MEMOIRS

OF THE

American Museum of Natural History.

VOLUME IX, PART I.

I.—The Osteology of Champsosaurus Cope.

BY BARNUM BROWN.

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VOLUME IX, PART I.

THE OSTEOLOGY OF CHAMPSOSAURUS COPE.

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AMERICAN MUSEUM OF NATURAL HISTORY.

I.—THE OSTEOLOGY OF CHAMPSOSAURUS COPE.

By Barnum Brown.

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During the summer of 1902, the writer secured for the American Museum three more or less complete skeletons of the semiaquatic rhynchocephaloid reptile *Champsosaurus*, from the Laramie Cretaceous exposures on Hell Creek, a tributary of the Missouri River, one hundred and thirty miles northwest of Miles City, Montana.

These animals were found in the lower strata of the lignite, above the Ceratops Beds, all close together near the same level. The skeletons supplement one another so completely that the entire osteology has been determined with the exception of the number of caudal vertebræ, and the structure of the tarsus and of the metatarsus.

Two new species are represented in this material, the first of which, *C.*

laramiensis, includes two beautifully preserved skulls and skeletons (Nos. 982, 981, Amer. Mus.). The latter (No. 981, Pl. I), which belonged to an immature animal, was found in position, with all the bones articulated as far back as the sacral region, where it was weathered out and partly missing. The relation of the abdominal ribs to the pectoral girdle is, therefore, determined absolutely. This specimen has been skilfully mounted by Mr. A. Hermann, head preparator. The abdominal ribs and pectoral girdle were left in the original matrix (Pl. II). Missing parts are modeled in plaster, after the adult specimen.

The second species, *C. ambulator*, is likewise represented by a nearly complete skeleton, No. 983.

The drawings are by Mr. Erwin Christman. I wish to acknowledge here the kindness of Professor Henry F. Osborn, in placing this material in my hands for description.

I.—Definition of the Order Choristodera.

The order Choristodera includes two genera, the European *Simœdosaurus* and the American *Champsosaurus*.

A detailed study of the new Champsosaur material tends to confirm Dollo's conclusion that the source of *Champsosaurus* is extremely near to the Protorosauria.

The order may be defined as follows:

Skull greatly elongated in the known forms; nares terminal; teeth protoacrodont; small teeth on vomers, palatines, pterygoids, and ectopterygoids. Mandible without postarticular process. Vertebræ amphicœlous, imperforate; pleurocentrum (odontoid) of atlas not united to axis. Ribs: cervicals double-headed, dorsals single-headed. Pubis and ischium continuous, *i. e.*, without puboischiadic fenestra. Humerus with ectepicondylar foramen.

Skull Openings.—The relations of the openings seen in the superior aspect of the skull are as follows:

Anterior nares confluent, terminal, bounded by the premaxillaries except in the median dorsal line, where the tip of the coössified nasals barely extends to the nares. Orbits looking principally upward, bounded externally by the anterior bar of the jugal, anteriorly by the lachrymal and prefrontal, internally by the prefrontal and frontal, posteriorly by the frontal and postorbital. Laterotemporal fenestra, an obliquely placed parallelogram, elongated in an anteromedial and posterolateral axis; the postorbital enters the anterior border. The infratemporal bar is formed chiefly by the quadratojugal (if this bone is correctly identified). Supratemporal fenestra similar to but larger than the laterotemporal fenestra, prolonged posteroexternally far behind the occiput. Posttemporal fenestra rather prominent in the superior aspect of skull, but much smaller than supratemporal fenestra.

In the palatal view the palatine fenestræ are seen to be large, the interpterygoid fenestra greatly reduced.

The following table of comparison of the two genera is made from Dollo's description of *Simœdosaurus* and from the new material in the American Museum.

Simædosaurus Gervais.	*Champsosaurus* Cope.
Skull.	
Length greater.	Length less = 3/5 that of *Simædosaurus*.
Maxillary forms lower boundary of orbit.	Maxillary excluded from orbit.
Basioccipital mostly exposed, showing fossa.	Basioccipital nearly covered by basisphenoid.
60 teeth on each half of lower jaw, 20 on symphysis.	40 teeth on each half of lower jaw, 17 on symphysis.
Anterior nares formed by premaxillaries, maxillaries, and nasals.	Anterior nares formed by premaxillaries and nasals.
Vertebræ.	
Odontoid, hypocentrum, and neurocentrum nearly equal.	Odontoid largest.
Sacrum composed of two vertebræ.	Sacrum composed of two sacrals and one sacrocaudal vertebra.
Girdles.	
Coracoid elongated?	Coracoid rounded.
Mandible.	
No dentary-splenial foramen.	Dentary-splenial foramen prominent.

II.—Historical Review of Champsosaurus.

In a paper published in 1876, Prof. E. D. Cope described the genus *Champsosaurus*, referring to it a new suborder, Choristodera, which he characterized by "the non-coössification of the sacral vertebræ and non-union of the neural arches of the vertebræ with the centra and the absence of the chordal perforation of the latter."

At that time he described four species from the Judith River beds (now considered Upper Pierre) of Montana, and subsequently three new species from the Puerco formation, the basal Eocene, of New Mexico.

All this Cope material is now in the American Museum and has been studied with the aid of the complete skeletons from the Laramie beds.

Cope determined his species principally from the often worn centra of vertebræ, and sometimes from single specimens.

Such variations occur in different parts of the same vertebral column that a determination based on vertebræ alone must be founded on distinctive features which hold good in more than one section of the body: for example, a fossa below the parapophysis may be present in one section and absent in another; the base of the neurocentrum is closer to the anterior end of the centrum in the anterior than it is in the posterior dorsal vertebræ; the articular facets of the centra may be vertical to the axis in the anterior and oblique in the posterior dorsals; the shape of the parapophysis is variable.

So similar are the vertebræ in this family that Cope himself mistook those of the European genus, *Simœdosaurus*, for *Champsosaurus*.

Of the seven species described by Cope four appear to be valid:

C. annectens from the Judith River beds was founded on the centrum of an axis with many referred vertebræ, and was considered the type of the genus. This specimen gives good generic characters, but specific definition must await better material from these beds.

C. profundus is a valid species, determined by the great vertical diameter of the centrum as compared with its transverse measurement and with the straight, non-concave sides of the centrum.

C. brevicollis, founded on a weathered axis-centrum of an immature animal, invalid.

C. vaccinsulensis, founded on half of a plesiosaur centrum, belongs to a different order.

C. australis, valid; vertebræ distinguished by superior transverse as compared with longitudinal and vertical extent. The outline of the articular face for the neurocentrum is pyriform with strongly decurved edge. Articular faces of centra nearly plane.

C. puercensis, invalid, founded on fragments and badly weathered vertebræ of an old individual which is probably referable to *C. saponensis*.

C. saponensis, valid. In addition to the characters given by Cope, it may be added that the transverse bar of the interclavicle is deeply excavated along its median line on the dorsal surfaces, and a process of the clavicle extends up to the excavation on the anterior dorsal surface.

III.—Historical Review of Simœdosaurus.

In February, 1877, Paul Gervais described some bones sent by Professor Lemoine, under the name of *Simœdosaurus*. It appeared to him that the ancestral forms approaching nearest to his *Simœdosaure* were the Simosaurians of the Triassic period.

Professor V. Lemoine, in 1884, recognized three species of *Simœdosaurus* from the Lower Eocene near Reims, which he defined as follows:

S. lemoinei, vertebræ convex, head of humerus asymmetrical.

S. remensis, vertebræ, some cylindrical, some hour-glass shaped, and some prismatic.

S. peroni, head of humerus elliptical.

To these three species he added a fourth from the lignites of Soissonnais, *Simœdosaurus suessonniensis*, differing from those described from Reims in the form of its teeth.

Little may be said regarding the value of these species, as the characters given are not adequate for specific determination.

IV.—Synopsis of Diagnostic Characters of the Genus Champsosaurus.

Skull.—Greatly elongated and gavial-like. Quadrate fixed. No quadrate foramen. Equal-sized supra- and laterotemporal fenestræ; large posttemporal fenestra; no pineal opening. Nares terminal, confluent; internal nares separated by prevomers. Teeth lodged in distinct shallow sockets but not firmly attached, in maxillaries, premaxillaries, and dentaries; pulp cavity persistent; teeth hollow, infolded internally as in *Ichthyosaurus*. Numerous small teeth implanted on palatines, prevomers, pterygoids, and ectopterygoids. Jaw without coronoid process. Splenial entering mandibular symphysis, symphysis sutural. No postarticular process.

Vertebræ.—Shallow amphicœlous to amphiplatyan, imperforate, but faces of centra often imperfect, showing remains of vestigial notochord. Neurocentra and centra suturally united in presacral vertebræ. Atlas and axis composed of seven pieces, namely: two separate neurocentra, hypocentrum, and free pleurocentrum (os odontoideum) in atlas. Axis composed of united neurocentra resting upon the centrum with hypocentrum below; five anterior cervicals with hypocentra, no hypocentra below remaining cervicals or dorsals. Dorsal vertebræ with para- and diapophyses gradually uniting, the capitulum rising to unite with the tuberculum, finally becoming confluent. Chevrons vertebral. Formula, 26 presacrals (9 cervicals and 17 dorsals), 2 sacrals and 1 sacrocaudal, 21 + caudals, 39 in restored skeleton.

Ribs.—Probably a rib on pleurocentrum of atlas (odontoid), a well-defined rib on axis. Vertebræ 2–10 with two-headed ribs, capitulum attached opposite pleurocentrum; all succeeding dorsal ribs single-headed. Dorsal ribs very massive. Anterior caudals 8, with ribs suturally attached to neurocentra and centra; caudals 9–13 with ribs coalesced to centra; posterior caudals without ribs or transverse processes.

Abdominal Ribs.—Heavy, a central angulate piece, sometimes bifurcated, and two lateral curved pieces.

Girdles.—Massive scapula and coracoid; a coracoid foramen. Interclavicle T-shaped, with broad posterior plate; stout clavicles. In pelvic girdle ilia reduced, with backward extension superiorly; pubis and ischium continuous, expanded into a broad ventral plate. An obturator foramen, but no puboischiadic (thyroid) foramen.

Limbs.—Humerus with radio- (ectepi-) condylar foramen or groove; no ulno- (entepi-) condylar foramen. Ulna and radius of equal size separated distally by large intermedium; a single free centrale. 1 and 5 of distal carpalia cartilaginous. Phalangeal formula, 2, 3, 4, 4, 3; terminal phalanges pointed and clawed. Distal ends of metacarpals and phalanges without dorsal reflexed articular surface. Femur much longer than humerus. Fibula reduced. Large tibiale. Five digits in pes.

V.—Descriptions of the Species.

Champsosaurus laramiensis sp. nov.

(Plates I–III; IV, Figs. 2–3*a*; V, Figs. 1, 2, 4, 7–13.)

Type.—A nearly complete skull and skeleton, No. 982, Amer. Mus. Paratype, a skull and skeleton lacking only parts of the tail and both hind feet. No. 981, Amer. Mus.

General Description of Skull.—The skull is long, triangular, and flattened, with extremely elongated, nearly straight snout. The surface is marked by irregular filiform striæ, most pronounced in the preorbital region. The large temporal fenestræ are of about equal size; the laterotemporal fenestra placed well in front of the supratemporal fenestra. A large posttemporal fenestra is present. There is no pineal foramen and no lachrymal foramen. The orbits are small as compared with *Sphenodon*, and elongated, located in the top of the head, very close together. The nares are terminal and wider than high. There is a large palatine foramen below each orbit. An interpterygoid foramen is present.

The lengthening of the skull, as Dollo points out in the case of *Simædosaurus*, is not a local enlargement of the maxillaries, as in the gavials, but a general drawing out of all the elements of the skull, and, especially in the preorbital region, the maxillaries and nasals.

Teeth.—The teeth of *Simædosaurus* are described by Dollo as in a stage which he calls protoacrodont, leading up to the acrodont type, and this term seems to describe best the conditions in *Champsosaurus:* that is, the teeth are firmly set in shallow sockets, but always remain distinct from the bone to which they are attached. They are borne in the premaxillaries, maxillaries, mandibles, palatines, prevomers, pterygoids, and ectopterygoids. The crown is relatively slender, nearly straight, with point curved inward. The extreme point is smooth, slightly compressed, presenting a cutting edge on either side parallel to the ramus. The middle of the tooth is marked by delicate longitudinal striæ, which fade out leaving a smooth band below. The base is coarsely ridged, showing the infolding of the surface. There are about 40 teeth in each mandibular ramus. On the symphysial part of each ramus there are 17 teeth. To judge from the alveolus and fragments of roots left, No. 2 in each jaw seems the largest of the series; Nos. 1 and 3 are of about the same size and somewhat smaller than No. 2; from 3 back they decrease gradually, but the last tooth is much larger than any of those on the prevomers, palatines, or pterygoids.

When the jaws were closed the teeth of the upper and lower jaws alternated in a row. On the anterior half of the symphysial region the points of the upper teeth extended below the alveoli of the mandible and were received in sulci, which from the basal view give the lower jaw the appearance of being

constricted between the teeth. In the anterior part of the mandible the teeth of the opposite rami are opposite, each to each, but posteriorly they are irregular. Posterior to the symphysis the mandibular teeth are set closer together.

The teeth in the prevomers, palatines, and pterygoids are very small, and are either in rows or arranged slightly irregularly; they are similar to the maxillary teeth in growth and implantation, but more firmly united to the bone which bears them.

SUPERIOR VIEW OF SKULL.

(Plate III.)

PREMAXILLARIES.—The premaxillary occupies about one tenth of the total length of the skull and is separated suturally from the nasals. Anteriorly it bends downward and inward, meeting its fellow below in the median line. The inferior surface, forming the floor of the nares, protrudes somewhat in front of the superior border, forming a broad, low, terminal nostril. The free border, is expanded and spatula-shaped in some forms, and each premaxillary bears 3 teeth.

NASALS.—The nasals are coössified, showing no suture between them. They are reduced to a narrow wedge which is exposed throughout more than half the length of the face. The extreme point extends out freely, overhanging the nares, and is separated from the premaxillaries anteriorly by an incision. From their union with the premaxillaries, which is the point of greatest width, they taper gradually, bordered by the premaxillaries and maxillaries, terminating in a narrow wedge between the prefrontals.

MAXILLARIES.—The maxillaries are much the longest bones of the skull: they are separated throughout their length, approaching each other most nearly in the facial surface at the posterior end of the nasals. The maxillary unites successively with the premaxillary, nasal, prefrontal, lachrymal, and jugal, and, passing under the jugal, is excluded from the orbit.

PREFRONTALS.—The prefrontals at their origin, anteriorly, are very thin, gradually rising and increasing in thickness posteriorly, forming with the frontals the high, narrow, arched bridge which separates the orbits. They are separated at the extreme anterior point by the nasals, then meet in the median line, and expand until they unite with the lachrymals, continuing the same width to the orbit. Posteriorly they are separated by the frontals along a line extending from the middle to the anterior border of the orbit. The prefrontals form the anterior inner quarter of the orbital boundary.

LACHRYMALS.—The lachrymal is a short triangular plate forming the outer anterior boundary of the orbit and extending forward in an obtuse point, uniting on the sides with the prefrontal, maxillary, and jugal.

FRONTALS.—The frontals are thick, narrow plates, uniting in the median line separating the orbits, and presenting anterior and posterior projecting

processes. The posterior processes are separated by the parietals and wedge in between the parietals and postfrontals; laterally they are bordered by the postorbitals. Their free border forms the inner posterior border of the orbits. The frontals rise anteriorly, reaching their highest point near the middle of the orbit, from which point the anterior processes descend slightly, wedging in between the prefrontals.

POSTORBITALS.—The postorbitals are irregular pentagonal plates. They form the posterior border of the orbit and part of the anterior border of the laterotemporal fenestra. Laterally, on the outer side, they unite with the jugals and on the inner side with the frontals and post frontals.

JUGALS.—The jugals are elongated. The posterior part is a flattened bar forming the anterior part of the infratemporal arch. It forms the outer boundary of the orbit and extends forward nearly as far as the anterior end of the lachrymal. It unites with the lachrymal and maxillary in front and the postorbital and quadratojugal behind.

POSTFRONTALS.—The postfrontal has a backwardly extending bar which joins the squamosal, forming the supratemporal arcade. Anteriorly it unites with the postorbital, frontal, and parietal.

PARIETALS.—The parietals unite in a prominent interparietal suture, forming a broad rugose crest excavated in the median line, with the outer border raised in node-like prominences. These nodes continue forward on either side of the median line nearly to the orbit. Anteriorly the parietals form an irregular wedge, separating the postfrontals and the posterior processes of the frontals. Posteriorly a narrow, thin, recurved process on either side diverges from the median line and joins a like bar of the squamosals, forming the posttemporal arcade. The relation of the parietals to the supraoccipital cannot be made out clearly but the supraoccipital must be a very small plate. Laterally the parietals unite with the squamosals and posteriorly with the exoccipitals. They form the inner wall of the supratemporal fenestra.

SQUAMOSALS.—The squamosals form the posterior angle of the skull, the greater part of the boundary of the temporal fossa, and the posterior half of the supratemporal arcade. Forming the floor of the temporal arcades is seen an anterior plate of the squamosals which unites with the exoccipitals and the broad expanding plate of the quadrate.

QUADRATOJUGAL.—The quadratojugal forms the greater part of the infratemporal bar and expands posteriorly, overlapping the squamosal and sending in on the lower side a projection which forms the outer buttress of the quadrate.

INFERIOR VIEW OF SKULL.

(Plate III, Fig. 2.)

PREMAXILLARIES.—On the inferior surface the premaxillaries unite to form all the anterior end of the palate. The sutural lines separating them from

the maxillaries do not show clearly, but the dorsal sutures come just behind the third tooth. The dentigerous portion is deeply pitted and carries 3 teeth. The premaxillaries entirely exclude the maxillaries from the nasal opening.

MAXILLARIES.—Inferiorly the maxillaries are separated along their greatest extent by the ethmoids, and posteriorly by the prevomers and palatines. Back of the internal nares the maxillaries are thin plates overlapping the jugals and just meeting the transverse bar of the pterygoid in front of the process on the transverse bar.

ETHMOID.—The homology of this bone is somewhat questionable. It is exposed in the palate as a narrow, median, rounded ridge separating the dentigerous portion of the maxillaries; it extends backwards from about the third tooth and wedges between the prevomers. The ethmoid and nasals unite in separating the narial passages as far as the premaxillary region.

VOMERS.—The vomers, or prevomers as determined by Broom, are united along the intervomerine suture. The anterior third is smooth and edentulous, tapering to a point between the maxillaries. Posteriorly each prevomer bears teeth in a single line or arranged somewhat irregularly. The opening of the internal nares begins near the middle of the prevomers, which at this point are slightly constricted and excavated on the sides. They form a wall separating the nares, and contribute about a third of the roof of the narial trench. Crossing the vomers at the narial opening is a smooth surface, dividing the vomerine teeth into an anterior and a posterior area. The prenarial teeth are more numerous on a given area than those situated posteriorly. The prevomers unite with the ethmoids, maxillaries, palatines, and pterygoids.

PALATINES.—Each palatine unites with the maxillary along its outer border and with the prevomer and pterygoid on the inner side. The middle of the palatine plate is raised, bearing teeth either in two rows or arranged somewhat irregularly. Anteriorly this raised portion forms a ridge without teeth, and fades into a thin wedge terminating just in front of the vomerine teeth. The greater part of the roof of the internal nares is formed by the palatines. Posteriorly the palatine is cleft by the palatine fenestra, forming two processes. The internal process unites with the pterygoids.

PTERYGOIDS.—The pterygoids are very irregular, united along their median line to a point opposite the posterior margin of the palatine fenestræ, where they are separated by an interpterygoid foramen. Posteriorly they are united. The ventral compression of the pterygoids completely obscures the parasphenoid, a highly specialized character. The anterior portion of each is a thin plate having two parallel ridges bearing teeth of which the inner row is much longer and nearly continuous with the vomers. The outer ridge is in line with the palatine ridge, and at first seems a continuation of it, but the line is interrupted by an edentulous portion across which the pterygo-palatine suture runs diagonally. These teeth extend to the outer edge of the bone. The transverse bar, or ectopterygoid, bears a narrow ridge surmounted by teeth

in two rows or arranged slightly irregularly. The bar forms the posterior border of the palatine fenestra and is firmly buttressed against the inner side of the jugals with a thin process extending forward to unite with the maxillary and ending opposite the penultimate maxillary tooth.

Posterior to the teeth on the transverse bars the pterygoids are constricted, forming the narrowest part of the sphenoidal rostrum. Then they diverge, separated by the basisphenoid, and unite with the quadrates along diagonal sutures.

BASISPHENOID.—The basisphenoid is the most prominent bone on the inferior surface. Anteriorly it is exposed as an elevated narrow convex sphenoidal rostrum separating the pterygoid processes. Posteriorly it expands in two wings, overlapping and nearly covering the basilar processes of the basioccipital, terminating in a filiform edge.

QUADRATES.—The quadrate is fixed and extensive. There is a long pterygoid process uniting along most of the inner side with the exoccipital and basioccipital. On the outer side of the extreme point it joins the posterior projection of the pterygoid. Posteriorly the flat blade of the quadrate broadens out, partly surrounding the posterior process of the exoccipital, and bends upwards, uniting along its whole extent with the squamosal. The articular surface of the quadrate is raised above the surrounding plate and is lengthened transversely. It is deeply excavated diagonally. This surface looks forward and downward. On the outer side it unites with the quadratojugal.

SQUAMOSALS.—The squamosal forms the posterior angle of the skull and unites with the quadrate, quadratojugal, exoccipital, and parietal.

POSTERIOR VIEW OF THE SKULL.

(Plate III, Fig. 3.)

BASIOCCIPITALS.—The condyle is large and circular, slightly excavated on the upper surface. The large basilar processes begin in front of and below the base of the condyle and extend outward, backward, and downward. The distal end of these processes terminates in an elliptical surface for muscular attachment. The basioccipital forms only the base of the foramen magnum, and is nearly covered by the exoccipitals.

EXOCCIPITALS.—The exoccipitals nearly surround the foramen magnum, and are separated above by the supraoccipital, though the sutures are not defined. On each side near the middle rises a shelf-like surface which projects backward and converges toward the median line, forming an articular surface for the anterior zygapophysis of the atlas. Laterally the exoccipital sends backwards a process (opisthotic) projecting out beyond the basilar process, which unites with the squamosal and, partly surrounded by the quadrate, ends abruptly in a truncated surface.

SUPRAOCCIPITALS.—The supraoccipital cannot be suturally defined, but was evidently greatly reduced and obscured by the overhanging parietals.

LOWER JAW.

(Plate IV, Figs. 2, 2a.)

MANDIBLE.—The mandible of *Champsosaurus* agrees very closely with that of *Simædosaurus*. Comparing it, however, with the profile view published by Dollo, the dorsal surface of the surangular seems more convex and while *Simædosaurus* is said to have no splenial opening *Champsosaurus* shows a medium-sized foramen on the lower half of the inside of the ramus below the fourteenth tooth from the posterior end. The rami are very slender for their length and height, and are suturally united along five elevenths of their extent.

The dentary bears about 40 teeth, of which the second is the largest, and the first and third are larger than the succeeding teeth. Behind the symphysis the teeth are placed closer together.

The splenials enter the symphysis and entirely separate the dentaries posteriorly. They form all the inner middle section of the rami, and in a profile of the outer side appear in the ventral surface of the jaw, extending posteriorly beyond the opening of Meckel's canal nearly to the articular.

The coronoid is reduced and not elevated in a dorsal process. Its middle is slightly convex and rugose. Ventrally it forms the upper surface of Meckel's canal. The surangular shows on the posterior upper fifth of the ramus and its outer border forms a prominent crest for the attachment of the temporal muscles, which were strongly developed. The inner surface is deeply excavated. Posteriorly the surangular presents a revolute border conforming to the articular surface and projecting inward as a shelf overhanging the Meckelian groove.

The angular forms the lower posterior fifth of the ramus and is the chief support of the articular. On the inner side it rises in front of the articular, nearly meeting the shelf of the surangular and partly enclosing the Meckelian groove.

The articular is very small, and nearly the whole of the exposed surface articulates with the quadrate. The articular surface is longer than wide and is diagonal to the ramus. The inner border is in front of and lower than the outer border, while the anterior border merges into the surangular and is higher than the posterior border. There is no post-articular process.

THE VERTEBRAL COLUMN.

(Plate I.)

ATLAS.—The atlas (Pl. V, Fig. 9) is composed of four pieces, a large free pleurocentrum, two neurocentra, and a hypocentrum.

The pleurocentrum or odontoid presents in profile a triangular outline, the posterior and superior faces of which form the sides, meeting at right angles. The posterior articular face is elliptical, flat, and smooth, showing no sign of

coalescence with the axis — a very primitive, unmodified condition. Its vertical is somewhat greater than its transverse diameter. The superior surface, forming the base of the neural canal, is slightly excavated and pitted, with an anterior projecting process, back of which is a shallow groove. The anterior articular face parallels the posterior face and is considerably wider transversely, projecting by nearly a third of the length of the vertebra in advance of the ventral surface; it is crescentic in outline, presenting three nearly equal articular surfaces, a slightly concave central face articulating with the condyle, and two lateral convex faces articulating with the neurocentra. Below the anterior articular surface, defining it on the lower side, is a deep groove running transversely which separates it from the hypocentrum. The ventral surface is divided into two surfaces for articulation with the hypocentrum of the atlas and the hypocentrum of the axis, the former reaching up on the anterior surface to the groove mentioned. The free sides of the pleurocentrum are somewhat depressed and striated; a small area in the upper border seems restricted, possibly for the articulation of a rib, though this does not show in the older specimens.

The neurocentrum is an irregular element composed of a heavy articular base from which rises a broad, flat, wing-like plate. This plate is concave on the upper side and broadly expanded anteriorly for articulation with a projecting shelf of the exoccipital. Running obliquely backward and downward from the inner angle of this articular surface is a ridge which gradually fades out at the origin of this plate. The posterior process narrows rapidly for articulation with the anterior zygapophysis of the axis and is about twice the length of the anterior wing. The anterior and inner borders thin out to an edge. The base is rounded on the outer side; the inner surface presents a concave surface articulating with the pleurocentrum. Below this, merging into it obliquely, is the surface articulating with the condyle, which forms the chief support of the neurocentrum. The extreme point articulates with the hypocentrum.

The hypocentrum of the atlas is, roughly, a wedge-like bone, its base articulating with the condyle in a deeply excavated surface, either end of which is rounded for articulation with the neurocentrum; immediately in front of and separating it from the axis hypocentrum is a shallow groove which with the groove mentioned in the pleurocentrum forms a transverse canal. Posteriorly it articulates with the pleurocentrum and hypocentrum of the axis; the distal end terminates in a rounded point which in the older individual is expanded and roughened. The anterior lower surface is triangular and rounded.

Axis.—The axis (Pl. V, Fig. 10) is composed of three pieces—centrum, neurocentrum, and hypocentrum. The anterior articular surface of the centrum is of much greater diameter vertically than the posterior surface, and is divided into a superior face for articulation with the pleurocentrum of the atlas (odontoid) and an inferior, oblique crescentic excavation for the hypocentrum.

The posterior articular surface is almost round and slightly cupped. The sides of the centrum are slightly depressed and pitted. On the ventral surface is a slight carina with roughened borders. The dorsal surface of the centrum has a deeply excavated facet with flared edges on either side of the neural canal for the reception of the neurocentrum. The hypocentrum is crescentic and smooth on the ventral surface, concave posteriorly for articulation with the centrum; this surface merges into the dorsal atlas-pleurocentrum articulation, which continues over into the ventral atlas-hypocentrum surface without any separation.

The neurocentrum differs from those of the succeeding vertebræ in having no high, differentiated spine. In the youngest specimen it shows no separation into two plates as described by Dollo in *Simædosaurus*. The top of the neurocentrum is a broad, thick plate, greatly elongated antero-posteriorly, with a slight median crest on the posterior end. Posteriorly it expands and is cleft into two lobes overhanging the zygapophyses, which look outward and downward. Anteriorly it narrows to a triangular central wedge. The anterior zygapophyses rise near the center of the arch below the spinous plate just described, forming an elongated articular facet which looks upward.

CERVICALS.—In the remaining cervical vertebræ (Pl. I and Pl. V, Fig. 11) the centra gradually increase in size; the anterior and posterior faces are oblique at the axis of the vertebræ, thus giving a decided upward arch to the neck, while the edges of the articular faces of the centrum are reflexed on the sides, allowing great lateral movement. A small parapophysis begins on the anterior border of the fourth vertebra, rising rapidly, increasing in size, and uniting with the diapophyses in the first dorsal. In the young individual there is a slight separation of the tubercle and capitulum in the head of the tenth rib.

The last three hypapophyses (intercentra) are free, triangular, and wedge-shaped, decreasing rapidly till in the fifth and last it is a very small element.

The ventral carina increases in size to the seventh vertebra and then gradually decreases, disappearing in the eleventh.

The spinous process in the third vertebra is prominent and pointed, set at an angle of 40°. In the succeeding vertebræ the spines become more erect, reaching their full size in C 6. The diapophyses of the neurocentrum in the first three cervicals do not completely fill their facets, the decurved edges of which give an additional support to the tuberculum of the rib; in the remaining cervicals the hypapophyses protrude beyond the centrum, looking outward, downward, and backward.

In C 3, C 4, and C 5 the anterior zygapophyses are wider and higher than the posterior, and look upward and inward, rising on prominent pedicles from either side of the arch. In the succeeding cervicals the anterior zygapophyses are lower, approach nearer in the median line, and look upward. The posterior zygapophyses look outward and downward in the anterior, and downward in the posterior vertebræ.

DORSAL VERTEBRÆ.—There are 17 dorsal vertebræ (*cf.* Pl. I). The centra are amphiplatyan and of about the same size throughout. The border of the articular faces is slightly reflexed. The sides of the vertebræ are slightly depressed and marked with a delicate thread-like sculpture. The neurocentra are not firmly coössified with the centra. The distal terminations of the paradiapophyses have the form of a figure 8 and are separated by the neurocentral suture. In the immature specimen the parapophysis continues into the reflexed anterior border of the centrum, but in the older specimen it is separated from it.

The facet for union of the neurocentrum with the centrum is excavated deeply in the center and is somewhat nearer the anterior end of the vertebra. The paradiapophyses face outward in the anterior vertebræ, turning toward the rear in the posterior vertebræ. The zygapophyses are normal.

The spines are highest in the first three dorsals, but are gradually reduced in height toward the sacrum, becoming broader antero-posteriorly and quite erect.

The ventral carina is gradually reduced, not showing in the fourteenth vertebra in the young specimen, disappearing in the eleventh in the adult.

In many dorsal vertebræ there is a small central cone resulting from the intervertebral ossification of the notochord. Sometimes this region is imperfectly ossified and the central part of the vertebra is imperfect.

SACRAL VERTEBRÆ.—The sacrals consist of two true sacrals and a sacrocaudal. The centra are flattened vertically. The neurocentra are not so high as in the dorsals; they are united to the centra by suture. The spines are heavier and thicker, with oval crests. The anterior are much longer than the posterior zygapophyses. The sacral ribs are stout, united to the centra suturally by firm bases, the parapophysis forming about two thirds of the support. The distal ends are expanded and touch each other; the proximal ends, together with the anterior face of the diapophysis, are somewhat excavated. The middle of each rib is constricted and flattened dorso-ventrally. The first sacral rib is curved backward. The second sacral rib is straight and takes the greatest part in the union with the ilium. The distal end is expanded, rugose, sometimes excavated; the proximal end expands forward in some specimens, articulating with the outer, most posterior corner of the centrum of the first sacral.

The sacrocaudal differs little from the sacrals; the centrum is not coössified to the sacrals. The posterior is smaller than the anterior end. The distal end of the rib is expanded and divided, the anterior part curved forward to unite with the ilium, while the posterior edge thins out and projects backward in a point. No chevron.

CAUDAL VERTEBRÆ.—The tail is estimated to contain at least 38 vertebræ. In the type (No. 982) 22 caudals are preserved. The centra (*cf.* Pl. I,) decrease in volume gradually but continue nearly the same in length to near the middle of the tail. They are compressed, and much thicker vertically than

transversely. The ventral surface of the posterior centra usually presents a central ridge, and a sharper ridge on either side which increases in height, ending in the large, deep facets for the chevrons. The umbilicus or cone, as it may be called, representing the ossified intervertebral notochord, is conspicuous throughout the tail. The neurocentra are free in the anterior and coössified in the posterior caudals. The spines are erect, high, thin, and wide antero-posteriorly. The zygapophyses are normal. The chevrons are vertebral, free, long, and stout.

The caudals may be divided as follows:

First two true caudals. No chevrons. Ribs and neurocentra suturally distinct from centra and neurocentra.

Caudals 4–8 inclusive. With chevrons. Ribs and neurocentra suturally distinct from centra and neurocentra.

Caudals 9–12 inclusive. With chevrons. Ribs and neurocentra coössified with centra.

Caudals 12 +. With chevrons. Neurocentra, but no ribs.

PECTORAL GIRDLE.

(Plate II.)

The pectoral girdle is composed of scapulæ coracoids, clavicles, and an interclavicle.

SCAPULA.[1]—The scapula, in general resembles that of *Sphenodon*. The blade is expanded dorsally with a rounded, excavated suprascapular border. The clavicular border presents near its upper end a widely rugose area for attachment of the upper end of the clavicle. The lower part of this border stands out in a prominent, ventrally inclined acromial process. The coracoid border is deeply pitted and triangular in shape when attached to the coracoid, thinning out toward the inner border of the coracoid and continuing forward to the clavicular border for about one third the length of the pitted surface. The glenoid border is thick and smooth on the articular surface, which does not furnish quite half the glenoid cavity.

CORACOID.—The coracoid resembles that of *Sphenodon* though not so much elongated; in outline it closely approximates a quarter-circle. The broad, thin plate is gently concave dorsally, with a thin cartilaginous inner border. A large supracoracoid foramen is present. The glenoid surface is smooth and forms nearly two thirds of the cavity. Above and behind the glenoid cavity on the free border is a very prominent tubercle.

CLAVICLES.—The clavicles are strongly curved L-shaped bones, rounded in front, with two posterior striated surfaces. The upright bar is much smaller, not half the bulk of the horizontal bar, and narrows at its extremity to a thin edge. Near the middle on the anterior surface of this bar there is a prominent

[1] Unfortunately Dr. Dollo was misled by the fragmentary condition of part of the pectoral girdle in his material, and in his elaborate paper on *Simœdosaurus* he described the scapula as the coracoid, and ***vice versa.***

tubercle, and at the base of the bar on the posterior surface is a facet for the acromial process of the scapula. The horizontal is much longer than the upright bar and is rounded and thickened in front. The dorsal surface is excavated and coarsely ridged for the firm union of the interclavicle. Sometimes this ridged surface in the posterior border extends under the ventral surface. The clavicles meet in the median line.

INTERCLAVICLE.—The interclavicle is a large T-shaped bone. The cross-bar is coarsely ridged on the ventral surface for union with the clavicles; sometimes this surface presents a V for the insertion of the clavicle. The dorsal surface of the transverse bar is strongly convex. The upright of the T is a long flattened plate ending a little beyond the coracoids in a finely notched, spear-like point.

FORE LIMBS.

HUMERUS.—The humerus (Pl. V, Figs. 1, 1*b*,) is shorter than the femur and more massive; it is twisted on its axis to about the same extent as *Simœdosaurus* and is nearly as long as in this form. The head is drawn out transversely and is oval. It is slightly separated from the ento- and ecto-tuberosity in the immature specimen, but well defined in the adult. The delto-pectoral crest is quite prominent and terminates in a tubercle in the adult. The distal end is widely expanded. The ento- and ecto-condyles are well defined in the adult. An entepicondylar groove is present but is never closed as a foramen.

RADIUS.—The ulna and radius (Pl. V, Figs. 2, 2*a*) are of the same length and about the same bulk. The radius is as long as the ulna and is strongly curved. The proximal end is larger, elliptical, and excavated. The lower end of the shaft is very rugose on the outer border, and the distal end is rounded and oval.

ULNA.—The ulna has a large obtuse olecranon. The proximal end is of triangular shape with a facet for articulation with the radius. The center of the shaft is elliptical in cross-section. The distal end is flattened or concave on the postaxial surface and has a ridge running down the preaxial face.

CARPALS.—There are five ossified carpals disposed in two rows, and, as the same elements are preserved in each foot, there seems little doubt that those missing were cartilaginous.

In the proximal row the large pyriform intermedium separates the ulna and radius. Its upper border is free and formed by the union of the dorsal and ventral surfaces. The lower border is thick and separated into two articular fields by a large, oblique, shallow groove which forms part of the intracarpal foramen.

The ulnare is a large, almost square element. The dorsal and ventral surfaces are smooth and concave. On the face which articulates with the intermedium is a wide, shallow groove forming part of the intracarpal foramen. The radiale was undoubtedly cartilaginous.

In the distal row Nos. 1 and 5 are missing. Of those preserved C. 2 is the smallest, C. 3 is somewhat larger, and C. 4 is about twice the size of C. 2. All are rounded, with concave dorsal and ventral surfaces.

METACARPALS.—The metacarpals are long and flattened, and are constricted in the middle. M I has an upturned entoproximal border which overlaps and rides on M II. The proximal is about twice the width of the distal end. M II is very much longer than M I, and overlaps M III which is the largest of the metacarpals. M IV is not quite as long as M III but of nearly equal bulk. M V is of about the same length as M I, but the outside is longer than the inside border and there is a small tubercle on the inner dorsal border near the middle of the shaft.

PHALANGES.—The most striking feature to be observed in the phalanges is the two articular faces which are parallel and very oblique to the shafts, giving a decided backward curve to the toes. In all except those articulating with the terminal claws the dorsal surface merges abruptly into the distal articular faces without any recurved border. This adjustment allows very little flexing of individual toes. The whole style of foot is peculiarly adapted for use as a paddle, and the toes may have been partly webbed. The terminal phalanges are sharp and claw-like, and the phalanges that articulate with them have a round shaft with distal end reflexed, pitted on either side. The shafts of the other phalanges are flattened.

The phalangeal formula is 2, 3, 4, 4, 3.

PELVIC GIRDLE.

The pelvis (Pl. IV, Figs. 3, 3*a*) consists of ilia, ischia, and pubes, forming a massive arch nearly equal to the pectoral girdle in size.

When in position the pubes are separated by a wide entering notch, filled during life by cartilage. The ischia unite firmly, forming the main union of the opposite halves of the pelvis.

ILIUM.—The ilium consists of a triangular basal portion and an upwardly inclined vertical plate projecting backwards. This plate is long, about two thirds of it projecting beyond the base. The inner surface is slightly convex and marked with coarse ridges from which run small filiform ridges to the border. The outside is smoother than the inside and the dorsal crest is very rugose. The extreme point has a small area showing cartilaginous attachment. The lower border is nearly parallel with the upper border along the greater part of its length, turning upward at the point to unite with the cartilaginous area. The basal portion is convex on the inner surface, with a shallow acetabular excavation on the outer side. The rugose ischial and pubic surfaces unite in an obtuse angle, the former much smaller than the latter.

ISCHIUM.—The ischium is a triangular plate having one angle, the articular, very thick. The ventral surface is uniformly curved, smooth, and flat. The

articular angle has three well-defined surfaces uniting a little to one side of the center; one smooth, taking part in the acetabulum; the other two uniting with the ilium and pubis. The pubic surface runs out into a very thin plate continuous with the pubis throughout, but not quite meeting the opposite ischium. When placed in position the ischia are separated by an entering notch. This notch soon closes and the ischia meet in a thin line which rapidly thickens, forming near its middle the main union of the arch. On the posterior border near the extreme angle is a prominent tubercle.

PUBIS.—The pubis is a broad plate slightly larger than the ischium. It takes the smallest part in forming the acetabulum. There is a large true obturator fenestra but no thyroid nor puboischiadic. Anterior to the acetabulum the border forms a broad rugose process which projects forward. The anterior border is widely incised and smooth, joining the process mentioned. The interpubic symphysis is not as broad as the ischial symphysis. The ventral surface is nearly flat, while the dorsal surface is slightly curved.

HIND LIMBS.

The hind limbs are much longer than the fore limbs.

FEMUR.—The femur (Pl. V, Figs. 4, 4*a*) is much longer than the humerus and not as massive. It is curved more strongly than the humerus and twisted on the shaft. The trochanter is well developed; there is a bridge connecting it with the head. Posteriorly between the head and the trochanter it is excavated and rugose.

TIBIA.—The tibia is long and strongly curved on the distal end. The articular ends are oval; the proximal end is about twice the size of the distal end. There are two well-defined rugose ridges; one begins near the middle of the shaft on the outer posterior border, runs upward, and ends near the midde of the posterior surface; the other begins above the middle of the shaft on the outer surface and runs diagonally downward, fading away below the middle of the shaft.

FIBULA.—The fibula is greatly reduced. It has not half the bulk of the tibia and is considerably shorter. The proximal end is rounder. The distal end is widely expanded laterally. The anterior face is convex and the posterior surface is concave. The distal articular surface is enlarged on the inner face for articulation with the large intermedium. Near the middle of the distal end on the outer side there is a reflexed surface for ligamentous attachment.

PES.—The large irregular intermedium is concave on the dorsal and ventral surfaces and lengthened laterally, with a free border about one third of its length on the upper surface separating the tibia and fibula. All the other tarsals are missing.

Of the metatarsals, I, II, and III are preserved in No. 981; IV and V were modeled from No. 982 and were determined by a process of elimination from material in the collection.

M I resembles that of the manus, with the inner proximal border overlapping M II. M III is the longest of the series, and M V as restored has an outer projection on the proximal end.

RIBS.

The free vertebral ribs are divided into cervicals and dorsals.

The cervical ribs, of which there are 8, are double-headed, with a large tuberculum and a smaller capitulum which gradually approaches the tuberculum and unites with it in the second dorsal.

The first cervical preserved is that borne by the axis, and is a flattened convexo-concave triangular plate, curved downwards and backwards, with tuberculum set well away from the shaft, and with a pointed, free capitulum. In the succeeding cervicals the anterior border continues upward in a thin edge on the dorsal surface, ending in a prominent spine at the origin of the tubercular neck.

The shafts gradually increase in length in succeeding cervicals, becoming heavier and expanded at the distal end.

The dorsals (Pl. V, Figs. 7, 8) comprise 17 single-headed ribs, very stout and comparatively straight. The capitular and tubercular surfaces of the first dorsal are slightly separated in the young specimen, but are completely united in the adults. In the remaining dorsals the surfaces are confluent, forming one articular head, 8-shaped in outline.

The shafts are curved obliquely and are elliptical in cross-section. The distal ends are expanded and slightly ridged. In the anterior and posterior dorsals the posterior border forms a thin edge. The last three ribs are straight and reduced, without distal cartilaginous attachment.

ABDOMINAL RIBS.

The abdominal ribs (Pl. II) in *Champsosaurus* are proportionally heavier than in any known type, forming a broad basket beginning with the sixteenth vertebra and extending to the pelvis. This basket is composed of a series of bars disposed in transverse rows, of which there are three to each vertebra. Each bar consists of three elements, a median rod and two lateral rods. The first bar is the one exception, where there are two lateral rods on the right side.

The median rod extends nearly across the basket, terminating a little beyond the middle of the lateral bars near their largest diameters. This rod is sometimes bifurcated and irregular in the older individuals, but is quite uniform and nearly straight in the restored specimen. It is possible that this bifurcation is a result of the union of two rods. In the middle line the median rod is slightly curved, having a boss-like raised center. On either side it presents an elliptical cross-section and gradually tapers to the point, where it terminates in a thin edge. On the anterior ventral surface at a point about one fourth of its length

from the end a groove starts, gradually widening and deepening to its center, then tapering out to the point. This groove changes its course from the ventral-anterior to the dorsal-anterior surface, describing a quarter-circle in its course and striated longitudinally throughout.

The lateral bars are about one third of the length of the median bar and are placed in front of it, excavated on the ventral posterior surface to fit into the groove on the median bar, and tapering so as to form with the median bar a continuous rod of uniform dimensions. Where the median bar terminates, the lateral bar expands to its greatest diameter, then gradually tapers to a sharp backwardly curved point in the anterior region. Posteriorly this point becomes obtusely rounded and shorter.

EPIDERMIS.

In the matrix near the middle of the left humerus was a small area showing the impression of the skin, which was enfolded with very fine markings on what must have been the side or upper surface. This merges into an area of larger figures, probably on the lower surface of the limb. The reticulations are smaller than in *Sphenodon* and of a different character. The skin probably had no corneous scales.

Champsosaurus ambulator sp. nov.

(Plates IV, Fig. 2; V, Figs. 3, 3*a*, 5, 5*a*, 6, 6*a*, 14, 15.)

This species is founded on the greater part of a skeleton, No. 983, of the Museum Collection, which lacks only the mesopodials, metapodials, and part of the caudal vertebræ. It was found within a hundred yards of and about six feet above the other specimens. This form is somewhat more specialized than the preceding. Its limbs and girdles apparently indicate an animal of crocodilian habits, as the feet were probably used in walking to a greater extent than in *C. laramiensis*.

SKULL.—The skull (Pl. IV, Fig. 1) is somewhat crushed and part of the arches are missing, while the extreme point of the mandible must have been bitten off before the animal died. In general appearance and association of the elements it agrees, so far as can be made out, with the skull of *C. laramiensis* but with the following exceptions:

The distal end of the muzzle is expanded and spatula-shaped, and the constriction behind the premaxillaries is strongly marked. The teeth in the palatines and pterygoids are much more numerous than in *C. laramiensis* and are very irregular.

The interpterygoid foramen is round.

VERTEBRÆ.—The vertebral column (*cf.* Pl. V, Figs. 14, 15) differs from that of *C. laramiensis* in having the neck straighter, the articular faces of the vertebræ not being so oblique to the axis. The ventral carinæ are not so promi-

nent in the cervicals, and the ventral surfaces of the anterior dorsals are broad, the first three very rugose and straight in profile. Throughout the vertebral column the paradiapophyses are nearer the middle of the vertebræ antero-posteriorly, while in *C. laramiensis* they are nearer the anterior than the posterior end. The parapophyses seem somewhat smaller and rounder. The pit under and in front of the paradiapophyses is prominent in the anterior dorsals.

RIBS.—The ribs apparently are more curved than in *C. laramiensis*. The dorsal surface of the head and neck is very rugose, marked by fine tubercles. In *C. laramiensis* a ridge rises on the anterior side of the upper half of the rib, becomes prominent, and ends near the neck. In *C. ambulator* the ridge is prominent and is reinforced in the dorsal ribs by a shorter, stronger ridge just in front of it which is usually produced on the capitular surface.

LIMBS AND GIRDLES.—In the limbs and girdles are to be seen differences great enough to make this form a new genus, if only we were certain of the amount of variation due to age. The girdles are more massive and expanded, while the limbs are shorter, their shape and articulations indicating a more ambulatory type than *C. laramiensis*.

HUMERUS.—The humerus (Pl. V, Figs. 3, 3*a*, 3*b*) is markedly different from that of *C. laramiensis*. The proximal end is twisted on its shaft at least 15° more, so that in a preaxial view the entotuberosity and ectotuberosity are in a line at right angles to the distal expansion. The ento- and ectotuberosities are much lower and distinctly separated from the head. The delto-pectoral ridge is strongly marked, extending in a rugose elevation to the ectotuberosity. In the distal end the ectepicondylar groove is entirely closed, making a distinct foramen. The greater part of the articular surface is on the preaxial border. The entepicondyle, entocondyle, and ectocondyle are distinctly separated, increasing in size successively. The ectepicondyle and ectocondyle are not well separated, and the latter is exposed entirely on the preaxial surface. There is a small tuberosity on the ulnar border above the entepicondyle.

ULNA.—The ulna is not preserved.

RADIUS.—The radius does not differ appreciably from that of *C. laramiensis*.

PECTORAL GIRDLE.—The pectoral girdle is somewhat more massive than in *C. laramiensis*. The horizontal bar of the clavicle is much stronger and is smooth on the ventral and anterior surfaces; the facet for the clavicular process of the scapula is not so deep.

The interclavicle is more robust than in *C. laramiensis*. The stem of the T is much wider and the cross-bar is shorter and more robust.

The scapula is not markedly different, although the coracoid is about the same size; the infraglenoid process is much more prominent and longer.

PELVIC GIRDLE.—Although the hind limbs are shorter than in *C. laramiensis*, the pelvic girdle is much larger than in the type of that species, both skeletons being supposedly of adult animals. The superior backwardly

extending portion of the ilium is one fifth longer; otherwise they are similar. The ischium is of about the same size and shape, except that the inter-ischial surface is longer, projecting farther backward. The pubis is much larger, preserving relatively the same contour, excepting that the interpubic surface is much longer; the preacetubular process is more strongly decurved.

FEMUR.—The femur (Pl. V, Figs. 5, 5*a*) is shorter than in *C. laramiensis* and more strongly curved. The shafts and ends of the femora are about equal. The trochanter, however, is placed much lower. On the preaxial inner border of the upper half of the shaft is a small tubercle. The articulation of the distal end of the femur is mostly on the postaxial face.

TIBIA AND FIBULA.—The tibia and fibula (Pl. V, Figs. 6, 7) differ from those of *C. laramiensis* only in being smaller.

MEASUREMENTS.

C. laramiensis,—Cotype (mounted skeleton, Amer. Mus. No. 981).

	mm.
Length of skeleton	1500.
" " skull	344·4
" " cervical vertebræ	155·7
" " dorsal vertebræ	348·3
" " sacrals and sacrocaudal	52·5
" " caudals	599·1
" " front leg	217.
" " hind leg	316.
Width across body at widest part	150.
" " pectoral girdle	138.
" " pelvic girdle	107.

C. laramiensis, adult.—Type (No. 982).

	mm.
Extreme length of skull	404·5
Length of skull from tip of snout to condyle	340.
Width of skull across condyles	174.
Length of humerus	120.
" " ulna	75.
" " radius	73.
" " scapula	92.
" " coracoid	68.
Width " coracoid	65.
Length " femur	144.
" " tibia	107.
" " fibula	98.
" " axis centrum	23.
Width " " " posterior end	19.
Height " " " " "	21.
Length " 1st dorsal centrum	25.
Height " " " " posterior end	23.
Width " " " " " "	26.

		mm.
Length of 1st sacral centrum	.....	25.
Height " " " " posterior end	.....	19.
Width " " " " " "	.....	25.
Length " 1st caudal " without rib	.....	24.
Height " " " " posterior end	.....	15.
Width " " " " " "	.....	16.

C. ambulator.—Type (No. 983).

		mm.
Length of skull from tip of nose to condyle	.....	339.
Width " " across condyles	.....	180.
Length " humerus	.....	114.
" " radius	.....	70.
" " scapula	.....	96.
" " coracoid	.....	77.
Width " "	.....	65.
Length " femur	.....	136.
" " tibia	.....	102.
" " fibula	.....	93.
" " centrum of 1st dorsal vertebra	.....	25.
Height " " " " " " posterior end	.....	22.
Width " " " " " " " "	.....	26.
Length " " " 1st sacral " " "	.....	24.
Height " " " " " " " "	.....	20.
Width " " " " " " " "	.....	24.

VI.—Conclusions.

Briefly, in conclusion, I consider that the Choristodera is a well-established order of semiaquatic rhynchocephaloid reptiles. *Champsosaurus* cannot be considered ancestral to the Rhynchocephalia proper because it is already a long-nosed type derived from a short-nosed form. It has lost the notochord. The pterygoids are highly specialized, compressed, and extended backwards and forwards, completely obscuring the basisphenoid, while the ethmoid is developed in front of the prevomers.

Although similar to *Sphenodon* in many characters, this similarity emphasizes rather the very persistent primitive features of *Sphenodon*.

The primitive condition of the atlas, with its free pleurocentrum (odontoid) never united to the axis, and with the neurocentrum articulating directly with a process of the skull, separates *Champsosaurus* distinctly from other known forms.

The median constriction and expanded articular surfaces of the shaft in the proximal phalanges with scarcely appreciably recurved terminal borders, indicate a partially webbed foot, and the massive, broad ribs point to an animal of bottom-crawling habits.

VII.—Bibliography.

Boulenger, G. A. A New Permian Rhynchocephalian Reptile. *Nature*, 1889, Vol. XXXIX.

Cope, E. D. On Some Extinct Reptiles and Batrachia from the Judith River and Fox Hills Beds of Montana. *Proc. Acad. Nat. Sc. Phila.*, 1876, p. 348.

Cope, E. D. The Choristodera. *American Naturalist*, Aug., 1884, p. 815.

Dollo, L. Première Note sur le Simœdosaurien d'Erquelinnes. *Bull. Mus. Roy. Hist. Nat. Belg.*, Dec., 1884, p. 152.

Dollo, L. Nouvelle Note sur le *Champsosaure*, Rhynchocéphalien adapté à la vie fluviatile. *Bull. Soc. Belg. Geol.*, 1891, p. 151.

Gervais, P. Énumération de quelques ossements d'animaux vertébrés recueillis aux environs de Reims par M. Lemoine. *Journal de Zoölogie*, 1877, p. 75.

Günther, A. Contribution to the Anatomy of *Hatteria* (*Rhynchocephalus* Owen). *Phila. Trans. Roy. Soc. London*, 1867.

Howes, G. B., and H. H. Swinnerton. On the Development of the Skeleton of the Tuatara, *Sphenodon punctatus*, etc. *Trans. Zoöl. Soc. London*, Vol. XVI, part 1, 1901.

Lemoine, V. Du Simœdosaure, reptile de la faune cernaysienne des environs de Reims. *Comptes rendus de l'Académie des Sciences de Paris*, 17 Mars, 1884.

Lemoine, V. Étude sur les caractères génériques du Simœdosaure, reptile nouveau de la faune cernaysienne des environs de Reims. 8vo, pp. 38, pll. 2. Matot-Braine, Reims, Avril, 1884.

Lemoine, V. Nouvelle note sur le genre Simœdosaure de la faune cernaysienne des environs de Reims. 8vo, pp. 16. Matot-Braine, Reims, 1885.

Lemoine, V. Sur la présence du Simœdosaure dans les couches éocènes inférieures de Sézanne. *Bull. Soc. Géol. de France*, 3e sér., t. XIV, 1885–86, pp. 21–32, pll. iii–v.

Osborn, H. F. The Reptilian Subclasses Diapsida and Synapsida and the Early History of the Diaptosauria. *Mem. Amer. Mus. Nat. Hist.*, Vol. I, part viii, Nov., 1903.

Seeley, H. G. Researches on the Structure, Organization and Classification of the Fossil Reptilia. I. On *Protorosaurus speneri*. *Phil. Trans. Roy. Soc. London*, 1887, Vol. CLXXVIII (B), p. 187.

PLATE I.

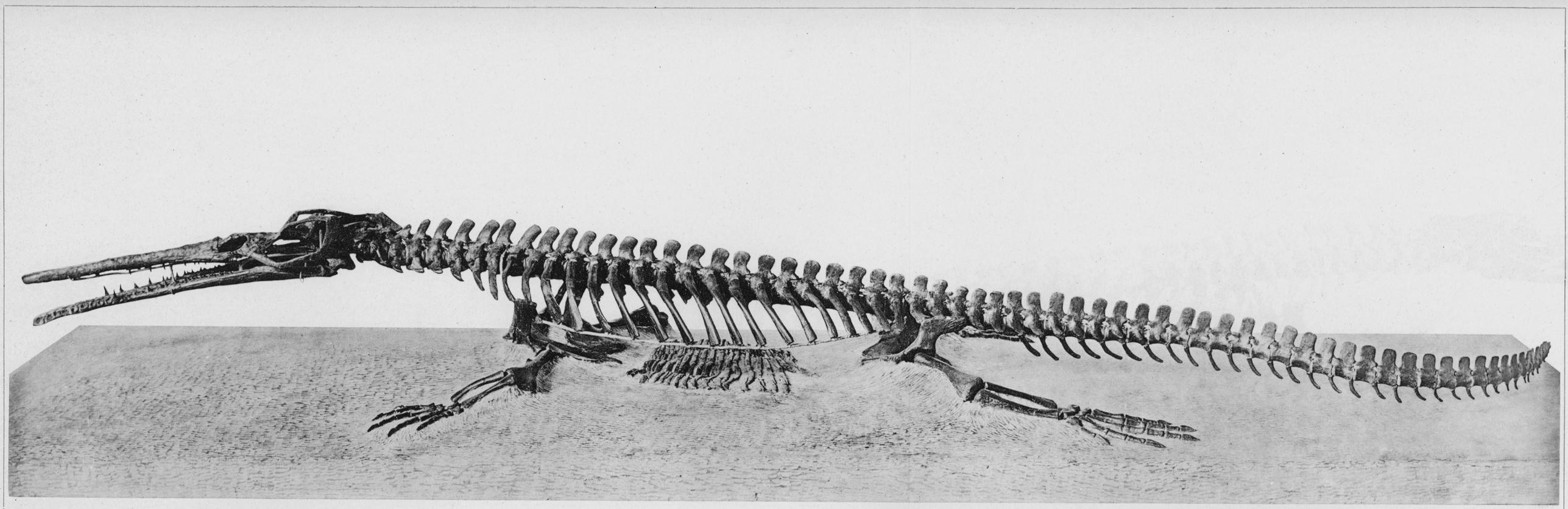
EXPLANATION OF PLATE I.

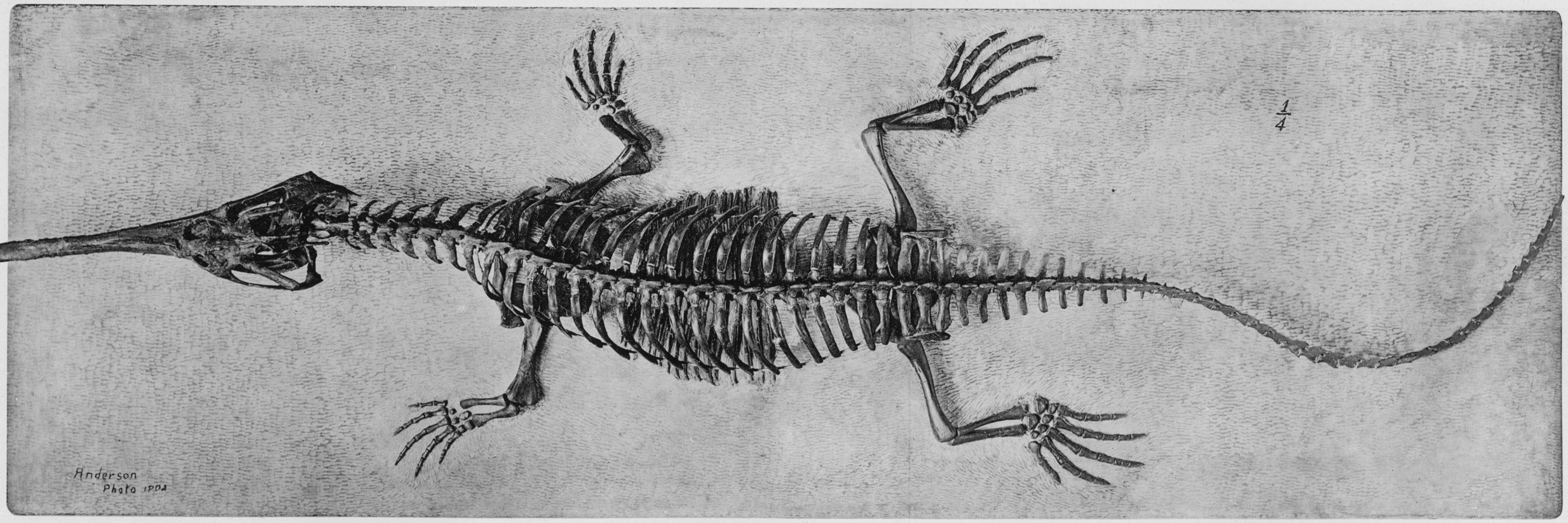
Figures one fourth natural size.

Champsosaurus laramiensis.

Side and top view of mounted skeleton, No. 981. The skull, jaws, and all the presacral portion of the skeleton were found articulated in position. The pectoral girdle and abdominal ribs are mounted in the original matrix in relation to the vertebral column exactly as found.

The restored portions are: most of the caudal spines, chevrons, and part of the centra back of the eleventh caudal vertebra; also the left fibula, the distal phalanges of both hind limbs, and all but one of the tarsals.





Champsosaurus laramiensis.

Helio Alfred Ditisheim, Basle.

PLATE II.

EXPLANATION OF PLATE II.

Figures natural size.

Champsosaurus laramiensis.

Pectoral girdle and abdominal ribs in original matrix as found in No. 98.

Helio Alfred Ditisheim, Basle.

Champsosaurus laramiensis.

PLATE III.

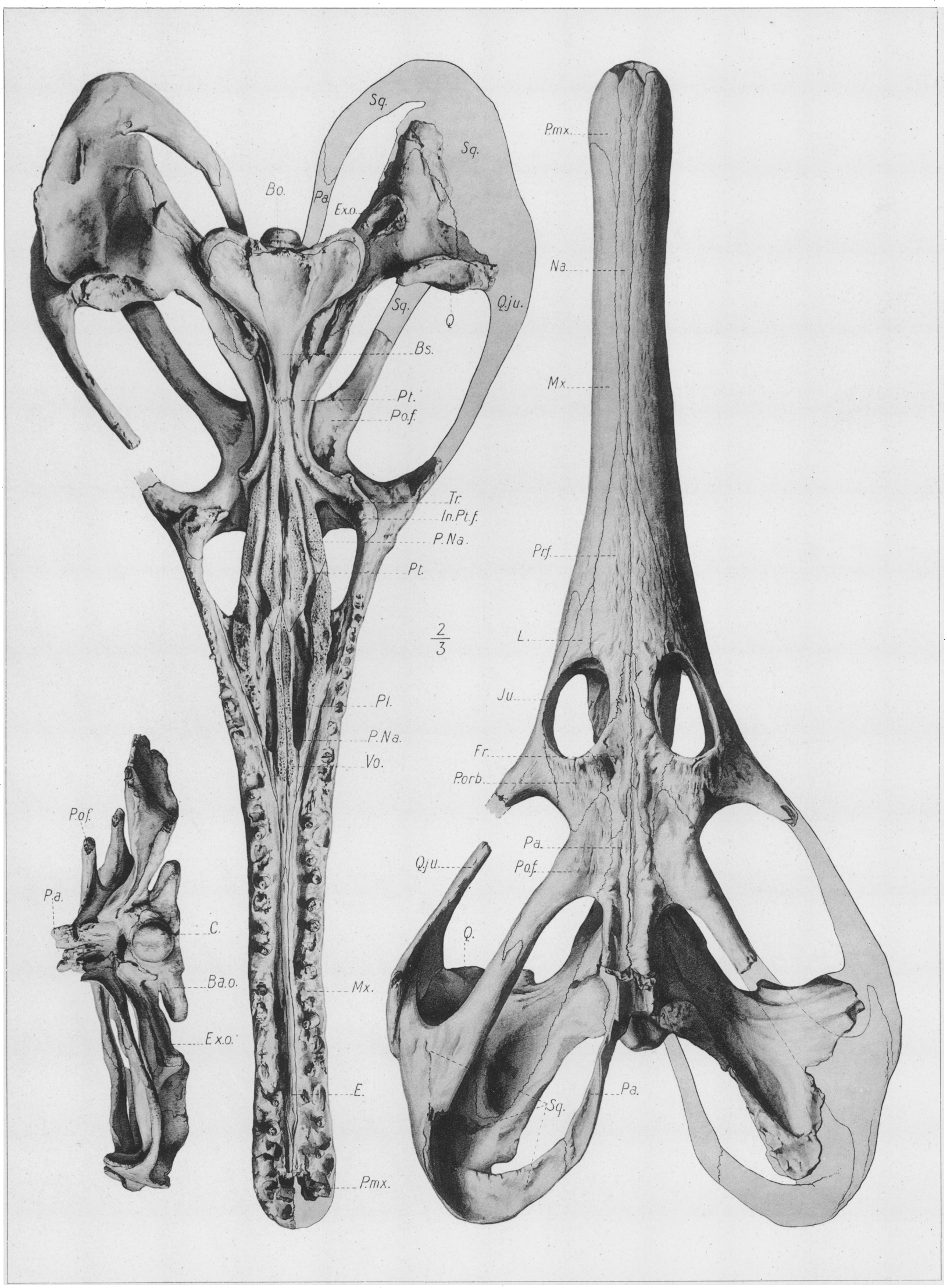
EXPLANATION OF PLATE III.

Figures two thirds natural size.

Champsosaurus laramiensis, No. 982.

Right-hand figure, superior view of skull.
Middle figure, inferior view of skull.
Left-hand figure, occipital view of skull.
The right side of the arches has been restored from the opposite side.
The following abbreviations are used:

Bo. = basioccipital.
Bs. = basisphenoid.
C. = coronoid.
E. = ethmoid.
Ex. o. = exoccipital.
Fr. = frontal.
In. Pt. f. = interpterygoid foramen.
Ju. = jugal.
L. = lachrymal.
Mx. = maxilla.
Na. = nasal.
Pa. = parietal.
P. orb. = postorbital.
Po. f. = postfrontal.
Pr. f. = prefrontal.
P. mx. = premaxilla.
P. Na. = posterior nares. Same symbol for [posterior extension of nares.
Pl. = palatine.
Pt. = pterygoid.
Q. = quadrate.
Q. ju. = quadratojugal.
Sq. = squamosal.
Tr. = transverse or ectopterygoid.
Vo. = vomer.



Helio Alfred Ditisheim, Basle. Erwin Christman, del.

Champsosaurus laramiensis.

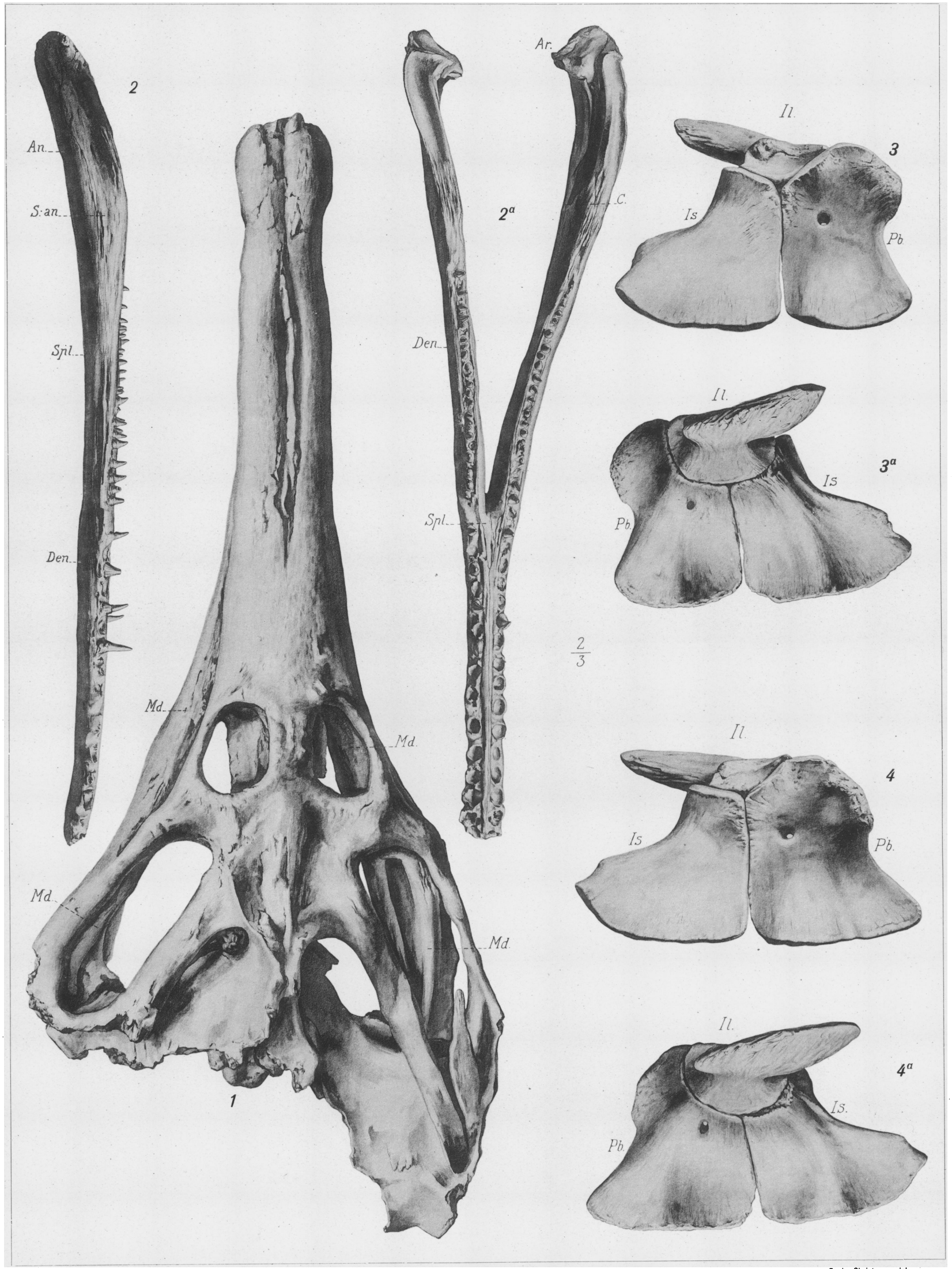
PLATE IV.

EXPLANATION OF PLATE IV.

All figures two thirds natural size.

Fig. 1, skull of *Champsosaurus ambulator*, No. 983.
Figs. 2, 2*a*, lower jaws of *Champsosaurus laramiensis*, young animal, No. 981.
Figs. 3, 3*a*, pelvis of *Champsosaurus laramiensis*, No. 982.
Figs. 4, 4*a*, pelvis of *Champsosaurus ambulator*, No. 983.
The following abbreviations are used:

An. = angular.
Ar. = articular.
C. = coronoid.
Den. = dentary.
Il = ilium.
Is. = ischium.
Md. = mandible.
Pb. = pubis.
S. au = surangular.
Spl. = splenial.



Helio Alfred Ditisheim, Basle.

Erwin Christman, del.

Champsosaurus laramiensis, C. ambulator.

PLATE V.

EXPLANATION OF PLATE V.

All figures two thirds natural size.

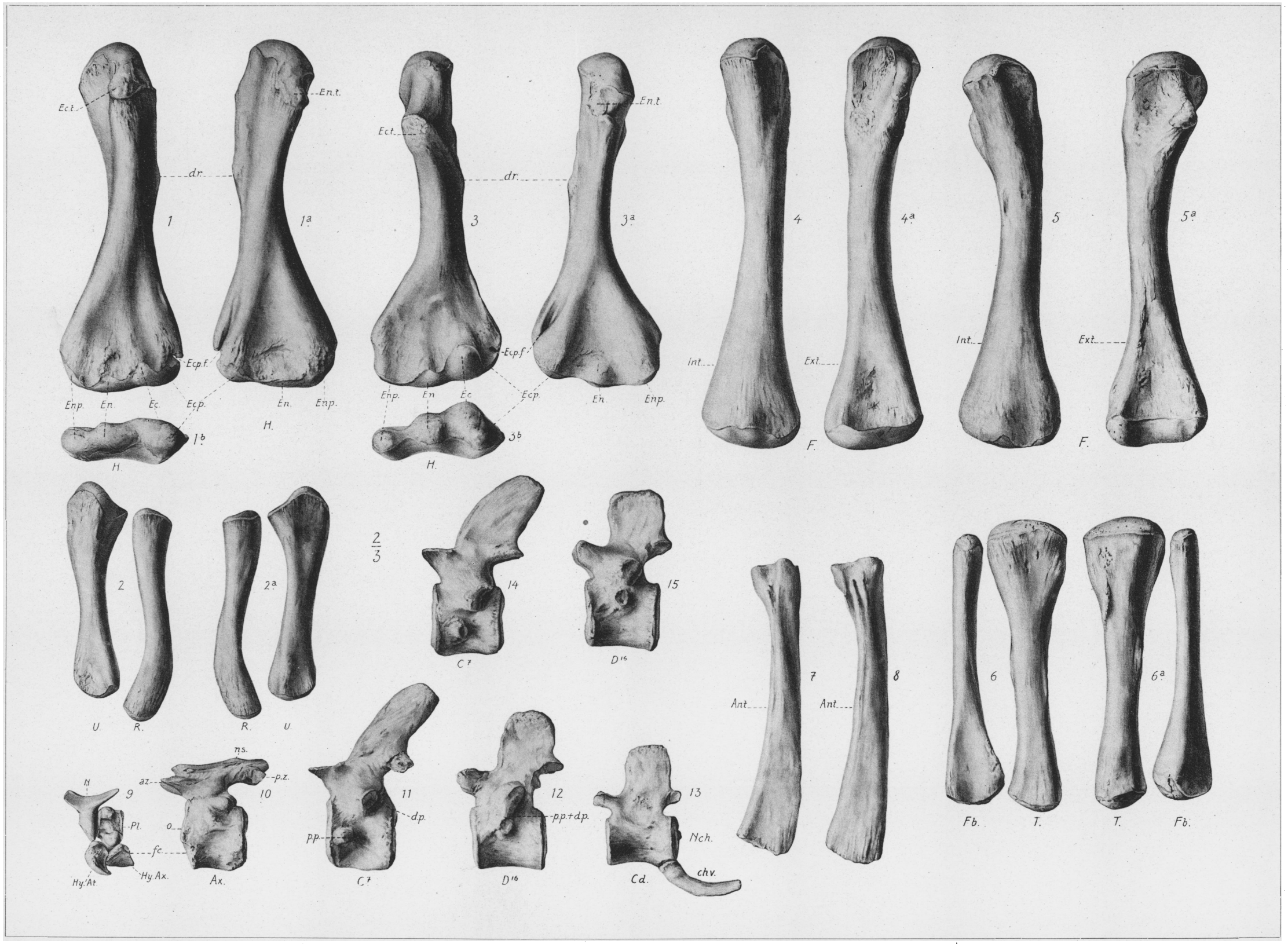
Champsosaurus laramiensis.

Figs. 1, 1*a*, 1*b*, preaxial, postaxial, and distal end views of humerus, No. 982.
Figs. 2, 2*a*, postaxial and preaxial views of ulna and radius, No. 982.
Figs. 4, 4*a*, preaxial and postaxial views of femur, No. 982.
Figs. 7, 8, dorsal ribs, No. 982.
Fig. 9, atlas of young animal, mounted skeleton, No. 981, hypocentrum of axis in position.
Figs. 10, 11, 12, 13, axis, seventh cervical, sixteenth dorsal, thirteenth caudal vertebræ of No. 982.

Champsosaurus ambulator.

Figs. 3, 3*a*, 3*b*, preaxial, postaxial, and distal end views of humerus, No. 983.
Figs. 5, 5*a*, preaxial and postaxial views of femur, No. 983.
Figs. 6, 6*a*, preaxial and postaxial views of tibia and fibula, No. 983.
Figs. 14, 15, seventh cervical and sixteenth dorsal vertebræ, No. 983.
The following abbreviations are used:

Ant. = anterior.
Ax. = axis.
Az. = anterior zygapophysis.
chv. = chevron.
dp. = diapophysis.
dr. = delto-pectoral ridge.
Ec. = ectocondyle.
Ecp. = ectepicondyle.
Ect. = ectotuberosity.
Ecp. f = ectepicondylar foramen.
En. = entotuberosity.
Enp. = entepicondyle.
Ext. = external.
fc. = facet.
Hy. At. = hypocentrum of atlas.
Hy. Ax. = hypocentrum of axis.
Int. = internal.
N. = neurocentrum.
Nch. = notochord.
ns. = neural spine.
o. = odontoid articulation.
pl. = pleurocentrum or odontoid.
p.p. = parapophysis.
p. z. = posterior zygapophysis.



Helio Alfred Ditisheim, Basle. Erwin Christman, del.

Champsosaurus laramiensis, C. ambulator.

(*Continued from 4th page of cover.*)

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