mosasaurus*; but the form of the teeth and the other characters place the specimen with the narrow-muzzled *Leiodon*, so that the apparent width of the mouth indicated in this specimen must be attributed to dislocation.

No. 10 i.—In the Canterbury Museum are several vertebræ from Waipara, which agree with the characters attributed above to *Leiodon*, and probably the *Teleosaurus*, mentioned by Mr. Hood as having been sent home in the Matoaka, is to be referred to this genus.

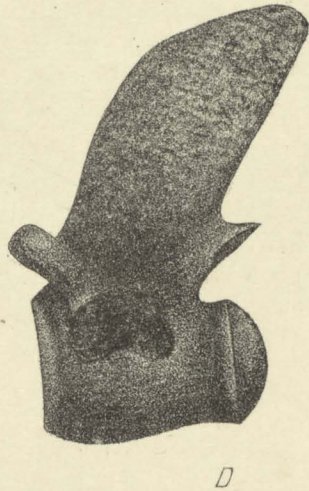
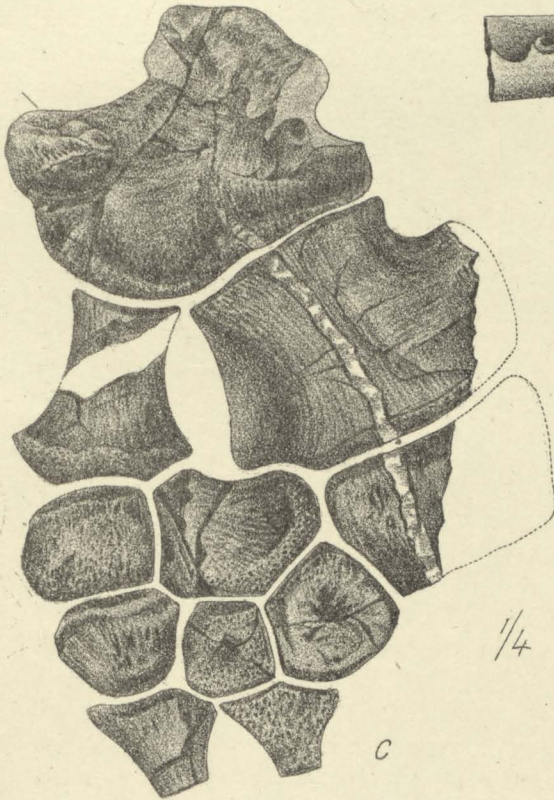
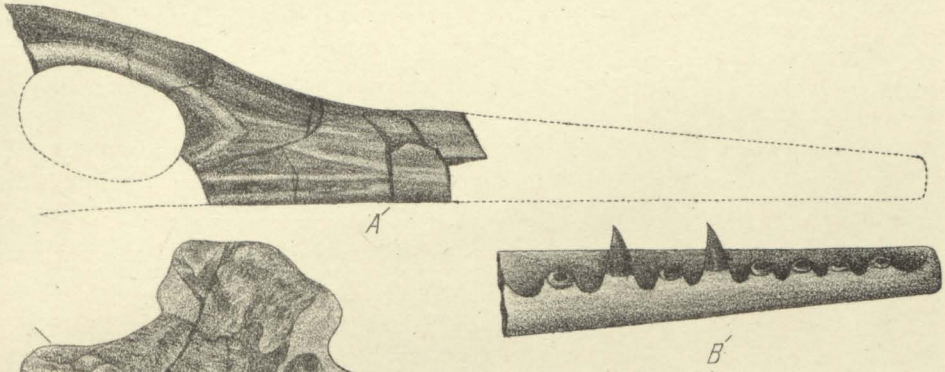
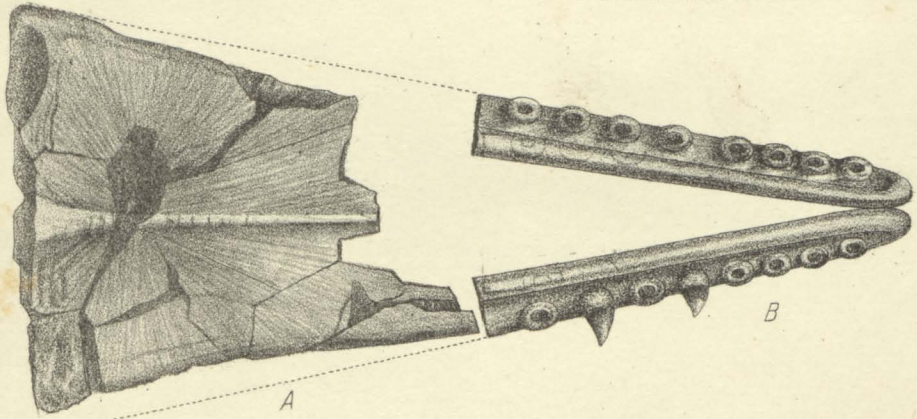
11. TANIWHASAUROS OWENI, n. sp.

I have applied this term to a mass of vertebræ, a skull, and paddle bones from the Amuri Bluff, which, though occurring in three separate portions, have been identified as belonging to the same species. The dorsal vertebræ, of which seven are preserved, are proœelian, and characterized by their bodies having a greater anterior than posterior diameter, the cup end having a much greater diameter than the ball which it receives. The plane of each

articular surface is, moreover, displaced obliquely backwards with reference to the general axis of the vertebral column. Surrounding the ball end of the vertebra is a very distinct capsular ridge and groove. The neural arches are continuous with the anterior portions of the centra, and articulate by bold transverse processes, the anterior being the longer in each case. A slight overhanging continuation of the anterior margin of the spine over the neural canal seems to indicate a rudimentary zygosphene.

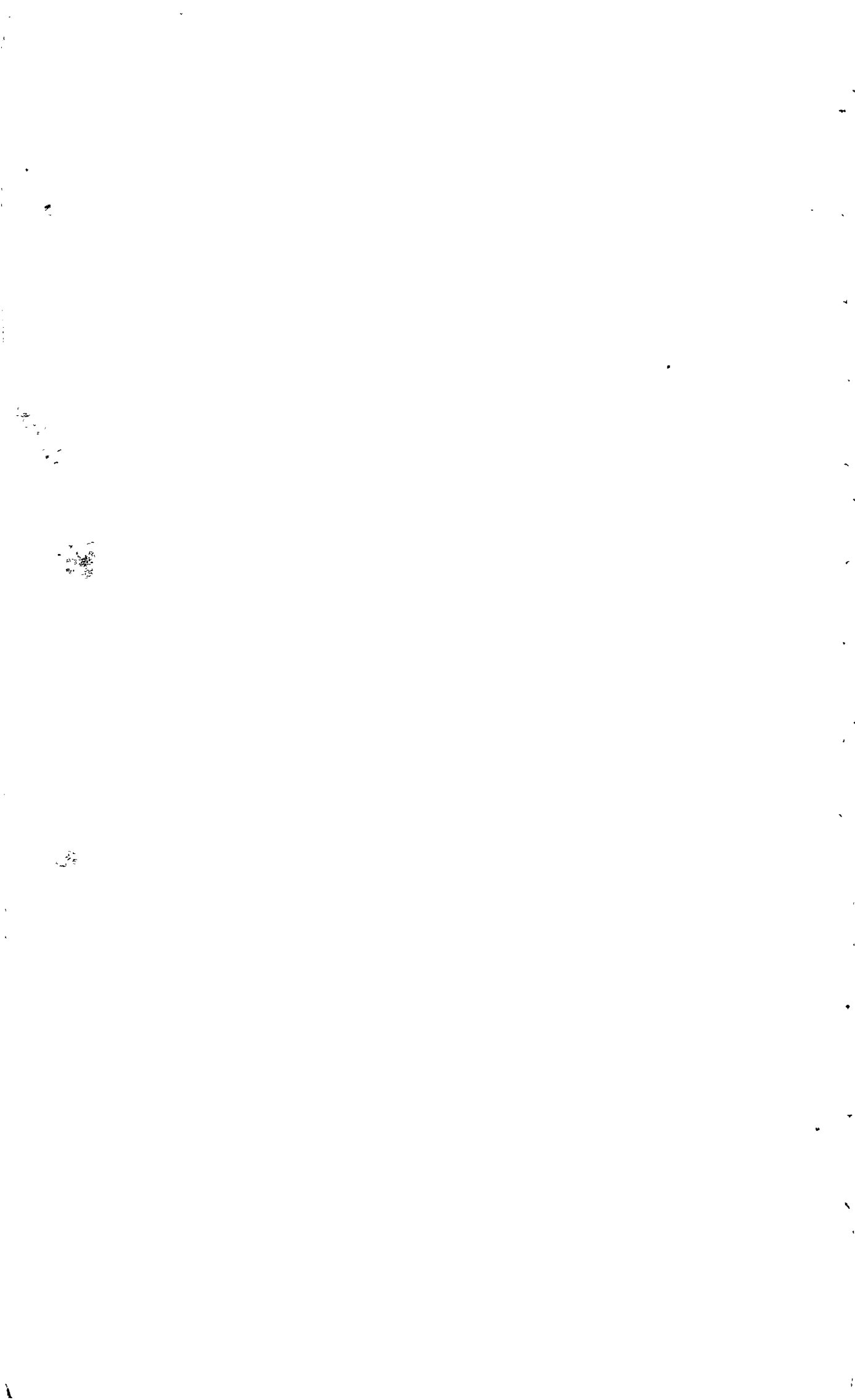
The ribs appear to have articulated with a rough surface, placed on the anterior and upper part of the centra. A few fragments of ribs are preserved, and show the articular head to have had a convex surface. The inferior two-thirds of the circumference of the centra presents an even striated surface. The centra are compressed laterally, but not constricted; length 4 inches, height 3·5 inches, transverse diameter of anterior articular surface 3·5 inches, posterior about 3 inches. The ribs, which are 1·5 inches wide, are flattened, and only slightly expanded at their insertion.

The paddle bones are very remarkable, and differ altogether from anything else in the collection. The humerus is extremely short in proportion to its width, having a flattened form, and strong irregular much-recurved anconal processes. Its length is 6 inches, proximal width 3 inches, distal width 6 inches. Radius 4·5 inches in length, 3·5 at the distal extremity, and 2·5 in the middle. The carpals are remarkably thin and flattened, their borders being raised and roughened. Only a few fragments of phalanges are preserved, from which they appear to have been rather elongate cylindrical bones expanded at both ends. The head is preserved in two portions from the orbit forwards, but a part is wanting in the middle. The orbital width is 7 inches, and the total length was about 24 inches; the length of the tooth series 14 inches. The form of the symphyseal surface uniting the two rami, and the angle of divergence which they show, would make the gape about 7 inches wide, or about half the length of the tooth series. The teeth are badly preserved, but consisted of a thin layer of enamel enclosing a widely conical cavity, not constricted at the base. The teeth are finely striated, only slightly compressed, and without any well-marked ridge; length, 1 inch, greatest diameter at base ·8 inch. Although firmly imbedded in cement they appear to have been attached by thin bases to the inner side of the floor of the dental groove, the exterior parapet being very low, so that the teeth must have been set in the jaw with a marked lateral divergence, and not placed vertically as in *Leiodon*. This is shown in two sections of the jaw on Plate XXVI., figs. *b* and *c*, but in which the lines *xy* are perpendiculars, the drawings having been wrongly placed on the stone. By working out the base of the skull, which is much fractured, a smaller and more cylindrical tooth was exposed, which was probably a pterygoid tooth, such as are found in *Mosasaurus*. The cranial



TANIWHASAUROS OWENI. n. sp.

J. B. del. et lith.



bones which have been exposed have a thin squamous structure, with ridges radiating from the centres of ossification, that give them the appearance of fish bones. The orbit is well defined by a distinct bony arch having a rounded margin.

13. *ICHTHYOSAURUS AUSTRALIS*, n. sp.

This genus is only represented in the collection by a single vertebral centrum, in a matrix of dark-coloured, fine-grained, micaceous sandstone belonging to the rocks of Mount Potts, in the Rangitata district of the Province of Canterbury. Dr. Haast thus describes the strata from which the specimen in question was obtained:—The beds are here “represented by a great thickness of dark shales, often becoming so slaty that they may be termed clay-slates, alternating with thinner layers of sandstone, sometimes with a ferruginous or calcareous matrix. Amongst these occur a few beds of conglomerate, which fairly may be termed bone beds, as they consist, besides boulders and pebbles of light-coloured slates, of great quantities of well-rounded pieces of bones and broken shells. The former often show considerable dimensions. I was thus able to measure the proximal end of, probably, a humerus, which I found to be 8 inches across, and some other bones of similar dimensions. However, the bones, as before observed, were so much rolled, and the cementing medium of such considerable hardness, that I was unable, with the tools at my command, to procure any characteristic specimens, but I have no doubt that they are of Saurian origin. No teeth were visible amongst this bone breccia.”*

From the associated fossils Dr. Haast concludes that these beds are of carboniferous age, but they appear to be identical with strata that, in other parts of the colony, are considered to be triassic.

The foregoing imperfect notes have been prepared under great disadvantages from want of the necessary works of reference, and sufficient leisure from other duties for conducting so intricate an investigation; but it is hoped that they will serve to indicate the extraordinary variety and interest of these fossil remains, which prove that the ocean during the upper mesozoic period was, in the Southern as in the Northern Hemisphere, tenanted by huge Saurians performing the functions in the animal economy that are now fulfilled by the predaceous Cetacea and marine Carnivora.

NOTE. Jan., 1874.—Having visited the Amuri district since the foregoing paper was written, I have arrived at the opinion that the section exposed at the Amuri Bluff, from which the Saurian remains were obtained, includes a lower formation than any yet found in the Waipara district, and that this lower group can be distinguished by its included fossils.

The section is much obscured by landslips at the points where the most

* Geol. Surv. Rep., 1873, p. 5.

important junctions occur, but the following is an approximation to the sequence and thickness of the strata, as seen in descending order along the north-east face of the bluff.

I.—Chalk Group.

- a. *Leda Marls* (700 feet).—Greenish sandy and argillaceous marls, with hard and soft layers. *Pecten zitelli*, *Leda*, *Waldheimia*, *Scalardia*, *Cidarites*, and *bone fragments*. These marls strike N. 40° E., with an increasing dip from 15° to 40° towards the base, where they gradually pass into greensands or yellow calcareous sandstone speckled with glauconite.
- b. *Fucoidal Limestone* (50 feet).—An indurated calcareous sandstone, generally separated from (a) by a thin layer of brecciated fragments of calcareous greensand, but frequently the greensand is interlaminated, and fills the fucoid casts. The character of this junction is constant over a large area—from the Weka Pass to the Kaikoura—but at the latter place a corrugated concretionary disturbance of the calcareous beds has given rise to an apparent unconformity. *Fish teeth* and *Fucoids*.
- c. *Flaggy Limestone* (30 feet).—Yellowish-white, smooth-grained limestone, like indurated chalk, in thin layers. *Pentacrinus*, *Pecten* (fragments, like *P. hochstetteri*), *Inoceramus* in large fragments.
- d. *Cherty Limestone* (300 feet).—Chalk, with flints. At Kaikoura the flints are more abundant, and are sometimes quite black.
- e. *Grey Limestone* (100 feet).—A gritty, subcrystalline limestone, weathering white. *Worm casts* and *Pecten*.
- f. *Chalk Marl* (300 feet).—With hard indurated bands and layers of greensand.

II.—Greensand Group.

The strike changes in this group to N. 20° E., the dip being 30° E.S.E.

- g. *Teredo Limestone* (20 feet).—Dark grey, subcrystalline, ferruginous limestone, weathers red, almost entirely composed of *Teredo casts*. Contains *Trigonia alceformis* var., and *Pentacrinus*.
- h. *Greensand* (20 feet).—Incoherent, rather coarse-grained, clear sands, of bright colours, generally green.
- i. *Concretionary Greensand* (300 feet).—Calcareous green or grey sandstone, with large calcareous concretions irregularly dispersed.
Cucullæa (*alta*?), *Dentalium* (like *D. irregularis*, but with large and small ridges alternating), *Tellina* (*scitulina*?), *Leda*, *Scaphites* or *Hamites*, *Ammonites* (like *A. daintreei*, but still more compressed),
† *Belemnitella lindsayi* (n. sp., also found over the brown coal at Green Island, near Dunedin), *Inoceramus* (large fragments). *Plesiosaurus australis* (No. 1 b) was obtained from this stratum.

- k. *Boulder Sands* (100 feet).—Dark grey, laminated, micaceous sands, with large spheroidal calcareous concretions, containing *Mauisaurus haastii*, *Plesiosaurus traversii*, *P. hoodii*, *Polycotylus tenuis*, *Leiodon haumuriensis*, and *Taniwhasaurus oweni*; also *Aporrhais ornata* and *Ostrea*.
- l. *Gypseous or Sulphur Sands* (400 feet).—Dark grey and brown false-bedded sands, coarse and fine in grain, the upper part being greensand. No fossils, but contains pyrites and gypsum, with coaly streaks* and silicified wood. The weathered surface often covered with a sulphur yellow efflorescence.

III.—Amuri Group.

Strike nearly N. and S.

- m. *Black Grit* (20 feet).—Fine-grained grit of small, water-worn pebbles of green and white quartz, and a small quantity of titaniferous iron, in a grey calcareous matrix. Fossils abundant, but all rolled. *Belemnitella*, *Pecten obovatus* var., *Radula*, *Plagiostoma*, *Inoceramus cuvieri*, *Trigonia sulcata*, *Mytilus*. Fragments of bone and teeth, chiefly of fishes, but also Saurians—*Polycotylus*, *Plesiosaurus*.
- n. *Grey Sandstone* (130 feet).—Compact calcareous sandstone, formed in parts almost entirely of shells. *Panopæa plicata*, *Trigonia sulcata*, *Eriphylla (Dosinia) haumura*, *Axincea (Pectunculus) cuneiforme*, *A. cardioides*, *Inoceramus multiplicatus*, *I. mytiloides*, *I. haastii*, *I. simplex*, *Aucella plicata*, *Radula*, *Alaria*, *Turbo*, *Pleurotomaria*, *Neptunæa*, *Ostrea*, *Crenella*, *Belemnites aucklandicus*, *B. compressus*, n. sp. Fragments of bone, teeth, and scales of fish.
- o. *Calcareous Conglomerate* (70 feet).—Light grey calcareous sandstone, with pebbles interspersed, chiefly of black siliceous sandstone and layers of fossils, principally *Belemnites* and fish teeth.

IV.—Jurassic.

Green argillaceous sandstones and shales, with spherical concretions and obscure plant remains. These resemble the plant beds, or Mataura series, of the south of Otago, and the Putataka beds, in part, of the North Island, which are characterized by *Tæniopteris*, *Camptopteris*, *Pecopteris*, and Conifers, accompanying irregular seams of coal. There is distinct unconformity between these strata and the foregoing, and on the western side of a narrow ridge of these jurassic rocks the same section is again repeated in ascending order on the eastern side of a syncline. But on following the beds to the western side of the same syncline, the lower members

* Pitch-brown coal, non-caking—water 14, carbon 54, ash 5.

of the section are wanting, and the upper, or chalk, group is found to rest against the older sandstone rocks of the district. In the estimated thickness of 2,500 feet of strata exposed at the Amuri Bluff, it is evident, from the fossils, that the sub-divisions as above may be, at least provisionally, adopted with advantage. The only fossil that appears to be common to the second and third groups is *Trigonia sulcata*,* and unless No. III. is the equivalent of the Belemnite beds at Waikato Heads and Kawhia, it has not yet been found at any other part of the colony than the Amuri Bluff. If it is the same formation the evidence obtained from the above section would seem to require the sub-division of the Putataka beds into two distinct formations.

ART. LIII.—*On the Teeth of the Leiodon.* By CHARLES KNIGHT, F.R.C.S.,
President of the Wellington Philosophical Society.

Plates XXIV.—XXVI.

[Read before the Wellington Philosophical Society, 16th January, 1874.]

AT the suggestion of our late President, Dr. Hector, I have examined microscopically the fossil teeth of the remains of the *Leiodon* in the Museum.

The aquatic Saurians are arranged under Sauropterygia and Pythonomorpha. The former had two pairs of limbs, the latter an anterior pair only. The *Leiodon* belongs to the Pythonomorpha, with snake-like bodies of immense length. The *L. dyspelor*, discovered in New Mexico, is estimated at not less than 100 feet in length, and would be, says Professor Cope, the longest reptile known, and may well excite our astonishment.

The *Leiodon* is closely allied to the celebrated gigantic *Mosasaurus hoffmanni*, or what was at first called the crocodile of Maestricht. Neither Mantell nor Owen were able to say, from the few and scattered remains to which they had access, whether the *Leiodon* is a species of *Mosasaur* or a distinct genus. The chief distinction is in the teeth, which, in the *Mosasaur*, have the outer side flat with two sharp edges, while the inner side is round. Where the teeth are absent the unsettled distinction between the *Mosasaur* and the *Leiodon* renders it probable that some of the former species may really be *Leiodon*, as suspected by Professor Cope in his paper on the fossil reptiles of the cretaceous

* *Trigonia sulcata*, n. sp. General form like *T. gibbosa*, but sculpturing different. Traversed radially by a wide groove; posterior area with radial striæ; anterior with divaricate ridges cut into tubercles by concentric striæ, that are continued over the whole surface. Valve rather flat; hinge-margin rounded and overhanging; hinge-plates strong. Length, 3.5 inches; width, 3 inches.