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NEMEGTOSAURUS MONGOLIENSIS N. GEN., N. SP. (SAUROPODA) FROM THE UPPERMOST CRETACEOUS OF MONGOLIA

(Plates VIII—XIV)

Abstract. — The skull of *Nemegtosaurus mongoliensis* n. gen., n. sp. assigned to the subfamily Dicraeosaurinae, family Atlantosauridae (= Titanosauridae) from the uppermost Cretaceous of the Nemegt Basin (Gobi Desert) in Mongolia, is described and figured. It is shown to be in some respects intermediate between the genera *Dicraeosaurus* and *Diplodocus*. The first completely preserved sclerotic ring in the suborder Sauropoda was found in the studied skull. The cranial structure of *Nemegtosaurus* is compared with that of *Dicraeosaurus*, *Diplodocus*, *Barosaurus* and *Antarctosaurus*.

INTRODUCTION

During the third Polish-Mongolian Palaeontological Expedition to the Gobi Desert in 1965 (see KIELAN-JAWOROWSKA & DOVCHIN, 1968/69) a sauropod skull was found at the locality of Nemegt in the Nemegt Basin, in Upper Cretaceous sandstones designated by GRADZIŃSKI *et al.* (1968/69) as the Upper Nemegt Beds. During the same expedition an almost complete skeleton of a sauropod, lacking a skull and neck, was found at the locality of Altan Ula IV, in the same Basin, situated about 40 km westward from the Nemegt locality and in beds of the same age. The exact location of both specimens is given by GRADZIŃSKI *et al.* (*l. c.*, Text-figs. 2, 4). The age of the Upper Nemegt Beds has been considered as Campanian or Maastrichtian (GRADZIŃSKI *et al.*, *l. c.*). The sauropod skull from Nemegt is described in the present paper as *Nemegtosaurus mongoliensis* n. gen., n. sp. and assigned to the subfamily Dicraeosaurinae. The sauropod skeleton from the locality of Altan Ula IV is still under preparation and will be described at a later date.

The Soviet Palaeontological Expeditions, which worked between 1946—1949 in the Nemegt Basin (EFREMOV, 1948, 1954), recovered only fragments of sauropod skeletons (personal communication Dr. A. K. ROZHDESTVENSKY), which have not been described. The American Central Asiatic Expeditions (ANDREWS, 1932) collected sauropod fragments in the territory of Outer and Inner Mongolia, in Lower Cretaceous deposits. These include: *Asiatosaurus mongoliensis* OSBORN, 1924 (two teeth, Oshih (Ashile) formation, *Psittacosaurus mongoliensis* life zone, from Outer Mongolia (OSBORN, 1924), and *Mongolosaurus haplodon* GILMORE, 1933 (basicranium and cervical vertebrae, from Upper Cretaceous Djadokhta Formation equivalent, Western Inner Mongolia (GILMORE, 1933)). The genera *Asiatosaurus* and *Mongolosaurus* have been assigned by ROMER (1956, 1966) to the family Titanosauridae. WIMAN (1929) described *Euhelopus zdanskyi* from Lower Cretaceous beds of the territory of the present People's Republic of China. The skull of *Euhelopus zdanskyi* is completely preserved and quite different from that of *Nemegtosaurus*. BOHLIN (1953) described *Chiayuesaurus lacustris* (one tooth) from Cretaceous beds, Kansu (China). YOUNG (1937) described *Tienshanosaurus chitaiensis* (partial skeleton) from Upper Jurassic beds of Singkiang (China). In 1939 YOUNG described *Omeisaurus junghsiensis* (partial skeleton, isolated teeth) from ?Upper Jurassic beds of the territory of Szechuan and in 1958 described *Omeisaurus changshouensis* (an incomplete skeleton) from Upper Jurassic beds, Szechuan (China). The genera *Chiayuesaurus*, *Tienshanosaurus* and *Omeisaurus* have been assigned by ROMER (1966) to the family Euhelopodidae. YOUNG (1954) described *Mamenchisaurus constrictus* from the Upper Jurassic of Szechuan (China), based on complete skeleton, lacking a skull (HUENE, 1958, 1959; HUENE & MATLEY, 1933).

The only previously described representatives of the Dicraeosaurinae are: *Dicraeosaurus hansemanni* JANENSCH, 1914, known from the Upper Jurassic of Tendaguru (JANENSCH, 1929, 1935/36; MÜLLER, 1968) and *Dicraeosaurus sattleri* JANENSCH, 1914 from the Cenomanian of Egypt (JANENSCH, 1929, 1936; MÜLLER, 1968). The assignment of *Nemegtosaurus* to the Dicraeosaurinae extends the stratigraphic range of this family to the Uppermost Cretaceous.

The specimen described in the present paper is housed in the Palaeozoological Institute of the Polish Academy of Sciences in Warsaw, abbreviated as Z. Pal.

ACKNOWLEDGEMENTS

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DESCRIPTIONS

Infraorder SAUROPODA MARSH, 1878
Family ATLANTOSAURIDAE MARSH, 1877
Subfamily DICRAEOSAURINAE JANENSCH, 1929

Genus **NEMEGTOSAURUS** nov.

Type species: Nemegtosaurus mongoliensis n. sp.
Derivation of the name: From the locality of Nemegt, Gobi Desert; Gr. *sauros* = lizard.

Diagnosis. — *Nemegtosaurus* n. gen. intermediate in some respects between *Dicraeosaurus* JANENSCH and *Diplodocus* MARSH. Skull lightly built, strongly elongated. Snout long, bent downwards. Accessory preorbital foramen absent. Palatine bones very narrow, strongly elongated longitudinally. Ectopterygoid absent. Lacrimal extensive, contributing to margin of external naris. Nasal does not contact maxilla. Orbit very large, prefrontal entering margin of orbit and of external naris. Supratemporal fossa very small, elongated transversely, open dorsally. Squamosal contacts quadratojugal and does not contribute to margin of supratemporal fossa. Parietal crest very prominent. Occipital condyle placed far anteriorly and slopes ventroanteriorly, forming an angle of about 100° with horizontal plane. Lower jaw very light, mandibular vacuity present. Teeth lanceolate, crown/root length ratio 2 : 1.

Stratigraphical and geographical range. — Upper Nemegt Beds (Campanian or Maastrichtian), Nemegt Basin, Gobi Desert.

Nemegtosaurus mongoliensis n. sp.

(Pls. VIII-XIV; Text-figs. 1-9)

Type specimen: A nearly complete skull (Z. Pal. No. MgD-I/9) in which the following bones are absent: left lacrimal, anterior parts of nasals, most of both premaxillae, upper rami of both maxillae.

Type horizon and locality: Uppermost Cretaceous, Upper Nemegt Beds, zone of *Tarbosaurus bataar* (MALEYEV), *Saurolophus angustirostris* ROZHDESTVENSKY and *Dyoplosaurus giganteus* MALEYEV.

Diagnosis. — As for the genus.

Material. — Only the type specimen is known.

Dimensions: see Tables 1 and 2.

Description. — Skull as a whole. The skull is strongly elongate and lightly built (Pls. VIII—X; Text-figs. 1, 2, 9*a*). The external nares are situated far posteriorly and the cranial roof slopes strongly downwards posteriorly. The accessory preorbital foramen is absent. The orbit is very large. In lateral view the snout strongly tapers anteriorly, the depth of the cranium being more than twice that of the snout at the level of the last tooth. A most characteristic feature is the position of the occipital condyle, which is directed downwards and somewhat anteriorly. This position indicates that in life the snout was directed anteroventrally relative to the neck. The lower jaw is comparatively small and lightly built.

Snout. Only the anterior parts of the premaxillae are preserved. The premaxilla is widest in the most anterior part and tapers slightly posteriorly (Pl. XI). In lateral view the anterior part of the premaxilla is strongly rounded ventrally. The premaxilla is deepest (in lateral view) at its contact with the vomer. The whole dorsal surface of the premaxilla is covered by numerous, longitudinally elongate vascular foramina which are randomly distributed. The maxilla is large, forming most of the snout (Pl. XI; Text-fig. 3). Anteriorly the maxilla slopes downwards, but less so than does the premaxilla. At its midlength (in lateral view) there is a shallow recess on the surface of the bone. The premaxillo-maxillary suture is subparallel to the median suture posteoriorly, while in its anterior part it extends anterolaterally. The alveolar margin is slightly sigmoid behind the last tooth, curving upwards. On both sides of the cranium the upper ramus of maxilla has been largely destroyed, although the lower ramus is more completely preserved. The lower margin of the preorbital foramen is in part preserved on the right side of the skull. The exact shape of the preorbital foramen is not apparent, but, judging from the preserved parts of the margin of the preorbital foramen on the lower ramus of the maxilla and on the lacrimal (see below), it was very large and longitudinally elongate. In the middle of the lateral surface of the maxilla there are two or three infraorbital foramina (this part of the maxilla has been partly destroyed). The first one is oval longitudinally elongate. The second one is lower, and is shallower and longer posteriorly (Text-figs. 1, 2). The intermaxillary foramen lies entirely within the maxilla, being situated very close the premaxillo-maxillary suture (Text-figs. 1, 2). It is large and longitudinally elongate. The anterior part of the surface of the maxilla is covered by numerous vascular foramina from which vertical grooves (sometimes dichotoming) extend towards the alveolar margin of the maxilla. The suture between the maxilla and the jugal is convex anteriorly and ventrally, and somewhat sigmoid dorsally. The jugal is subrectangular in lateral view, sending a long process posteriorly towards the anterior process of the postorbital (Text-fig. 1). The suture between the jugal and postorbital is very distinct. The lacrimal-jugal suture is horizontally directed. The suture between the jugal quadratojugal is also distinct and horizontally directed. The dorsoposterior margin of the jugal contributes greatly to the upper and anterior margin to the infratemporal fenestra. The quadratojugal is longitudinally

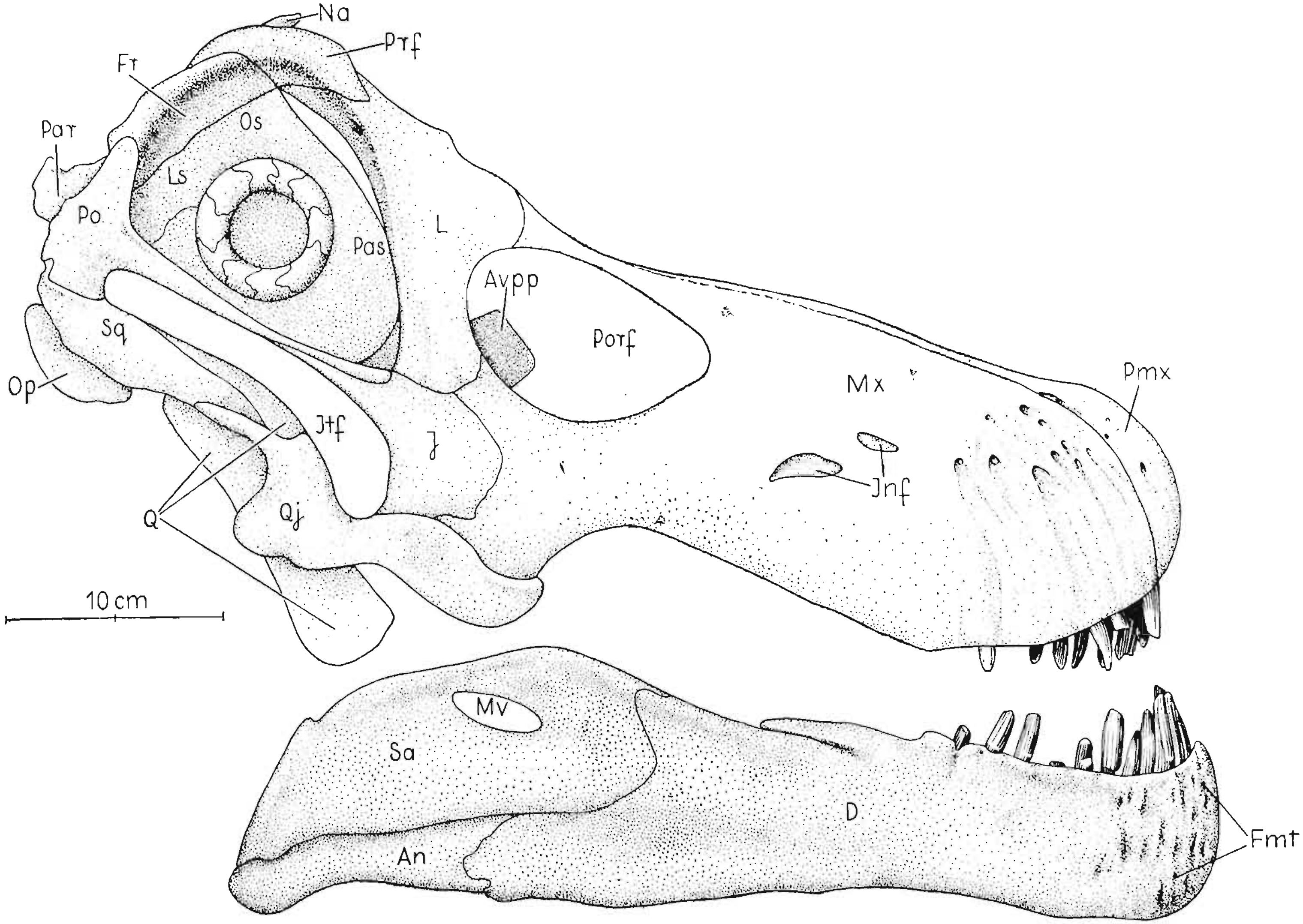

Fig. 1

Nemegtosaurus mongoliensis n. sp. Reconstruction of the skull and lower jaw in right lateral view. Abbreviations — as in Text-fig. 2.

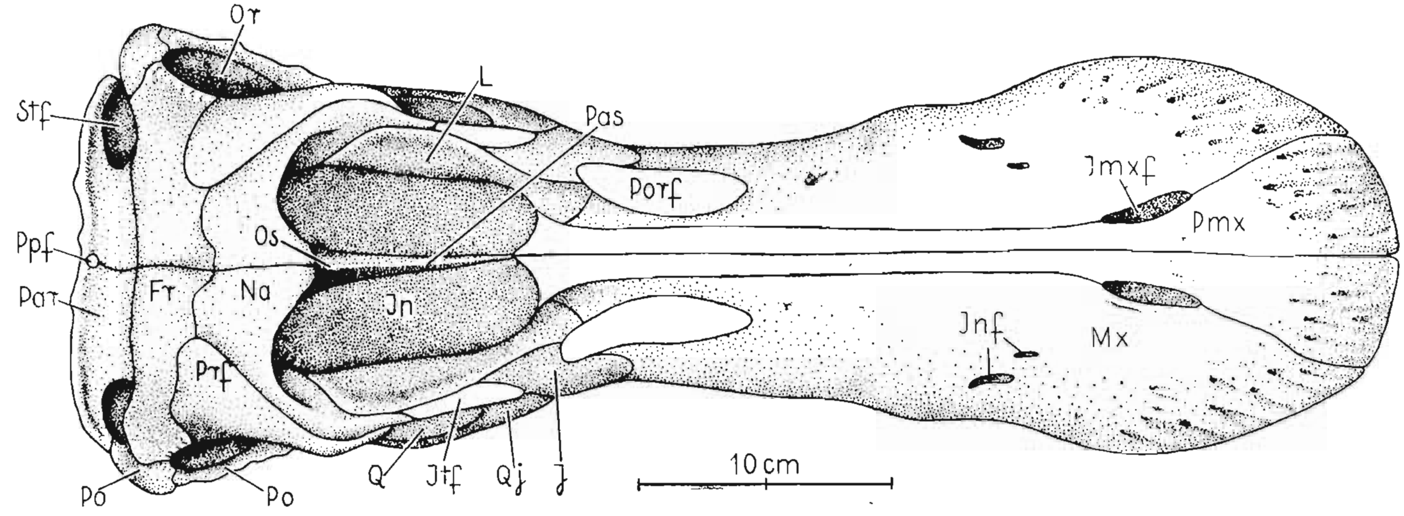

Fig. 2

Nemegtosaurus mongoliensis n. sp. Reconstruction of the skull in dorsal view. Abbreviations: *Adf* — adductor fossa, *Adpp* — anterodorsal process of the pterygoid, *An* — angular, *Apf* — accesory preorbital foramen, *Ar* — articular, *Avpp* — anteroventral process of the pterygoid, *Bo* — basioccipital, *Bpt* — basipterygoid process, *Bs* — basisphenoid, *Bst* — basisphenoid tuber, *C* — coronoid, *Ch* — choana, *D* — dentary, *En* — external naris, *Eoc* — exoccipital, *Fbv* — foramina for blood vessels, *Fm* — foramen magnum, *Fmt* — foramina mentalia, *Fr* — frontal, *Glf* — glenoid fossa, *Imxf* — intermaxillary foramen, *Inf* — infraorbital foramina, *Itf* — infratemporal fenestra, *J* — jugal, *L* — lacrimal, *Lf* — lacrimal foramen, *Ls* — laterosphenoid, *Mc* — meckelian canal, *Mst* — mandibular symphyse, *Mv* — mandibular vacuity, *Mx* — maxilla, *Na* — nasal, *Op* — opisthootic, *Or* — orbit, *Os* — orbitosphenoid, *Paf* — parietal foramen, *Pal* — palatine, *Par* — parietal, *Pas* — parasphenoid and presphenoid, *Pc* — parietal crest, *Pmx* — premaxilla, *Po* — postorbital, *Porf* — preorbital foramen, *Ppf* — postparietal foramen, *Prf* — prefrontal, *Pt* — pterygoid, *Q* — quadrate, *Qj* — quadratojugal, *Sa* — surangular, *Soc* — supraoccipital, *Sp* — splenial, *Sq* — squamosal, *Stf* — supratemporal fossa, *V* — vomer, *IX*, *X*, *XI*, *XII* — foramina for respective cranial nerves.

Table 1

Nemegtosaurus mongoliensis n. sp. (measurements in mm)

Length of the skull		560
Height of the skull perpendicular to the length		280
Maximal width of the skull in occipital region		220
Angle between the dorsal margin of the snout and the horizontal plane		20°
Angle between the cranial roof and the dorsal margin of the snout		115°
Angle between the cranial roof and the horizontal plane		45°
The orbit: length × height	right	180 × 120
	left	185 × 120
Maximal width of the external naris opening		80
Angle between the external naris plane and the cranial roof		90°
Length of the infratemporal fossa	right	170
	left	190
Dimensions of the supratemporal fenestra	right	37 × 12
	left	45 × 15
Width of the labial margin of the premaxilla	right	75
	left	75
Length of the alveolar margin of the maxilla	right	125
	left	125
Length of the postdental margin of the maxilla	right	230
	left	235
Dimensions of the intermaxillary foramen	right	45 × 4
Length of the palatal bone	right	150
	left	143
Angle between the pterygoids	ca.	25°
Length of the basipterygoid process	right	42
	left	50
Length of the squamosal	right	150
	left	150
Maximal length of the quadrate	right	220
	left	215
Dimensions of the articular surface	right	46 × 29
	left	45 × 25
Angle between the quadrate and the horizontal plane	ca.	130°
Maximal length of the lacrimal (measuring to the curve)	right	225
Length of the lacrimal canal	right	72
Length of the orbital sector of the frontal	right	77
	left	77
Length of the parietal (transversally)	right	54
	left	54
Length of the parietal crest	right	87
	left	78
Dimensions of the foramen magnum		36 × 25
Articular surface of the occipital condyle: length × width		55 × 60
Angle between the axis of the condyle and the quadrate	ca.	30°
Angle between the axis of the condyle and the horizontal plane	ca.	100°
Length of the mandible in dorsal view		450
Length of the mandible along the curve	right	500
	left	495
Maximal height in the region of adductor fossa	right	116
	left	112

Table 1 *(continued)*

Minimal height at the 11th alveola	right	62
	left	60
Angle between the symphysis and the long axis of the mandible		90°
Mandibular vacuity: length × height	right	25×22
	left	45×17
Length of the alveolar margin of the dentary	right	175
	left	175
Height of the symphysis	right	85
	left	75
Number of the teeth-total		50
Premaxilla	right	4
	left	4
Maxilla	right	8
	left	8
Dentary	right	13
	left	13

Table 2

Comparison of sclerotic rings in various dinosaur species

Species	Outer diameter	Inner diameter	Width of the sclerotic ring	Number of plates	Type
	in mm				
Nemegtosaurus mongoliensis n. sp.	76	44	16	10	modification of the type A
„*Struthiomimus samueli*" (PARKS, 1928)	ca. 60	ca. 33	ca. 13	20	A
Plateosaurus frasianus HUENE, 1932	—	—	—	16	?B
Brachiosaurus brancai JANENSCH, 1914	ca. 83	ca. 43	19—20	ca. 10	?A
Diplodocus hayi HOLLAND, 1924	—	25—30	—	—	—
Saurolophus osborni BROWN, 1912	88	52	ca. 18	are known only 10	?A
Anatosaurus annectus MARSH, 1892	—	—	—	13	A
Lambeosaurus lambei PARKS, 1923	60	—	—	14	A
Corythosaurus casuarius BROWN, 1914	70	—	—	14	A

and horizontally elongate. A short posterior vertical ramus contacts the squamosal and quadrate, forming the lower margin of the anterior part of the infratemporal fenestra. The anterior part of the lower margin of the quadratojugal is free. The suture between the maxilla and quadratojugal is clearly preserved.

Palate. The premaxilla is comparatively small in lateral aspect, and tapers slightly posteriorly (Pl. XI; Text-fig. 3). There are four oval, longitudinally elongate vascular foramina along the posterior margin of the premaxilla, corresponding to the four alveoli. The distance between the labial and lingual margins in the premaxilla measures about 20 mm. In ventral view the maxilla is comparatively flat in the middle part, while the postdental margin is strongly bent downwards (Pls. VIII, IX; Text-figs 1, 3). To the rear of the premaxilla, the maxilla sends the transverse process which joins its counterpart from the other side. In ventral view this process is not visible as it is covered by the anterior, transverse part of the vomer. The palatal process of the maxilla rises from the maxilla posterolaterally and is covered ventrally by the anterior part of the palatine. Medial to this process there is a large cavity of the internal naris, which is separated from its counterpart by the vomer. The cavity of internal naris is rounded anteriorly and strongly elongated longitudinally. Along the lingual margin of the maxilla are eight oval

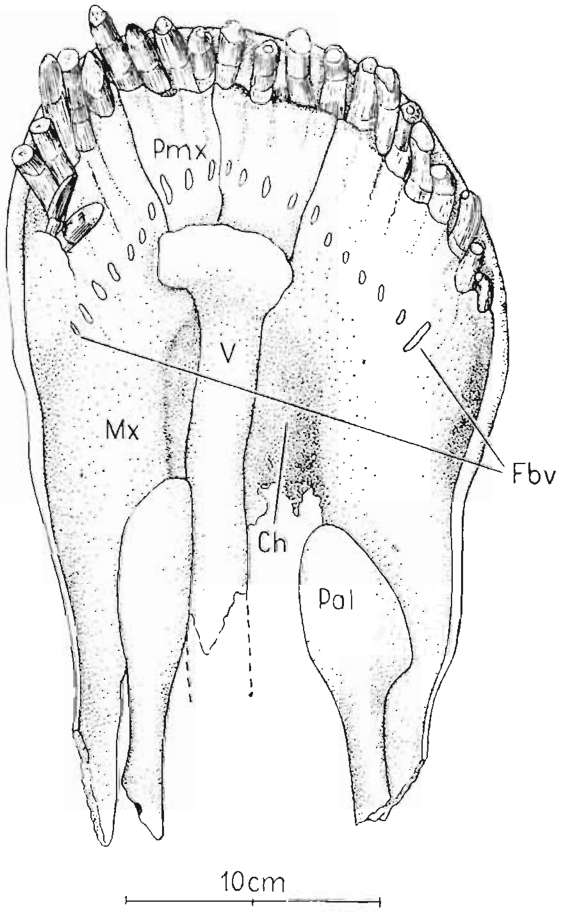

Fig. 3

Nemegtosaurus mongoliensis n. sp. Anterior part of the skull in palatal view. Abbreviations — see Text-fig. 2.

vascular foramina, which correspond to the eight alveoli. The palatine is a comparatively small and slender, longitudinally oriented bar (Pl. XI; Text-fig. 3). It contacts the postdental margin of the maxilla at an angle of about 30°. The palatine narrows posteriorly, becoming rather compressed laterally, and lies in a horizontal plane. The anterior part of palatine widens somewhat transversely, abuting ventrally against the palatal process of the internal wall of the maxilla. The short middle part of the palatine is narrow and oval in the cross section. In ventral view the palatine extends subparallel to the internal wall of the lower ramus of the maxilla, being separated from it by an elongated furrow which extends from the infraorbital foramina posteriorly. The ectopterygoid is absent. The pterygoid is extensive, triradiate, and almost vertical in position.

In ventral view, the pterygoids meet at an angle of about 25°. A large depression is present in the middle of the medial wall of the pterygoid. Three wide and elongated processes project from the central region of the pterygoid. The anterodorsal process, laying in front of the anterior margin of the parasphenoid and presphenoid, is vertically oriented. It is attached through a large surface to its counterpart from the opposite side. The anteroventrally directed process abuts against the ventral end of the palatine bone at an angle of about 90°. The third process of the pterygoid is directed posteroventrally. Its posterior margin is strongly concave, abuting against the convex process of the basipterygoid. The vomer is incompletely preserved. It lies in a relatively anterior position and is T-shaped. The anterior part of the vomer is short, deep and

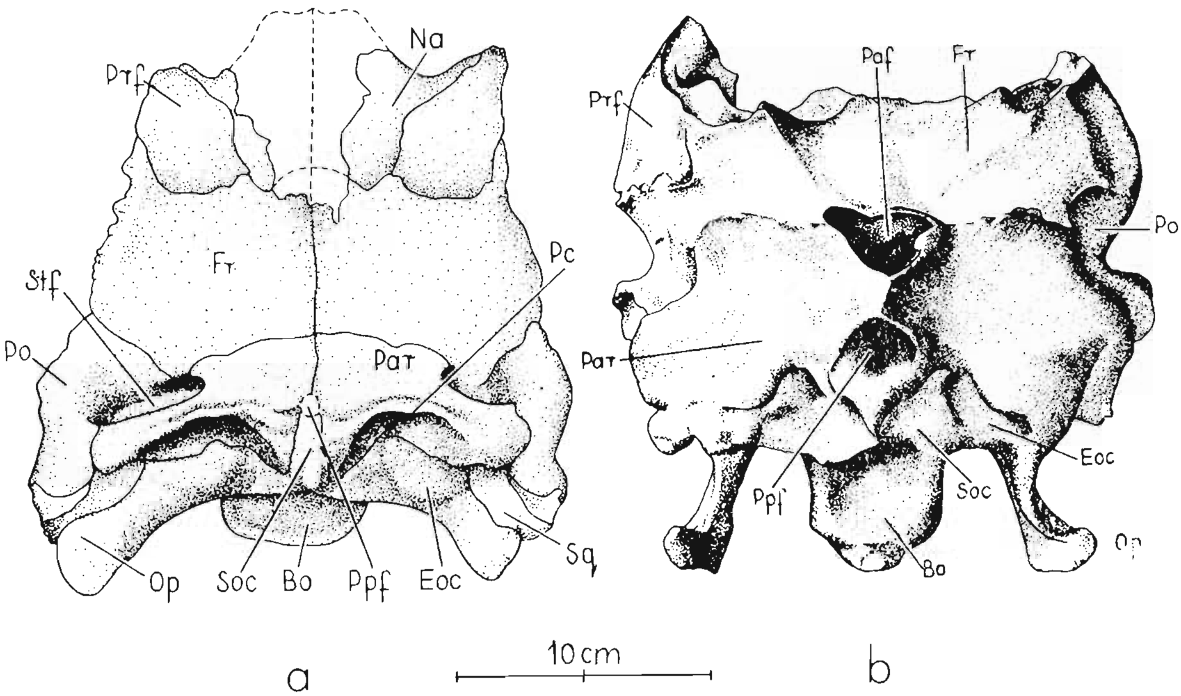

Fig. 4

Reconstruction of the cranial roof in posterodorsal view. *a* — *Nemegtosaurus mongoliensis* n. sp., *b* — *Dicraeosaurus hansemanni* JANENSCH (after JANENSCH, 1935/36). Abbreviations — as in Text-fig. 2.

transversally elongate in the horizontal plane (Pl. XI; Text-fig. 3). This region of the bone projects ventrally much below the posterior part of the vomer. On the boundary between the anterior and posterior parts of the vomer there is a large recess, which deepens anteriorly. The suture between the vomer and the premaxilla and maxilla is convex anteriorly. The posterior part of the vomer forms a strongly longitudinally elongate bar. In its anterior part this bar is slightly widened. Posteriorly it has free lateral margins which partly close the choanal cavity ventrally. The posteriormost part of the vomer is not preserved.

The cranial roof (in lateral view) slopes posteriorly at an angle of about 45° to the horizontal plane. The nasals are comparatively small, posteriorly situated (Pl. XIII; Text-fig. 4*a*). The naso-frontal suture is sinuous and anterolaterally directed. The dorsal processes of nasals, lying in the topmost region of the skull, are partly damaged. The median suture between the nasals is not preserved, also due to the damage sustained by the medial regions of the nasals. The naso-prefrontal suture is long, distinct and directed obliquely ventromedially towards the depression on the cranial roof (see below). The anterior process of nasal is depressed laterally and tapers anteriorly. It covers the lacrimal dorsally. In anterodorsal view the nasals form the posterior and posterolateral rim of the external nares. The external nares are very large and situated far back on the dorsal surface of the skull. They are cordate in dorsal view, although tapered somewhat anteriorly (Pls. X, XII; Text-fig. 2). It cannot be ascertained with certainty whether the external narial opening was single or double, as the anterodorsal part of the orbitosphenoid, parasphenoid and presphenoid are not preserved. The external narial opening is not preserved anteriorly, but it is possible that both the premaxillae and maxillae contributed to its anterior margin (Text-fig. 2). The frontals are large and flat, and form most of the cranial roof. In dorsal view they are rectangular (Pl. XIII; Text-fig. 4*a*). The medial suture between the frontals is very distinct. The stuture between the frontal and postorbital is obliquely directed, from the orbit rim to the central part of the anterior wall of the supratemporal fossa. The lateral margin of the frontal extends for 75 mm along the rim of the orbit. The prefronto-frontal suture is short and perpendicular to the median suture of the frontals. The prefrontal covers the frontal somewhat dorsally. The suture between the frontals and nasals is partly destroyed. The internal surface of the frontal forms the posterodorsal wall of the orbit. Medially the frontal contacts the orbitosphenoid, the suture between them being almost vertical with respect to the sagittal plane. The suture between the frontal and laterosphenoid slopes posterolaterally towards the postorbital. Both of these sutures are well seen on the posterior wall of the orbit (Text-fig. 1).

Orbit and infratemporal fossa. The orbit is very large and lies within the posterior one-third of the skull. When seen from behind the edges of the orbit lay in a subvertical plane. In dorsal view the plane of the orbit is somewhat anteromedially inclined, forming an angle of about 15° with the sagittal plane of the skull (Pl. X). The orbit has a shape of an elongate triangle, with the acute angle directed anteroventrally towards the jugal. Both orbits are separated medially by the vertical orbitosphenoid, parasphenoid and presphenoid.

The lacrimal (completely preserved only on the right side) is comparatively large and vertically elongate. The suture between the upper ramus of the maxilla and the lacrimal is not preserved. The lower part of the anterior margin of lacrimals are well preserved anteroventrally where it forms the posterior margin of the preorbital fossa (Pls. IX, XII; Text-fig. 1). The posterior margin of the lacrimal, which is convex, forms the anterior border of the orbit. Posterodorsally the lacrimal sends a process towards the prefrontal. The suture between the lacrimal and prefrontal is clearly visible, the prefrontal overlapping the lacrimal laterally. The lacrimal also forms part of the roof of the orbit where there is an extensive, centrally located lacrimal foramen. The lacrimal canal is directed horizontally across the lacrimal, its anterior opening lying near the suture between the lacrimal and maxilla. The length of the lacrimal canal is 72 mm. The medial margin of the lacrimal is concave, forming most of the lateral margin of the external naris. The prefrontal is small and longitudinally elongate (Text-figs. 1, 2). Its posterior end is widened transversely and curves posteroventrally in an arch. The anterior end of the prefrontal is strongly tapered. It covers the lacrimal laterally, ending on the level of the lacrimal foramen. The prefronto-lacrimal suture is clearly visible on the dorsal wall and on the edge of the orbit. It is obliquely inclined towards the orbitosphenoid. The lateral, outer edge of the prefrontal contributes to the roof and to the dorsal edge of the orbit.

The triradiate postorbital is T-shaped in the lateral view (Pl. IX; Text-fig. 1). Its vertically elongate supratemporal ramus joins the occipital plate with the cranial roof. Ventrally this structure abuts against the posterodorsal end of the squamosal, the suture between them being short and horizontally directed. The descending anteroventral process of the postorbital is very long and thin. More posteriorly this process widens in a transverse direction. The contact between the inner margin of the postorbital and the laterosphenoid is short and may be clearly seen in the posterior wall of the orbit. The contact between the postorbital and the ascending process of the jugal is nearly parallel to the long axis of the skull. The postorbital separated the orbit from the infratemporal fenestra, which lies below the orbit and even extends in front of it ventroanteriorly. It is very long and narrow. The posterodorsal part of the infratemporal fenestra is especially narrow. The anteroventral part is wider and somewhat ventrally recurved. The posteroventral wall of the infratemporal fenestra is formed by the anterodorsal surface of the quadrate. Medially and dorsally the fossa communicates with the orbit, while anteromedially it is enclosed by an ala of the pterygoid, the pterygoid wing of the quadrate and the lower ramus of the maxilla. In lateral aspect the squamosal parallels the dorsoposterior part of the quadrate. The suture between the dorsal margin of the squamosal and quadrate is straight, longitudinally directed and clearly visible on the ventral wall of the infratemporal fenestra. The squamosal is strongly depressed laterally and slightly bent downwards (Text-fig. 1). The anteroventral end of the squamosal is partly covered by the quadratojugal. The anterodorsal margin of the squamosal forms the posteroventral rim of the infratemporal fenestra. The posterior terminus of the squamosal is free. Between the lateral sur face of the quadrate and the squamosal there is a large, longitudinally elongate space, which is visible in occipital view (Pl. XII; Text-fig. 5*a*). The quadrate is large and lies at an angle of about 130° with respect to the horizontal plane of the skull. The laterally compressed posterodorsal part of the quadrate is inserted between the opisthootic and squamosal (Pl. XII; Text-fig. 5*a*). In occipital view the anterior parts of the quadrate meet at an angle of 20°. The articular surface of the quadrate is directed anteroventrally and outwards. It is crescent-shaped and ventromedially convex. In anterior aspect there is a broad groove parallel to the longitudinal axis of the quadrate on its anterodorsal surface, which begins above the articular surface and extends up to the level of the dorsal process of the quadrate. The dorsal ala of the quadrate abuts against the pterygoid, basipterygoid process and basisphenoid over a large area.

The occipital plate is almost twice as wide as it is deep (Pl. XII; Text-fig. 5*a*). The basioccipital is comparatively small. The occipital condyle is massive and ventroanteriorly directed with respect to the horizontal plane of the skull. As seen from the articular surface it is subtriangular in shape and slightly widened transversely (Pl. XII; Text-fig. 5*a*). The coarse articular surface faces ventroanteriorly with respect to the horizontal plane of the skull. It is bordered by a sharp crest, which is very distinct on the ventral and lateral surfaces of the condyle, and disappears dorsally. The dorsal surface of the condyle is flat and divided by a wide groove, which becomes deeper on the neck of the condyle. An indistinct basioccipital-exoccipital suture extends obliquely across the dorsal surface of the condylar neck. The exoccipital does not contribute to the structure of the condyle. The neck of the condyle is short, wide and slightly flattened ventrodorsally. The exoccipital and opisthootic (in ventral view) are extensive, strongly anteroventrally inclined in sagittal section, and directed to the posterior end of the quadrate (Pl. XII; Text-fig. 5*a*). The exoccipital forms the rim of the foramen magnum. The suture between the exoccipital and supraoccipital is horizontal in its central part, but becomes vertical laterally The exoccipital-parietal suture is horizontal and is slightly convex dorsally. The foramen magnum. is comparatively small, oval and sagittally elongate. Above the basioccipital-exoccipital suture, on the internal surface of the foramen magnum, there is a foramen for the hypoglossal nerve (XII). The outer foramen of the canal for the hypoglossal nerve lies on the ventral edge of the

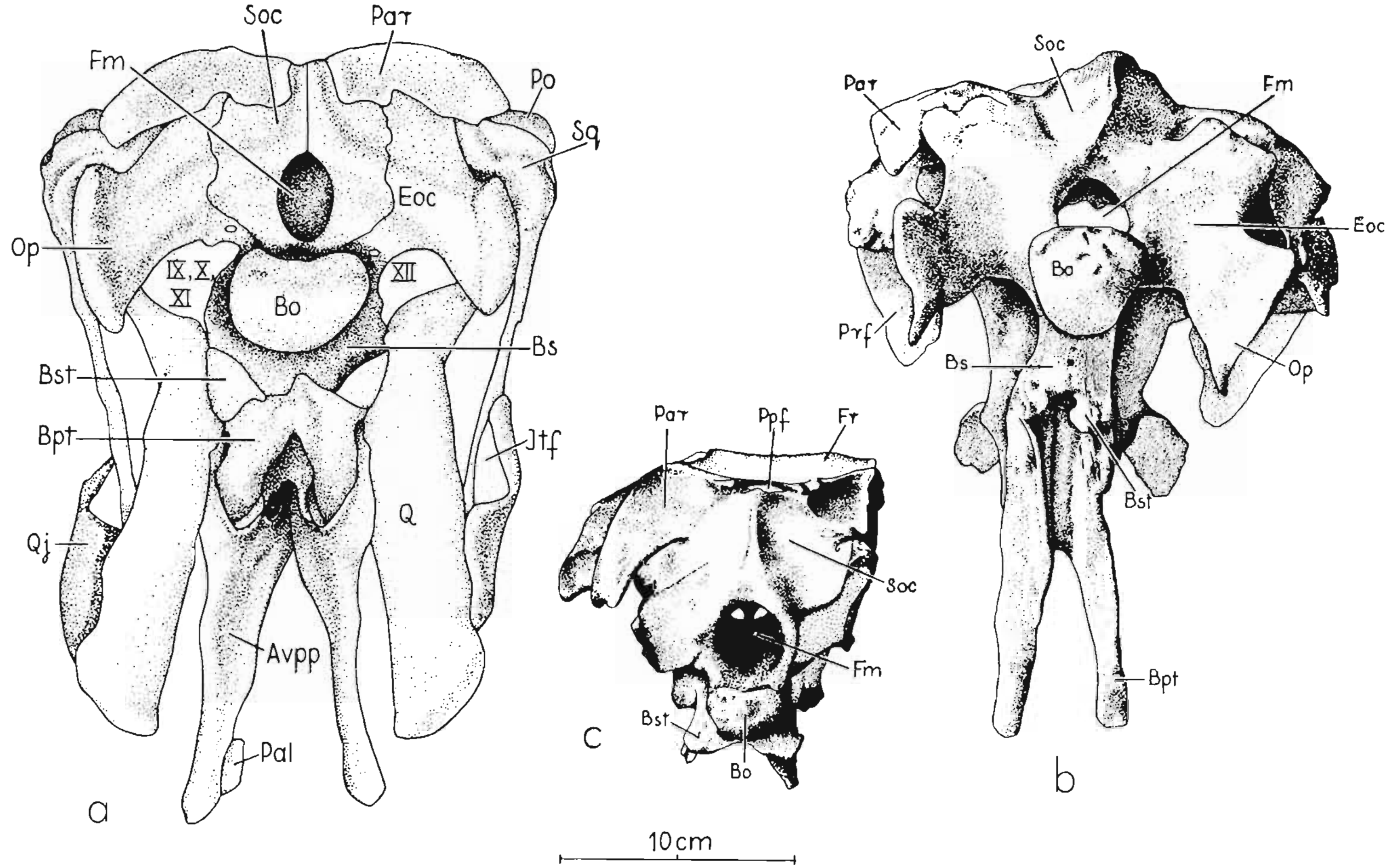

Fig. 5

Reconstruction of the occipital plate in posteroventral view. *a* — *Nemegtosaurus mongoliensis* n. sp., *b* — *Dicraeosaurus hansemanni* JANENSCH (after JANENSCH, 1935/36), *c* — *Barosaurus africanus* JANENSCH (after JANENSCH, 1935/36). Abbreviations — as in Text-fig. 2.

exoccipital, close to the base of the condylar neck (Text-fig. 5*a*). A suture between the exoccipital and opisthootic is not apparent. The ventral margin of the exoccipital is strongly bent downwards. Its medial part abuts against the basisphenoid, but the suture between the bones is obliterated. The dorsal and ventral margins of the exoccipital are parallel. The opisthootic is expanded in a vertical direction. Its inner surface abuts against the posterior end of the quadrate. The ventral margin of the occipital, the lateral margin of the prootic, basisphenoid and medial margin of the posterodorsal end of the quadrate enclose a large semicircular foramen for the nerves IX, X and XI (Text-fig. 5*a*). The supraoccipital forms the convex central part of the occipital plate (Text-fig. 5*a*). The median suture is indistinct. The wider end of the supraoccipital is directed against the opithootic. The suture between supraoccipital and parietal is sinuous and horizontally directed. The dorsal processes of the supraoccipitals are parallel to the median suture and are inserted between the parietals. Above them is a poorly preserved postparietal foramen. In ventral view the basisphenoid is subquadrate and strongly convex anterodorsally. Basisphenoid not a paired element. The ventral margins of the basisphenoid diverge, forming two short basisphenoid processes which are directed anteroventrally. The tuber of the basisphenoid is triangular in shape and not very prominent. Laterally the tuber contacts the middle part of the quadrate. Anteriorly and medially the edge of the basisphenoid merge with the posterodorsal region of the basipterygoid processes. The basipterygoid processes are very short and wide, meet together at an angle of about 30°. The convex ventral end of the basipterygoid process articulates with a concave surface on the posteroventral process of the pterygoid. Laterally the basipterygoid process contacts the dorsal wing of the quadrate. The parietals form the most posterior part of the cranial roof. They are comparatively small and triangular (Text-fig. 5*a*). The parieto-supraoccipital suture is sinuous and transversely oriented. Above the parieto-supraoccipital suture and parallel to it there extends a very prominent crest. The lateral part of the crest forms an arc, which curves ventrally and contacts the posterodorsal part of the postorbital. The anterolateral surface of the crest forms the posterior wall of the supratemporal fossa. In front of the crest the parietal is trapezoidal in shape. The parieto-frontal suture is long and transversely oriented, while the contact between the parietals is short. The supratemporal fenestra is quite small and lies on the posterior wall of the skull, between the occipital plate and the cranial roof. The anterior wall of this fenestra is formed by the ventral part of the frontal and dorsal part of the postorbital. In dorsal view the supratemporal fenestra is transversely elongate, kidney-shaped and open dorsally (Pl. XIII; Text-fig. 4*a*). The fenestra communicates anteroventrally into a somewhat medially directed canal, which extends below the laterosphenoid. In this region the canal communicates with the posterior part of the orbit and infratemporal fenestra.

The *braincase* is comparatively small. The laterosphenoid is large and transversely directed to the postorbital, subparallel to the exoccipital + opisthootic. The bone is well exposed on the posteroventral wall of the orbit. The suture between the orbitosphenoid and laterosphenoid is not recognizable. The dorsal region of the orbitosphenoid, which meets inner surface of the nasal posteriorly, is partly damaged. Posteriorly the orbitosphenoid contacts the inner surface of the frontal. The lateral margin of the orbitosphenoid approximately parallels the orbital margin of the frontal. The course of this margin is visible on the posterodorsal wall of the orbit. Ventrally the orbitosphenoid widens transversely and contacts the prootic, and dorsal surface of the basisphenoid. Anteriorly, it contacts the parasphenoid + presphenoid. The suture between the orbitosphenoid, parasphenoid and presphenoid is not clearly visible. The parasphenoid and presphenoid are large and form a high wall, which is strongly elongate sagitally. Its anterior extremity contacts the anterodorsal process of the pterygoid. The dorsal region of the parapshenoid and presphenoid is not preserved (Pl. IX; Text-fig. 1). On the lateral wall of the orbitosphenoid there are several foramina for cranial nerves. This region requires further preparation and will not be interpreted in the present study.

Mandible. The lower jaw is lightly built and U-shaped in dorsal view (Pl. XIV; Text-figs. 1, 6). The symphysis is placed almost perpendicular to the long axis of the lower jaw. The surface of the symphysis is narrow and nearly vertical, with a slight anterolateral inclination, the mandibles therefore do not contact broadly, and a furrow, which is widely open anteriorly, lies between them. In lateral view the lower jaw is the shallowest at the last alveolus, and its depth increases posteriorly, reaching a maximum 150 mm from its posterior termination. Anteriorly the depth of the lower jaw also increases up to the symphysis.

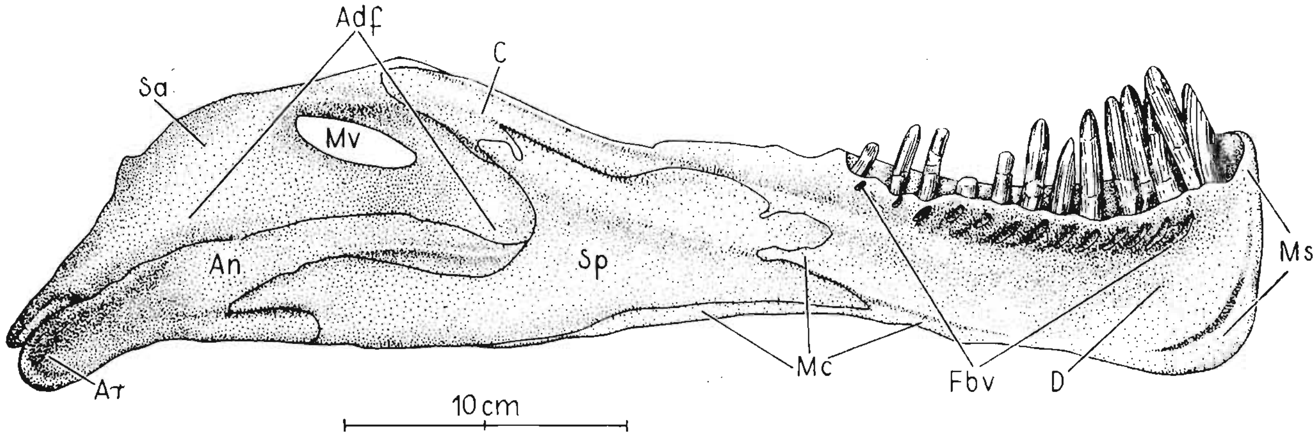

Fig. 6
Nemegtosaurus mongoliensis n. sp. Reconstruction of the left lower jaw in inner view. Abbreviations — as in Text-fig. 2.

The dentary is large and flattened ventrodorsally in the posterior part. The alveolar segment of the dentary is thick and bent to form an arc. In lateral view the posterior part of the dentary divides into two rami (Text-fig. 1). The upper ramus of the dentary is short and overlaps the anterior end of the surangular. The lower ramus is much more elongate and covers the angular. As a result of this division, the posterior margin of the dentary is deeply incised. The outer surface of the dentary is smooth. On the inner surface in the alveolar region there are numerous, irregularly arranged foramina mentalia. The lower margin of the dentary is smooth. The lower branch of the Meckel's canal is situated just above this margin and parallel to it, on the inner surface of the dentary, and ends as a deep notch on the symphysial surface. The point of division of the Meckel's canal into two branches lies opposite the 13th alveolus (Text-fig. 6). The upper ramus of the canal passes below the splenial towards the end of the dentary and the adductor fossa. The alveolar part of the margin of the dentary is sinuous. It comprises half of the length of the dentary and one-third of the total length of the lower jaw. In each dentary there are 13 alveoli. The lingual alveolar margin of the dentary extends obliquely with regard to the labial margin. Both edges meet behind the last alveolus. On the inner surface of the dentary, below the lingual edge, there are 13 oval foramina to facilitate the development of replacement teeth (EDMUND, 1969). The longitudinal axes of these foramina are parallel to each other and placed obliquely (Pl. XIV; Text-fig. 6). Inside these foramina one can see the crown of the replacing teeth. The inner surface of the posterior part of the dentary is covered by the splenial. The suture between the dentary and coronoid is not visible. The coronoid is narrow and long. The anterior part of the coronoid is triangular in cross section, with its apex bent towards the sagittal plane. The upper margin of the coronoid is in the form of a sharp vertical edge, which lies in a posterior extension of the alveolar margin of the dentary. This edge, as seen on the outer surface of the lower jaw, is separated from the dentary by a deep, narrow furrow. The lower surface of the anterior part of coronoid is almost entirely covered by the splenial. The posterior part of the coronoid is narrow, posterodorsally directed and does not contact the upper part of the surangular. The lower margin of the posterior part of the coronoid forms the upper edge of the adductor fossa. The splenial is triangular in shape (Text-fig. 6). Its sharp anterior edge overlaps the dentary. The anterior process of the splenial lies opposite the last alveola. The posterior region of the splenial is separated into dorsal and ventral. The inner margins of these rami form the anterior and lower edges of the adductor fossa. The lower ramus of the splenial lies entirely on the inner surface of the angular. The dentary-splenial suture extends longitudinally along the ventral edge of the lower jaw. The surangular is a very delicate lamina of bone, and is longitudinally elongate and strongly convex laterally. The anterodorsal end of the surangular is inserted between the coronoid and the upper ramus of the dentary. It contacts the lower ramus of the dentary on the outer surface of the lower jaw in a horizontally oriented suture. The surangular-angular suture is horizontal. The middle part of the inner wall of the surangular rimmed by the margins of the coronoid, splenial and angular, forming the adductor fossa (Pl. XIV; Text-fig. 6). This fossa is widely open posterodorsally. Behind the adductor fossa the dorsal margin of the surangular bends abruptly downwards and contacts the posterior part of the angular. In the dorsal part of the adductor fossa there is a small mandibular vacuity, which is oval in shape. The longitudinal axis of the mandibular vacuity is anteroventrally inclined, forming an angle of about 20° with the lower edge of the lower jaw (Text-fig. 1, 6). The angular and articular form a flattened laterally bar, the posterior margin of which is bent downwards. The suture between the angular and articular is not discernible. The anterior end of the angular is inserted deeply between the lower ramus of the splenial and the lower ramus of the dentary. The articular is bent ventrally. The glenoid fossa is small and slightly longitudinally elongate.

Dentition. The description and measurements of the teeth given in the present paper are based on the completely preserved replacing teeth. The lengths of the crowns and roots of the functional teeth are based on the reconstruction. The dentition of the described skull is isodont and nearly complete. Altogether there are 50 teeth, placed in 50 separate alveoli. The teeth are lanceolate in lingual view. In mesial and distal view all the teeth are characteristically bent, the lower teeth less so than the upper. The teeth in the premaxilla and maxilla are bent lingually, those of the dentary — labially. On the lingual side the crowns of both upper and lower teeth are slightly flattened. The labial surface of all the teeth is convex. As a result of the lingual flattening, there are two not very prominent edges (mesial and distal) on the crowns. These edges are more prominent in the lower teeth than in the upper. The roots are cylindrical, circular in cross--section, the lower ends being open and funnel-shaped. Towards the crown the root becomes more robust. The boundary between the crown and the root is very distinct, forming the horizontal or oblique line. The teeth are the largest in the front of jaws, decreasing in all the dimensions posteriorly (Pls. XI, XIII). The ratio of the crown/root length is about 2 : 1. The enamel on the surface of the crowns is brown in colour and badly cracked.

The teeth are arranged in the single marginal rows, in the anterior part of the jaws (Pls. XI, XII). In the upper jaw the length of the tooth row is about 190 mm, in the lower jaw — about 170 mm, which amounts to about one-third of the total length of the lower jaw. The implacement of teeth is thecodont. Each tooth is set in a separate, comparatively large, closed alveolus. The teeth do not touch each other. In lateral view the line of the tips of the functional teeth is approximately parallel to the alveolar edge of the lower jaw. One can recognize the two generations of the teeth by the degree of the wear. The functional teeth are being displaced by the respective replacing teeth; in the left upper jaw in the 3rd and 8th alveolus, in the right upper jaw in the 11th and 12th, in the 2nd and 3rd alveolus of the right dentary and the 4th of the left dentary. The tips of these replacing teeth in these cases are visible, in lingual view, in the cavum pulposum of the functional teeth. Usually the exchange of teeth takes place when half of the height of the functional teeth is worn off and the tip of the replacing tooth is opposite the outer edge of the jaw. Of the 50 teeth preserved in the studied skull, there are 37 (74%) functional teeth, 12 (24%) replacing teeth and one tooth in the right maxilla cannot be classified due to damage. These bones contain the following number of teeth:

Right premaxilla . . .	4 teeth	(3 functional,	1 replacing)		
Left premaxilla . . .	4 „	(all functional)			
Right maxilla	8 „	(5 functional,	2 replacing)		
Left maxilla	8 „	(6	„	2	„)
Right dentary	13 „	(10	„	3	„)
Left dentary	13 „	(9	„	4	„)

The replacing teeth randomly occur between the functional teeth, but there is certain regularity in their vertical arrangement (Text-fig. 7). The sequence of teeth replacement forms a replacement wave along the jaws (WHITE, 1958 and see EDMUND, 1960, 1969). A single replacement wave consists of teeth that grow simultaneously and their height above the edge of the jaw is more or less the same. In the studied skull three replacement waves may be recognized:

First wave (the oldest teeth, which were nearly lost) —

Premaxilla+maxilla. . .	right — 2, 4, 11;	left — 1, 3, 4, 6, 8.
Dentary	right — 4, 7, 11, 13;	left — 1, 3, 7, 10, 13.

Second wave (functional teeth) —

Premaxilla+maxilla. . .	right — 1, 6, 8, 12;	left — 9, 10, 12.
Dentary	right — 6, 9, 10;	left — 6, 9, 11, 12.

Third wave (youngest teeth, mainly replacing) —

Premaxilla+maxilla. . .	right — 3, 5, 7, 9;	left — 2, 5, 7, 11.
Dentary	right — 1, 2, 3, 5, 8, 12;	left — 2, 4, 5, 8.

The tips of the crowns are chisel-shaped, the upper teeth covering the lower labially. However, the upper teeth do not bite exactly opposite the lower teeth, but somewhat between them, as deduced from the fact that the mesial and distal surface of the teeth are worn (in some cases mesio-labial and disto-labial surfaces).

Sclerotic ring. Only the right sclerotic ring is preserved in the present skull (Pl. IX). One quarter of its outer margin is damaged. The ring has been displaced medially and fits tightly to the vertical wall formed by the orbitosphenoid, parasphenoid and presphenoid. Only four detached, damaged plates of the ring were present on the left side. The ring is very small (see Table 2). The outer surface of the ring is slightly convex. The central rim is more laterally situated

Fig. 7

Diagram showing the relation of the development of the teeth and three replacement waves in the upper and lower jaws in *Nemegtosaurus mongoliensis* n. sp. *Black colour* — crown, *white* — root, *M* — labial rim of the premaxilla, *D* — labial rim of the lower jaw, *X* — occlusal line, *F* — functional teeth, *Z* — replacing teeth, **1** — first replacement wave, **2** — second replacement wave, **3** — third replacement wave. The crowns of the teeth: 2, 4, 5 in right maxilla and 6, 13 in left dentary are damaged. Height of the teeth is 1/2 natural size.

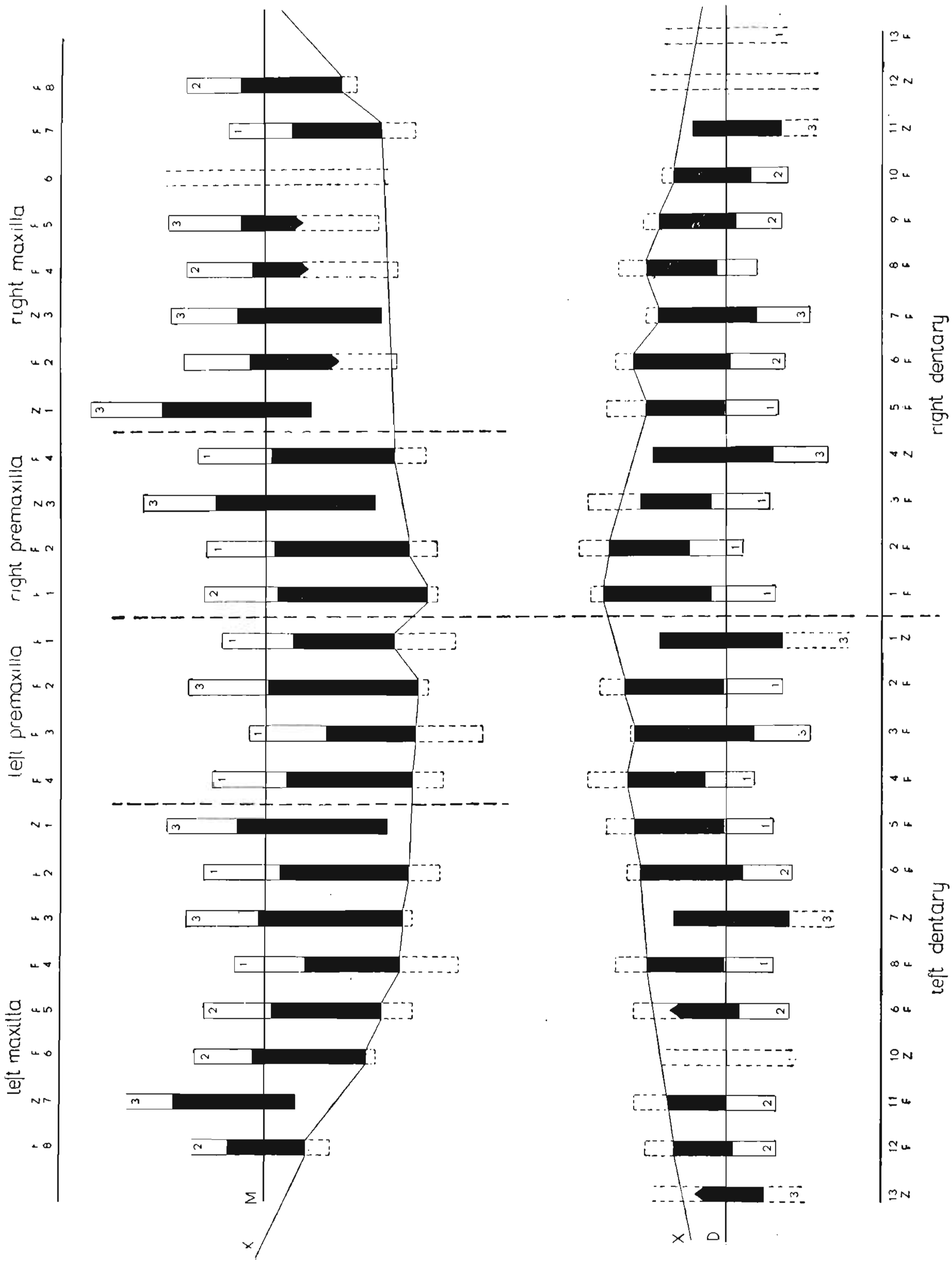
left maxilla
left premaxilla
right premaxilla
right maxilla
left dentary
right dentary
M
X
D

Fig. 7

than the peripheral rim. The sclerotic ring consists of 10 overlapping plates, arranged in a very characteristic way (Text-fig. 8 *c*). The individual plates have the form of elongated hexagons. The long axes of the plates parallel the circumference of the ring. The following notations are introduced for the sclerotic plates: *Ev.* — external ventral, *Ed.* — external dorsal, *Ip.* — internal posterior, *Ia.* — internal anterior. The notations *a*, *b*, *c* and *d* are given to the plates placed between the external and internal plates. If there is more than one plate between the external and internal plates the successive numbers are added to the notation *a* or *b*, for example a_1, a_2 and so on. The ring may be divided into four unequal parts. The boundaries between these parts are designated by four plates (Text-fig. 8 *d*). Two external (positive) plates *Ed.* and *Ev.* lay opposite each other, along the diameter of the ring. Plate *Ed.* is placed posterodorsally, and *Ev.* anteroventrally. Laterally *Ed.* and *Ev.* overlap the adjacent plates (a_1, a_2 and c_1, c_2). The two internal (negative) plates *Ip.* and *Ia.* are also situated opposite each other, *Ia.* forming with *Ed.* and the centre of the orbital ring the angle A = 57°, and *Ip.* forming with *Ed.* and the centre of the orbital ring the angle D = 72°. The plate *Ia.* lies in a nearly dorsal position, while *Ip.* is situated posteroventrally. The negative plates are overlapped by the adjacent plates (a_2, b_2 and a_1, b_1). Between the positive and negative plates there are plates which overlap each other successively. In the first (I) part of the ring, there is only one such plate a_2, in the second part (II) there are two plates b_2 and c_2, in the third (III) there are two plates b_1 and c_1, while in the fourth part (IV) there is one plate a_1. In the inner view the arrangement of the plates is of course reversed. The arrangement of plates is in fact symmetrical about a plane of symmetry extending along the middle of plates *Ed.* and *Ev.* The arrangement of plates in the posteroventral part is the mirror image of the arrangement in the anterodorsal part (Text-figs 1, 8 *d*). The plates are approximately the same size. Their margins are smooth. The outer surface of plates is covered by minute cracks, usually paralleling the long axis of plates. The degree of overlapping is such that two-thirds of the length of each plate is in contact with two adjacent plates, while one-third of the length is free. The line of the symmetry of the ring forms an angle of about 50° with the horizontal plane. In lateral view the ring lies in an anteroventral position within the orbit, close the jugal (Text-fig. 1). The periphery of the sclerotic ring encloses an area equal to about 25% of the area enclsed by the orbital fenestra.

Discussion. — A monotypic new genus is erected for *Nemegtosaurus mongoliensis* n. sp. *Nemegtosaurus* n. gen. is assigned to the subfamily Dicraeosaurinae JANENSH, 1929, family Atlantosauridae MARSH, 1877 (see APPLEBY *et al.*, 1967, and STEEL, 1970) on the basis of the similarity of the type skull to the skull of the only representative of the subfamily Dicraeosaurinae: *Dicraeosaurus hansemanni* JANENSCH, 1914. In general shape and proportions the skull of *Nemegtosaurus* is reminiscent of that of *Diplodocus* MARSH (Text-fig. 9 *b*). However, it differs strongly from that of *Diplodocus* in details of the structure of the occipital region and lower jaw, in the shape of the temporal fosses and teeth, and in the absence of the accessory preorbital foramen. These differences preclude the assignment of the new genus to the family Diplodocidae. On the other hand, the skull of *Nemegtosaurus* resembles that of *Dicraeosaurus hansemanni* JANENSCH, 1914 in the structure of the occipital region, the size of supratemporal fossa, the structure of the lacrimal, the lack of the accessory preorbital foramen and the structure of the teeth. The above similarities are more significant than the general shape of the skull, in which *Nemegtosaurus* resembles *Diplodocus*, and the new genus is therefore placed in the subfamily Dicraeosaurinae.

In the lateral view the skull of *Nemegtosaurus* generally resembles those of *Dicraeosaurus hansemanni* JANENSCH, 1914 (see JANENSCH, 1935/36), *Diplodocus longus* MARSH, 1878 (see

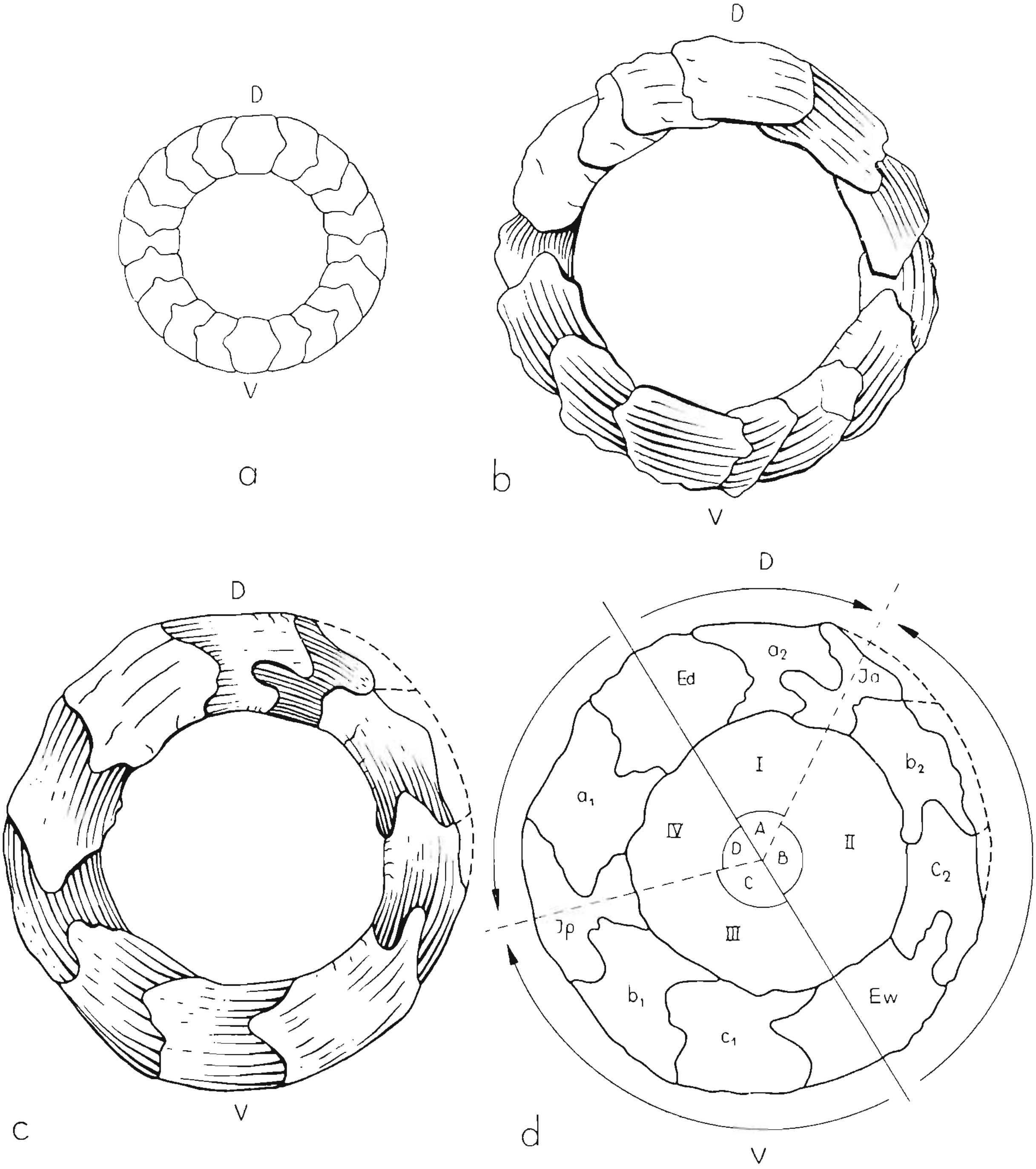

Fig. 8

Reconstruction of the sclerotic rings: *a* — right sclerotic ring in „*Struthiomimus samueli*" (after PARKS, 1927), × 1; *b* — right sclerotic ring in *Corythosaurus casuarius* (after OSTROM, 1961), × 1; *c* — right sclerotic ring in *Nemegtosaurus mongoliensis* n. sp., × 1; *d* — schematic reconstruction of the right sclerotic ring of *Nemegtosaurus mongoliensis* n. sp. showing the arrangement of plates. *Ed*, *Ev* — positive (external) plates, *Ia*, *Ip* — negative (internal) plates, a_1, a_2, b_1, b_2, c_1, c_2 — plates placed between the external and internal plates, *S* — line of the bilateral symmetry, *I*, *II*, *III*, *IV* — four parts of the sclerotic ring marked by the positive and negative plates. The arrow shows the direction of overlapping. *D-V* — dorso-ventral direction, perpendicular to the horizontal plane (see also Plate IX and Text-fig. 1).

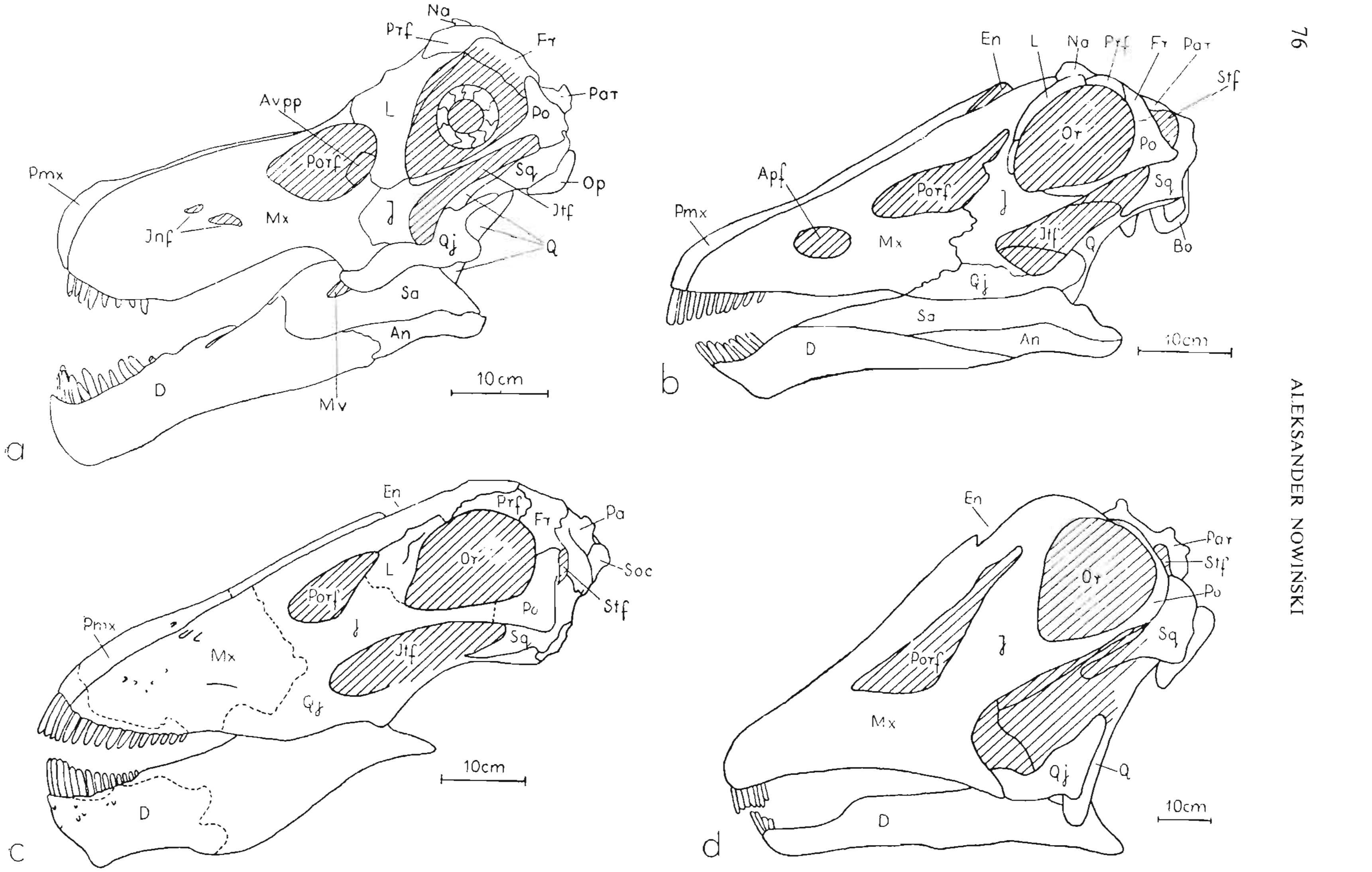

Fig. 9

Comparison of the skulls of: *a — Nemegtosaurus mongoliensis* n. sp., *b — Diplodocus longus* MARSH (after MARSH, 1878), *c — Dicraeosaurus hansemanni* JANENSCH (after JANENSCH, 1935/36), *d — Antarctosaurus wichmanianus* HUENE (after HUENE, 1956). Abbreviations — as in Text-fig. 2.

MARSH, 1878), 1896; see also OSTROM, 1966; COPE, 1884; GILMORE, 1932; HATCHER, 1901; HOLLAND, 1924; HUENE, 1932; OSBORN, 1899; OSBORN & MOOK, 1921; HAY, 1908) and *Antarctosaurus wichmanianus* HUENE, 1929 in possessing a strongly elongate snout and in the position of the orbit and infratemporal fenestra (Text-figs. 9*a-d*). The skull of *Barosaurus africanus* (FRAAS, 1908) is incomplete (JANENSCH, 1935/36) and has not been reconstructed. The skull of *Barosaurus lentus* MARSH, 1890 is unknown (see LULL, 1919). Posteriorly, the height of the skull of *Nemegtosaurus* is similar to that of *Diplodocus*, but is relatively higher than in *Dicraeosaurus* and lower than in *Antarctosaurus*. The snout of *Nemegtosaurus* (and of *Antarctosaurus*) is higher anteriorly than in *Dicraeosaurus* and *Diplodocus*, due to the fact that the premaxilla and maxilla are strongly bent downwards. The accessory preorbital foramen, characteristic of the maxilla of *Diplodocus*, is absent in *Nemegtosaurus*, *Dicraeosaurus* and *Antarctosaurus*. Unfortunately, it cannot be stated whether or not it was present in *Barosaurus*, which is assigned to the Diplodocinae (see ROMER, 1956) as this part of the maxilla is not preserved. The presence of an accessory preorbital foramen in *Diplodocus* in an important feature (MARSH, 1896; ROZHDESTVENSKY, 1964), which is not known to occur in other sauropods. The palatine bones in *Nemegtosaurus* are narrower than in *Diplodocus*. The vomer in *Nemegtosaurus* is made of the single bone and is more elongate than in *Diplodocus*. In *Diplodocus* the vomer is separated by the anterior parts of the pterygoids into a bipartite structure (MARSH, 1896). The ectopterygoid, which is present in *Diplodocus*, is absent in *Nemegtosaurus*. The pterygoid is smaller in *Nemegtosaurus* than in *Diplodocus*, and almost vertically oriented. It sends a strong processes (absent in *Diplodocus*) anterodorsally, which is visible within preorbital fossa in lateral aspect (Text-figs. 1, 9*a*). The preorbital fenestra in *Nemegtosaurus* is partly damaged, but the preserved parts of the lacrimal and maxilla show that the fenestra was comparatively larger and more oval than in *Dicraeosaurus*. The preorbital fenestra of *Diplodocus* and *Antarctosaurus* is very long. The posterior part of the quadratojugal in *Nemegtosaurus*, in contrast to that of *Diplodocus*, contacts the squamosal. In *Nemegtosaurus* the orbit and infratemporal fenestra are similar in shape and position to those of *Dicraeosaurus*, *Diplodocus* and *Antarctosaurus*. In *Dicraeosaurus* the infratemporal fenestra is more anteriorly situated, its anterior edge lying opposite the anterior edge of the preorbital fenestra. In *Nemegtosaurus* the squamosal is narrower, longer and more anteriorly placed than in *Dicraeosaurus*, *Diplodocus* and *Antarctosaurus*. In *Nemegtosaurus* this bone does not enter the margin of the supratemporal fenestra, but forms the lower margin of the infratemporal fenestra. In *Dicraeosaurus* and *Diplodocus* the squamosal enters the margins of both fenestrae. The anteroventral process of the postorbital is longer in *Nemegtosaurus* than in *Diplodocus*, contacting the ventral end of the lacrimal. In *Dicraeosaurus* the anterior part of the postorbital is not preserved. The lacrimal in *Nemegtosaurus* is very extensive, forming the anterior rim of the orbit, posterior rim of the preorbital fenestra and lateral rim of the external narial opening. In *Dicraeosaurus* this bone is similarly developed, forming the rims of the orbit and preorbital fenestra, but does not contribute to the margins of the external narial opening. In *Diplodocus* the lacrimal is very small and only enters the anterior margin of the orbit. The external narial opening in *Nemegtosaurus* (and in *Antarctosaurus*) is located further back on the dorsal surface of the skull than in *Dicraeosaurus* and *Diplodocus*. In *Diplodocus* this opening is single. In *Nemegtosaurus* it was probably double, but this cannot be stated with certainty, as this part of the skull (dorsal part of the orbitosphenoid, parasphenoid and presphenoid) is badly damaged. In *Nemegtosaurus* the prefrontal is shaped as in *Dicraeosaurus*, being larger than in *Barosaurus* and smaller than in *Diplodocus*. In contrast, the upper ramus of the maxilla does not contact the prefrontal in *Nemegtosaurus*. In *Dicraeosaurus* the relations of these bones are not known. The cranial roof in *Nemegtosaurus*, *Diplodocus* and *Antarctosaurus* is similar in outline, flat and distinctly separated from the nuchal and occipital surfaces. In *Dicraeosaurus* the cranial roof is smaller than in *Nemegtosaurus*, is convex posteriorly and merges evenly with the roof of the snout. In *Nemegtosaurus* the cranial roof is formed almost entirely from the frontals, which are extensive and contribute greatly to the rims of the orbits. In *Dicraeosaurus*, *Diplodocus* and *Barosaurus* the frontals are small. The nasals in *Nemegtosaurus* and *Diplodocus* are small, but in the former genus they do not contact the upper ramus of the maxilla, as is the case in *Diplodocus*. In *Nemegtosaurus* the parietal foramen is absent, while in *Dicraeosaurus*, *Diplodocus* and *Barosaurus* it is very large (Text-figs 4*a*, *b*, 5*c*. The occipital plate in *Nemegtosaurus* is lower than in *Dicraeosaurus* (see JANENSCH, 1935/36), *Diplodocus* (see OSTROM, 1966; HAAS, 1960; OSBORN, 1912) and *Barosaurus* (see JANENSCH, 1935/36). The occipital condyle in *Nemegtosaurus* is very low and anteriorly bent, which is unusual in sauropods. In *Dicraeosaurus*, *Diplodocus*, *Barosaurus* and *Antarctosaurus* the condyle is directed posteroventrally. This position of the occipital condyle indicates that in *Nemegtosaurus* the skull was placed at a high angle to the neck, with the snout being directed downwards. The supratemporal fenestra is very small in *Nemegtosaurus* and *Dicraeosaurus*, and in occipital view is covered by the extensive dorsal crests of the parietals. In *Nemegtosaurus* the supratemporal fenestra is transversely elongate and opens dorsally, while in *Dicraeosaurus* it is ventrodorsally elongate and opens laterodorsally. In *Diplodocus* the supratemporal fenestra is very extensive, longitudinally elongate and opens laterodorsally. The supratemporal fenestra in *Antarctosaurus* is smaller than in *Nemegtosaurus*. The parietal in *Nemegtosaurus* (as in *Dicraeosaurus*) contacts the squamosal, which is not the case in *Diplodocus*. The parietal crest, which is very prominent in *Nemegtosaurus*, is only very slightly developed in *Dicraeosaurus*, and is absent in *Diplodocus* and *Barosaurus*. The postparietal foramen is present in *Nemegtosaurus*, *Dicraeosaurus* and *Barosaurus*, but is absent in *Diplodocus*. In *Nemegtosaurus* the supraoccipital does not contribute to the structure of the occipital condyle, and extends only up to the neck, while in *Dicraeosaurus* it forms a part of the condyle. The basipterygoid processes and basisphenoid are shorter in *Nemegtosaurus* than in *Dicraeosaurus*, *Diplodocus* and *Barosaurus*.

In the lateral view the lower jaw of *Nemegtosaurus* closely resembles that of *Brachiosaurus brancai* JANENSCH, 1914 (see JANENSCH, 1935/36) in having the upper margin of the surangular strongly convex upwards. In *Dicraeosaurus* nad *Barosaurus* only the anterior part of the lower jaw is preserved. The anterior part of the lower jaw in *Nemegtosaurus*, *Dicraeosaurus* and *Diplodocus* is semicircular and U-shaped in dorsal view, while in *Barosaurus* it is V-shaped. The dentary in *Nemegtosaurus*, *Diplodocus* and *Antarctosaurus* is more lightly built than in *Dicraeosaurus*. In lateral view the mandibular symphysis in *Nemegtosaurus* is perpendicular with respect to the long axis of the lower jaw, while in *Dicraeosaurus* the angle between the symphysis and long axis of the lower jaw is about 115°, in *Barosaurus* it is 130°, and in *Diplodocus* —145°. On the lingual side, the Meckel's canal is similarly divided in *Nemegtosaurus* and *Dicraeosaurus*. In lateral view the dentary in *Nemegtosaurus* forms two rami (upper and lower) and its posterior margin is emarginate. In *Diplodocus* only the lower ramus of the dentary is present which contacts the angular through an oblique suture. The adductor fossa in *Nemegtosaurus* is larger than in *Diplodocus*. In *Nemegtosaurus* a mandibular vacuity is present within the surangular, which is unknown in other sauropods. Such an opening occurs in the Plateosauridae (*Plateosaurus frasianus* HUENE, 1932 and *P. quenstedti* HUENE, 1905 (see HUENE, 1926, 1932)).

The teeth of *Nemegtosaurus* are in particular strongly similar to those of *Dicraeosaurus*, and also resemble those of *Barosaurus* (see JANENSCH, 1935/36). They are distinctly different from the teeth of *Diplodocus*. The crowns of the teeth in *Nemegtosaurus* (as in *Dicraeosaurus* and *Barosaurus*) are lanceolate, while in *Diplodocus* they widen upwards and are peg-like. In *Nemegtosaurus* and *Dicraeosaurus* the crown occupies about two-thirds of the total length of the teeth, in *Diplodocus* it occupies about one-third of the tooth length. In both genera (*Nemegtosaurus* and *Dicraeosaurus*) the lower teeth are perpendicular to the alveolar margin of the lower jaw. The tooth row is more or less the same length in *Nemegtosaurus*, *Dicraeosaurus*, *Diplodocus* and *Barosaurus*, while in *Antarctosaurus* it is much shorter, extending only along the most anterior part of the snout. There are altogether 50 teeth in the studied skull of *Nemegtosaurus mongoliensis* n. gen., n. sp., in *Dicraeosaurus hansemanni* JANENSCH, 1914 there are 64 teeth (see JANENSCH, 1935/36), in *Diplodocus longus* MARSH, 1896 (according to Holland, 1905) — 46 teeth, while in *Barosaurus* there are 54 teeth.

The sclerotic ring of *Nemegtosaurus mongoliensis* is the first completely preserved ring to be described in the suborder Sauropoda. Fragmentary rings are known in the following sauropods: badly damaged ring in *Camarasaurus lentus* (MARSH, 1889), single plates in *Brachiosaurus brancai* JANENSCH, 1914 and an imprint of the ring in *Diplodocus hayi* HOLLAND, 1924 (see GILMORE, 1925; JANENSCH, 1935/36; HOLLAND, 1924). Well preserved sclerotic rings are known in other dinosaur groups (see Table 2). LEMMRICH (1931) recognized two types (A and B) of sclerotic rings in modern birds, differing in number and arrangement of the positive (external) and negative (internal) plates. Similar types may be recognized in dinosaurs (OSTROM, 1961). The sclerotic ring of *Nemegtosaurus mongoliensis* differs from the known dinosaur rings in being bilaterally symmetrical and in the arrangement of the positive and negative plates with regard to the main axis of the skull. Thus it cannot be assigned to either of Lemmrich's types A or B (see Text-figs. 8*a-d*). In the sclerotic ring of *Nemegtosaurus* the positive plates are not arranged in dorsal and ventral positions, but lies posterodorsally, while the second anteroventrally. In recent birds and in known dinosaurs the positive plates are arranged ventrally and dorsally. It is not impossible that in *Nemegtosaurus* these plates were also arranged dorsally and ventrally in life, and that the preserved orientation is due to displacement after the death of the animal. The plates in the ring of *Nemegtosaurus* contact the adjacent plates along two-thirds of their length, while the inner one-third of the length is free. A similar arrangement of the plates is characteristic of the Hadrosauridae (*Lambeosaurus lambei* PARKS, 1923, *Anatosaurus annectus* (MARSH, 1892), *Corythosaurus casuarius* BROWN, 1914 and *Saurolophus osborni* BROWN, 1912) (see RUSSELL, 1940; EDINGER, 1929; OSTROM, 1961; BROWN, 1912; PARKS, 1928; LULL & WRIGHT, 1942). The hadrosaur rings differ from that of *Nemegtosaurus* in having seven inverse axes of the bilateral symmetry and in lacking the plane of symmetry. It appears from the Table 2 that all the known dinosaur sclerotic rings are of Lemmrich's type A, with an exception of *Plateosaurus frasianus* HUENE, 1932 (see HUENE, 1926, 1932), which is probably of his type B.

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Warszawa, March 1970

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PLATES

Palaeontologia Polonica, No. 25, 1971

A. NOWIŃSKI: *NEMEGTOSAURUS MONGOLIENSIS* N. GEN., N. SP.

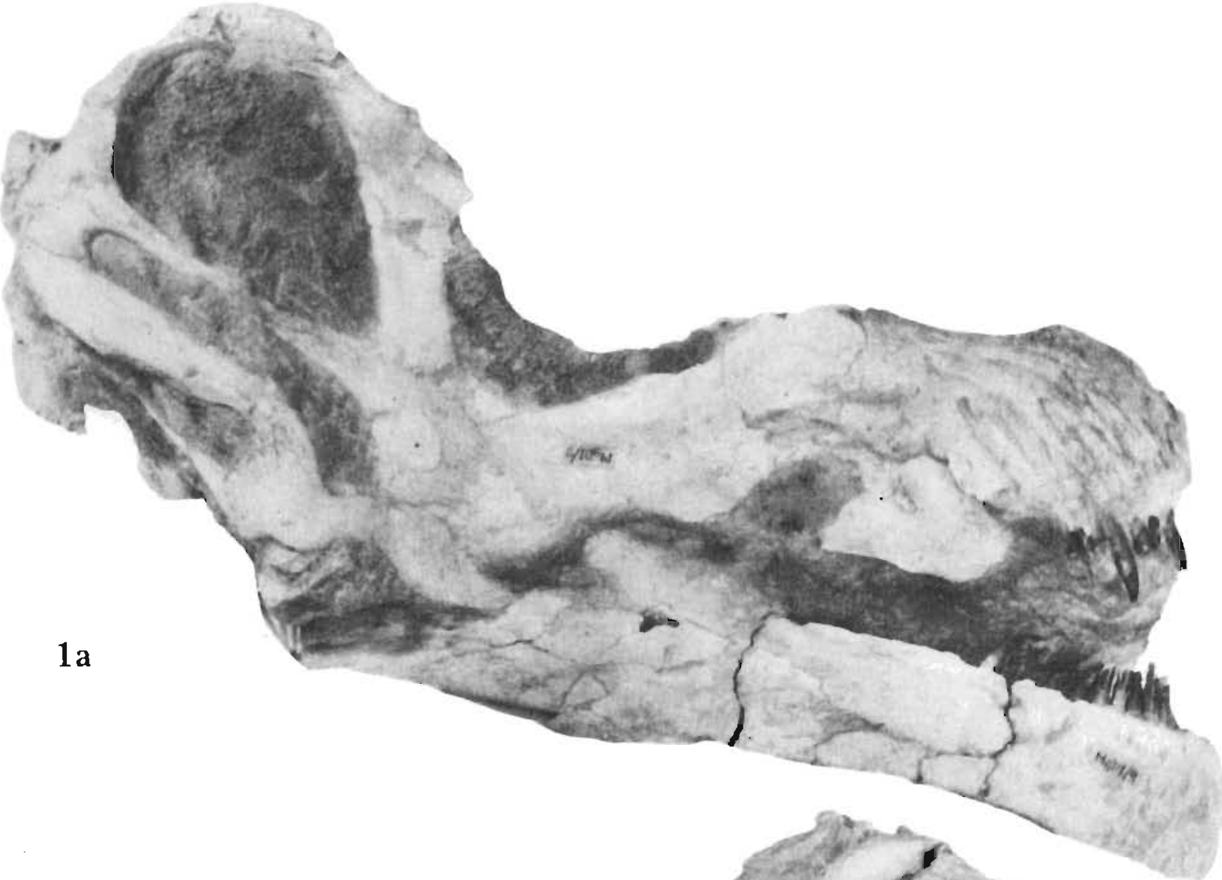
PLATE VIII

(see also Plates IX-XIV)

Upper Cretaceous, Upper Nemegt Beds, Nemegt, Nemegt Basin, Gobi Desert, Mongolia. Type specimen (Z. Pal. No. MgD-I/9).

Fig. 1*a*. The skull before the final preparation in right lateral view; ×0.25.
Fig. 1*b*. The same in left lateral view; ×0.25.

Photo: W. Skarżyński



1a

1b

A. NOWIŃSKI: NEMEGTOSAURUS MONGOLIENSIS N. GEN., N. SP.

A. NOWIŃSKI: *NEMEGTOSAURUS MONGOLIENSIS* N. GEN., N. SP.

PLATE IX

(see also Plates VIII and X-XIV)

Upper Cretaceous, Upper Nemegt Beds, Nemegt, Nemegt Basin, Gobi Desert, Mongolia. Type specimen (Z. Pal. No. MgD-I/9).

Fig. 1*a*. The skull without mandible in right lateral view. Dorsal portion of the skull (upper ramus of the maxilla and posterior part of the premaxilla) is not preserved; ×0.4.

Fig. 1*b*. The right lower jaw in lateral view. Posterior portion of the jaw (posterior part of the surangular) is not preserved; ×0.4.

Photo: W. Skarżyński

A. NOWIŃSKI: NEMEGTOSAURUS MONGOLIENSIS N. GEN., N. SP.

A. NOWIŃSKI: *NEMEGTOSAURUS MONGOLIENSIS* N. GEN., N. SP.

PLATE X

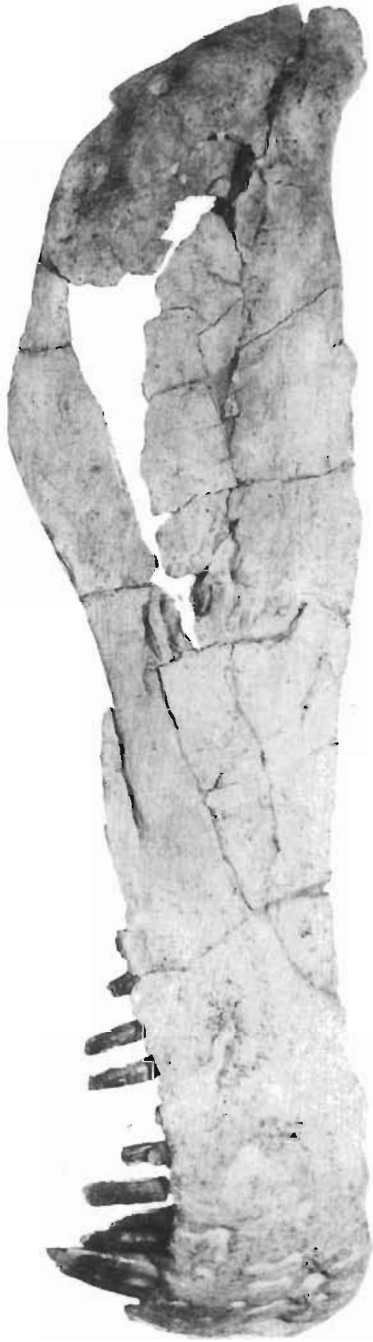
(see also Plates VIII, IX and XI-XIV)

Upper Cretaceous. Upper Nemegt Beds, Nemegt, Nemegt Basin, Gobi Desert, Mongolia. Type specimen (Z. Pal.. No. MgD-I/9).

Fig. 1*a*. The skull in dorsal view; ×0.4.
Fig. 1*b*. The left lower jaw in lateral view; ×0.4.

Photo: W. Skarżyński

1a



1b

A. Nowiński: *Nemegtosaurus mongoliensis* n. gen., n. sp.

A. NOWIŃSKI: *NEMEGTOSAURUS MONGOLIENSIS* N. GEN., N. SP.

PLATE XI

(see also Plates VIII-X and XII-XIV)

Upper Cretaceous, Upper Nemegt Beds, Nemegt, Nemegt Basin, Gobi Desert, Mongolia. Type specimen (Z. Pal. No. MgD-I/9.

Fig. 1. Stereo-photograph of the snout, in palatal view; ×0.25.

Fig. 2*a*. Right and left premaxilla in anterior view. As a result of lateral compression of the skull, the right premaxilla overlaps the left premaxilla; ×0.5.

Fig. 2*b*. The same, in palatal view; ×0.5.

Fig. 3. The left maxilla, in palatal view; ×0.5.

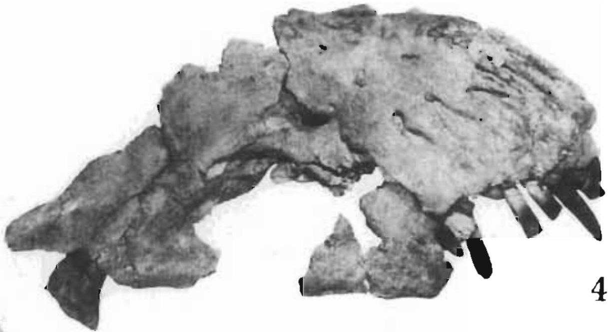
Fig. 4. The right maxilla, in lateral view. The dental margin and the postdental margin of the maxilla are partly destroyed; ×0.25.

Photo: W. Skarżyński

1

2a

3



4

2b

A. Nowiński: Nemegtosaurus mongoliensis n. gen., n. sp.

A. NOWIŃSKI: *NEMEGTOSAURUS MONGOLIENSIS* N. GEN., N. SP.

PLATE XII

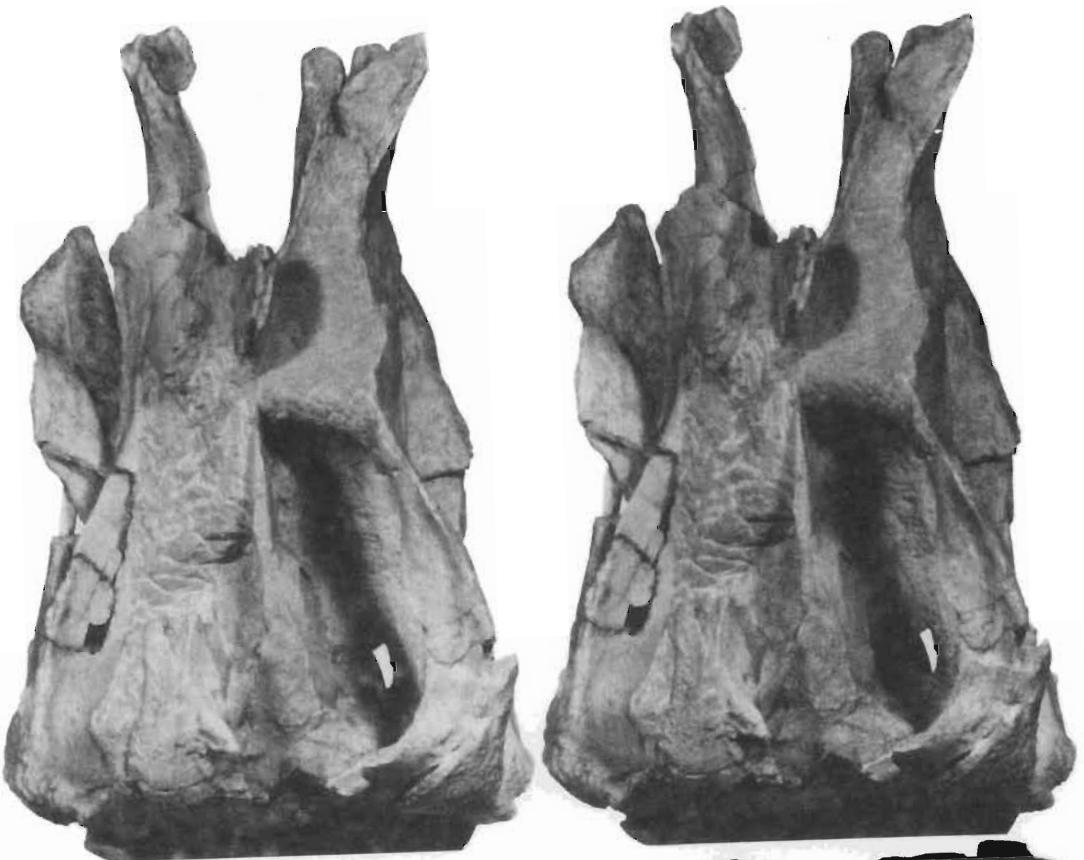
(see also Plates VIII-XI and XIII, XIV)

Upper Cretaceous, Upper Nemegt Beds, Nemegt, Nemegt Basin, Gobi Desert, Mongolia. Type specimen (Z. Pal. No. MgD-I/9).

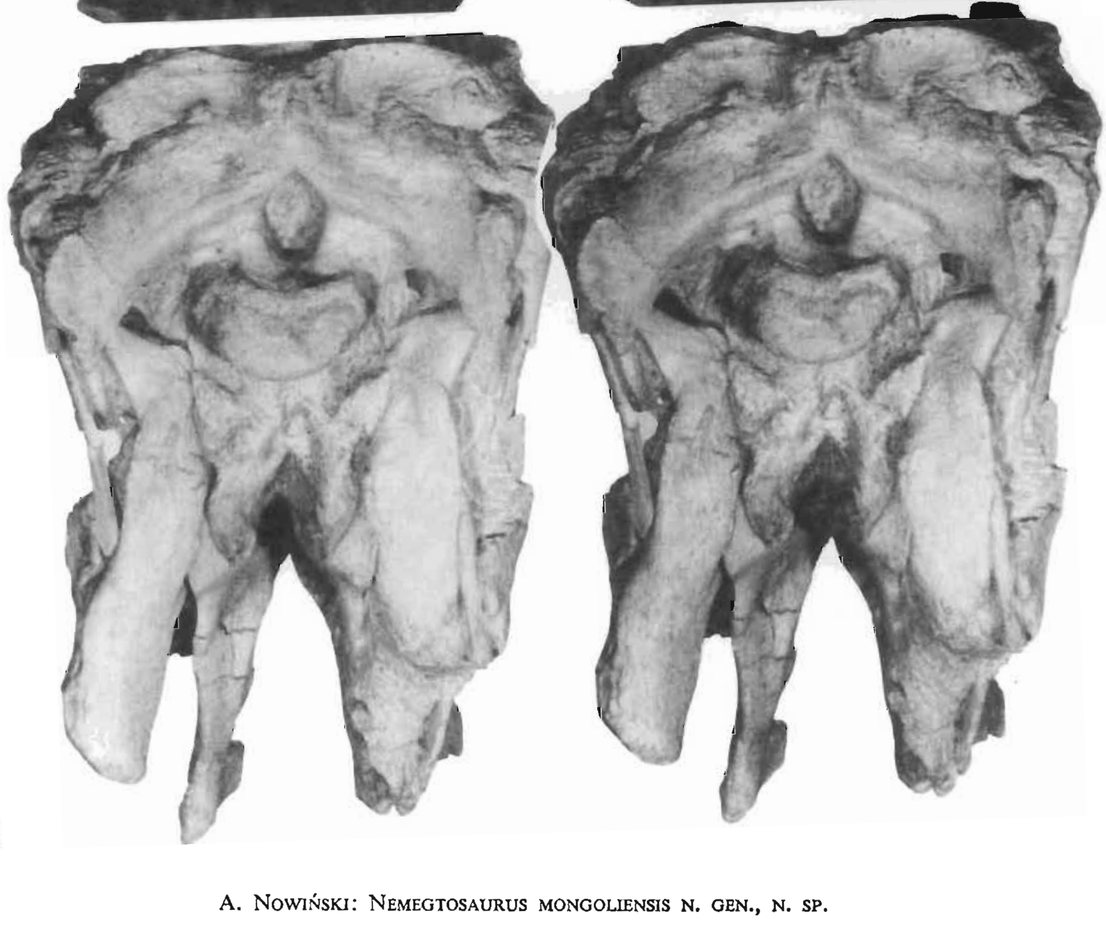
Fig. 1. Stereo-photograph of the posterior part of the skull, in dorsal view. The left lacrimal and dorsal part of the laterosphenoid, parasphenoid and presphenoid are partly destroyed; ×0.33.

Fig. 2. Stereo-photograph of the occipital region of the skull, in posteroventral view; ×0.33.

Photo: W. Skarżyński



1



2

A. Nowiński: Nemegtosaurus mongoliensis n. gen., n. sp.

A. NOWIŃSKI: *NEMEGTOSAURUS MONGOLIENSIS* N. GEN., N. SP.

PLATE XIII

(see also Plates VIII-XII and XIV)

Upper Cretaceous, Upper Nemegt Beds, Nemegt, Nemegt Basin, Gobi Desert, Mongolia. Type specimen (Z. Pal. No. MgD-I/9).

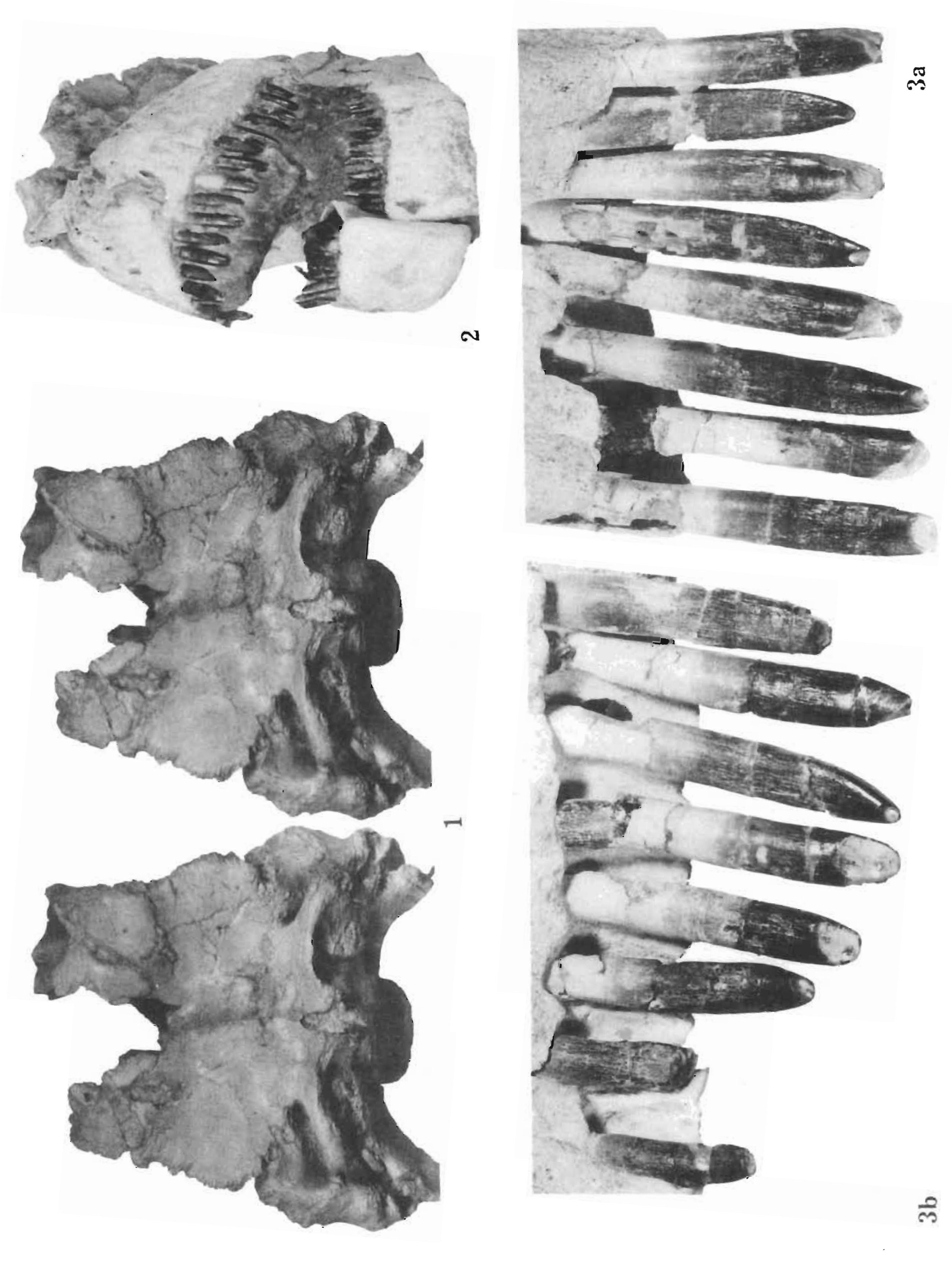
Fig. 1. Stereo-photograph of the cranial roof in posterodorsal view. Central part of the nasals is partly destroyed; ×0.33.

Fig. 2. The skull before the final preparation, in anterior view; ×0.25.

Fig. 3*a*. The teeth of the right and left premaxilla, in lingual view; ×1.

Fig. 3*b*. The teeth of the left maxilla, in lingual view; ×1.

Photo: W. Skarżyński



A. NOWIŃSKI: NEMEGTOSAURUS MONGOLIENSIS N. GEN., N. SP.

A. NOWIŃSKI: *NEMEGTOSAURUS MONGOLIENSIS* N. GEN., N. SP.

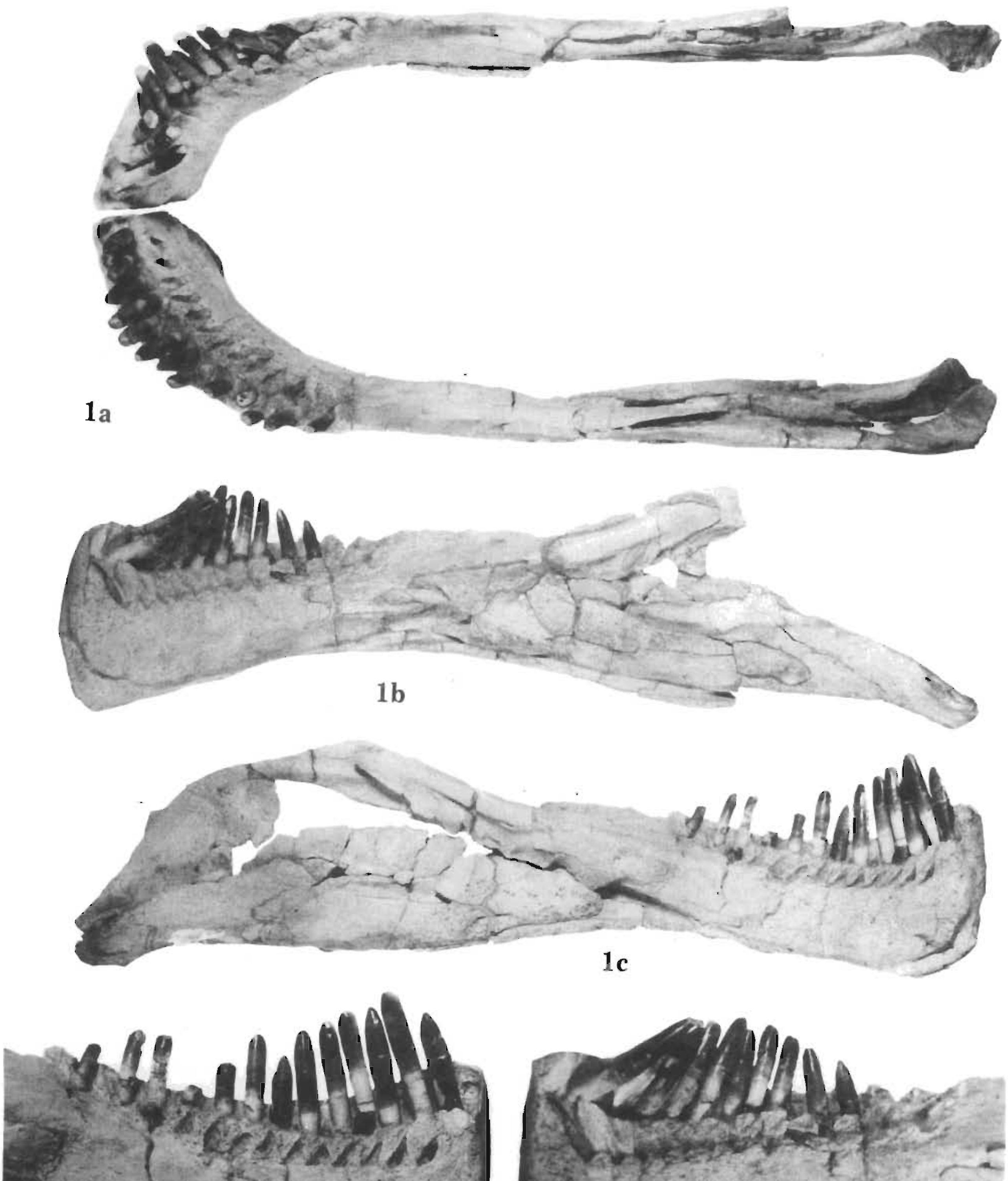
PLATE XIV

(see also Plates VIII-XIII)

Upper Cretaceous. Upper Nemegt Beds, Nemegt, Nemegt Basin, Gobi Desert, Mongolia. Type specimen (Z. Pal. No. MgD-I/9).

Fig. 1*a*. The lower jaws in dorsal view; ×0.33.
Fig. 1*b*. The right lower jaw in lingual view; ×0.33.
Fig. 1*c*. The left lower jaw in lingual view; ×0.33.
Fig. 1*d*. The anterior part of the right lower jaw in the lingual view; ×0.5.
Fig. 1*e*. The anterior part of the left lower jaw in lingual view; ×0.5.

Photo: W. Skarżyński



A. Nowiński: Nemegtosaurus mongoliensis n. gen., n. sp.