NIPPONOSAURUS SACHALINENSIS

A NEW GENUS AND SPECIES OF TRACHODONT DINOSAUR FROM JAPANESE SAGHALIEN

By

Takumi NAGAO

With 12 Plates

INTRODUCTION

Trachodonts or Hadrosaurs, a group of Cretaceous herbivorous dinosaurs, are known to occur in abundance in North America, most of the genera having been reported from that continent. From outside of North America we know three forms, viz., *Orthomerus transsylvanicus* (NOPCSA)[1] from Europe, *Manchurosaurus amurensis* (RIABININ)[2], and *Tanius sinensis* WIMAN[3], both from Eastern Asia. Toward the end of November, 1934, a specimen was quite unexpectedly met with at the Kawakami colliery of the Mitui Mining Company in Japanese Saghalien. This specimen which is treated in the present paper is the first example of this remarkable sort of reptile discovered in Japan.

The material includes various parts of one individual comprising more than a half of the skeleton and a few fragments of the skull. Of these bones, some have been sent to the present writer by Mr. K. NEMOTO, an arduous collecter of fossils in Otaru near Sapporo, and some others were purchased through his good offices, to whom the writer is thankful. The remaining portion of the material was presented to our

(1) F. B. NOPCSA: Dinosaurierreste aus Siebenburgen (Schadel von *Limnosaurus transsylvanicus* nov. gen. et spec.). Denkschr. d. Kaiserl. Akad. d. Wiss., Mathem.-Naturwiss. Cl., Bd. LXVIII, 1900, p. 555. B. BROWN proposed 1910 a new name *Hectasaurus* to replace *Limnosaurus* which is preoccupied. B. BROWN: The Cretaceous Ojo Amalo beds of New Mexico with description of the new dinosaur genus *Kritosaurus*. Bull. American Mus. Nat. Hist., Vol. XXVIII, 1910, p. 273.

(2) A. N. RIABININ: A mounted skeleton of the gigantic reptile *Trachodon amûrense* nov. sp. Bull. d. Com. Géol. (Leningrad), Vol. XLIV, 1925, p. 11. A.N. RIABININ: *Manchurosaurus amurensis* nov. gen. nov. sp., a hadrosaurian dinosaur from the Upper Cretaceous of Amur River. Mém. Soc. Paléont. d. Russie, Vol. XI, 1930, p. 5.

(3) C. WIMAN: Die Kreide-Dinosaurier aus Shantung. Palaeont. Sinica, Ser. C, Vol. VI, Fac. 1, 1929, p. 41.

Institute by courtesy of the officers of the Kawakami colliery; the writer should like to express his gratitude to the officials of the colliery, especially to Messrs. K. TODA and M. KITAZIMA. Very lately a fragment of the skull of this individual has been kindly donated by Mr. W. HASIMOTO. Besides, the writer's sincere thanks are due to Prof. H. YABE of the Institute of Geology and Palaeontology in Sendai for the free use of very extensive literature in his private library, and also to Mr. S. ÔISHI of our Institute for his kind assistance during the preparation of the material.

The animal fell on a mud bottom not far from the coast; numerous fragments of plants, some of which are doubtless terrestrial in origin, are contained in the matrix. Some disturbance of the bones was brought about by the action of waves before the entombment in sediments, and although the entombment was rapid enough to prevent a great collapse of the skeleton, most of the bones were found disarticulated and more or less dislocated [Pl. XII (II)]. The head was strongly flexed and found near the sacral region in association with some dorsal vertebrae. Fortunately, however, the crushing of the bones had not been great, and most of them were discovered close together. It is evident that the full specimen had represented an almost complete skeleton with the skull before the excavation from the bed-rock; the missing bones may have been lost by careless removal from the rock.

The huge nodule in which the fossil was contained was discovered in a cliff during the widening of the ground for the hospital belonging to the colliery. It had been broken into pieces some of which cannot be regained. More than ten of these pieces each including some fragments of the skeleton were sent to Sapporo and were readjusted in possible natural position for the preparation. Owing to the hardness of the rock and the brittleness of the bones it was very difficult to remove them from the matrix, and almost all of them have been injured more or less before and during preparation.

Some detailed descriptions of a member of the family Trachodontidae (Hadrosauridae) have been published and various features of these animals are known to a certain extent; L. M. LAMBE's article on *Edmontosaurus regalis*[1] contains one of the most detailed accounts and W. A. PARKS' description on *Kritosaurus incurvimanus*[2] is another

(1) L. M. LAMBE: The Hadrosaur Edmontosaurus from the Upper Cretaceous of Alberta. Geol. Surv. Canada, Mem. 120, 1920.

(2) W. A. PARKS: The osteology of the Trachodont dinosaur *Kritosaurus incurvimanus*. Univ. Toronto Studies, Geol. Ser., 1920.

fairly complete one. The present specimen discovered in Saghalien is far from being perfect and its skull is regretably so poor as to make its closer comparison with some American forms difficult. It has sufficient interest, however, to warrant a somewhat detailed description, for it is an unique example of dinosaur from Japan, discovered in a place so far from the American continent, and moreover quite different from the two before mentioned species from Asia.

DESCRIPTION OF THE MATERIAL

Nipponosaurus sachalinensis nov. gen. et sp.

Type specimen: Various parts belonging to a single individual. Regist. No. 6590, Institute of Geology and Mineralogy, Hokkaido Imperial University.

Locality: Kawakami Colliery, Toyohara-gun, Japanese Saghalien.

Horizon: Upper Ammonites Bed.

Age: Senonian.

Generic and Specific Characters: A small trachodont dinosaur with the skull deep, rather broad, short, and probably steep in front. The cranium squarish in outline in lateral view. The frontal region with a low swelling. The "crest" presumably represented by an incipient dome-like prominence. Vertebrae with large neural canls. Cervical centra strongly opisthocoelous, with very convex anterior articular surfaces. Dorsal centra much reduced in size, moderately opisthocoelous, and almost flat anteriorly, with well developed and high neural spines. Caudal centra slightly amphicoelous with well developed chevrons. Scapula slender and straight. Ischium with a well developed foot-like expansion which is distinctly excavated externally. Femur, tibia and fibula of nearly equal length. Metatarsals rather long and massive.

Skull

Pl. XIII (III), Fig. 1.

There is preserved the left side of the skull comprising the greater part of the jugal, the frontal, the postfrontal, the parietal, the squamosal, and the posterior portions of both maxillary and dentary with a number of teeth. Besides, a few fragments of bones derived from the skull are contained in the material, the natural position of which is not determinable.

The skull apparently resembles that of *Tetragonosaurus*[1] from the Belly River formation of Alberta, Canada. It is very deep with the

(1) W. A. PARKS: A New Genus and Two New Species of Trachodont Dinosaurs from the Belly River Formation of Alberta. Univ. Toronto Studies, Geol. Ser. No. 31, 1931.

upper surface nearly horizontal from the parietal region to the prefrontal. The frontal is distinctly indicated to bear a dome-like swelling. The prefrontal bone is missing but the anterior margin of the skull is shown to descend downward rather abruptly. The nasalia and premaxillary are almost lost except a few fragments, but as far as observable there is no indication of a well developed helmet-like crest as seen in *Corythosaurus*(1), *Lambeosaurus*(2), *Hypacrosaurus*(3), nor a horn-shaped process as in *Saurolophus*(4) and *Parasaurolophus*(5). It may be more closely similar to *Cheneosaurus tolmanensis* LAMBE(6) and to *Tetragonosaurus*. In the last two genera the "crest" is low, broad, and somewhat dome-like.

Jugal. This bone is very imperfectly preserved and much deformed, incomplete along the margins and especially broken in its anterior and posterior extremities. Consequently the general features are not certainly known. It is thin, apparently long, and deep, forming a plate-like appearance, almost flat vertically and slightly convex antero-posteriorly. The lower margin is produced downward to overlap the coronoid process

(1) B. BROWN: *Corythosaurus casuarius*, a New Crested Dinosaur from the Belly River Cretaceous, with Provisional Classification of the Family Trachodontidae. Bull. Amer. Mus. Nat. Hist., Vol. XXXIII, 1914, p. 559, Pl. XLI. C. W. GILMORE: A Species of *Corythosaurus*, etc. Can. Field Naturalist, Vol. XXXVII, 1923, p. 46. W. A. PARKS: *Corythosaurus intermedius*, a New Species of Trachodont Dinosaur. Univ. Toronto Studies, Geol. Ser,, No. 15, 1923, p. 5. W. A. GILMORE: New Species of Trachodont Dinosaurs from the Cretaceous Formations of Alberta with Notes on Other Species. Ibid., No. 37, 1935, p. 21.

(2) L. M. LAMBE: On a New Genus and Species of Carnivorous Dinosaur from the Belly River Formation of Alberta, with a Description of the Skull of *Stephanosaurus marginatus* from the Same Horizon. Ottawa Naturalist, Vol. XXVII, 1914, p. 17. W. A. PARKS: *Corythosaurus intermedius*, a New Species of Trachodont Dinosaur. Op. cit., p. 6. C. W. GILMORE: On the Genus *Stephanosaurus*, with a Description of the Type Specimen of *Lambeosaurus lambei* PARKS. Geol. Surv. Canada, Bull. No. 38, 1924, p. 29.

(3) B. BROWN: A New Trachodont Dinosaur, *Hypacrosaurus*, from the Edmonton Cretaceous of Alberta. Bull. Amer. Mus. Nat Hist., Vol. XXXII, 1913, p. 395. C. W. GILMORE: On the Skull and Skeleton of *Hypacrosaurus*, a Helmet-crested Dinosaur from the Edmonton Cretaceous of Alberta. Geol. Surv. Canada, Bull. No. 38, 1924, p. 49.

(4) B. BROWN: A Crested Dinosaur from the Edmonton Cretaceous. Bull. Amer. Mus. Nat. Hist., Vol. XXXI, 1912, p. 131.

(5) W. A. PARKS: *Parasaurolophus walkeri*, a Now Genus and Species of Crested Trachodont Dinosaur. Univ. Toronto Studies, Geol. Ser. No. 13, 1922. C. WIMAN: *Parasaurolophus tubicen* n. sp. aus der Kreide in New Mexico. Nova Acta Regiae Soc. Sci. Upsal., ser. IV, Vol, VII, 1931, p. 3.

(6) L. M. LAMBE: On *Cheneosaurus tolmanensis*, a New Genus and Species of Trachodont Dinosaur from the Edmonton Cretaceous of Alberta. Ottawa Naturalist, Vol. XXX. 1917, p. 117.

of the lower jaw. The upper margin is marked by the indentations which form the lower boundaries of the orbital and lateral temporal fenestrae. It displays above a rather narrow projection which separates the two fenestrae and meets the lower bar of the postfrontal. The facet for the maxillary is not preserved but is apparently concave internally as shown by the natural cast. The total length is unknown, both extremities being missing.

Lateral temporal fenestra. This opening is incomplete below, but seems to be elongate ovate in outline and oblique downward and forward; the posterior margin is imperfect.

Orbital fenestra. Broadly oval, also oblique downward and forward, rather narrow antero-posteriorly.

Postfrontal. This bone is partly preserved; it is nearly horizontal, with an almost vertically descending projection between the orbital and lateral temporal fenestrae. The anterior and posterior margins are excavated.

The squamosal is represented by its small part bounding the upper part of the orbital fenestra.

Quadrate. This element is also very imperfect, the lower extremity and the inner flange being almost lost. As far as observed, it is long and thin, with the upper portion of its outer surface directed backwards; the contact with the quadratojugal is not preserved. The anterior portion bounding the orbital fenestra from behind is also broken. The upper extremity is a little injured, but seems to be much compressed antero-posteriorly and elongated transversely with its flat outer surface directed backwards.

The flange projecting from the inner side is only partly visible, facing forward and inward with the lower margin deeply excavated.

Mandible. The mandible is also very poorly preserved in the material, lacking both extremities. It is rather deep, with the lower border practically straight and the lateral surface flat antero-posteriorly and convex vertically. The antero-dorsal margin is excavated, the postero-dorsal one also distinctly concave around the mandibular fossa. The edentulous portion of the dentary is not preserved. The coronoid process is as far as observed placed far back and gives to the dentary its maximum breadth.

Maxillary. The maxillary bone preserves its posterior portion which is not, however, well exposed, the only exposed portion being the middle part with a number of teeth. There is a fragment of this

bone found in association with a broken piece of the premaxillary and bearing a few teeth.

Premaxillary. A few fragments of this bone are preserved.

TEETH

Pl. XIV (IV), Fig. 5.

The dentition is only partly available, the middle and posterior regions of the left upper jaw dentition and the posterior half of the left lower being preserved. Most of the teeth are concealed in the matrix and many of them have been weathered before, or broken during the preparation.

The teeth in both dentary and maxillary are, as in all other trachodont dinosaurs, arranged in vertical and horizontal series and closely set, the vertical series being curved outward in the lower jaw and inward in the upper. The cutting surface is apparently highly inclined upwards and inwards. The number of teeth exposed in one time on the cutting surface is unknown in either jaw. The number of vertical series is also undeterminable. As far as observed, however, 10 vertical series are counted in the distance of ca. 63 mm. in the mid-portion of the maxillary.

The number of individual teeth in the vertical series is also difficult to determine, but it is quite apparent that there can not be more that three fully developed teeth in one vertical series.

The teeth are lozenge-shaped in outline in lateral aspect, with the longer diameter vertical. In the dentary, a majority of the teeth are very incomplete making it impossible to state the precise features, but as exposed internally, they seem to present the usual quincuncial arrangement in mosaic. It is quite apparent that the teeth at the mid-length of the jaw are longer than others. One tooth without the upper portion (Pl. IV, fig. 5) and another represented by only the apical portion are rather well exposed. The former is about 10 mm. in width and about 26 mm. from the base to the broken tip, the upper several millimeters being missing. The outer surface is convex antero-posteriorly; the inner enamelled surface is rather flat with a narrow, prominent and sharp-edged median carina, on either side of which the surface is slightly concave; on the surface posterior to the carina there are one or two indistinct longitudinal striae lying at the middle. The anterior and posterior margins, though much injured in various ways, are slightly raised and ornamented, at least in the upper part above the

point of greatest diameter of the posterior margin, with crowded, irregular and small papillae. The posterior margin is much weathered.

In another tooth which lies more posteriorly than the above mentioned one and has been covered by the alveolar margin of the jaw, is rather sharply pointed on top, the actual termination being lost, with a very prominent median carina; the base of the carina is rather narrow. The margins are apparently convex with distantly arranged and upwardly directed low papillae. As in the above mentioned larger tooth, it is semicircular in cross section in its upper part, but tapers downward and is nearly circular and hollow toward the lower end.

The teeth of the maxillary are also very incomplete. Laterally and externally viewed, the enamelled surface does not combine to form a continuous fluted surface, but presents a rather irregular longitudinal row of crowns in which the less protrudent or non-functioning teeth are seen at a point where the roots of the used up teeth have dropped out, being deep-set between the functioning ones. As shown in one of these teeth, the inner surface is strongly convex transversely. The outer enamelled surface is elongate lozenge-shaped, with a median carina which is very high forming a sharp ridge; on either side of the carina there is a distinct excavation between the carina and slightly raised margins. The margins are almost always incomplete, but that they are distinctly papillated up to the end of the root is evidently shown in a well preserved tooth.

VERTEBRAE

There are a number of vertebrae preserved, most of which have been discovered disarticulated, more or less injured, and, moreover, weathered.

The cervicals are strongly, the dorsals moderately, and the caudals slightly opisthocoelous. The anterior articular surface is very convex in the cervicals, almost flat in the dorsals and slightly concave in the caudals.

Neural spines are absent in the majority of the cervicals. In the dorsals they are very high, massive and broad. Transverse processes in the anterior dorsals are very stout, long, and directed upward with an inclination outward and backward. In the posterior dorsals they are almost horizontal or slightly inclined downward and less robust.

Cervical Vertebrae

Atlas.

Pl. XIII (III), Fig. 4, 5, 5a

This bone must have been composed of 4 pieces, a hypocentrum, an odontoid, and two halves of neural arch, as in other trachodonts, for example, *Kritosaurs incruvimanus* figured by PARKS (p. 23, fig. 2, 1920). Of these elements only the odontoid process is represented in the material. It is much broader than long, shallowly but distinctly excavated dorsally, with both right and left postero-lateral borders elevated. The posterior surface is flat; the lateral and ventral ones distinctly concave transversely, while the antero-ventral one is evenly convex, meeting the dorsal surface with a rather sharp ridge. The postero-ventral margin is relatively rounded.

It is similar to that of *Cheneousaurus tolmanensis*, to which reference has been made repeatedly. In this American form the odontoid process is longer and slightly smaller in depth.

Length.	20 mm.
Height.	19 mm.
Breadth.	24 mm.

Axis.

Pl. XIII (III), Figs. 4–4d

This bone is rather well preserved, though somewhat injured here and there. The centrum is 26 mm. long on the ventral line, broader than it is high (36 mm. high at the posterior surface), strongly opisthocelous, slightly convex in front, deeply convex on the lower side and especially apressed on the lateral sides. The lower margin of the posterior surface of the centrum is not much produced backwards. The neural canal is relatively large, being slightly less in height than the centrum. It is 20.5 mm. wide and 25 mm. high at the anterior margin and 30 mm. high at the posterior. The parapophyses are situated near the anterior margin of the centrum and are not much produced. The neural arch is well fused with the centrum, though the suture between them is distinct. The prezygapophyses are broken, but possibly as high as the diapophyses which are rather prominent, broad, and nearly trigonal at the base.

The postzygapophyses are much posterior to the posterior margin of the centrum and fused with the neural spine. The neural spine is very high, broadly plate-like, acute with horizontal crest and thickened

posteriorly, being triagngular in section in its posterior portion. The postzygapophyses facets oppose downward and strongly overlap the prezygapophyses of the third vertebra.

The total height of the axis, from the base of the centrum to the top of the spine, is ca. 85 mm. The neural spine is more than 45 mm. broad, ca. 37 mm. high from the base of the diapophyses.

Other Cervical Vertebrae

Pl. XIII (III), Figs. 2; Pl. XIV (IV), Figs. 1, 2, 4.

The remaining vertebrae [the third to the seventh] are strongly opisthocoelous with a very produced and rounded anterior surface. They do not seem to differ much from one another except for a gradually increasing size posteriorly.

The third vertebra [Pl. XIII (III), figs. 7–7b] which is one of the best preserved of the series is 28 mm. long on the ventral line.

Centrum. The centrum is slightly wider than high and shorter than it is wide. The anterior end is hemispherical, as wide as high, with a broad shoulder below formed by the anterior border of the ventral surface. The posterior end is deeply excavated; its upper border is thin and short, and the lower one extends backwards and is thickened for abutment against the before mentioned shoulder of the succeeding centrum. The ventral surface is narrow, slightly convex transversely, with a pronounced broad ridge between it and the much compressed and excavated lateral sides. On each lateral side there is a prominent longitudinal ridge carrying the capitular rib facet. The upper surface is depressed to form a shallow bowl corresponding to the floor of the neural canal.

Neural canal. Broadly circular in outline, 20 mm. in diameter.

Neural arch. The neural arch is flat above; the spine is not defined.

Postzygapophyses. These are not represented in this vertebra, but they are rather well preserved in the fourth vertebra. They are long, robust, and produced backwards far beyond the posterior end of the centrum and slightly divergent, each being elongate trigonal in upper view.

Prezygapophyses. These seem to be merely a low process. The articular surfaces of the pre- und postzygapophyses face downward and upward respectively, inclining but slightly from the horizontal.

Diapophyses (*transverse processes*). The transverse processes are very short, stout, and directed obliquely forward and outward.

Parapophyses. These are not preserved except the basal portion, situated on the longitudinal keels of the lateral sides of the centrum and longitudinally elongate.

Dorsal Vertebrae

[Pl. XV (V), Figs. 1, 1a, 2, 2a; Pl. XVI (VI), Figs. 1, 1a, 2, 2a; Pl. XVII (VII), Figs. 1, 1a; Pl. XIX (IX), Figs. 3, 3a]

Eight dorsal vertebrae, besides a few fragments pertaining probably to this part of the column, are preserved. Of these, the ones found in association with the thoracic ribs and the scapula, are regarded as the anterior dorsals [Pl. XIX (IX), figs. 3, 3a]. Three others were contained in a block with the backwardly displaced skull. They were found anterior to the pelvic girdle. These may be the mid-dorsal ones [Pl. XV (V), figs. 1–2a, Pl. XVII (VII), figs. 1, 1a]. Two remaining vertebrae, which have been embedded just anterior to the proximal end of the ischium, belong perhaps to the posterior region of the dorsal trunk [Pl. XVI (VI), figs. 1, 1a]. All the vertebrae at hand are more or less weathered and injured but show some features of the trunk of this animal.

The total height of the vertebrae is somewhat variable; among those preserved, the middle ones are the highest as follows:

	Anterior dorsal	Middle 1	2	Posterior
Height from the base of the centra to the top of the spines	130 mm.	200 mm.	203 mm.	192 mm.

Centra. The centra are longer than high, narrow downward, pinched on the sides and have a longitudinal keel below between the articular ends. The height increases gradually towards the posterior from the anterior vertebrae of the series.

Height.	Anterior centrum	37 mm.
	Middle centrum	45 mm.
	Posterior centrum	58 mm.

On the other hand, the length does not much differ among the centra, being the largest in the middle ones, although it is large in relation to the height in the anterior centra. The width surpasses the length in the posterior centra.

	Length	Width
Anterior centrum	51 mm.	41 mm.
Middle ,,	52 mm.	43 mm.
Posterior ,,	50 mm.	52 mm.

The form of the centra is variable. The anterior ones are low, rather wide and somewhat triangular in outline in anterior view, with the base of triangle directed upward and the apex downward. The basal surface has a longitudinal keel between the ends.

The mid-dorsal centra become higher in relation to be wide. The basal keel is more pronounced, owing to the distinctly compressed lateral sides. The posterior centra are relatively wide, with the basal keel more rounded and less distinct than in the more anterior ones. These posterior dorsals differ in the last feature from the sacrals and the anterior caudals to be described later.

The neural canal is generally large, especially in the anterior centra.

Neural arch. The neural arch is strong, wide, and high, separated from the centrum by a distinct suture which is high in position.

Neural spines. The spines are almost lost in the anterior dorsals in hand, but they are met with in some of the middle and posterior dorsals. In these vertebrae the spines are rather thick distally with a stout and squarish top, but thin downwards, coming to a sharp edge along its anterior slope, the base of which regains the thickness and is vertical above the mid-length of the centrum. They are thickest at the mid-vertical point and attenuated both anteriorly and posteriorly, the posterior border being sharply edged in its greater length but rather abruptly thickened and vertically excavated near the base.

In the anterior dorsals the spines are shown by their preserved basal portion to incline backwards at an angle of about 45 degrees to the horizontal, while in the mid-dorsals they are nearly vertical and straight or sometimes a little curved anteriorly with a slight anterior inclination. In the posterior dorsals the spines are decidedly inclined forwards and much curved, with the concavity anterior. Some measurements are shown in the following table:

	Antero-posterior length	Width	Height from base of transverse process
Anterior dorsal	36 mm.	5 mm.	? mm.
Mid-dorsal	45	13	116
,,	51	?	115
Posterior dorsal	46	16	112?

Diapophyses (*transverse processes*). The diapophyses of the anterior dorsals are stout, thick, long (ca. 80 mm.) and directed outwards and upwards, with a strong backward inclination. They are relatively slender at the basal portion, more solid and triangular in cross-section distally. These processes have the anterior edge drawn out to a sharp

flange near the point of origin. Similarly the posterior edge assumes a like character, the flange merging into a backwardly directed extension at the base of the neural spine. These extensions function as pre- and postzygapophyses respectively, the former overlapping the latter of the next centrum. There is a third, less distinct flange leading down to the lateral wall of the neural arch.

In the mid-dorsals the processes are slender, but shorter than in the anterior dorsals above described, somewhat compressed dorso-ventrally, straight, being directed upward but not much backward. In the posterior dorsals they are 55 mm. long, decidedly compressed dorso-ventrally, elongated horizontally, rather thin, directed a little upward and straight outward.

Prezygapophyses. These are often lost, but when preserved they are prominent, projecting a little beyond the anterior surface of the corresponding centrum, broad transversely, opposing upwards; they are nearly horizontal at the origin to take a shelf-like appearence, deeply excavated below toward the neural arch.

Postzygapophyses. The postzygapophyses are also lost in some cases. They are as high as the prezygapophyses, almost horizontal, originating from the upper border of the neural canal and posterior to the origin of the transverse processes.

Capitular facets for the reception of the ribs are broad, shallow, and situated at the level of the upper border of the neural canal.

There is, besides, a centrum with the lower half of the arches preserved. This bone has been found with the ischium and is considered as one of the hindermost dorsals. The centrum is somewhat similar to that of the anterior caudal but is smaller with a broader neural canal and a keeled ventral surface. Moreover, its transverse processes do not appear to be connected with the neural spine by a thin vertical plate as seen in the anterior caudals. It is much larger, wider, and presumably shorter than the preserved sacrals. The anterior end is nearly flat and the posterior one distinctly excavated. The dimensions of this vertera are:

	Height	Length	Width
Centrum	58 mm.	50 mm.	68 mm.

The massive, relatively high neural spines and comparatively degenerate centra characterise the dorsal vertebrae of this animal. In these points the present species bears some resemblances to *Hypacrosaurus altispinus* in which, however, these features are much more

pronounced. The dorsal vertebrae of the Japanese species differ from those of that American from in having a larger neural canal, more slender transverse processes, and weaker plates running down from the postzygapophyses. Moreover, the anterior dorsals preserved have rather flat anterior articular surfaces of the centra, while the anterior dorsals of *Hypacrosaurus* are stated to have concave anterior ends of the centra.

Sacral vertebrae

Pl. XXI (XI), Figs. 3, 3a.

The sacrum is composed of vertebrae of an undetermined number, of which three are represented in a very bad state of preservation. It is most probable that all the sacrals have been coössified, for two of them are found in this condition. Neither neural spines nor diapophyses are observable in the specimen; perhaps they have been lost during the excavation. Between the two sacrals there is preserved a sacral rib. The head of the rib is large and rounded in outline with the neck compressed in postero-dorsal and antero-ventral direction.

The centrum is narrower, lower, and much longer than in the anterior caudals described in later pages, and also much longer than that of the posterior dorsals mentioned above. It seems to be amphicoelous, being much expanded near the ends, quadrangular in anterior and posterior views; the lateral faces are distinctly excavated with a rounded ridge between each of them and the flattened basal face. The dorsal face is broadly excavated to form the floor of the neural canal.

The measurements of two sacral vertebrae are tabulated below:

	Length	Height	Width
a.	55 mm.	46 mm.	50 mm.
b.	51 mm.	45 mm.	61 mm.

Caudal vertebrae

Anterior caudal vertebrae

Pl. XVI (VI), Figs. 3-3b; Pl. XVII (VII), Figs. 2-6b; Pl. XIX (IX), Fig. 4; Pl. XX (X), Figs. 5-5b; Pl. XXI (XI), Figs. 2-2b; Pl. XXII (XII), Figs. 5-5b.

There are 11 large vertebrae preserved near the pelvic girdle and considered as pertaining to the anterior region of the caudal column (A—K). The centra are much larger than those which are described later and regarded as the posterior caudals.

These vertebrae are found scattered and disarticulated, and consequently their mutual relation is not determined with certainty. However, there is no great evidence of the presence of undiscovered centra within this series. They are rearranged as they might be in natural position in the annexed plate [Pl. XIX (IX), fig. 4].

The centra are distinctly amphicoelous, their size decreasing rather rapidly from the anterior one to the posterior as shown below:

		Width	Height
1st		74 mm.	71 mm.
2nd	ca.	70	68
last		50	53

The posterior centra are relatively higher than wide.

On the other hand, the length does not much differ:

1st . . . 43 mm. 2nd . . . 45 mm. last . . . 40 mm.

The 2nd (B) and 3rd (C) seem to have the longest centra.

The centra are nearly circular in anterior view with a rounded base in the anterior vertebrae but in the posterior ones they become higher, and are oval or trapezoid in outline with truncated base and flat lateral faces. In these posterior centra both ends are distinctly expanded.

Many of the centra bear facets for the chevrons. The first vertebra and probably the second have no scars. In the third these scars are indistinct owing to the bad state of preservation, but in the fourth and the more posterior vertebrae there are well defined broad and long facets.

The neural canal is relatively small and short, far smaller than in the dorsals. It is 18 mm. wide and 20 mm. high in the second vertebra. The neural arch is robust, rather low.

The neural spines are almost always missing except for one vertebra (E) [Pl. XVI (VI), figs. 6, 6a]. This spine is inclined backwards, slightly curved with the concavity anterior, relatively short, very thick, rather broad antero-posteriorly, and elongate ovate in cross-section.

The transverse processes are always broken, being represented by only their basal portion except in two cases (B and E) [Pl. XVI (VI), fig. 6a; Pl. XVII (VII), figs. 4, 4a, 4b]. As judged from the basal portion, they seem to arise from the supero-lateral angles of the centra, situated slightly forward in the anterior vertebrae, and at nearly mid-length in the remaining ones; somewhat circular in cross-section in

the first centrum, and in the posterior centra apparently antero-posteriorly elongate and triangular with the base of the triangle in front and the apex behind.

Of the second vertebra (B) is preserved the left process which is long (about 85 mm.), stout in its basal portion, distally soon decreasing in depth and thickness, straight, directed outward nearly horizontally and connected with the spine by a high and thin vertical plate as seen in *Hypacrosaurus altispinus*. In the fifth vertebra (E) is represented also the left one, 51 mm. long, straight, slightly downwards and backwards, and compressed dorso-ventrally.

The prezygapophyses are very incomplete in all cases. As far as observed, they are relatively strong, projected beyond the anterior margin of the centra. The postzygapophyses are also lost, presumably higher up in position than the prezygapophyses.

Posterior Caudal Vertebrae

Pl. XVI (VI), Figs. 4-5a; Pl. XVII (VII), Figs. 7-7b; Pl. XVIII (VIII), Figs. 7-9b; Pl. XIX (IX), Figs. 5; Pl. XX (X), Figs. 6, 7; Pl. XXI (XI). Figs. 4-7; Pl. XXII (XII), Figs. 2-4a.

There are twenty two (a—v) small caudal centra in the material, of which the largest and accordingly the foremost one is much smaller than the hindermost centra of the preserved anterior caudals just described, so that these smaller ones now under consideration are regarded as pertaining to the posterior portion of the caudal column. The lost vertebrae behind these are undermined in number, and it is also highly probable that there may be undiscovered vertebrae between some of the preserved ones. The vertebrae before us are provisionally arranged as shown in the annexed plate [Pl. XIX (IX), fig. 5].

These vertebrae are mostly represented by the centra only, the neural arches and the transverse processes as well as the zygapophyses being missing. However, 8 anterior centra have the basal portion of the neural arch preserved.

The centra are slightly concave in the anterior and posterior ends. They decrease very gradually in size from the anterior ones to the posterior.

	a(1)	f	j	l	p	v
Length along the base	39 mm.	38 mm.	38 mm.	36 mm.	34 mm.	23 mm.
Width	44	45	45	43	40	26
Maximum height	44	40	34	33	33	24

(1) a. . . . . v. See Pl. XIX (IX), Fig. 5.

As shown in the above table, the anterior centra are rather high, narrow, relatively short, the middle ones slightly, and the posterior ones moderately, wider than high. Going backward the length becomes larger in relation to the height.

The facets for the chevrons are short on the anterior margin of the centra and relatively long on the posterior margin.

More detailed descriptions of some vertebrae in the series:

2nd (b) vertebra [Pl. XVI (VI), figs. 5, 5a]. The centrum is a little higher than wide, oval in anterior view, weakly concave anteroposteriorly on the lateral sides, with a narrow excavated basal surface which is distinctly separated from the sides by a longitudinal keel. The neural arch is relatively low and stout, with a distinct suture. The neural spine is apparently strong, thick, and steeply inclined backwards and has a flat anterior face excavated at the base. The neural canal is large, wide and long. The parapophyses are broken, but seem to be high in position and directed upwards and forwards.

6th (f) vertebra [Pl. XXI (XI), figs. 4–4c]. The centrum is relatively low, wide, sharply hexagonal in anterior view, the widest point lying a little above the mid-height. The upper surface is deeply grooved longitudinally. The lateral sides are distinctly keeled longitudinally, the keel being at about the mid-height of the centrum. The basal surface is less excavated than in the anterior centra, with the ridges between it and each of the lateral sides less pronounced. The neural canal is also low and wide.

Posterior vertebrae. The centrum is relatively long, and wide, hexagonal in anterior view, with the angles of the hexagon rather rounded.

CHEVRONS

Pl. XIII (III), Figs. 3, 6; Pl. XV (V), Figs. 3–4a; Pl. XX (X), Figs. 2–3b.

These bones are apparently well developed in this animal as shown by distinct and pronounced articular facets for them in the caudal vertebrae.

All the chevrons were discovered near the anterior caudal vertebrae and are represented by fragments, except one in which the two branches are preserved in their original state [Pl. XIII (III), fig. 6]. The total length is not estimable. They are relatively massive with two articular facets on the head of each branch. The head is much expanded. The

internal surface of the neck is deeply excavated and the external one nearly flat, the neck itself being thin transversely and broad antero-posteriorly.

The two articular facets are well developed [Pl. XV (V), fig. 4a], broad, roughly trigonal in both, forming together an ovate outline. Of the facetes, the anterior one is shorter, nearly perpendicular to the axis, while the posterior one is slightly inclined inwards and backwards.

In one of the fragments the upper and lower rami are preserved (Pl. III, fig. 3). The lower ramus is strong, nearly straight downward, almost circular in cross section in the upper portion and gradually narrowing downwards until it is lenticular toward the end, with a median keel gradually accentrated. The anterior surface has a broad shallow groove in the upper portion, which soon becomes obliterate downwards.

In one of the fragments, the neck is 30 mm. long. The antero-posterior breadth is ca. 20 mm. at the proximal end.

THORACIC RIBS

Pl. XV (U), Figs. 5, 5a; Pl. XVIII (VIII), Figs. 2-6a; Pl. XX (X), Fig. 4

There are more than ten thoracic ribs derived from the left-hand side of the body. They have been preserved in a fragment of mother rock in association with some anterior thoracic vertebrae. No rib is complete, the lower portion of the shaft being lost in all cases. The head and the tubercles, however, are preserved in some fragments.

Majority of the ribs are generally equal to one another in many features. They are long, rather weakly built, and double-headed.

The shaft is abruptly curved towards the capitular branch and flatly bent for the remainder of the length downward. The deepest portion is just below the tubercle and the thickness largest at a point a little down from the tubercle. In the upper half of the shaft, the bone is thick with a flattened and slightly concave anterior surface along the antero-ventral (internal) curve. Along the postero-dorsal (external) curve and between the tubercle and the head there is a sharp thin edge. The postero-ventral surface in the upper half of the shaft and for a short distance past the tubercle toward the inner border of the neck, is transversely concave. For a corresponding distance the dorsal surface is transversely a little convex, the convexity developing down the shaft into a well defined median ridge which merges further down into the antero-internal border. It is along this ridge that the

bone is thickest. In the lower half of the shaft the bone becomes more nearly ovate in cross-section, it being somewhat thicker near the outer curve with the greatest diameter directed externo-internally. Along this lower portion of the shaft the rate of tapering is generally lessened.

The tubercular branch is very short, being scarcely elevated. The tubercle is not well preserved but apparently very reduced as far as observed and continued outward along the shaft for some distance downward as a flange, giving the bone the above mentioned broad dorsal surface nearly at right angles to the deep anterior face.

The capitular branch is stout, long, deep, and laterally compressed, gradually becoming thicker and deeper toward the end. Seen from above the neck is straight; in side view it shows a tendency to bend slightly upward near the head.

The head of the rib is large, and expands with the articular surface rugose. The last surface is of an irregular and very elongate ovate outline, about twice as deep as broad, the upper margin rounded and the lower acute. The terminal surface is obliquely truncated.

The distal extremities are not preserved in all cases, but there are some fragments presenting the distal portion of some of the ribs. These fragments show that the bones are flattened toward the end with a thin lenticular cross-section.

Some of the stouter ones have a maximum width of ca. 24 mm.

PECTORAL GIRDLE

Scapula

Pl. XIX (IX), Figs. 1, 1a.

There is in the material a very fragmentary left scapula without either the coracoid or the distal extremity. The preserved portion is 295 mm. long, the total length of the bone being unknown.

The blade is straight, relatively narrow, thicker along the anterior margin and attenuated towards the other. The distal end is broad and seems to have been squarish, from this point downwards the blade narrows gradually to the proximal end. It is thick at the proximal end and tapers towards the other. The anterior margin is straight, with a slight curvature near the proximal end. The posterior margin seems also to be nearly straight with a weak concavity near the proximal end. The outer surface of the bone is very flat in the upper

third, becoming more convex downwards with the crest of the concavity ranging forward. The inner surface is almost flat transversely and slightly concave longitudinally.

The scapula of this animal is characterised by an extremely straight and rather slender blade. This bone is somewhat like that of *Saurolophus*(1) and *Parasaurolophus*(2). It is also akin to the scapula of *Tetragonosaurus praeceps* PARKS(3), while it is distinctly less curved than in *Manchurosaurus amurensis* RIABININ(4) and slightly straighter with a narrower neck and a broader distal portion than in *Tanius sinensis* WIMAN(5).

Measurements:

	Thickness	Width
Proximal end.	8 mm.	45 mm.
Distal end.	20 mm.	ca. 90 mm.

PELVIC GIRDLE

A fragment of the left ilium and imperfect ischia are preserved.

Ilium

Pl. XVIII (VIII), Fig. 1.

The ilium is very imperfect, being represented by its middle portion only. It seems to be elongate, irregularly shaped, rather deep, and apparently massive with a well developed and deflected external process. Neither pubis peduncle nor scar for Flexor tibialis is preserved. The posterior extremity and lower border are missing, but the posterior process is shown to be moderately thin, straight, and nearly vertical as in other forms of this family. From the posterior process forward the supero-internal border, which is rounded, is fairly concave, forming a sigmoidal curve. The preacetabular process is also very incomplete,

(1) B. BROWN: The Skeleton of *Saurolophus*, a Crested Duck-billed Dinosaur from the Edmonton Cretaceous. Bull. Amer. Mus Nat. Hist., Vol. XXXII, 1913, p. 387.

(2) W. A. PARKS: *Parasaurolophus walkeri*, a New Genus and Species of Crested Trachodont Dinosaur. Univ. Toronto Studies, Geol. Ser., No. 13, 1922, p. 5.

(3) W. A. PARKS: A New Genus and Two New Species of Trachodont Dinosaurs from the Belly River Formation of Alberta. Ibid., No. 31, 1931, p. 3.

(4) A. N. RIABININ: *Manchurosaurus amurensis* nov. gen. nov. sp., a Hadrosaurian Dinosaur from the Upper Cretaceous of Amur River. Op. cit., 1930.

(5) C. WIMAN: Die Kreide-Dinosaurier aus Shantung. Op. cit., 1929, p. 41.

but apparently thin, vertical, and rather deep. This portion of the bone appears to be triangular in cross-section with a thickened and rounded upper border; the sides below this border are moderately excavated internally as well as externally. Above the ischiac peduncle, which is not preserved in the specimen, the superior border of the bone folds outwards in a broad, thick and shelf-like external process hanging over a broad and concave rugose area. The bone is thickest at this process. This process, which is for the attachment of Musculus iliofemoralis externus, is higher in position than in *Saurolophus*(1). The superior border in front of the process curves high upwards, showing a great curvature of its anterior portion. The process is elongate trigonal in outline in upper view with an evenly curved outer margin. Along the outer margin the border of the process is narrow, somewhat rounded, It separates the convex upper surface of the process from the deeply concave lower one, There is no distinct groove between the shelf and the surface above the peduncle. The inner surface of the bone opposing to the sacrum is rough and fairly concave, and the superior border distinctly excavated at the origin of the posterior process.

Althogh the illium of this animal is very imperfectly preserved, it is easily distinguished from that of *Tanius sinensis Wiman*(2) in being very massive also in having a much more prominent and expanded external process and a deeper, more decidedly elevated upper border of the preachtabular process. It is also different from that of *Parasaurolophus walkeri*(3) to which it is somewhat akin, in that the external process is more trigonal in outline and not so much hanging over. It does not much differ from the corresponding bone of *Corythosaurus*(4), *Hypacrosaurus*(5), and *Saurolophus*(6).

---

(1) B. BROWN: The Skeleton of *Saurolophus*. Op. cit., 1913, p. 387.

(2) C. WIMAN: Die Kreide-Dinosaurier aus Shantung. Op. cit., 1929, p. 41.

(3) W. A. PARKS: *Parasaurolophus walkeri*, a New Genus and Species of Crested Trachodont Dinosaur. Op. cit., 1922, p. 5.

(4) B. BROWN: *Corythosaurus casuarius:* Skeleton, Musculature and Epidermis. Bull. Amer. Mus. Nat. Hist., Vol. XXXV, 1916, p. 709. W. A. PARKS: *Corythosaurus intermedius*, a New Species of Trachodont Dinosaur. Univ. Toronto Studies, Geol. Ser. No. 15, 1923, p. 5. W. A. PARKS: New Species of Trachodont Dinosaurs from the Cretaceous Formations of Alberta with Notes on Other Species. Ibid., No. 37, 1935, p. 21

(5) B. BROWN: A New Trachodont Dinosaur, *Hypacrosaurus*, from the Edmonton Cretaceous of Alberta. Bull. Amer. Mus. Nat. Hist., Vol. XXXII, 1913, p. 395.

(6) B. BROWN: The Skeleton of *Saurolophus*, a Crested Duck-billed Dinosaur from the Edmonton Cretaceous. Op. cit., 1913, p. 387.

Ischia

Pl. XIX (IX), Figs. 2, 2a.

Both right and left ischia are preserved; although the proximal portion is unfortunately lost in both cases, the distal expanded portion is fairly well represented.

These bones are long (ca. 530 mm.) with a much expanded foot-like distal end. In many points they are similar to those of most crested trachodonts.

The proximal portion is apparently expanded and almost flat with a moderate inward direction at the ventral portion. The face for union with the postacetabular peduncle of the ilium and that for the pubis are not preserved in the bones before us. The superior margin of the proximal portion curves distinctly downwards and backwards in a concave arc passing gradually into the posterior shaft-like section. The inferior margin is very imperfect, but seems to be concave at the junction with the shaft. In this feature this bone is similar to that of *Hypacrosaurus altispinus*(1) and distinct from that of *Saurolophus*(2). As the obtulater process is missing, the presence of a round foramen observed by C. W. GILMORE(3) in *Hypacrosaurus* is uncertain.

The shaft is very slender in its greater length. Its superior and inferior margins are parallel to each other. The superior border is broadly and the inferior one narrowly rounded, giving an oval section, the greater diameter directed dorso-ventrally. Towards the distal end the shaft gradually increases in depth with the upper border flat and the inferior one acutely ridged to form a high trigonal section. In this distal portion the shaft is flattened internally and makes contact with its fellow by a flat and longitudinally striated inner surface.

The distal foot-like expansion is well developed, 104 mm. long antero-posteriorly, moderately massive, and thick (28 mm. thick). The terminai surface is quite flat externo-internally, very weakly convex dorso-ventrally, and almost perpendicular to the dorsal surface of the shaft. The inner surfrce is flat, and the outer one slightly convex

(1) B. BROWN: A New Trachodont Dinosaur, *Hypacrosaurus*, from the Edmonton Cretaceous of Alberta. Op. cit., 1913, p. 395.

(2) B. BROWN: The Skeleton of *Saurolophus*, a Crested Duck-Billed Dinosaur from the Edmonton Cretaceous. Opl cit., 1913, p. 387.

(3) C. W. GILMORE: On the Skull and Skeleton of *Hypacrosaurus*, a Helmet-Crested Dinosaur from the Edmonton Cretaceous of Alberta. Geol. Surv. Canada, Bull. No. 38, Geel. Ser. 43, 1924, p. 49.

with a broad and shallow longitudinal median excavation, giving to the terminal surface a distinct broad concavity along the external margin [Pl. XIX (IX), fig. 2a].

Compared with the ischium of *Hypacrosaurus altispinus*, this bone has a shaft more slender and an expanded end apparently less massive and more distinctly excavated externally.

HIND LIMB

The hind limbs are the most complete of the skeleton, comprising both femura, the left tibia, the left fibula, and the greater part of the left pes.

Femur

Pl. XX (X), Figs. 1–1e.

Of the femura, the left one is better preserved. In neither case is the outer layer of the shaft preserved, and hence in the appended plates the shafts are illustrated to be much smaller in diameter than in the original state.

The bone is heavy and massive with a long, straight shaft and abruptly much expanded extremities. It attains 533 mm. in length which is about 63 mm. longer than the tibia. B. BROWN[1] stated that the femur of *Hypacrosaurs altispinus* is nearly equal in length to the tibia, making that species distinct from other genera in this respect, while later C. W. GILMORE[2], when he described a dinosaur referable to the same species, observed that this bone is 124 mm. longer than the tibia. The present specimen is not different in this point from many trachodont dinosaurs.

The shaft of the bone seems to be evenly rounded internally for the greater part. In internal view it maintains a fairly constant diameter up to near the lower extremity. The lower extremity is rather abruptly expanded, much more so posteriorly than anteriorly, into the very large internal condyle. The internal condyle is slightly concave internally and shows distinct longitudinal fluting near the rounded articular surface.

The external surface of the shaft appears to be less evenly rounded. Proximally there is doubtless a wide and thin expansion in the anterior

(1) B. BROWN: A New Trachodont Dinosaur, *Hypacrosaurus*, from the Edmonton Cretaceous of of Alberta. Op. cit., 1913, p. 405.

(2) C. W. GILMORE: Op. cit., 1924, p. 60.

position which is interrupted as the lesser trochanter, the latter being very imperfectly shown. This flange-like extension continues around the upper external side, there forming the greater trochanter. The external surface between the upper trochanters is flattened and appears to be depressed. These two trochanters lie almost in a plane on the external surface of the bone. The greater trochanter is thicker than the lesser and fades gradually into the shaft internally.

On the external side the shaft swells distally into a large outer condyle which is similar in position and shape to the inner one and also longitudinally fluted. The main part of the outer condyle is separated from the posterior part by a distinct excavation. The two condyles are separated from each other by deeply excavated depressions. The posterior depression is about 60 mm. deep and confined to the overhanging part of the condyles, while the anterior one, more deeply excavated into the distal end of the shaft, extends for a short distance upwards as a shallow groove on the anterior face of the shaft.

Neither intercondylar groove is closed, but the anterior one shows a tendency in this direction as a distinct prominence developed on the inner condyle which nearly touches an almost equally developed prominence of the outer condyle. The distance between these two prominences is only 4 mm.

Anterior sides of both condyles show fluting at the upper margin of the rounded articular surface, from which the anterior surface of the shaft slopes upwards and backwards. The posterior groove is also bounded posteriorly by two distinct processes, each of which projects from the outer as well as inner condyles. The lesser trochanter is separated by a narrow cleft and ends perhaps below the greater trochanter which rises slightly lower than the head. The head is prominent and set well inward, being separated from the greater trochanter by a distinct concavity on the posterior face of the proximal end of the shaft.

The fourth trochanter is not preserved.

The proximal end.	Maximum diameter at the external part, antero-posteriorly . . .	ca. 110 mm.
,,	intero-externally	ca. 150 mm.
The distal end.	Maximum diameter, antero-posteriorly.	ca. 140 mm.
,,	intero-externally	ca. 117 mm.
Extreme length.	520 mm.	

Tibia

Pl. XXI (XI), Figs. 1-1e.

The left tibia, somewhat incomplete distally, is preserved.

This bone is very heavy in its construction with a strong enemial crest and well developed condyles, slightly shorter than the femur, the maximum length being about 470 mm. The shaft is weathered but appears to have been contracted, and the extremities greatly expanded. The proximal expansion is nearly antero-posterior, while the distal one is almost at right angle to that direction. This twist occurs in such a manner that the inner face proximally becomes the posterior face distally.

The proximal end has a greater diameter antero-posteriorly of ca. 185 mm., and is thin anteriorly and turned outwards as a prominent enemial crest, the apex of which is broken. On the outer surface and posteriorly to the crest, is a wide and distinct depression followed by a robust inner condyle which has a backward direction. The proximal end of the bone overlaps this condyle laterally. A second condyle (the outer one) is separated from the first by a narrow, deep intercondylar notch and forms the postero-lateral angle of the bone. The inner surface of the proximal end of the bone is evenly convex antero-posteriorly. The large proximal expansion has a maximum transverse diameter of approximately 135 mm. It fades into the shaft in long sweeping curves. The distal expansion, in anterior view, shows a very sharp and prominent edge running down to the extremity of the elongate and thin outer malleolus.

The inner side of the bone shows the proximal expansion as a fairly flat surface, longitudinally fluted and turned sharply outwards at the enemial crest. The distal expansion, in inner view, appears as a much thicker and slightly shorter malleolus than the outer.

In posterior view the distal end of the bone shows the longer external and shorter internal malleoli separated by a shallow depression. The posterior side of the distal expansion is broad and weakly concave transversely. The anterior side is somewhat injured, but seems to have a rather flat surface between the two malleoli.

The distal articular surface is elongate, and irregularly trigonal in outline.

Fibula

Pl. XV (V), Figs. 11–11c.

The left fibula is at hand, in which the distal end is lost, but the proximal one is well preserved except for the posterior angle.

This is long, straight, very slender, and expanded proximally. The shaft has anterior and posterior margins nearly parallel to each other. The proximal end is convex externally and concave internally, the convexity extending almost half way down the shaft. The shaft is distally broadened with a convex antero-external face and flat postero-internal one. It has a rather narrow ridge antero-internally while it is rounded and broader postero-externally. The anterior side is somewhat flattened but becomes upwards narrower and more convex, until it fades into a sharp ridge near the proximal end, where it is abruptly concave between the shaft and the anterior angle of the proximal end. The anterior angle is much projedted, narrow, and thin.

Astragalus

Pl. XIV (IV), Figs. 3–3c.

The left astragalus is included in the material.

This is an irregular, cup-shaped bone, hollowed proximally to fit over the inner malleolus of the tibia. The distal surface is well rounded antero-posteriorly, and slightly concave laterally. Internally the surface slopes nearly vertically up to a rather sharp edge of the external margin of the proximal face; the external edge is thicker. The articular face for the calcaneum is missing.

The anterior border of the proximal side is anteriorly sharply elevated, especially towards the antero-external angle, into a raised sharp, thin edge which fits in between the two malleoli.

The proximal face is truncated externo-posteriorly by an oblique straight margin which passes over a rounded angle into the posterior margin.

Maximum diameter	(antero-posterior)	68 mm.
,,	(externo-internal)	75 mm.

Pes

Three left metatarsals and a few detached phalanges were obtained.

Metatarsals

Pl. XVI (VI), Figs. 2, 2a; Pl. XXII (XII), Figs. 1-1c.

The metatarsals are found nearly in natural relative position except for M. IV which is slightly displaced upwards. They are stout, rather elongate, and much expanded at both ends.

M. II is the lightest of all, much flattened vertically and greatly expanded in this direction at the proximal end. The internal face is rather smoothly convex transversely and evenly concave longitudinally. The external face is quite flat in the proximal region where it contacts closely with M. III; distally it diverges and is more irregular. The anterior edge is rather sharp at the proximal region and fades downwards. There is a robust protuberance above the articular facet. The posterior edge is fairly sharp, especially in the distal region, and evenly concave longitudinally. The anterior and internal sides form a continuous curvature though the latter is somewhat flatter.

The proximal articular surface is strikingly flat, very elongate vertically, and compressed laterally, forming a somewhat lenticular outline. The distal articular surface is rhomboidal or rather irregularly triangular in outline, the upper and lower sides of the rhombus being concave and inclined downward. The articular facet is strongly convex with an indistinct concavity below.

M. III is much the longest and heaviest bone of the pes; it is stout and shaft-like at mid-length but expands at both ends. The proximal expansion is irregularly pentagonal, flat internally and rounded externally; its posterior side is short, slightly concave, the anterior side long inclining outward and downward and slightly convex. The two sides between which the apex of the pentagon lies, are also short and straight.

The distal expansion is quadrangular in outline. The external aspect shows a distinct concavity in the distal expansion between the upper and lower margins. Proximally this deression passes into a distinct, round ridge which becomes the round apex of the subpentagonal head. The internal face is rather flat at the distal end and seems to be convex at mid-length. Proximally it forms a broad, flat triangle. This surface fits closely against the corresponding flattening on M II.

The distal articular surface is continued well up on the anterior face; it is convex vertically and slightly concave laterally. The proximal articular surface is flat and irregularly pentagonal in outline.

M. IV is nearly equal in length to M. II, irregularly shaped, flattened dorso-ventrally in the shaft and expanded at both ends. The

distal expansion is subrhomboidal and concave on all sides, the internal one causing rounded tuberosities in the anterior and posterior positions. The external concavity is as deep as the internal, forming also a rounded tuberosity on the anterior position. The posterior concavity is shallow and broad, and the anterior one very slight.

Proximally the bone expands on the anterior and posterior sides; the external sides rise to a rather sharp edge against the articular surface. Internally it is strongly excavated in a broad hollow which fits over the rounded apex of the subpentagonal surface of M. III. The floor of this hollow runs out on the internal side of the bone into a conspicuous roughened point above mid-length.

The proximal articular surface is slightly concave and subtriangular in outline. The base of this triangle is situated internally and it is concave distinctly. The apex is external and rounded. The distal articular surface is rhomboidal in outline with concave sides, except for the anterior one which is straight,

	Length
M. II.	155 mm.
M. III.	190 ,,
M. IV.	158 ,,

Phalanges

Pl. XV (V), Figs. 6–10a.

A few detached phalanges are at hand, but most of them are very imperfect and undeterminable as to their position in the pes.

The bone figured in Pl. XV (V), fig. 9 is the largest of all and provisionally regarded as the first phalangis of dight IV. This bone is elongate, about 56 mm. long and approximately 49 mm. wide at the proximal end. The proximal articular surface is subquadrangular and excavated. The distal articular surface is also subquadrangular, convex vertically, and almost flat transversely. It is apparently concave in all lateral sides.

Another fragment of a bone [Pl. XV (V), figs. 10, 10a] is represented; it has a much expanded end. The articular surface is almost flat, both vertically and transversely, and irregularly rhomboidal in outline. This bone may be the first phalangis of dight II (?).

A third bone (fig. 7) is small and short, with the proximal articular surface concave and the distal one vertically convex and slightly concave transversely. This bone in anterior view is semicircular with the base straight and the upper margin rounded.

TENDONS

There are preserved a number of ossified tendons at the dorsal and anterior caudal regions. They are very imperfectly represented and do not show the whole length. Each is slender, 2-3 mm. in diameter and nearly circular or oval in cross-section at the middle portion.

Tendons are well described by B. BROWN[1] in the skeleton of *Corythosaurus casuarius*. They are stated not to extend below the transverse process of the vertebrae. In the Saghalien form, they are situated below the transverse processes, if it is not accidental that they have taken this position.

CLASSIFICATION AND RELATIONSHIP

A great number of genera belonging to the Trachodontidae (Hadrosauridae) have been proposed, many of which are, however, founded on inadequate and insufficient material and their validity has been more than once questioned. As far as the writer is aware, twelve genera which are thought to be justifiable have been reported from North America.

BARNUM BROWN[2] recognised in 1914 two subfamilies in the trachodont dinosaurus from North America, viz. the Trachodontinae and the Saurolophinae, the latter including *Saurolophus*, *Hypacrosaurus*, and *Corythosaurus*. In 1920, L. M. LAMBE[3] proposed a third subfamily, the Stephanosaurinae, to receive *Stephanosaurus*, *Corythosaurus*, *Cheneosaurus*, and doubtfully also *Hypacrosaurus*; these genera were considered by him as different in some features from the Saurolophinae in which he put *Saurolophus* and *Prosaurolophus*. The genera belonging to the Saurolophinae and the Stephanosaurinae are generally thought to differ from those of the Trachodontinae in having a crested skull and ischia terminating in a foot-like expansion.

---

(1) B. BROWN: *Corythosaurus casuarius*: Skeleton, Musculature and Epidermis. Op. cit.; 1916, p. 711.

(2) B. BROWN: *Corythosaurus casuarius*, a New Crested Dinosaur from the Belly River Cretaceous, with Provisional Classification of the Family Trachodontidae. Bull. Amer. Mus. Nat. Hist.: Vol. XXXII, 1914, p. 564.

(3) L. M. LAMBE: The Hadrosaur Edmotosaurus from the Upper Cretaceous of Alberta. Geol. Surv. Caneda, Mem. 120, Geol. Ser. No. 102, 1920, p. 67.

Later, in 1923, W. A. PARKS[1], when he revised the specimens referred to *Stephanosaurus*[2] proposed the name Lambeosaurinae to replace the third subfamily and enumerated *Lambeosaurus*, *Corythosaurus*, and *Cheneosaurus* as belonging to it, *Parasaurophus* having been regarded as a member of the Saurolophinae by him in 1922[3]. C. W. GILMORE[4], 1924, classified all Canadian genera known until that time as follows:

1. Subfamily Hadrosaurinae
   Kritosaurus, *Edmontosaurus*, *Thespesius*.
2. Subfamily Saurolophinae
   Saurolophus, *Prosaurolophus*.
3. Subfamily Lambeosaurinae
   Lambeosaurus, *Corythosaurus*, *Parasaurolophus*, *Hypacrosaurus*, *Cheneosaurus*.

Yet he questioned the value of the Lambeosaurinae, for "Parasaurolophus shows strong affinities with this subfamily as well as with the Saurolophinae". *Tetragonosaurus* established in 1931 by PARKS[5] on two species from the Belly River group in Alberta should be added to the genera of the third subfamily.

The two forms from Asia, *Manchurosaurus amurensis* RIABININ[6] from Manchuria (Manchoukou) and *Tanius sinensis* WIMAN[7] from Shantung, China, may be excluded from the present consideration, for they are thought to belong to Hadrosaurinae. The latter species is

(1) W. A. PARKS: *Corythosaurus intermedius*, a New Species of Trachodont Dinosaur. Univ. Toronto Studies, Geol. Ser. No. 15, 1923, p. 9.

(2) L. M. LAMBE: On a New Genus and Species of Carnivorous Dinosaur from the Belly River Formation of Alberta, with a Description of the Skull of *Stephanosaurus marginatus* from the Same Horizon. Ottawa Naturalist, Vol. XXVII, 1914, p. 17. C. W. GILMORE: On the Genus *Stephanosaurus*, with a Description of the Type Species of *Lambeosaurus lambei*, Parks. Geol. Surv. Canada. Bull. No. 38, Geol. Ser. No. 43, 1924, p. 29.

(3) W. A. PARKS: *Parasaurolophus walkeri*, a New Genus and Species of Crested Trachodont Dinosaur. Ibid., No. 13, 1922, p. 5.

(4) C. W. GILMORE: Ibid., p. 34.

(5) W. A. PARKS: A New Genus and Two New Species of Trachodont Dinosaurs from the Belly River Formation of Alberta. Univ. Toronto Studies, Geol. Ser. No. 31, 1931, p. 3.

(6) A. N. RIABININ: A Mounted Skeleton of the Gigantic Reptile *Trachodon amurense* n. sp. Bull. Com. géol. Leningrad, LXIV, 1925. A. N. RIABININ: *Manchurosaurus amurensis* nov. gen. nov. sp., a Hadrosaurian Dinosaur from the Upper Cretaceous of Amur River. Soc. Pal. Russie, Mém. 11, 1930.

(7) C. WIMAN: Die Kreide-Dinosaurier aus Shantung. Pal. Sinica, Ser. C, Vol. VI, Fasc. 1, 1929.

regarded by WIMAN as having no crested skull, though the ischia are stated to be expanded distally. The bone considered by him (Pl. VII, figs. 6, 6a) as an ischium, is quite different in form from the corresponding bone of all known crested Hadrosaurs and the species here described.

The specimen from Saghalien may be placed in either of the Saurolophinae or the Lambeosaurinae as stated below. Although there is not in the material such a prominence preserved on the skull as seen in crested trachodont dinosaurs, the ischia terminate in a well developed foot-like end. The last feature has been observed in most crested trachodonts, and the species under consideration may find its proper position in the two above mentioned subfamilies.

It is thus highly probable that the Japanese species is provided with a crest of some kind. As far as observed during its removal from the matrix there was no trace of any well developed crest comparable with that of *Corythosaurus*(1), *Hypacrosaurus*(2), or *Lambeosaurus*(3) the state of preservation being such that if any prominent crest had been present, it might have been preserved in the matrix just above the cranium. Under this circumstance the Saghalien dinosaur might be in future shown to have a low incipient crest, instead of a high, helmet-like one, and to be more allied to *Cheneosaurus tolmanensis*(4) and the species of *Tetragonosaurus* in respect to the nature of the crest.

(1) B. BROWN: *Corythosaurus casuarius*, a New Crested Dinosaur from the Belly River Cretaceous, with Provisional Classification of the Family Trachodontidae. Op. cit., 1914.
B. BROWN: *Corythosaurus casuarius*: Skeleton, Musculature and Epidermis. Op. cit., 1916.
W. A. PARKS: *Corythosaurus intermedius*, a New Species of Trachodont Dinosaur. Op. cit., 1923.
W. A. PARKS: New Species of Trachodont Dinosaurs from the Cretaceous Formations of Alberta with Notes on Other Species. Univ. Toronto Studies, Geol. Ser. No. 37. 1935, p. 21.

(2) C. W. GILMORE: On the Skull and Skeleton of *Hypacrosaurus*, a Helmet-Crested Dinosaur from the Edmonton Cretaceous of Alberta. Geol. Surv. Canada, Bull. No. 38, Geol. Ser. No. 43, 1924, p. 49.

(3) L. M. LAMBE: On a New Genus and Species of Carnivorous Dinosaur from the Belly River Formation of Alberta, with a Description of the Skull of *Stephanosaurus marginatus* from the Same Horizon. Op. cit., 1914, p. 17.
W. A. PARKS: *Corythosaurus intermedius*, a New Species of Trachodont Dinosaur. Op. cit., 1923, p. 7.
C. W. GILMORE: On the Genus *Stephanosaurus*, with a Description of the Type Specimen of *Lambeosaurus lambei* PARKS. Op. cit., 1924, p. 35.

(4) L. M. LAMBE: On *Cheneosaurus tolmanensis*, a New Genus and Species of Trachodont Dinosaur from the Edmonton Cretaceous of Alberta. Ottawa Naturalist, Vol. XXX, No. 10, 1917, p. 117.

It is also worthy of note that the present form is very small, only about half as large as most species of known trachodont dinosaurs. It is almost improbable that this specimen represents a young individual of *Corythosaurus, Hypacrosaurus,* or other large forms; it must be an adult as indicated by its coössified sacral vertebrae, of which three are preserved. In size, it stands near *Cheneosaurus tolmanensis* and the two species of *Tetragonasaurus.* The last three forms are similar in many respects to one another, viz., in the small size, the great relative depth of the head, steep anterior margin, and the incipient, low crest. The Saghalien species also seems to be associated with these American trachodonts in the above mentioned features, except for the anterior margin of the head, which is lost in the present material.

Moreover, there is the indication of a very low dome-like swelling in the frontal region as seen in the above cited American forms. Of these American forms, *Cheneosaurus tolmanensis* has the narial passages almost entirely closed, while in the two species of *Tetragonosaurus* these passages are "long and open externally nearly to the summit of the head"[1]. In the Japanese specimen this part is very poorly preserved, only a small portion of the premaxillary and other fragments of bones belonging to this region being represented. As far as these fragments are concerned, there is no indication of the closed passage.

Under such conditions, it might be somewhat inadequate for establishing a new genus on the present species. However, by its several distinctive points, by its occurrence at a place very far from North America where the above referred genera have been discovered, and moreover by the special importance from geological as well as palaeontological points of view, the writer feels warranted to introduce here a new generic name, **Nipponosaurus,** for the Saghalien species for the time being. That some other better material may prove in future its congeneric association with either of the above mentioned species or some other forms is by no means impossible.

Cheneosaurus tolmanensis LAMBE[2] represented by a skull and three anterior cervical vertebrae was described from the Edmonton formation of Alberta, Canada. The skull is provided with a more obliquely descending projection of the postfrontal and an antero-posteriorly much longer orbital fenestra, than in the present specimen. As to the three

(1) W. A. PARKS: A New Genus and Two New Species of Trachodont Dinosaurs from the Belly River Formation of Alberta. Op. cit., 1931, p. 3.

(2) L. M. LAMBE: On *Cheneosaurus tolmanensis,* a New Genus and Species of Trachodont Dinosaur from the Edmonton Cretaceous of Alberta. Op. cit., 1917, p. 118.

preserved cervical vertebrae, the odontoid process, the axis, and the third cervical, one may judge only by reference to LAMBE's figure. As far as may be judged therefrom, the odontoid process is a little longer and less deep; the centra of the axis and the third cervical are also longer than in the Saghalien species. The neural spine is very imperfectly preserved in the latter form, but thin transversely and blade-like with the lateral sides subparallel and the top acute, while it seems to be roof-like, the sides sloping more gently, in *C. tolmanensis*.

Tetragonosaurus includes two species, *T. praeceps* PARKS[1] and *T. erectofrons* PARKS[2], both from the Belly River formation of Alberta. The latter species is known only from the skull while the former is represented by the vertebral column from the atlas to the sacrum, the right scapula, and fragments of ribs, besides the skull.

As far as the very incomplete skull of the present material is concerned, its orbital fenestra is more narrowly oval than in *T. praeceps*, and its lateral temporal fenestra seems to be narrower antero-posteriorly than in *T. erectofrons*. Some of the measurements are given below:

	T. praecpes	*T. erectofrons*	*N. sachalinensis*
Width of the cranium above orbit	97 mm.	94 mm.	ca. 120 mm. (estimated)
Distance from the frontal dome to the posterior margin	(75)[3]	(78)[3]	ca. 83
Lowermost point of the jugal to highest point of the superior surface	181	212	ca. 190 (estimated)

From the above table it is quite apparent that these three forms are nearly identical in the size of the posterior portion of the skull, but there is one significant difference in the width of the cranium. In the Japanese form the cranium is much wider than in the others.

The right scapula which is preserved in *T. praeceps* is compared with the left one of our species, there being no right one; in both cases this bone is imperfect, and especially both extremities are missing in ours.

(1) W. A. PARKS: A New Genus and Two New Species of Trachodont Dinosaurs from the Belly River Formation of Alberta. Op. cit., 1931, p. 4.

(2) W. A. PARKS: Ibid., p. 7.

(3) Estimated from the original figures.

The measurements are shown in the following table:

	T. praeceps	*N. sachalinensis*
Length	480 mm.	ca. 400 ? mm. (preserved length 290 mm.)
Maximum width of blade	110	ca. 85
Minimum width	51	ca. 44

This bone is relatively smaller in the Japanese form and appears to be more slender than in the American species.

The vertebrae are rather well preserved in *T. praeceps*. The length of fourteen cervicals is 565 mm. in this specimen and the anterior four (the 2nd to the 5th) of the Japanese form attain ca. 155 mm. in length. Some of the measurements are tabulated below:

	10th cervical of *T. praeceps*	4th cervical of *N. sachalinensis*
Length of centrum measured along the lower margin	36 mm.	30 mm.
Base of centrum to top of neural spine	49	59
Width across postzygapophyses	64	ca. 40

As shown in the above table it is quite apparent that in the latter the cervical vertebra is much higher with a short centrum and less divergent postzygapophyses than in the American species.

	11th dorsal vertebra of *T. praeceps*	One of the middorsal vertebrae of *N. sachalinensis*
Length of centrum along the lower margin	44 mm.	ca. 46 mm.
Base of centrum to top of neural spine	185	210
Length of neural spine	104	120
Width of neural spine	42	52
Length of transverse process	36	50

The present species bears some resemblances with *Hypacrosaurus altispinus* BROWN and *Corythosaurus casuarius* BROWN in the features of the vertebrae. The mid-dorsal vertebrae have rather long neural spines and more or less degenerate centra, but not so much pronounced as in the first of the latter. Moreover, the transverse processes are longer and more slender and the neural canal much larger. These American species are very large as shown in the following table:

	Hypacrosaurus altispinus[1]	*Corythosaurus casuarius*[2]	*Nipponosaurus sachalinensis*
Ischium, extreme length	1000 mm.	1030 mm.	ca. 530 ?
,, length of foot	302	220	104
Greatest length of femur	1070	1080	520
,, tibia	950	—	470
,, metatarsal II	290	310	155
,, ,, III	384	380	190
,, ,, IV	333	320	158
Length of second caudal centrum	69	—	45
Width ,,	140	—	75

GEOLOGICAL NOTE

The specimen delt with in the present paper was found in shale of Upper Cretaceous age exposed at the Kawakami colliery. An external cast of a small ammonite, supposed to be *Puzosia japonica* YABE, a species commonly found in the Upper Ammonites beds[3] (Senonian) of Hokkaido is discovered in the same matrix.

The Cretaceous deposits exposed at the colliery are unconformably overlain by the Palaeogene coal-bearing formation. The stratigraphy of the Cretaceous rocks at Kawakami is not yet fully determined, but a number of species of ammonites and *Inoceramus* are known, besides other molluscs, from the contemporaneous rocks in the surrounding country. Once Prof. H. YABE[4] listed numerous species of ammonites

(1) C. W. GILMORE: Geol. Surv. Canada, Bull. No. 38, Geol. Ser. No. 43. The measurements of the specimen No. 8501, Geol. Surv., Canada.

(2) B. BROWN: Bull. Amer. Mus. Nat. Hist., Vol. XXXV. The measurements of the type specimen.

(3) H. YABE: Zur Stratigraphie und Palaeontologie der oberen Kreide von Hokkaido und Sachalin. Zeitscher. d. deutsch. geol. Gesell., Vol. LXI, No. 4, 1909. H. YABE: A New Scheme of the Stratigraphical Subdivision of the Cretaceous Deposits of Hokkaido. Proc. Imp. Acad., Vol., II, No. 5, 1926.

(4) H. YABE: Cretaceous Stratigraphy of the Japanese Islands. Sci. Rep. Tôhoku Imp. Univ., Second Ser., Vol. XI, No. 1, 1927, p. 23. The following species are enumerated:

Phyloceras ezoense YOK.
P. cf. *ramosum* MEEK.
P. nera FORBES
Gaudryceras tenuiliratum YABE
G. striatum JIMBO
G. denseplicatum JIMBO
G. sp. nov. (*G. subkayei* YABE and SHIMIZU)
Tetragonites sphaeronotus JIMBO
T. popetensis YABE
T. spp.
Hamites quadrinodosus JIMBO
H. subcompressus YOK.
H. spp.
Brahmites (*Subbrahmites*) *sachalinensis* YABE and SHIMIZU
Desmoceras damesi JIMBO
D. laeve YABE

from Japanese Saghalien. These fossils were in the main derived from this district and many of them are known to occur at Kawakami.

Dr. S. SHIMIZU[1] divided the Cretaceous deposits exposed along the mid-valley of the Naibuti (Naibuchi) near the Kawakami district into five groups of which No. III group comprises the following four zones (in descending order):

	9.	Zone of *Inoceramus schmidti* MICHAEL
	8.	Zone of *Mortoniceras fukazawi* YABE and SHIMIZU
No. III group	7.	Zone of *Yezoites planus* YABE
	6.	Zone of *Pseudoaspidoceras* sp.

Divisions 9 and 8 with the zone of *Inoceramus schmidt* and the zone of *Mortoniceras fukazawai* respectively are especially rich in fossils. These beds are thought to be contemporaneous with the *Parapachydiscus* beds of Hokkaido[2], the middle part of the Upper Ammonites beds. Most

Puzosia japonica YABE
P. planulatiformis JIMBO
P. ishikawai JIMBO
P. sp.
Hauericeras gardeni BAILY
Mortoniceras aff. *fukazawai* YABE and SHIMIZU
Menuties menu FORBES
Mesopachydiscus haradai JIMBO
M. haradai var.
Neopachydiscus intermedius YABE and SHIMIZU
N. naumanni YOK.
Anapachydiscus cf. *fascicostatus* YABE and SHIMIZU
A. cf. *sutneri* YOK.
Epipachydiscus mamiyai YABE and SHIMIZU
Pseudopachydiscus kossmati YABE var.
Parapachydiscus karafutoensis YABE and SHIMIZU

The following species of molluscs are also known to occur is this district: See T. NAGAO: Some Cretaceous Mollusca from Japanese Saghalien and Hokkaido (Lamellibranchiata and Gastropoda). This Jour, Ser. IV, Vol. II, 1932, p. 23.

Nucula formosa NAGAO
N. radiatocostata NAGAO
Tessarolax acutimaginatus NAGAO
Rostellaris japonica NAGAO
Pseudogaleodea tricarinata NAGAO
Semifusus (*Mayeria?*) *sachalinensis* NAGAO

Besides, numerous specimens of *Inoceramus* and "*Helcion*" have been obtained from these deposits.

(1) S. SHIMIZU: Cretaceous Deposits of North and South Saghalin: a Comparison. Ann. Rep. Work Saito Ho-on Kai, No. 5, 1929, p. 31.

(2) H. YABE: Zur Stratigraphie und Palaeontologie der oberen Kreide von Hokkaido und Sachalin. Op. cit., 1909. H. YABE: A New Scheme of the Stratigraphical Subdivision of the Cretaceous Deposits of Hokkaido. Op. cit., 1926. H. YABE: Cretaceous Stratigraphy of the Japanese Islands. Op. cit., 1927. R. SAITO: On the Geology of the Ikusyunbetu District in the Province of Isikari. Promotion thesis, Hokkaido Imp. Univ., 1932 (MS.) (In Japanese). R. SAITO: On the Geology of the Yubari and Oyubari Districts, Isikari Prov. Graduate thesis, Hokkaido Imp. Univ., 1933 (MS.). (In Japanese).

of the fossils listed in Yabe's list, cited above, have come from these beds and indicate the Senonian age of the deposits. The zone of *Inoceramus schmidti* is characterized by the special abundance, besides other species, of *Inoceramus schmidti* MICHAEL[1]. This species of *Inoceramus* is considered by SOKOLOW[2] to be Campanian in age, and this zone may at any rate be placed in the upper Senonian rather than the lower. It is worthy of note that the animal under consideration has been discovered at a horizon not much below the Cretaceo-Tertiary contact, and hence the complex from which the animal has been taken belongs to this zone of *Inoceramus schmidti*, as there seems no evidence of the development of SHIMIZU's No. IV group which is almost equivalent to the Hakobuti (Hakobuchi)[3] Sandstone (Upper Senonian) of Hokkaido. It is also remarkable that the two species of *Tetragonosaurus*, to which the present reptile is regarded as related most closely and to which reference has been made repeatedly, came from the Belly River formation of Alberta. This complex, underlaid by the Fox Hill group, is thought to be Senonian in age as a whole.

---

(1) M. F. SCHMIDT: Über die Petrefakten der Kreidefermation von der Insel Sachalin. Mém. Imp. Sci. St.-Pétersb., Ser. VII, Vol. XIX, No. 3, 1873, p. 25 (*Inoceramus digitatus* SCHMIDT non Sow.).
R. MICHAEL: Ueber Kreidefossilien von der Insel Sachalin. Jahrb. d. k. Preuss. Geol. Landesanst., Vol. XIX, p. 162.

(2) D. W. SOKOLOW: Kreideinoceramen des russischen Sachalin. Mém. Com. Géol., U. S., 83, 1914, p. 91.

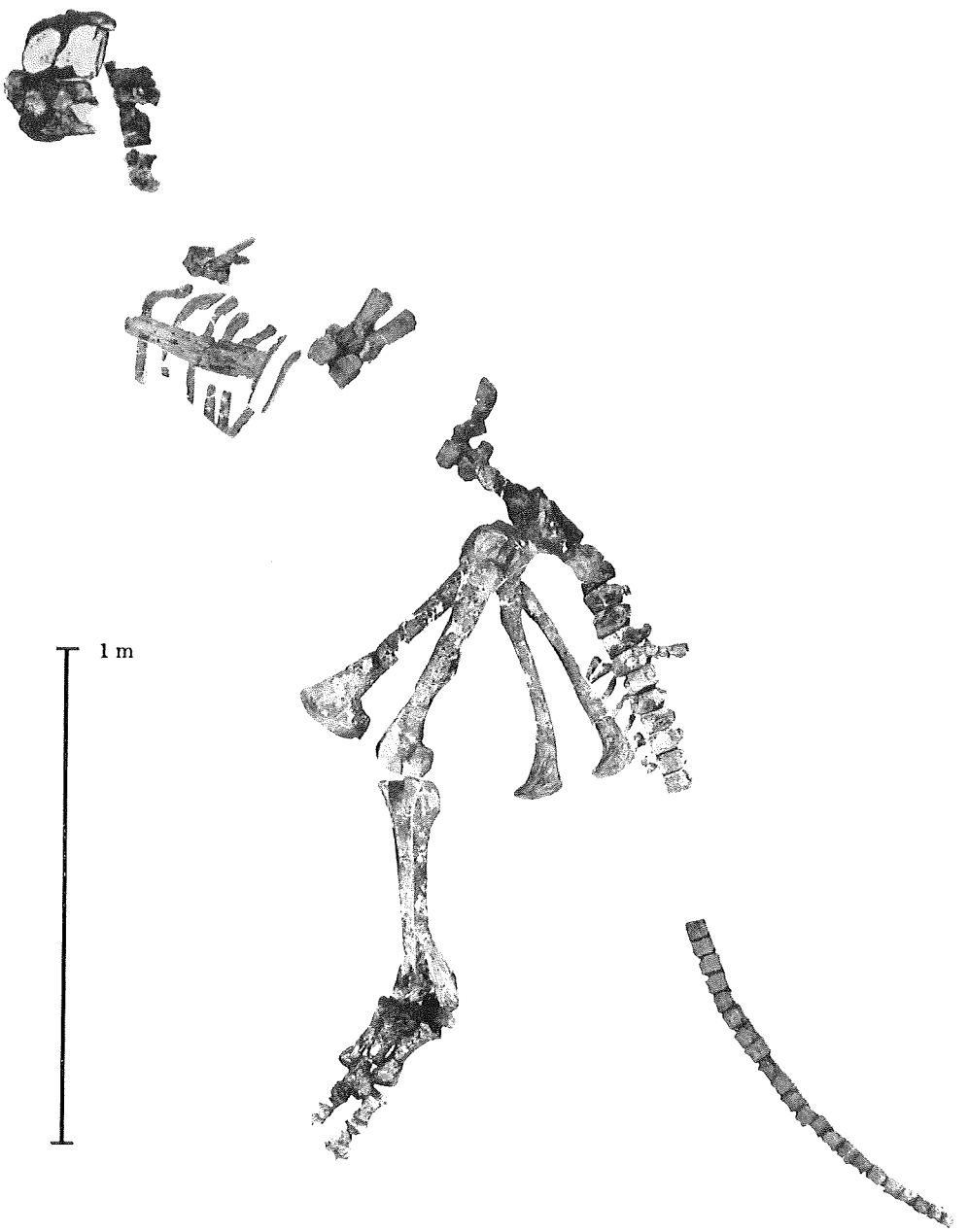
(3) H. IMAI: The Stratigraphical Relation between the Coal-bearing Tertiary (the Ishikari Series) and the Cretaceous Deposits in the Ishikari Coal-Field. Jour. Geol. Soc. Tokyo, Vol. XXXI, 1924, p. 107. (In Japanese).
H. YABE: Cretaceous Stratigraphy of the Japanese Islands. Op. cit., 1927, p. 40.
H. YABE: A New Scheme of the Stratigraphical Subdivision of the Cretaceous Deposits of Hokkaido. Op. cit., 1926, p. 217.

Plate XI (I)

PLATE XI (I)

Nipponosaurus sachalinensis NAGAO

(Left lateral aspect of the skeleton. About one-fifteenth natural size)



(Takeda and Monma photo.)

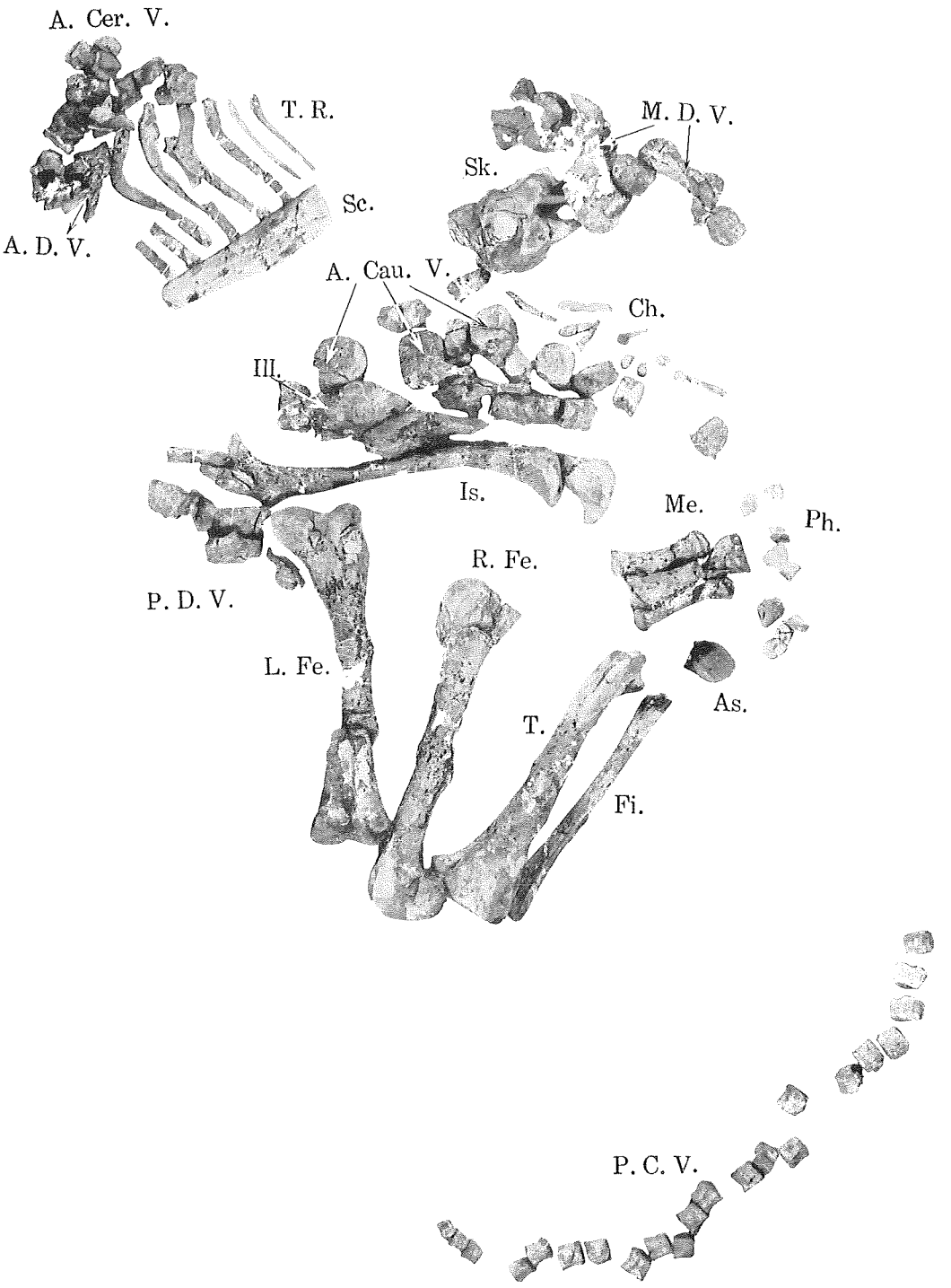
T. Nagao : Nipponosaurus sachalinensis.

Plate XII (II)

PLATE XII (II)

(Skeleton as found in the matrix. About one-eleventh natural size)

A. Cau. V.	Anterior caudal vertebrae
A. Cer. V.	Anterior cervical vertebrae
A. D. V.	Anterior dorsal vertebrae
As.	Astragalus
Ch.	Chevrons
Fi.	Left fibula
Ill.	Left illium
Is.	Ischia
L. Fe.	Left femur
M. D. V.	Mid-dorsal vertebrae
Me.	Left metatarsals
P. C. V.	Posterior Caudal vertebrae
P. D. V.	Posterior dorsal vertebrae
Ph.	Phalanges
R. Fe.	Right femur
Sc.	Scapula
Sk.	Skull
T.	Left tibia
T. R.	Thoracic ribs



(Takeda photo.)

T. Nagao : Nipponosaurus sachalinensis.

Plate XIII (III)

PLATE XIII (III)

(The figures are of a half natural size)

Fig. 1. Skull, viewed from the left.

Fig. 2. Fourth and fifth cervical vertebrae, viewed from the right.

Fig. 3. A fragment of a chevron, viewed from the anterior.

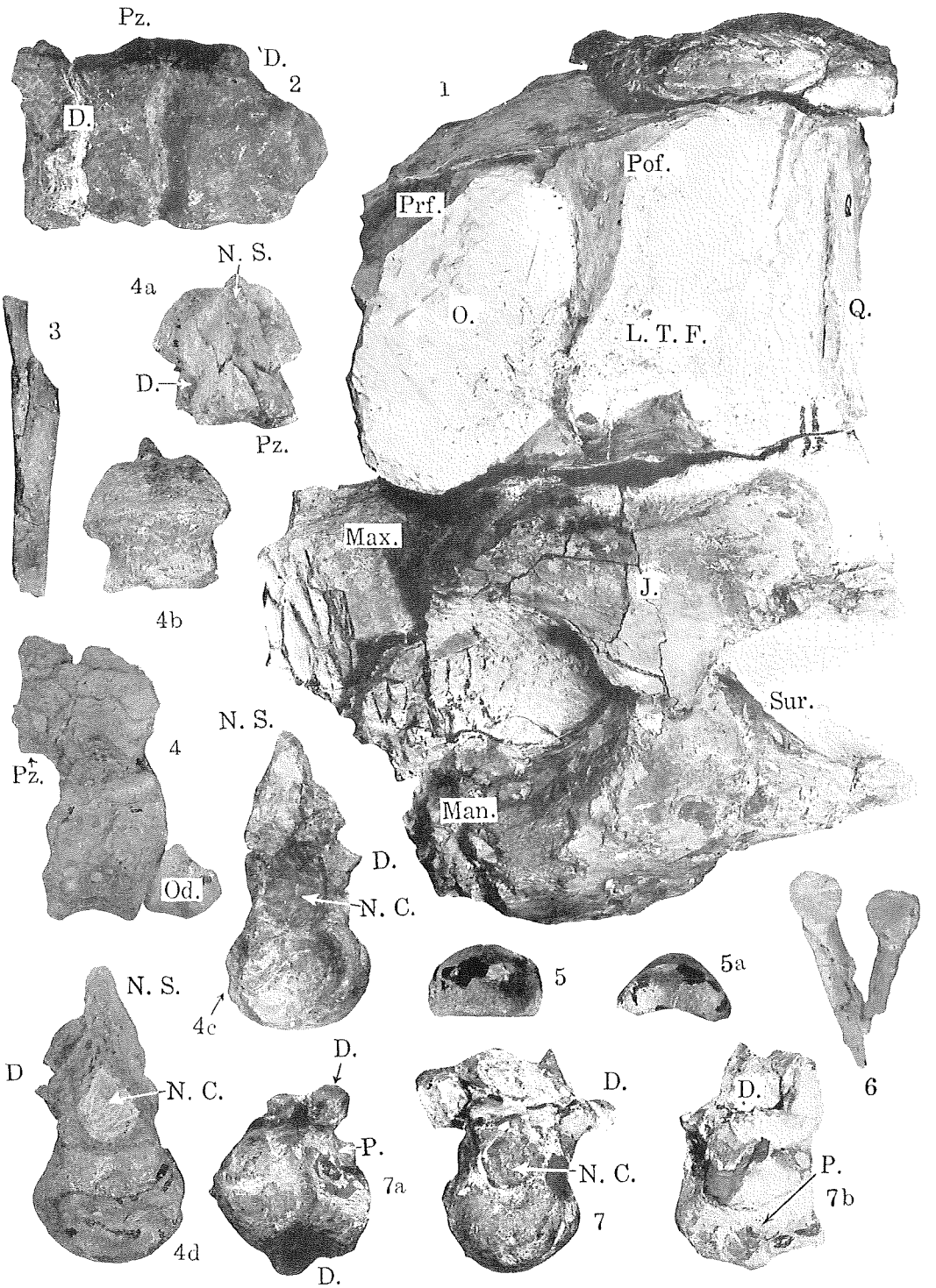
Fig. 4, 4a, 4b, 4c, 4d. Axis in right lateral, dorsal, ventral, posterior and anterior views.

Figs. 5, 5a. Odontoid process of the atlas in dorsal and anterior views.

Fig. 6. Upper ramus of a chevron in anterior view.

Figs. 7, 7a, 7b. Third cervical vertebra in anterior, ventral, and left lateral views.

D.	Diapophysis	Od.	Odointoid process
J.	Jugal	P.	Parapophysis
L. T. F.	Lateral temporal fenestra	Pof.	Postfrontal
Man.	Mandible	Prf.	Prefrontal
Max.	Maxillary	Pz.	Postzygapophysis
N. C.	Neural canal	Q.	Quadrate
N. S.	Neural spine	Sur.	Surangular
O.	Orbital fenestra		



(Takeda and Monma photo.)

T. Nagao : Nipponosaurus sachalinensis.

Plate XIV (IV)

PLATE XIV (IV)

(The figures are of a half natural size, unless otherwise stated)

Fig. 1. A block containing the left scapula, thoracic ribs, and anterior cervical and dorsal vertebrae. About one-fourth natural size.

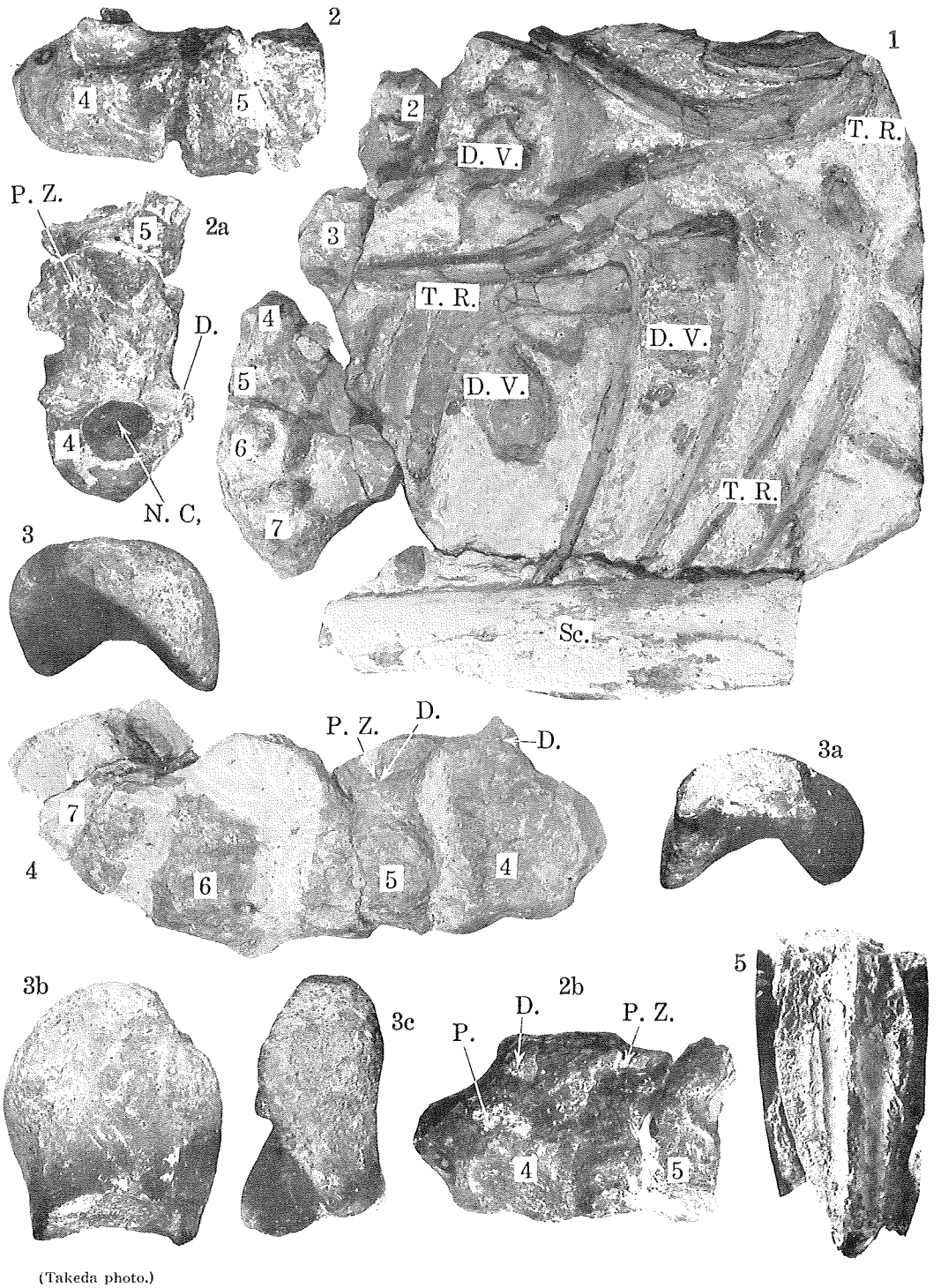
Figs. 2, 2a, 2b. Fourth and fifth cervical vertabrae; ventral, dorsal, and left lateral views.

Figs. 3, 3a, 3b, 3c. Left astragalus without the articular surface for the calcaneum; internal, external, distal, and posterior views.

Fig. 4. Fourth, fifth, sixth, and seventh cervical vertebrae; right lateral view.

Fig. 5. A tooth lacking the upper portion; inner view. About twice enlarged.

D.	Diapophysis
D. V.	Dorsal vertebrae
N. C.	Neural canal
P.	Parapophysis
P. Z.	Postozygapophysis
Sc.	Scapula
T. R.	Thoracic ribs
2-7	Cervical vertebrae



T. Nagao : Nipponosaurus sachalinensis.

Plate XV (V)

PLATE XV (V)

(The figures are of a half natural size, unless otherwise stated)

Figs. 1, 1a. Mid-dorsal vertebra in right lateral and anterior views.

Figs. 2, 2a. Mid-dorsal vertebra in right lateral and anterior views.

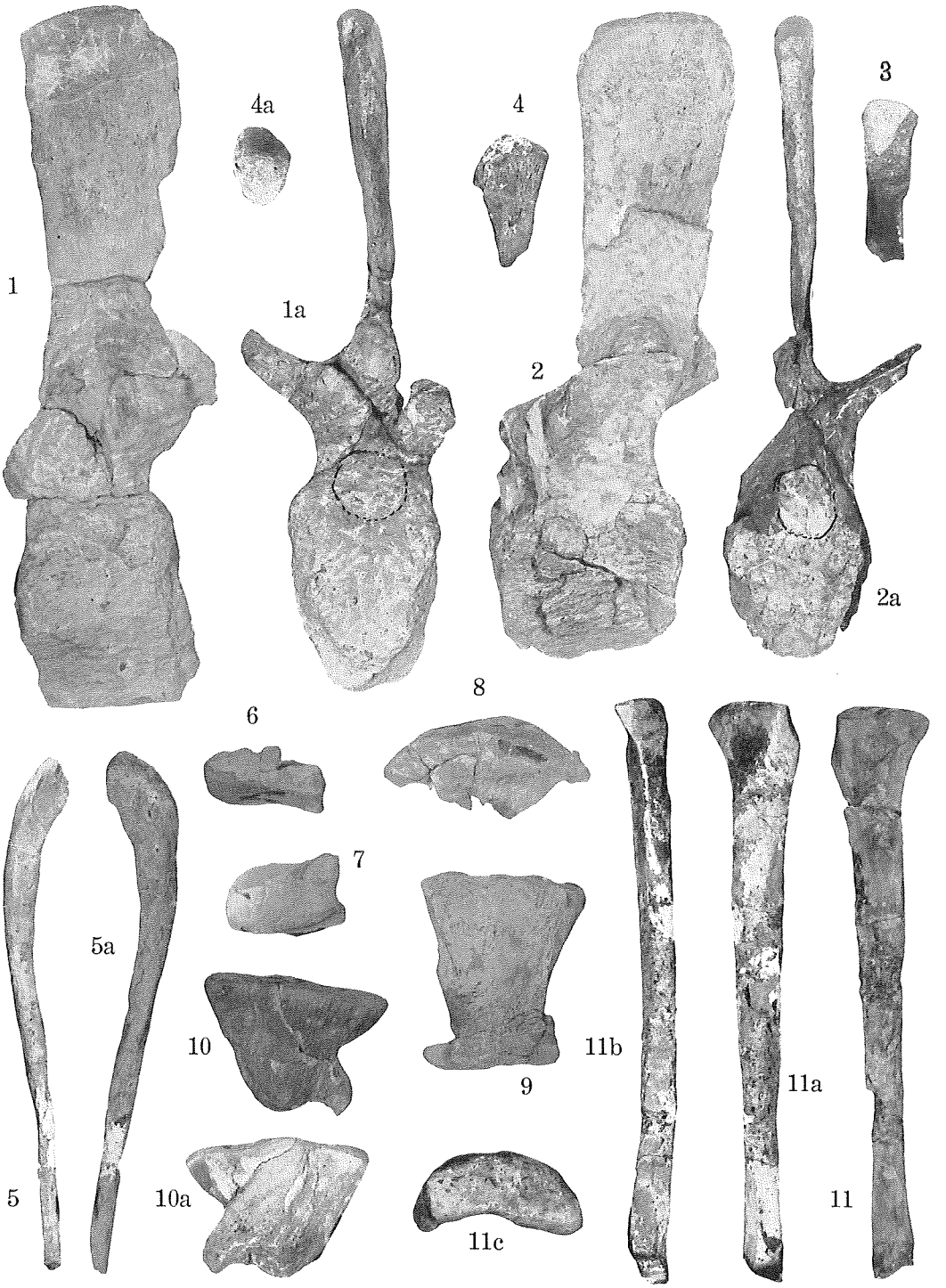
Fig. 3. A branch of the upper ramus of a chevron in posterior view.

Figs. 4, 4a. Right branch of the upper ramus of a chevron in internal and proximal views.

Figs. 5, 5a. Thoracic rib in antero-ventral and postero-dorsal views.

Figs. 6, 7, 8, 9, 10, 10a. Five phalanges; their natural positions unknown.

Figs. 11, 11a, 11b, 11c. Left fibula in internal, external, anterior, and proximal views. 11, 11a, 11b, one-fifth natural size. 11c, about one-third natural size.



(Takeda photo.)

T. Nagao : Nipponosaurus sachalinensis.

Plate XVI (VI)

PLATE XVI (VI)

(The figures are of a half natural size)

Figs. 1, 1a. Posterior dorsal vertebrae in right lateral and anterior views.

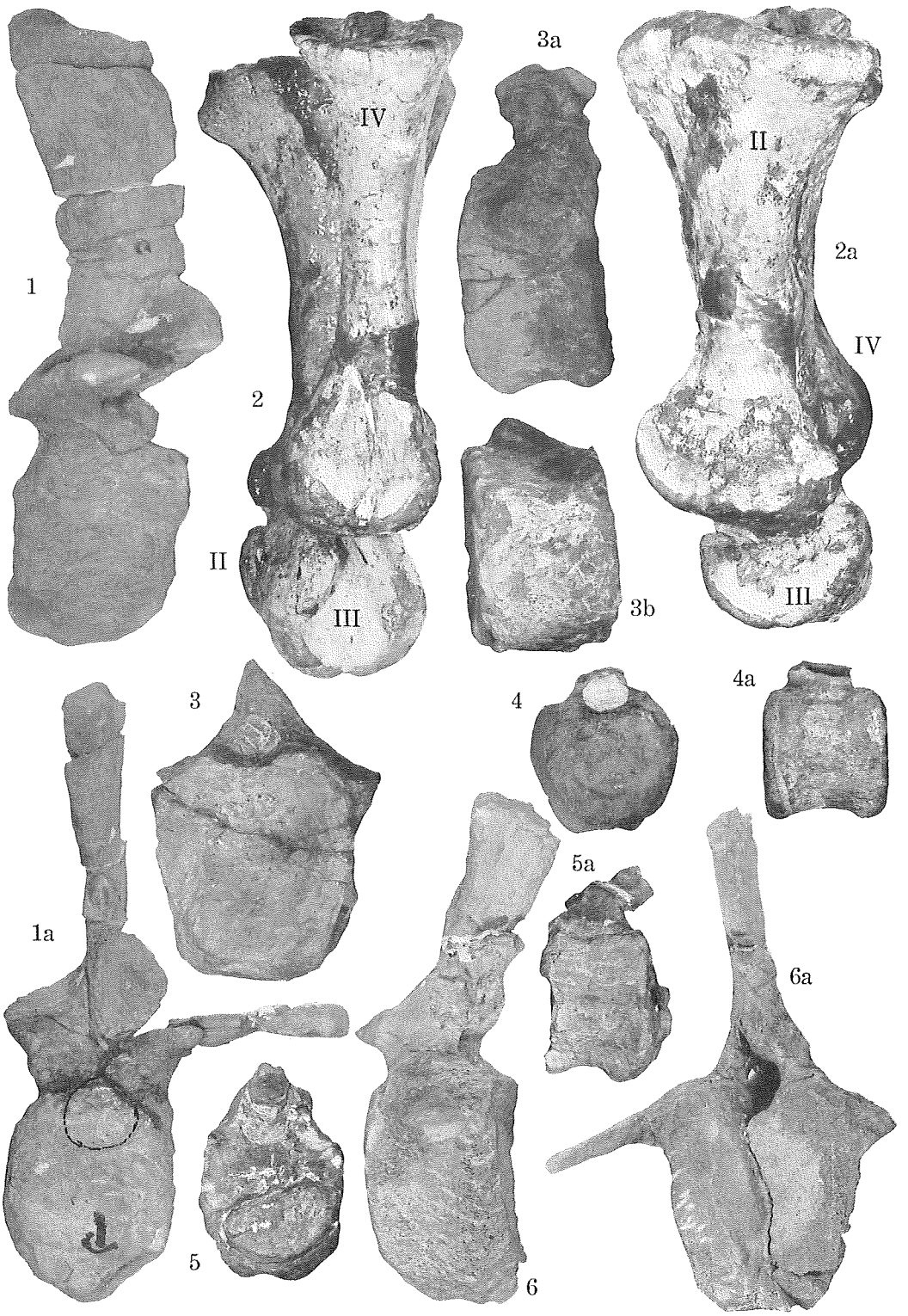
Figs. 2, 2a. Left metatarsals in external and internal views.

Figs. 3, 3a, 3b. Anterior caudal vertebra (D) in posterior, right lateral, and ventral views.

Figs. 4, 4a. Posterior caudal vertebra (e) in anterior and left lateral views.

Figs. 5, 5a. Posterior caudal vertebra (b) in posterior and left lateral views.

Figs. 6, 6a. Anterior caudal vertebra (E) in left lateral and posterior views.



(Takeda photo.)

T. Nagao : Nipponosaurus sachalinensis.

Plate XVII (VII)

PLATE XVII (VII)

(The figures are of a half natural size)

Figs. 1, 1a. Mid-dorsal vertebra in right lateral and posterior views.

Fig. 2. Anterior caudal vertebra (F) in posterior view.

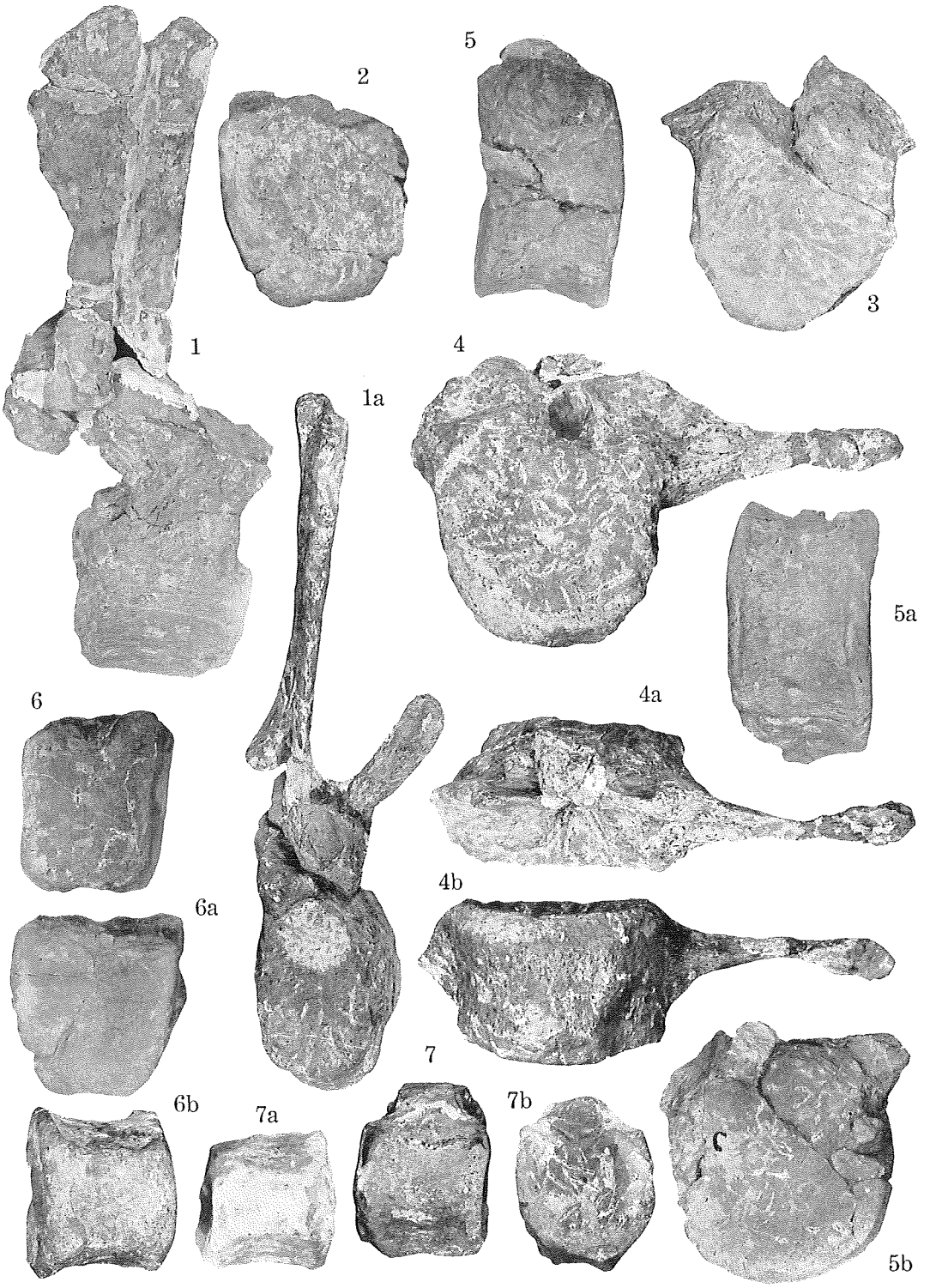
Fig. 3. Anterior caudal vertebra (C) in posterior view.

Figs. 4, 4a, 4b. Anterior caudal vertebra (B) in posterior, dorsal, and ventral views.

Figs. 5, 5a, 5b. Anterior caudal vertebra (A) in ventral, anterior, and left lateral views.

Fig. 6, 6a, 6b. Anterior caudal vertebra (J) in right lateral, posterior, and ventral views.

Figs. 7, 7a, 7b. Posterior caudal vertebra (a) in right lateral, posterior, and ventral views.



(Takeda photo.)

T. Nagao : Nipponosaurus sachalinensis.

Plate XVIII (VIII)

PLATE XVIII (VIII)

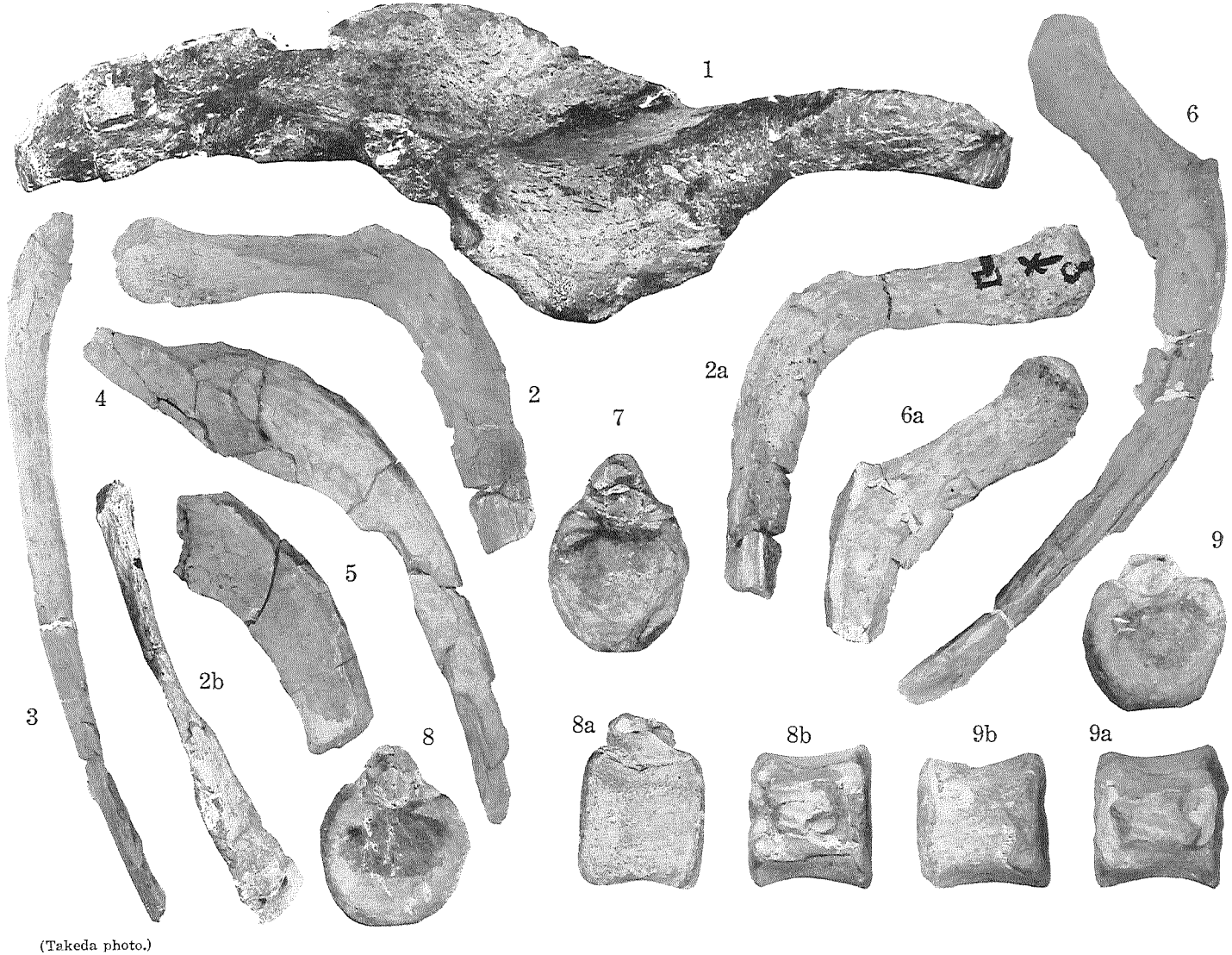
(The figures are of a half natural size)

Fig. 1. Imperfect left ilium in dorsal view.

Figs. 2, 2a, 2b, 4, 5. Three right thoracic ribs. 2, 4, 5, postero-dorsal views; 2a, antero-ventral view; 2b, external view.

Figs. 3, 6, 6a. Two left thoracic ribs. 3, 6a, antero-ventral views; 6, postero-dorsal view.

Figs. 7-9b. Three posterior caudal vertebrae. 7 (c), 8 (d), 9 (e). 7, 9, posterior views; 8, anterior view; 8a, right lateral view; 8a, 9a, dorsal views; 9b, ventral view.



(Takeda photo.)

T. Nagao : Nipponosaurus sachalinensis.

Plate XIX (IX)

PLATE XIX (IX)

Figs. 1, 1a. Imperfect left scapula; external and anterior views. one-third natural size.

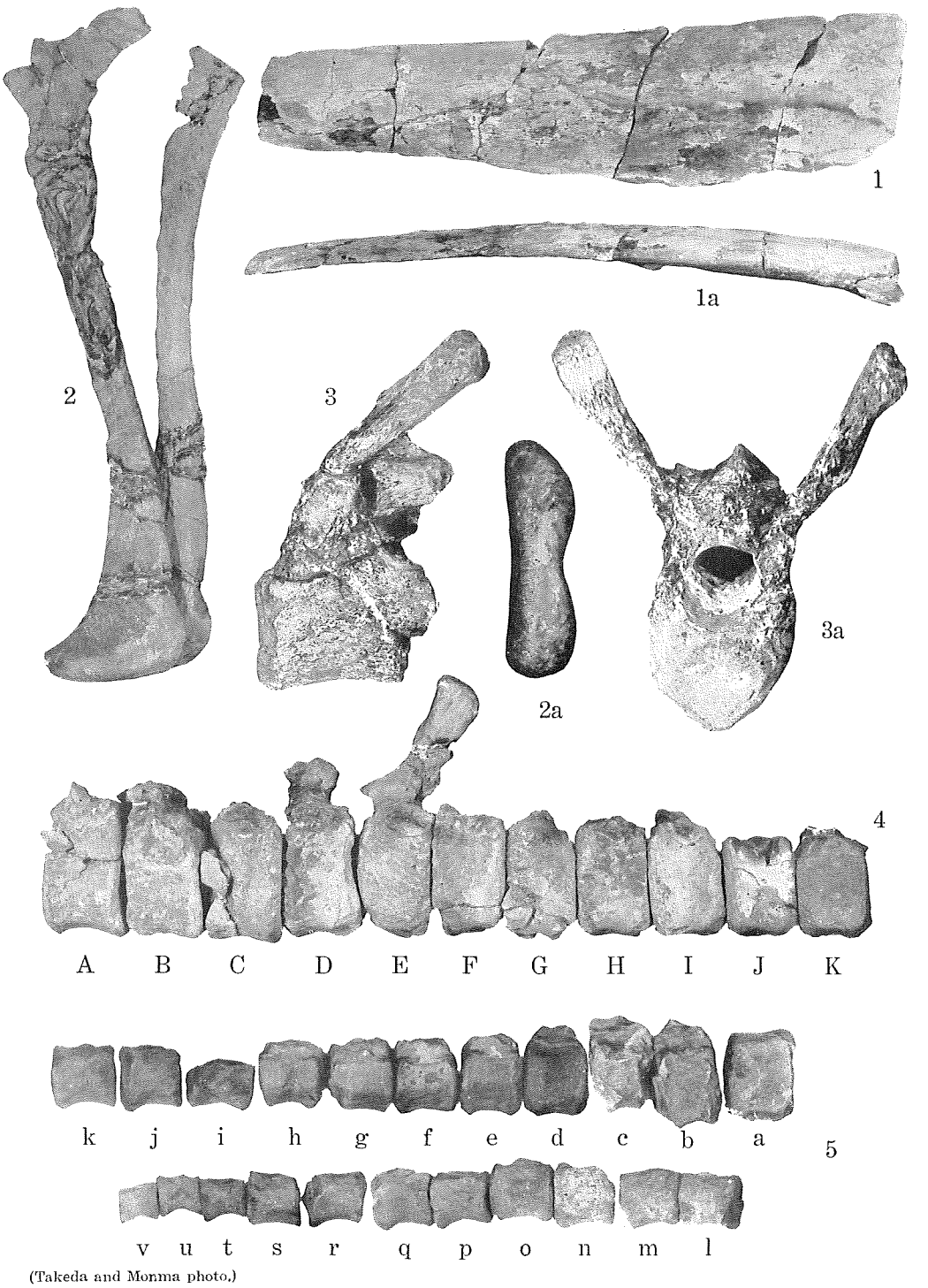
Fig. 2. Ischia; left side view. One-fifth natural size.

Fig. 2a. Terminal view of the foot-like expansion of the left ischium. One-fifth natural size.

Figs. 3, 3a. Anterior dorsal vertebra lacking the neural spine; right lateral and anterior views. A half natural size.

Fig. 4. Anterior caudal vertebrae preserved. One-fourth natural size.

Fig. 5. Posterior caudal vertebrae preserved. One-fourth natural size.



(Takeda and Monma photo.)

T. Nagao : Nipponosaurus sachalinensis.

Plate XX (X)

PLATE XX (X)

(The figures are of a half natural size, unless otherwise stated)

Figs. 1, 1a, 1b, 1c, 1d, 1e. Left femur in posterior, right lateral, left lateral, anterior, distal and proximal views. 1-1c, one-fifth natural size; 1d, 1e, one-third natural size.

Figs. 2, 2a. A fragment of a chevron in left lateral and anterior views.

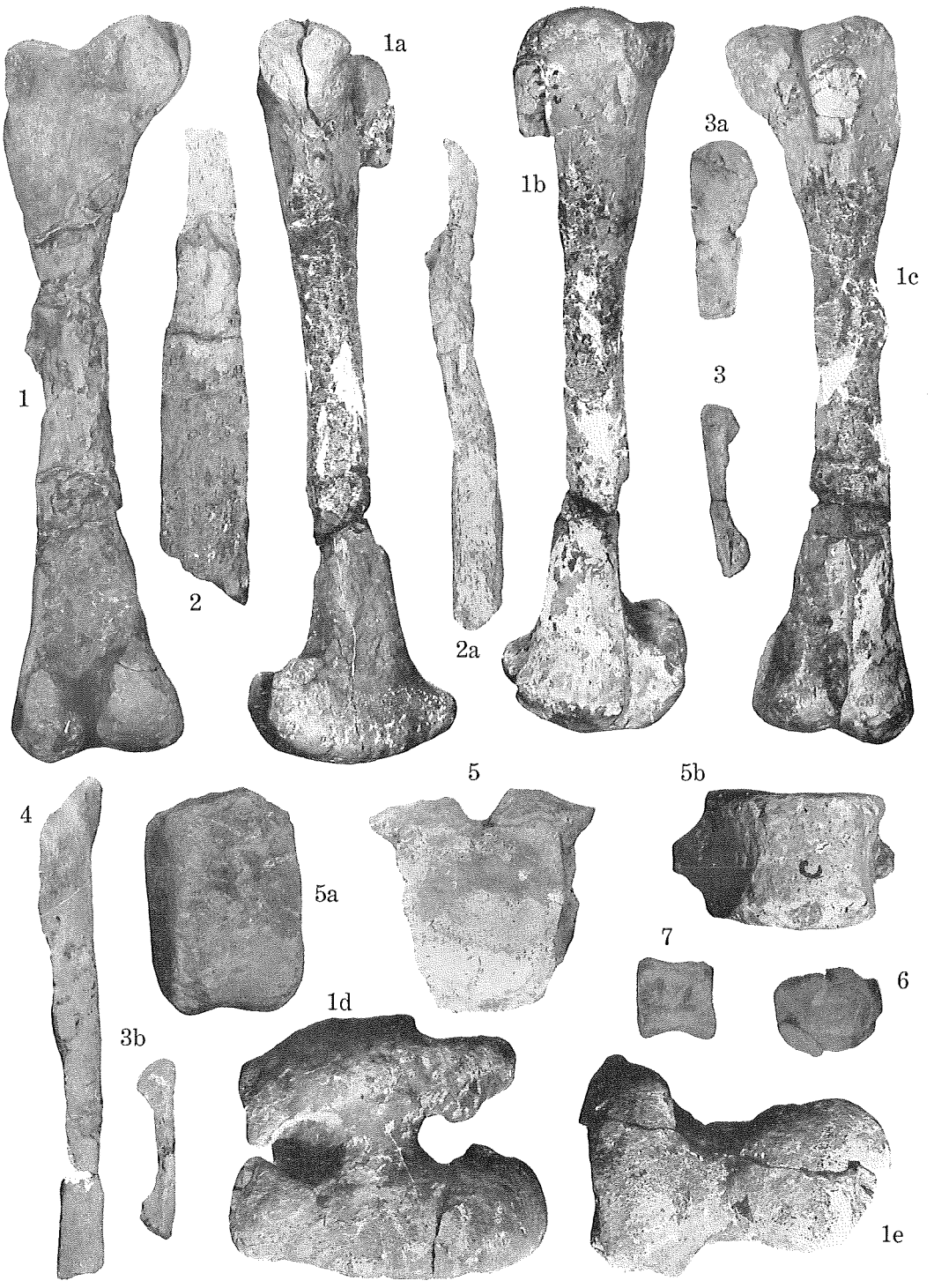
Figs. 3, 3a, 3b. Right branch of the upper ramus of a chevron in posterior, internal, and anterior views.

Fig. 4. Imperfect right thoracic rib belonging to the posterior portion of the series and lacking the capitular branch and the lower extremity; antero-ventral view.

Figs. 5, 5a, 5b. Anterior caudal vertebra (H) in posterior, left lateral, and ventral views.

Fig. 6. Posterior caudal vertebra (t), anterior view.

Fig. 7. Posterior caudal vertebra (v), ventral view.



(Takeda photo.)

T. Nagao : Nipponosaurus sachalinensis.

Plate XXI (XI)

PLATE XXI (XI)

(The figures are of a half natural size, unless otherwise stated)

Figs. 1, 1a, 1b, 1c, 1d, 1e. Left tibia in external, anterior, posterior, internal, proximal, and distal views. 1–1c, one-fifth natural size; 1d, 1e, one-third natural size.

Figs. 2, 2a, 2b. Anterior caudal vertebra (K) in ventral, left lateral, and posterior views.

Fig. 3. Three sacral vertebrae with a sacral rib preserved between two of them, dorsal view.

Fig. 3a. Two sacrals, lateral view.

Figs. 4, 4a, 4b, 4c, 5, 5a, 6, 7. Four posterior caudal vertebrae (f, p, r, k). 4, 5, posterior views; 4a, dorsal view; 4b, right lateral view; 4c, 7, ventral views; 5a, 6, left lateral views.

(Takeda photo.)

T. Nagao : Nipponosaurus sachalinensis.

Plate XXII (XII)

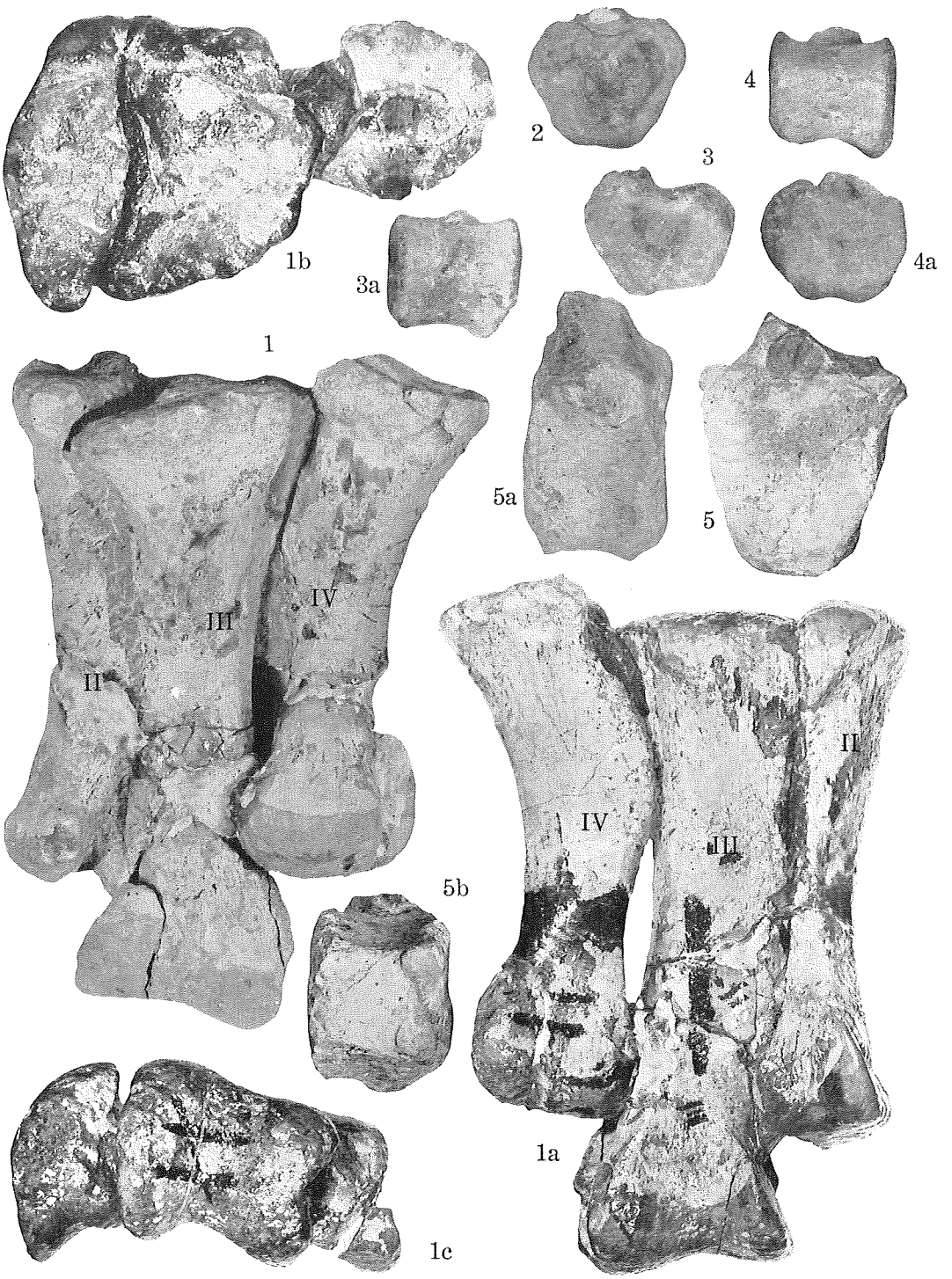
PLATE XXII (XII)

(The figures are of a half natural size)

Figs. 1, 1a, 1b, 1c. Left metatarsals in anterior, posterior, proximal, and distal views.

Figs. 2, 3, 3a, 4, 4a. Three posterior caudal vertebrae (g, h, j). 2, anterior view; 3, 4a, posterior views; 3a, 4, left side views.

Figs. 5, 5a, 5b. Anterior caudal vertebra (I) in anterior, right lateral, and ventral views.



(Takeda photo.)

T. Nagao : Nipponosaurus sachalinensis.