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A NEW DINOSAUR, *GALLIMIMUS BULLATUS* N. GEN., N. SP.
(ORNITHOMIMIDAE) FROM THE UPPER CRETACEOUS
OF MONGOLIA

(Plates XXIX-LIII)

Abstract. — A detailed anatomic description of a new genus and species *Gallimimus bullatus* (Ornithomimidae) from the Upper Nemegt Beds, Gobi Desert, Mongolia, is presented; a peculiar, bulbous development of the parasphenoid is described. The dinosaurian assemblages of the Upper Nemegt Beds, Edmonton Formation and Oldman Formation are compared.

INTRODUCTION

Skeletal remains of ornithomimids are relatively abundant among the dinosaurs in the Upper Cretaceous, Upper Nemegt Beds (GRADZIŃSKI *et al.*, 1968/69) of the Nemegt Basin, Gobi Desert, Mongolian People's Republic. The bulk of this material is represented by one species described here as *Gallimimus bullatus* n. gen., n. sp. However, some skeletal fragments, e. g. claws, metatarsals, vertebrae, most probably belonging to other representatives of the Ornithomimidae, were also found. The Polish-Mongolian Palaeontological Expeditions (KIELAN-JAWOROWSKA & DOVCHIN, 1968/69; KIELAN-JAWOROWSKA & BARSBOLD, 1972) collected three nearly complete skeletons, two of them with skulls, as well as many fragments of skeletons of *G. bullatus*. This material comes from localities within the Nemegt Basin: Nemegt, Tsagan Khushu, Altan Ula IV and Naran Bulak. Furthermore, the Mongolian Palaeontological Expedition in 1967 found in Bugeen Tsav (outside the Nemegt Basin, about 60 km NNW of the outcrop in Altan Ula IV) a small skeleton with a skull, lacking the forelimbs. All these skeletons are of different sizes, the skull of the smallest individual measuring 133 mm, while that of the largest is 320 mm. This material is the most complete and the best preserved of all ornithomimids hitherto described, it allowed us to give a detailed description of the skull and skeleton and to make certain observations concerning growth changes.

In two of the known skulls of *Gallimimus bullatus*, a strange bulbous structure is present, which is hollowed and formed by the parasphenoid. It opens broadly on the base of the skull, the opening presumably representing Rathke's pouch. No such structure has ever been noted in any reptile, but it is also present in the yet undescribed skull which is assigned to *Sauornithoides* sp. from the Upper Nemegt Beds in Bugeen Tsav, Gobi Desert and housed in the Geological Institute of the Mongolian Academy of Sciences in Ulan Bator.

Our present knowledge of the dinosaur assemblage in the Upper Nemegt Beds enables us to compare it with the dinosaur assemblage known in North America from the Oldman

and Edmonton (members A and B) Formations. The forms common (on the generic or family level) to the Oldman Formation and the Upper Nemegt Beds are: *Dyoplosaurus* PARKS, 1924, Pachycephalosauridae STERNBERG, 1945, Ornithomimidae MARSH, 1890, Troödontidae *sensu* RUSSELL, 1948, *Stenonychosaurus* STERNBERG, 1932 in North America, and *Saurornithoides* OSBORN, 1924 in Mongolia) and Tyrannosauridae OSBORN, 1907. The forms common to the Edmonton Formation and the Upper Nemegt Beds are: *Saurolophus* BROWN, 1912, Pachycephalosauridae, Ornithomimidae and Tyrannosauridae. According to the unpublished data (personal communication from dr D. A. RUSSELL) the dinosaurian assemblage from the Oldman Formation may be of the early Upper Campanian age, and this from the Edmonton Formation (members A and B) of the late Upper Campanian and Lower Maastrichtian age. Thus, it is also possible that the Upper Nemegt Beds are not younger than the Lower Maastrichtian. Among the dinosaurs reported from the formations mentioned in North America and not found so far in the Upper Nemegt Beds are: Ceratopsidae MARSH, 1888 and Hypsilophodontidae DOLLO, 1882. On the other hand, in the Upper Nemegt Beds a representative of the Atlantosauridae MARSH, 1877 (*Nemegtosaurus* NOWIŃSKI, 1971) and Deinocheiridae OSMÓLSKA & RONIEWICZ, 1970 (*Deinocheirus* OSMÓLSKA & RONIEWICZ, 1970) were found, which have not been reported to date in the formations mentioned in North America.

The only representative of the Ornithomimidae s. s. known to date from Asia is *Archaeornithomimus asiaticus* (GILMORE, 1933) from Iren Dabasu, Inner Mongolia. Its stratigraphic position is lower than that of *Gallimimus bullatus*.

The family Ornithomimidae was established by MARSH (1890), who assigned here one genus — *Ornithomimus* MARSH, 1890 with three species, which were based on the fragments of postcranial skeletons. In 1917, OSBORN added a new genus *Struthiomimus*, based on a perfectly preserved skeleton with skull. Later, GILMORE (1920, 1933), PARKS (1926, 1928, 1933) and STERNBERG (1933) described a few new ornithomimid species from North America and Asia, assigning them either to *Ornithomimus* or to *Struthiomimus*. Their materials were not of uniform worth from a systematic point of view containing different postcranial bones, and only exceptionally complete skeletons with skulls. For some time *Struthiomimus* was regarded as a younger synonym of *Ornithomimus* (e. g. ROMER, 1956, 1966; MALEYEV, 1964). Recently RUSSELL (1972) revised the species hitherto assigned to the two genera mentioned above, excluding some species and establishing new genera for them: *Dromiceiomimus* RUSSELL, 1972 and *Archaeornithomimus* RUSSELL, 1972, accepting, at the same time, *Struthiomimus* and *Ornithomimus* as separate genera. RUSSELL's (1972) diagnosis of the family Ornithomimidae is based on „the Late Cretaceous ornithomimids” (i. e. four genera mentioned above), though he does not state clearly whether or not he considers them as the only components of the family. According to us, the Ornithomimidae should be limited to five genera: *Ornithomimus* MARSH, *Struthiomimus* OSBORN, *Dromiceiomimus* RUSSELL, *Archaeornithomimus* RUSSELL and *Gallimimus* n. gen. The range of this family, proposed recently by ROMER (1966), seems too broad, including besides Ornithomimidae s. s.: *Betasuchus* HUENE, 1933; *Ornithomimoides* HUENE, 1933, *Oviraptor* OSBORN, 1924, *Macrophalangia* STERNBERG, 1932, *Chirostenotes* GILMORE, 1924. However, the assignment to the two first genera to the family Ornithomimidae is highly questionable, their being based on a damaged femur (*Betasuchus*) or several dorsals and a phalanx (*Ornithomimoides*), thus on systematically insufficient material. As far as the genus *Oviraptor* is concerned, the structure of its skull, strongly deviating from the typical ornithomimid pattern, excludes it from this family. According to RUSSELL (1972, table I), the hind limbs of *Macrophalangia* are not characteristic of the family Ornithomimidae.

The previous descriptions of the ornithomimid species are brief, illustrations few and generally insufficient, which makes comparison with the new species described here difficult. Moreover, the majority of specimens hitherto described are fragmentary, thus only certain bones of individuals representing different species, not complete skeletons, could be compared. Occasionally, adequate ornithomimid material are lacking, comparisons have been made with other, non-ornithomimid theropods, which fact implies a functional rather than phyletic relationship.

The material of *Gallimimus bullatus* n. sp. described here is housed in the Geological Institute, Academy of Sciences of the Mongolian People's Republic, Ulan Bator (G. I.) and in the Palaeozoological Institute, Polish Academy of Sciences, Warsaw (Z.Pal.). Furthermore, some material of this species is known to be stored in the Palaeontological Museum, Academy of Sciences of the USSR, Moscow, but was not referred to in this paper.

We are extremely grateful to Dr. DALE RUSSELL (National Museum of Canada, Ottawa), who generously made available to us his unpublished manuscript on ornithomimids. Dr. RUSSELL also helped in the interpretation of certain cranial elements, critically read the manuscript and gave his most valuable suggestions. We would like to express our sincere thanks to Mrs. JOANNA SKARŻYŃSKA for her patient and skilful preparation of the skulls of *Gallimimus bullatus*; thanks are also due to Mr. WOJCIECH SKARŻYŃSKI for his photographs and to Mrs. KRYSZYNA BUDZYŃSKA and Mrs. DANUTA SŁAWIK for their drawings (all of the Palaeozoological Institute, Polish Academy of Sciences, Warsaw).

DESCRIPTIONS

Order SAURISCHIA

Suborder THEROPODA

Infraorder COELUROSAURIA

Family ORNITHOMIMIDAE MARSH 1890, emend. RUSSELL 1972

Genus **GALLIMIMUS** nov.

Type species: Gallimimus bullatus n. sp.

Derivation of the name: Lat. *Gallus* = a chicken; because of strikingly similar structure of anterior portion of neck to that in representatives of the Galliformes.

Diagnosis. — The genus is monotypic; the generic characters are those of the type species.

Stratigraphic and geographic range. — Known only from the Upper Cretaceous, Upper Nemegt Beds (Upper Campanian or Lower Maastrichtian), Gobi Desert, Mongolia.

Discussion. — See p. 134.

Gallimimus bullatus n. sp.

(Pls. XXIX-LIII; Text-figs. 1-18)

Type specimen: Nearly complete specimen with skull (G.I.No.DPS 100/11); Pl. XXIX, Fig. 3. Pls. XXXI-XXXVI, Text-Figs. 2, 3A-C, 4-8, 11, 12B-D, 13, 14, 16A, B, 17).

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

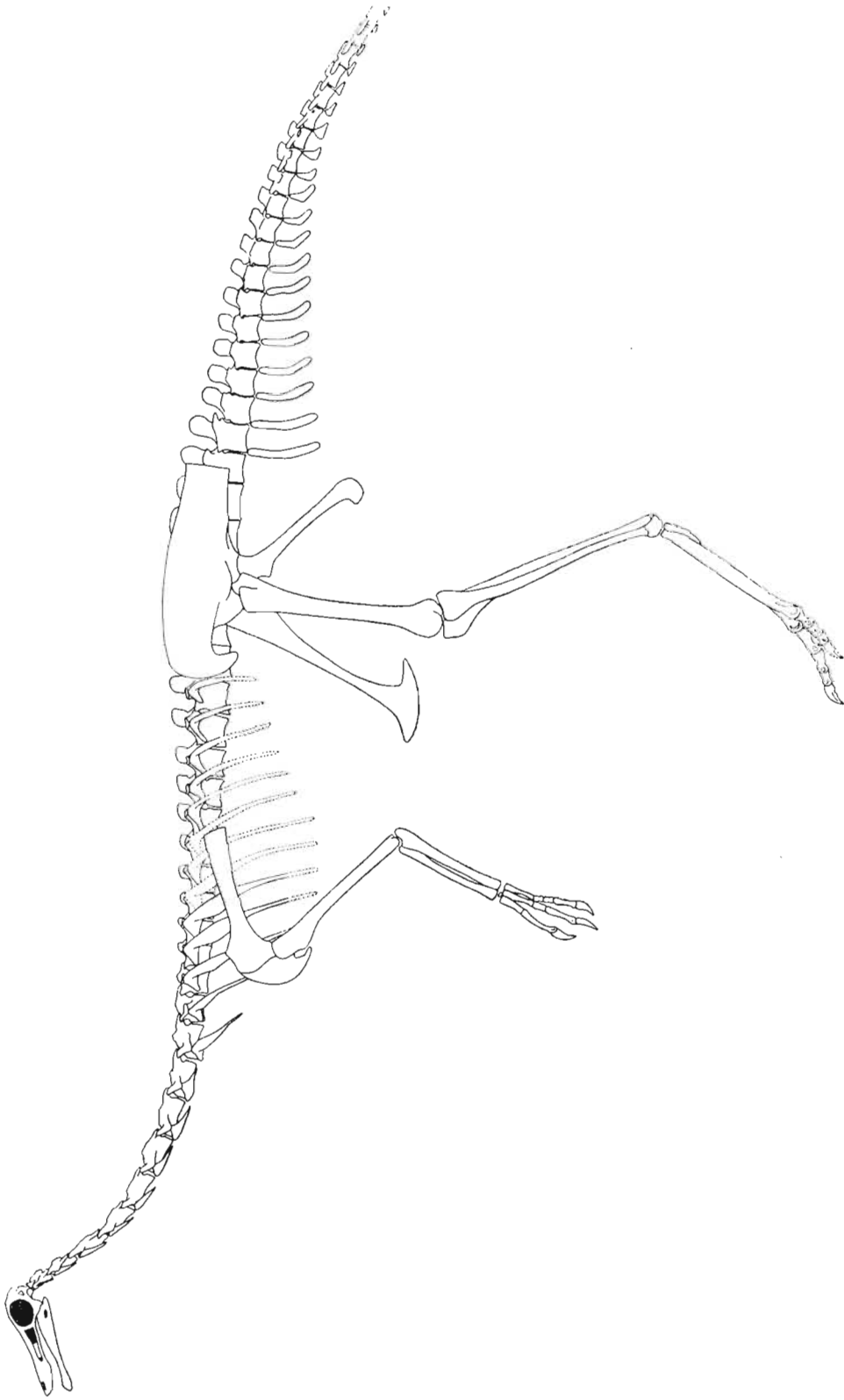


Fig. 1
Gallinimus bullatus n. sp.

Reconstruction of the skeleton based on specimens Z.Pal.No.Mg.D-1/94 and G.I.No.DPS 100/11

Type locality: Tsagan Khushu, Nemegt Basin, Gobi Desert, Mongolian People's Republic.

Derivation of the name: Lat. *bulla* = the capsule of gold worn on the neck by young boys of noble Roman families; because of the unusual capsule occurring in the skull base.

Diagnosis. — Species of large size, with very long snout, broad and flattened dorso-ventrally at the tip. Infratemporal fossa subtriangular, jugal being excluded from its borders. Common exit for third and fourth nerves merges with the optic fissure. Lower jaw shovel-like anteriorly, with elongated external mandibular fenestra. Length of presacral vertebral column equal combined length of femur, tibia-astragalus and third metatarsal. Posterior width of anteriormost fifteen caudal centra greater than half of central length. Transition point¹ between caudals 15 and 16. Humerus longer than scapula. Manus equal about a quarter of total forelimb length. Ungual of digit III shorter than the penultimate phalanx of digit III. Metatarsus more than 70% of crural length; metatarsal II equal 97% of length of metatarsal IV. Pedal digit III equal a third of crural length.

Material. — Type specimen; G.I.No.DPS 100/11 almost complete skeleton with skull and mandible from the Upper Nemegt Beds of Tsagan Khushu; brain case well preserved, the snout somewhat distorted, lower jaw incomplete; vertebral column represented by: comparatively well preserved cervicals 1—4 and incomplete cervicals 6, 7, ?8, 10, fragments of the centra of dorsals 11, 12, ?13, 17—23, centra of five sacrals, nearly complete series of 38 caudals (caudal 27 lacking, the proximal caudals represented by the centra only); fragments of the cervical ribs fused to vertebrae, some fragments of the dorsal ribs and haemal arches; pectoral girdle complete with slightly damaged scapulae and coracoids; forelimbs almost complete, the right radius lacking the proximal end; carpal bones mostly lacking and only radiale of the right manus preserved; unguis of the first digit and the second phalanx of the second digit of the left manus lacking their distal parts; pelvic girdle incomplete, part of the iliac blades lacking as well as part of the shaft of the ischium; hind limbs almost complete but left femur damaged, proximal and distal ends of the right femur lacking as well as the metatarsal V and the unguis of the third digit of the right pes; in left pes phalanx II of the second digit, phalanx III and unguis of the third digit, unguis of the fourth digit are not preserved.

Z.Pal.No.Mg.D-1/1 — fragmentary skeleton with skull and mandible from the Upper Nemegt Beds in Tsagan Khushu; skull crushed, brain case comparatively well preserved, basis cranii somewhat crushed, snout lacking the very tip; vertebral column includes: somewhat damaged cervicals 2—10, several centra of unidentified dorsals, sacrals 2—5 and complete series of 36 caudals; some fragmentary cervical ribs fused with vertebrae; dorsal ribs fragmentary and mostly not preserved, several haemal arches in the proximal and medial part of the tail preserved; pectoral girdle and forelimbs fragmentary; pelvic girdle nearly complete lacking antilium and with slightly damaged pubis; left hind limb very incomplete; right hind limb complete, with a somewhat damaged femur, fibula lacking the distal end, metatarsal V lacking, metatarsal III damaged distally; in pes unguis of the second digit, the whole third digit, phalanx I and unguis of the fourth digit not preserved.

Z.Pal.No.Mg.D-1/7 — centra of sacrals 2—5, fragmentary pelvic girdle from the Upper Nemegt Beds of Nemegt.

Z.Pal.No.Mg.D-1/8 — centra of three dorsals, fragmentary six proximal caudals, left humerus lacking the distal end, incomplete hind limb from the Upper Nemegt Beds of Nemegt.

¹ See foot-note 2 on p. 122.

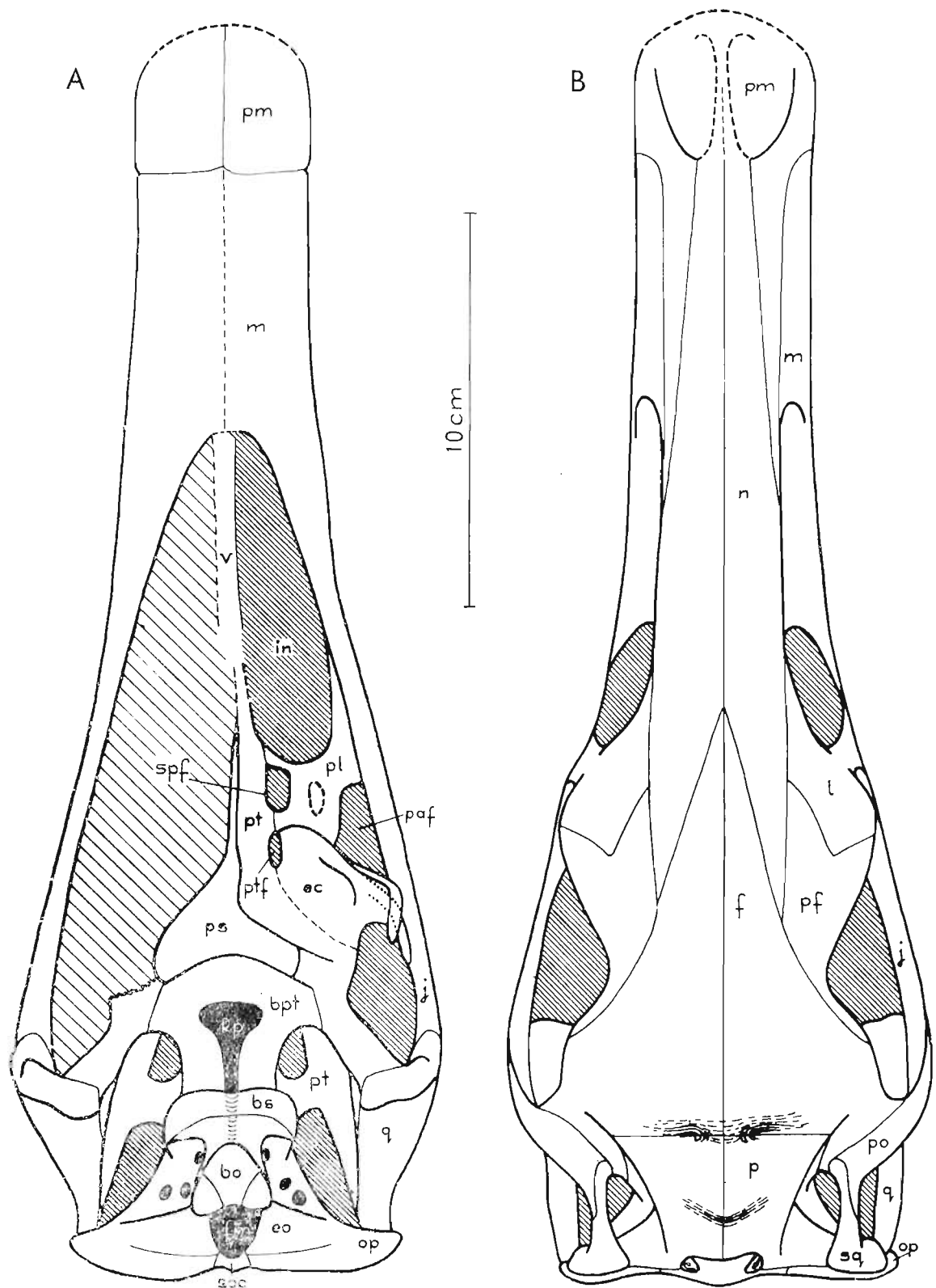


Fig. 2 *Gallinimus bullatus* n. sp.

Restoration of the skull based on type specimen (G.I.No.DPS 100/11): *A* — palatal view. *B* — dorsal view. Abbreviations: *a* — angular, *ar* — articular, *ob* — basioccipital, *bpt* — basipterygoid process, *bs* — basisphenoid, *bt* — basal tuber, *c* — coronoid, *co* — occipital condyle, *d* — dentary, *e* — epipterygoid, *?e* — supposed site of the epipterygoid, *ec* — ectopterygid, *eo* — exoccipital, *f* — frontal, *fo* — fenestra ovalis, *fr* — fenestra rotunda, *fm* — foramen magnum, *ic* — internal carotid, *in* — internal nares, *j* — jugal, *l* — lacrimal, *ls* — laterosphenoid, *m* — maxilla, *n* — nasal, *op* — opisthotic, *p* — parietal, *pa* — palatal artery, *paf* — palatine fenestra, *pf* — prefrontal, *pitf* — pituitary fossa, *pl* — palatine, *pm* — premaxilla, *po* — postorbital, *pps* — parasphenoid process, *pr* — prootic, *pt* — pterygoid, *ptf* — pterygoid fenestra, *ps* — parasphenoid, *q* — quadrate, *qj* — quadratojugal, *Rp* — Rathke's pouch, *sa* — surangular, *si* — sinus, *sif* — foramen leading to the sinus system, *soc* — supraoccipital, *sp* — splenial, *spf* — subsidiary palatine fenestra, *sq* — squamosal, *v* — vomer, *I-XII* — exits of cranial nerves.

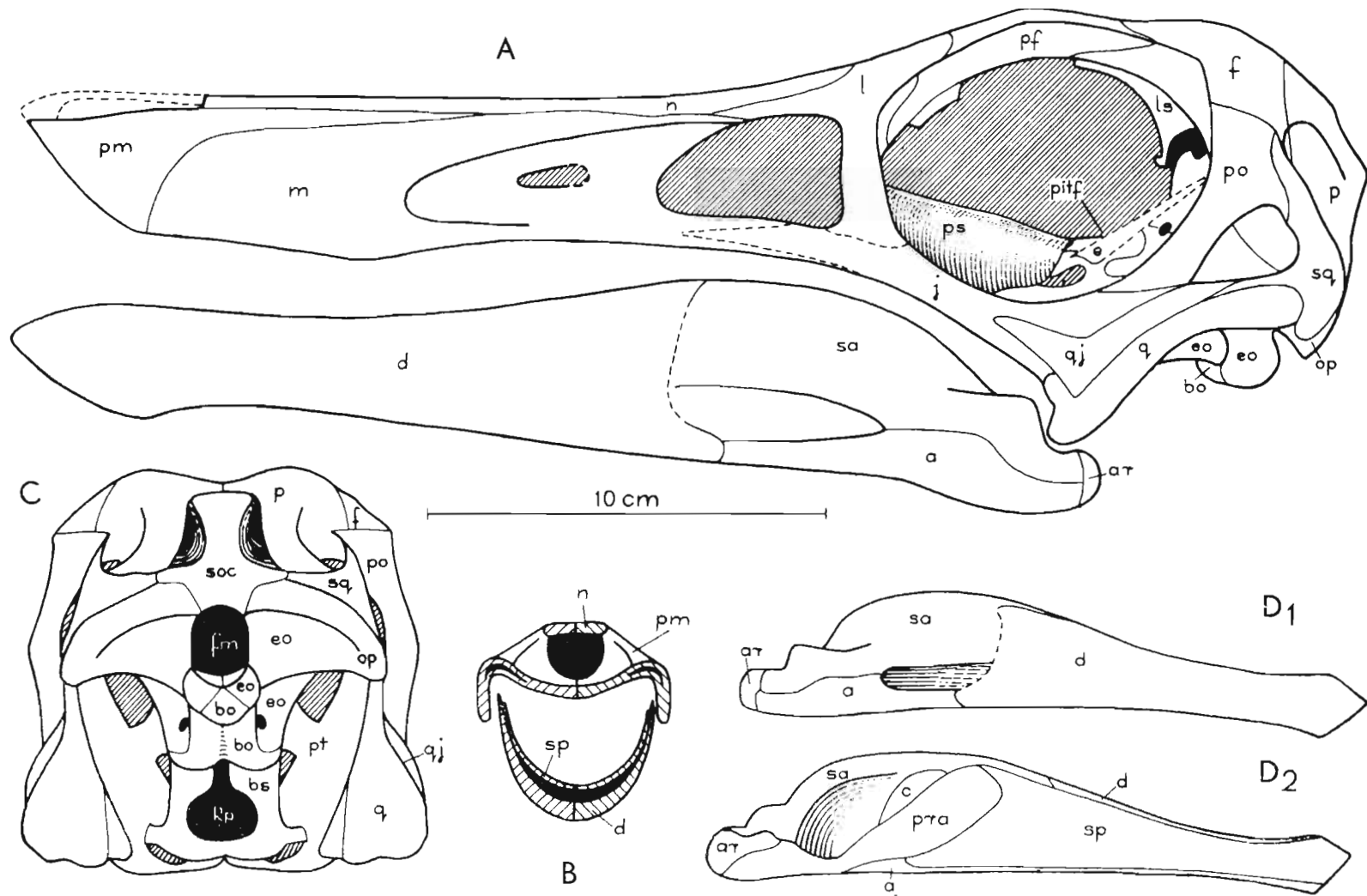


Fig. 3

Gallimimus bullatus n. sp.

A - Restoration of the skull and mandible, lateral view; B - section across distal part of snout and mandible; C - occipital view of the skull, based on type specimen (G.I.No.DPS 100/11); D - mandible in: lateral (1) and medial (2) views (Z.Pal.No.Mg.D-1/1); abbreviations as in Fig. 2.

Z.Pal.No.Mg.D-1/10 — two fragmentary sacrals, fifteen proximal caudals, fragments of the left and right pes from the Upper Nemegt Beds of Tsagan Khushu.

Z.Pal.No.Mg.D-1/11 — 5 fragmentary dorsals from the Upper Nemegt Beds of Nemegt.

Z.Pal.No.Mg.D-1/15 — fragment of right tibia, two fragments of vertebrae from the Upper Nemegt Beds of Nemegt.

Z.Pal.No.Mg.D-1/24 — almost complete left metatarsus and pes, only distal end of phalanx I of the second digit and phalanx IV of the fourth digit lacking; from the Upper Nemegt Beds of Tsagan Khushu.

Z.Pal.No.Mg.D-1/32 — fragmentary: pectoral girdle, forelimbs, hind limbs, fragments of various skeletal parts from the Upper Nemegt Beds of Altan Ula IV.

Z.Pal.No.Mg.D-1/33 — fragments of left hind limb, 10 caudals, other skeletal fragments from the Upper Nemegt Beds of Tsagan Khushu.

Z.Pal.No.Mg.D-1/39 — four vertebrae from the cervico-dorsal region (9, 10, 12, 13) and distal part of the tail consisting of 17 caudals, from the Upper Nemegt Beds of Nemegt.

Z.Pal.No.Mg.D-1/74 — fragmentary right femur from the Upper Nemegt Beds of Altan Ula IV.

Z.Pal.No.Mg.D-1/77 — fragmentary pectoral girdle from the Upper Nemegt Beds of Nemegt.

Z.Pal.No.Mg.D-1/78 — damaged right tibia, one caudal and fragments of iliac blade from the Upper Nemegt Beds of Naran Bulak.

Z.Pal.No.Mg.D-1/94 — nearly complete skeleton, lacking: the skull, atlas, distal portion of the tail, pectoral girdle as well as forelimbs, of which only right ulno-radius with the proximal half of the metacarpus preserved; in left hind limb metatarsus damaged; from the Upper Nemegt Beds of Nemegt.

G.I.No.DPS 100/10 — almost complete skeleton with skull, lacking the pectoral girdle and forelimbs, as well as some vertebrae and ribs, from the Upper Nemegt Beds of Bugeen Tsav.

Additionally, numerous single bones: fragments of the limb bones, vertebrae, phalanges, unguals, metacarpals, and metatarsals housed under the numbers Z.Pal.Nos.Mg.D-1/: 14, 17, 18, 20, 51, 55, 58, 73, 75 from the Upper Nemegt Beds of different localities within the Nemegt Basin.

Dimensions — see Tables 1—5.

Description. — **Skull.** The present description is based on three skulls of *Gallimimus bullatus* n. sp. (Z.Pal.No.Mg.D-1/1, G.I.Nos.DPS 100/10, 100/11), which represent different growth stages (Pls. XXIX, XXX, Pl. XXXI, Fig. 1, Pl. XXXII, Fig. 1, Pls. XXXIII, XXXIV). All are well preserved, with most of the sutures recognizable. The skulls of the ornithomimids thus far described have yielded information concerning the external cranial bones, the brain case being but little known. The largest of the skulls of *G. bullatus*, that of the type specimen (G.I.No.DPS 100/11, Pl. XXIX, Fig. 3, Pl. XXXI, Fig. 1, Pl. XXXII, Fig. 1, Pls. XXXIII, XXXIV, Text-figs. 2, 3 A—C, 4—8) has this latter region particularly well preserved, thus allowing us to obtain new data. For the sake of brevity, the external and palatal elements, which in *G. bullatus* display little new as compared with other ornithomimids, are described here only when they deviate from the usual pattern. More space is devoted to a detailed description of the brain case and the base of the skull.

Because of the extensive length of the snout, the skull of *G. bullatus* is extremely long. Its temporal region is deep, the basicranial plane lies at an angle of about 30° to the palatal plane.

External cranial elements. In the posterior part of the skull roof, along the fronto-parietal suture, a pair of deep scars is developed. Further posteriorly, across the parietals, another, shallower scar is visible, which is V-shaped, with its apex directed posteriorly (Text-fig. 2B). Among the external cranial elements the squamosals, parietals, supraoccipital and their mutual relations on the posterior face of the skull are of some interest. In the posterior region of parietals (Text-fig. 3C), their lateral flanges are abruptly bent down and directed vertically, the outer surface of these latter forming the medial walls of the supratemporal fossae, overlapping with their inner surfaces the dorsal extension of the supraoccipital on both sides. There is a deep slit at the point where the two bones make contact. Postero-lateral extremities of the parietal flanges direct somewhat horizontally outwards, loosely covering the junction between the squamosals and the lateral extensions of the supraoccipital. Simultaneously the suture between the supraoccipital and the medial portions of the parietals is not firm (p. 140).

Brain case. The basioccipital and exoccipital participate to an equal degree in forming the occipital condyle (Text-fig. 3C, 4). The condylar neck is not developed. Basioccipital tubera are stout and separated by a deep furrow, which continues up to the occipital condyle. Between the condyle and the tubera, basioccipital forms a prominent platform, along the lateral edge of which runs the suture basioccipital-exoccipital. The bone is pierced by the sinuses which open on the posterior face of this platform.

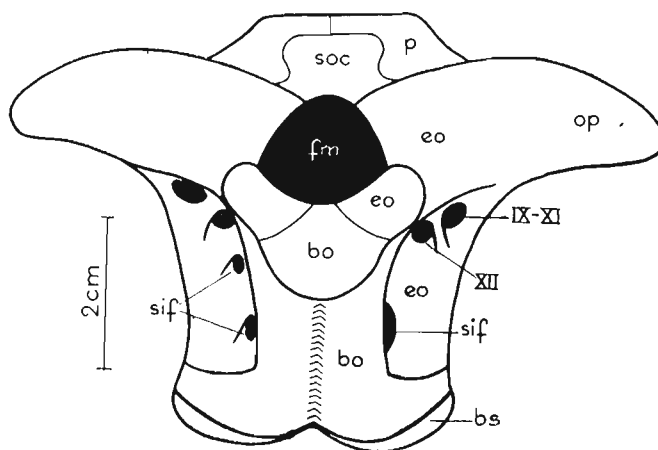


Fig. 4

Gallimimus bullatus n. sp.

Occipital region in postero-ventral view (G.I.No.DPS 100/11); abbreviations as in Fig. 2.

The exoccipital (Text-fig. 3C) is large and divided transversely into two parts by the crest forming the lower edge of the paroccipital process. Its ventral portion extends down to the basioccipital tuber, flanking the above mentioned platform of the basioccipital. The dorsal portions of the exoccipitals form the sides and bottom of the medular cavity, into which leads the subtriangular foramen magnum. Laterally, the exoccipital occupies about half of the paroccipital process, but its suture with the opisthotic is obscure. The lateral margin of the exoccipital forms a crest, which continues from the basioccipital tuber to the paroccipital process meeting the transverse crest above mentioned.

The basisphenoid (Text-figs. 5—7) is here an extensive and very complicated bone, the boundaries of which are not always clear. Viewed ventrally it invades backwards the anterior

and ventral surface of the basal tubera, while forwards it gives two separate alae surrounding a very large opening in the base of the skull, most probably homologous to Rathke's pouch (Pl. XXXII, Fig. 1, Pl. XXXII, Fig. 1 C, Text-fig. 2A). The opening is closed anteriorly by a strong transverse bar of the basisphenoid, which is prolonged laterally into relatively short basipterygoid processes. The opening above mentioned is narrow, slit-like posteriorly,

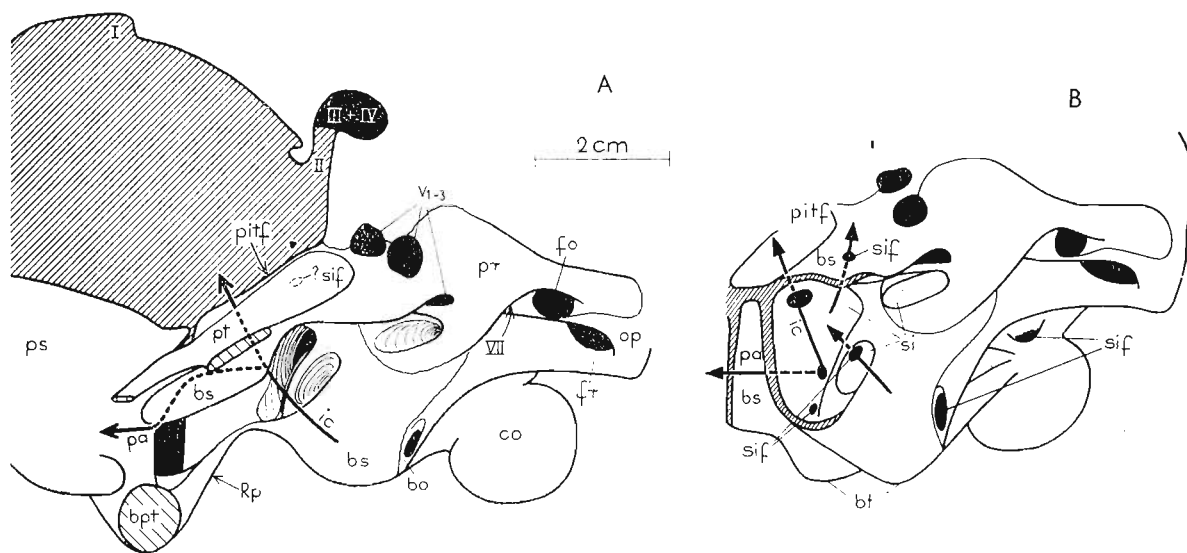


Fig. 5

Gallinimus bullatus n. sp.

Restoration of the basicranial region: A — lateral view. B — anterolateral view, based on type specimen (G.I.No. DPS 100/11); abbreviations as in Fig. 2.

but strongly broadened, subquadrangular anteriorly. It leads to a cavity inside an unusual, bulbous structure, situated above to the pterygoids (Pl. XXX, Fig. 2, Pl. XXXIII, Fig. 1a, Pl. XXXIV, Fig. 1b, Text-fig. 7). In dorsal aspect, the basisphenoid seems to extend far backwards, almost to an optic fissure (Text-fig. 6B). Its posterior portion is somewhat folded in the centre, forming the bottom and overhung flanks of the pituitary fossa.

Pituitary fossa is shallow and contains in its anterior half a pair of entrances for the carotids; medially a small pit is marked: posteriorly, on the periphery of the pituitary fossa, under the overhung folds of the basisphenoid which bound it laterally, there is a pair of slits (Text-fig. 6B) which lead to an anastomosing system of sinuses, penetrating the basisphenoid and opening also on the outer surface of its lateral wings. Laterally, the basisphenoid slopes steeply in a postero-ventral direction, contacting the prootic posteriorly; more ventrally, its thinning tongue is wedged between the opisthotic and basioccipital (Text-fig. 5). Anterior to the pituitary fossa, the basisphenoid is somewhat raised bridging above the slit-like portion of Rathke's pouch (Text-fig. 5B). In front of this basisphenoidal bridge there is a canal piercing the basis cranii vertically (Text-fig. 7A).

The „bulbous structure” is formed from the thin-walled parasphenoid (Pl. XXIX, Fig. 3, Pl. XXX, Fig. 2, Pl. XXXIV, Fig. 1b, Text-fig. 7). It is somewhat pear-shaped, gently rising forward and prolonged anteriorly into the delicate cultriform process. Postero-ventrally it abuts against the transverse basisphenoidal bar, and as a result, the basisphenoid is here covered

by a thin sheet of the parasphenoid the suture between these two bones being invisible. Laterally, the structure is connected by a pair of thin bridges to the medial edges of the descending laminae of the basisphenoid (Text-fig. 7 A). Along the lower surface of the „bulbous structure” a shallow furrow is present which faces the medial edges of the pterygoids.

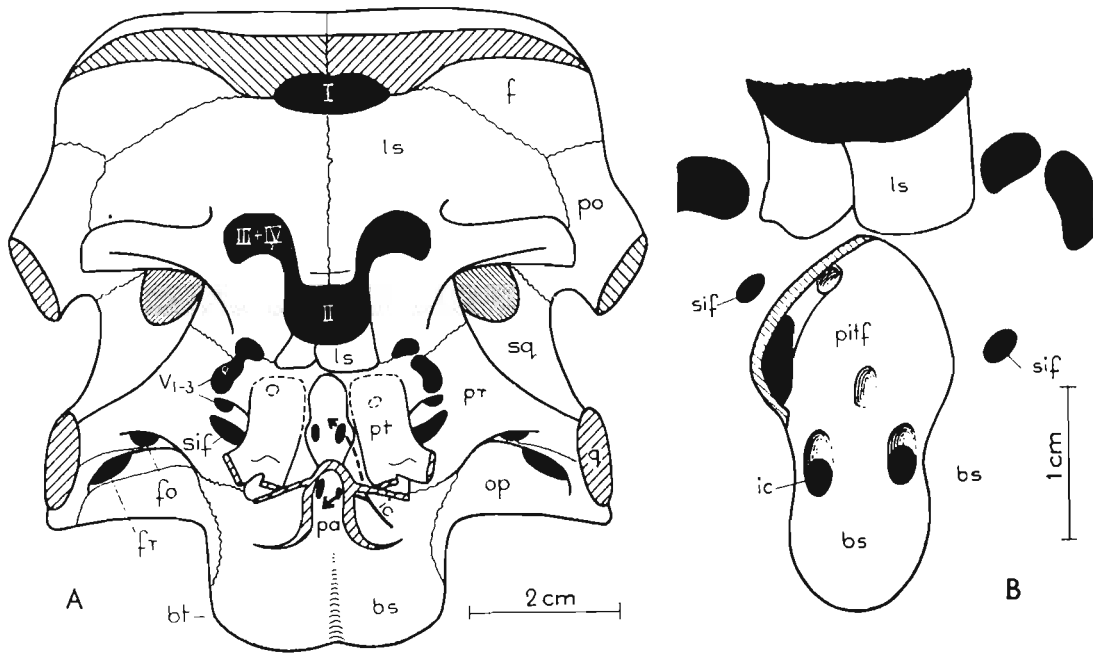


Fig. 6

Gallimimus bullatus n. sp.

A — restoration of the brain case in anterior view, B — pituitary fossa and its periphery, with the pterygoids removed, based on type specimen (G.I.No.DPS 100/11); abbreviations as in Fig. 2.

The prootic (Text-fig. 5, 6A) is suturally connected with the parietal, supraoccipital, opisthotic, basisphenoid and laterosphenoid. It is expanded antero-medially, posteriorly being developed in the form of a strong bar of bone — the paroccipital extension of the prootic. Its internal surface, exposed in one skull, is concave, the upper and lower edge contacting the lateral extension of the supraoccipital, both bones bounding a deep cavity for the dura mater invagination (p. 115). Externally, the distal end of the prootic forms a „foot” which abuts against the opisthotic. In its upper portion prootic bears a large depression placed just above the „foot” mentioned. This depression is posteriorly in contact with the cavity developed between the supraoccipital and squamosal. The antero-medial extension of the prootic contacts the basisphenoid below, above bounding an extensive sinus. There is no suture visible between the prootic and basisphenoid along the central portion of the latter, while it is very distinctly marked below and above it.

The laterosphenoid is very loosely bound to the cranial roof (p. 140). Medially, under the optic fissure its margin is developed into antero-ventral tongue which overhangs the postero-dorsal edge of the basisphenoid (Text-fig. 6). The upper wing of the laterosphenoid is mounted by a strong ridge, directed obliquely downwards, from the postorbital towards the exits of the trigeminal nerve. The groove running along this ridge and posterior to it, most

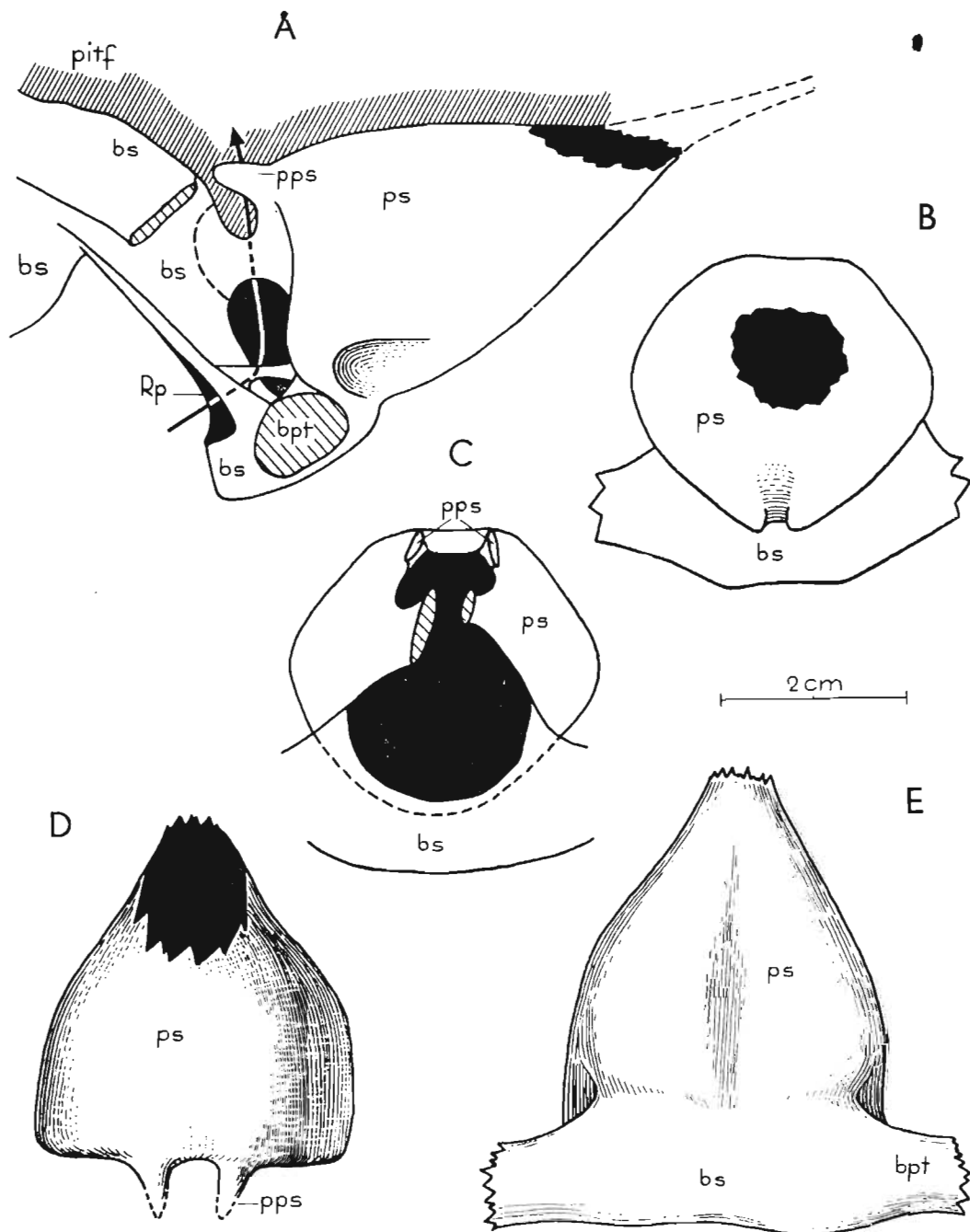


Fig. 7

Gallimimus bullatus n. sp.

Restoration of the „bulbous structure“: *A* — lateral view, *B* — anterior view, *C* — posterior view, *D* — dorsal view, *E* — ventral view, based on type specimen (G.I.No.DPS 100/11); abbreviations as in Fig. 2; arrow shows communication between Rathke's pouch and dorsal surface of the basicranial region.

probably received the dorsal extremity of the epipterygoid, the ventral extremity of the latter resting on the pterygoid.

The epipterygoid is not preserved in any skull of *G. bullatus* recovered.

The intracranial cavity was not exposed in any skull of *G. bullatus*, except posteriorly, where a pair of comparatively extensive invaginations of the dura mater is developed (p. 113), each of which being bordered medially by the supraoccipital and laterally by the prootic, the opisthotic closing at the bottom. The axis of this invagination is more or less parallel to that of the paroccipital process. Imprints of the olfactory bulbs are visible on the internal surface of the frontals close to their point of contact with the nasals. They are judged to have been comparatively large and elongate, and separated, anteriorly at least, by the interorbital septum, the bony remnant of which is preserved in this region in two skulls.

The exits for the cranial nerves could be investigated superficially only in the type specimen (Text-figs. 4B). The optic fissure, including the infundibulum exit as well, is very extensive and seems to be bounded exclusively by the laterosphenoids. It merges dorso-laterally on either side with the common exit for the third and fourth nerves, which also lays within the laterosphenoid. The exits for three branches of the fifth nerve are placed in the prootic and the prootic-laterosphenoid suture. Two of the branches, presumably ophtalmic and maxillary

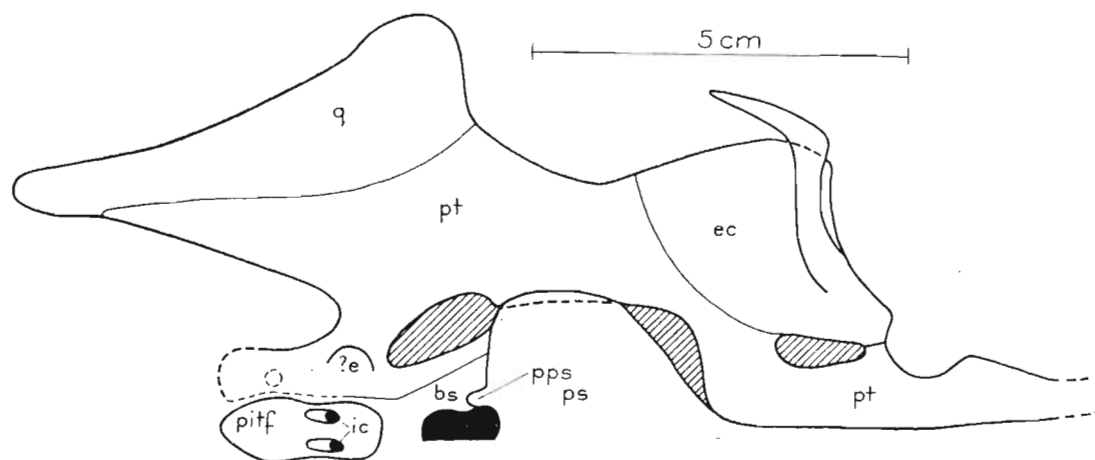


Fig. 8

Gallimimus bullatus n. sp.

Restoration of the pterygoid region in dorsal view, based on type specimen (G.I.No.DPS 100/11); abbreviations as in Fig. 2.

are close to each other, even merging together on the right side of the brain case. The third, smallest opening is suggested to be for the ramus mandibularis, because externally it gives rise to a shallow groove leading ventrally. No separate opening for the sixth nerve has been found. The seventh nerve exit is situated under the otosphenoidal crest, which bounds a broad groove dorsally. Within this groove, posterior to the nerve VII exit and somewhat above it, is located the foramen ovale, and still further back, the fenestra rotunda. The common exit for the ninth, tenth and eleventh nerves is large and pierces the exoccipital on the posterior face of the occipital region. It is located close to the occipital condyle and just under the strong transverse ridge, which forms the ventro-medial boundary of the paroccipital process. Somewhat lower and still more medially is located the smaller exit for the twelfth nerve. In addition to

the nerve exits on the occipital region, and below them are located other openings. They represent the foramina of the sinuses, which penetrate the basioccipital, and are placed close to the medial suture between the exoccipital and basioccipital.

Palatal elements (Text-fig. 2A). Within the palatal region the very large pterygoids, ectopterygoids and palatines are easily recognizable, while the vomer is only fragmentary. The internal nares are very large and shifted far backwards due to the strong development of the ventral extensions of the premaxillae and maxillae. Thus, an extensive secondary palate is developed, which seems to be the usual pattern in the Ornithomimidae.

The pterygoid is a triradiate bone (Text-fig. 8) which posteriorly exhibits two wings: a lateral wing or quadrate ramus; a medial wing or basisphenoid ramus, separated from each other by a deep notch (Text-fig. 8). The pterygoid exhibits a very long antero-medial extension, which underlies, when viewed dorsally, the frontal portion of the „bulbous structure” and nearly meets its counterpart medially. The most anterior portion of the pterygoid is unknown. Posterior to the „bulbous structure”, the pterygoid exhibits a large, elongate fenestra which is situated near the medial margin of the bone. The quadrate ramus is mostly thin, except ventrally, where it forms a buttress on the contact with the quadrate, close to the articular surface for the lower jaw. It rises almost vertically backwards, its lateral margin closely abutting the quadrate. The medial ramus of the pterygoid is horizontal, covering the basisphenoid, in a most unusual fashion, along the lateral border of the pituitary fossa. It reaches backwards almost as far as the posterior boundary of the latter structure.

The ectopterygoid (Text-fig. 8) is large; on the suture between the ectopterygoid and pterygoid a small vacuity is developed.

The palatine is a comparatively small bone (Text-fig. 2A) which exhibits a subsidiary fenestra along the suture with the pterygoid. May be another fenestra was present here as well, placed laterally to the latter, its boundary being, however, not quite clearly delimited. The maxillary portion of the palatine is narrow and projects forwards, but its contact with the maxilla seems to be rather loose (p. 140). On its dorsal surface, opposite the antorbital bar, the palatine is mounted by a vertical lamina of bone, which is concave on its surface facing the orbit. Its relation to the lacrimal is unclear.

The vomer is badly crushed and only partially visible in the form of a thin and comparatively high vertical bony lamina. Its relation to the pterygoids and palatines is unknown.

Table 1

Skull and jaw dimensions of *Gallimimus bullatus* n. sp.
(measurements in mm)

| | G.I.No.DPS 100/10 | Z.Pal.No.Mg.D-I/1 | G.I.No.DPS 100/11 |
|---|-------------------|-------------------|-------------------|
| Length of skull (premaxilla-upper end of quadrate) | .120e | .185e | .330 |
| Greatest width of skull | — | — | .115 |
| Greatest height of skull | .057e | .085 | .100 |
| Orbit height | .040 | .055 | .070 |
| Orbit length | .043 | .058 | .075 |
| Antorbital length of skull | .065 | .100 | .215 |
| Postorbital length of skull | .020 | .028 | .035 |
| Lower jaw length | .104 | .160e | .290e |

Mandible. *The lower jaw* is a delicate structure and consists of very thin bones. It is slender and shallow anteriorly but very deep posteriorly. Distally the mandible of *G. bullatus* is shovel-like, so that when both jaws were shut, there was a gap between them at the tip (Text-fig. 3A, B, D). The retroarticular process in the mandible of *G. bullatus* is strongly developed. More than half of the lower jaw consists of the dentary and splenial, the latter being very extensive, reaching anteriorly to the very symphysis (Text-fig. 3D₂). The surangular, coronoid and prearticular are developed in the usual theropod manner. The angular, as in other theropods, is developed mainly on the outer side of the mandible, but here it reaches far backwards forming a large part of the retroarticular process. The articular on the outer side of the lower jaw is covered far backwards by the surangular and angular. The external mandibular fenestra is comparatively small and elongate.

Vertebral column. The vertebral column in *G. bullatus* consists of 64—66 vertebrae, including 23 presacrals, 5 sacrals and 36—38 caudals. Vertebral centra are generally of the platycoelus type, except the proximal caudals 1—6, where the posterior articular facets are flat, and at the very end of the tail, where the vertebrae are amphiplatyan. The neural arches are separated from the centra by a suture, except in the cervicals, where the suture is weakly visible, and in the caudals where it is absent behind the transition point. Pleurocoels are present in most of the presacral centra.

Cervical vertebrae. The neck consists of 10 vertebrae, all of which, except for the atlas, are long and wide. Two sections of the neck are distinctly different in structure. The proximal cervicals (axis, 3, 4), in ventral view, exhibit subtriangular centra, which taper posteriorly, the neural arches are low, the zygapophyses short and broad. In the posterior cervicals (5—10) the neural arches gradually become higher, the zygapophyses are long and thin, while the centra more spool-like.

The atlas (Pl. LII, Fig. 1), known only in one specimen (G.I.No.DPS 100/11) is represented by an intercentrum and two halves of the neural arch. The intercentrum is 17 mm high and 28 mm wide. Its dorsal surface is incised for receiving the odontoid process of the axis. The facet for contact with the neural arch is weakly pronounced and directed postero-laterally. The facet for contact with the occipital condyle is slightly concave and faces antero-ventrally. The two halves of the neural arch are inequally developed, the right one being the stronger. The pedicel is short with indistinctly separated articular facets for the intercentrum and the occipital condyle, that for the intercentrum being the smaller. The postzygapophyseal process is stout, extending backwards and bearing a large, semioval zygapophysal facet.

The axis (Pl. XXXII, Fig. 2, Pl. XXXVIII, Fig. 1, Pl. LII, Fig. 2) exposes a long, slender platycoelic centrum and broad, low neural arch. The odontoid process is comparatively large and rounded. The axial intercentrum is rectangular, fused to the centrum. The neural arch widens sharply backwards. The prezygapophyses are small and placed near the neural canal which is very wide here. Their articular facets are very faintly marked, small, facing laterally and slightly upwards. Postzygapophyses are very prominent, directed postero-laterally and not extending beyond the posterior articular surface of the centrum. Their articular facets are larger and face ventro-posteriorly. The upper surfaces of the postzygapophyses are surmounted by comparatively low epipophyses. They do not project backwards beyond the margins of the postzygapophyseal process. The diapophyses and parapophyses are hardly discernible, while a slender rib was present and found in contact with the axis on one specimen (Z.Pal.No.Mg.D-I/2).

The postaxial cervicals (Pl. XXXVIII, Pl. XXXIX, Fig. 1, Pl. LII, Figs. 3—5) with centra longer than high, increase in length to the cervical 8, and then distinctly decrease.

The ventral surfaces of the centra are flat. The anterior ends of the centra are flattened dorso-ventrally, while the posterior ends are laterally flattened. Centra are generally platycoelic with the posterior surfaces more concave than the anterior ones. The centra of cervicals 3—5 are angled, their anterior and posterior surfaces being oblique. The pleurocoels are small, oval and situated above and somewhat posteriorly to the parapophyses. The latter are low and situated on the ventro-lateral margins of the centra. Their articular facets are subtriangular in shape and join the anterior articular surface of the centrum. Neural spines and epipophyses are weakly developed. In ventral aspect the neural arches show excavations (hapidocoels of OSTROM, 1969).

The neural spines form long, low and sharp ridges, except on the last cervicals, where they are short, somewhat widened and elevated due to the high vaulting of the top part of the neural arches. Scars of the interspinous ligaments of the last cervicals are extremely enlarged and deep, that in front of the neural spine in the form of a deep, rounded depression, while that behind the spine in the form of a deep, long groove flanked by the vertical posterior prolongations of the postzygapophyses. The zygapophyses of the postaxial cervicals are strongly developed, wide in the proximal portion of the neck, in the distal portion beginning with the cervical 5, becoming elongate. The prezygapophyses in all postaxial cervicals extend in front of the centrum, their articular surfaces being slightly convex. The ventro-lateral edges of the prezygapophyses prolong ventrally and backwards into the diapophyses. The latter are flat and broad, in cervical 3 and 4 directed downwards, in the distal portion of the neck gradually pointing more laterally. The postzygapophyses in the proximal cervicals do not extend beyond the posterior surfaces of the centra, while in the distal cervicals they are very long, reaching far onto the succeeding vertebra. Their articular surfaces are concave. The epipophyses are faintly developed as insignificant elevations on all cervicals.

Dorsal vertebrae (Pl. XXXIX, Figs. 1, 2, Pl. XL, Pl. LII, Fig. 5, Pl. LIII, Fig. 4). The dorsal portion of the vertebral column includes 13 vertebral segments. Here, the centra are platycoelic, except the last one, which is slightly amphiplatyan. The centra are spool-like, comparatively short, tending to become longer and deeper posteriorly. Transverse processes increase slightly in length (tr.) posteriorly and direct somewhat upwards, except for the proximal dorsals. They are oriented backwards up to the dorsal 8, then somewhat forwards. The pleurocoels are extensive but shallow, though still deep in the first two dorsals. The parapophyses are slightly developed. The first two dorsals bear a transitional character between the cervical and dorsal series. Cervical characters include: small deep pleurocoels located in the anterior part of the centrum; parapophyses situated on the centrum, although that of the second dorsal is in a slightly more elevated position; low neural arches with small, tuber-like neural spines; large and deep scars for the interspinous ligaments; long postzygapophyses on the first dorsal, and although those of the second are shorter they still exceed those of more posterior dorsals in length; small epipophyses; long laterally situated prezygapophyses; broad diapophyses; and the presence of three hapidocoels on the ventral surface of the diapophyses. Though exposing so many cervical features, these two dorsals differ from the cervicals in having shorter centra which bear a sharp, low keel (ventrally) and in having rounded parapophyses. Diapophyses are horizontally oriented in the first dorsal; beginning with the second dorsal they angle upwards. The successive dorsals are very alike, with low parapophyses, somewhat laterally flattened centra, narrow diapophyses strengthened ventrally by a lamina of bone. Their neural spines are prominent, in dorsals 3—5 being subtriangular and lower than in the posterior dorsals where they are subrectangular. Scars of interspinous ligaments form narrow grooves. Zygapophyses are short and located close to the sagittal axis. Pleurocoels are extensive

but shallow. The last dorsal is distinctly different from the preceding ones, having a marked transitional character to the sacral vertebrae. In its general structure it resembles other dorsals but is devoid of the articular facet for the capitulum, while that for the tuberculum, placed at the extremity of the diapophysis, adheres to the inner surface of the ilium. The posterior end of the diapophysis is shifted forwards being situated about one third the distance from the end of the centrum. This means that the dorsal 13 was devoid of any rib. The whole structure of the diapophysis of the last dorsal differs from that of other dorsals. Its posterior margin is homologous with a lamina of bone which ventrally strengthens the diapophysis of the other dorsals. The diapophysis and the neural spine are connected here by a vertical lamina which, in turn, is homologous with the true posterior margin of the diapophysis. The post-zygapophyses of the last dorsal are undeveloped and its neural arch and that of the first sacral contact each other with their opposite edges above the neural canal.

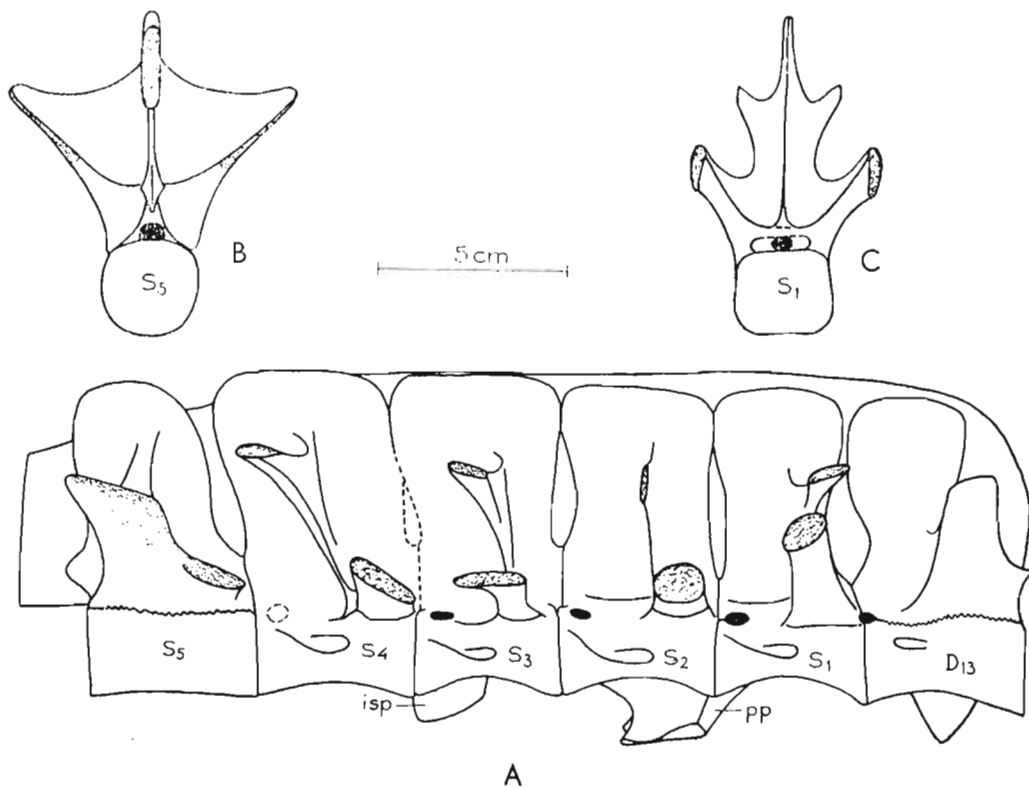


Fig. 9

Gallimimus bullatus n. sp.

A — lateral view of the sacrum (S_1 - S_5) with dorsal vertebra 13 (D_{13}) attached, ischiac (*isp*) and pubic (*pp*) peduncles of the ilium visible, *B* — fifth sacral vertebra in posterior view, *C* — first sacral vertebra in anterior view (Z.Pal.No. Mg.D-1/94).

Sacral vertebrae (Pl. XLV, Fig. 2b, Text-fig. 9). Sacrum is composed of 5 fused vertebrae of about equal length. Their centra are strong, spool-like, flattened ventrally, with comparatively deep, elongate pleurocoels (those of sacra 2 and 3 the deepest). The fifth sacral lacks a pleurocel. Sites of fusion of sacra 1—2, 2—3, 3—4 are marked ventrally by a medial

Table 2

Measurements (in mm) of the vertebral column of *Gallimimus bullatus* n. sp.

| No. | Length of centrum | | | | Width of centrum (anterior) | | | Height of centrum (anterior) | | | Greatest height overall | | |
|------------------|----------------------------|-----|-----|--------------------------|--------------------------------|-----|--------------------------|---------------------------------|----|--------------------------|------------------------------|-----|--------------------------|
| | Z.Pal.No.Mg.D-I/ 94 1 7 | | | G.I.No. DPS 100/11 | Z.Pal.No. Mg.D-I/ 94 1 | | G.I.No. DPS 100/11 | Z.Pal.No. Mg.D-I/ 94 1 | | G.I.No. DPS 100/11 | Z.Pal.No. Mg.D-I/ 94 1 | | G.I.No. DPS 100/11 |
| | 2 | 3 | 4 | | 5 | 6 | | 7 | 8 | | 9 | 10 | |
| Axis | 24 | 30e | — | 72 | 12 | — | 26 | 11 | — | 26 | 20 | 22e | 47e |
| C ₃ | 35 | 48 | — | — | 15 | 18 | — | — | — | — | 16 | 23 | — |
| C ₄ | 41 | — | — | 115e | 16 | 15 | 36e | 8 | — | — | 16 | 27 | — |
| C ₅ | 45 | — | — | — | 16 | — | 35e | 11 | — | — | 20 | — | — |
| C ₆ | 47 | 64 | — | — | 17 | 18 | — | 12 | 15 | — | 26 | 35 | — |
| C ₇ | 44 | 66 | — | 171 | 16 | 20e | 34e | 15 | 18 | 31e | 30 | — | 45e |
| C ₈ | 48 | 70 | — | — | 20 | 22 | — | — | 21 | — | 28 | 44 | — |
| C ₉ | 46 | 66 | — | — | 23 | 24 | — | 15 | 21 | — | 31 | — | — |
| C ₁₀ | 42 | 60 | — | — | 22 | 28 | — | 18 | 20 | — | 36 | 47 | — |
| D ₁ | 33 | — | — | — | 22 | — | — | 19 | — | — | 40 | — | — |
| D ₂ | 29 | — | — | — | 18 | — | — | 21 | — | — | 44 | — | — |
| D ₃ | 27 | — | — | — | — | — | — | — | — | — | — | — | — |
| D ₄ | 29 | — | — | — | — | — | — | — | — | — | — | — | — |
| D ₅ | 29 | — | — | — | — | — | — | — | — | — | — | — | — |
| D ₆ | 30 | — | — | — | — | — | — | — | — | — | — | — | — |
| D ₇ | 32 | — | — | 82 | 17 | — | — | — | — | 70e | — | — | — |
| D ₈ | 34 | — | — | 94 | — | — | 51e | — | — | 70e | 57 | — | — |
| D ₉ | 35 | — | — | 103 | 19 | — | — | — | — | 70e | — | — | — |
| D ₁₀ | 35 | — | — | 105 | 21 | — | 54e | 26 | — | 79e | 66 | — | — |
| D ₁₁ | 36 | — | — | — | 21 | — | — | 22 | — | — | — | — | — |
| D ₁₂ | 38 | — | — | 55 | 23 | — | — | 28 | — | — | 74 | — | — |
| D ₁₃ | 41 | — | — | 98 | 25 | — | 73e | — | — | 91e | — | — | — |
| S ₁ | 40 | — | 95 | 95 | 27 | — | 60e | — | — | 67e | 81 | — | — |
| S ₂ | 40 | 57 | 95 | 92 | 38 | — | — | — | — | — | 81 | — | — |
| S ₃ | 39 | 50 | — | 85 | 35 | — | — | — | — | — | 85 | — | — |
| S ₄ | 41 | 55 | — | 115 | 35 | — | — | — | — | — | 90 | — | — |
| S ₅ | 44 | 58 | 118 | 118 | 25 | — | — | — | — | — | 81 | — | — |
| Ca ₁ | 36 | 47 | — | 103 | 28 | 39 | 82 | — | 45 | 88 | 78 | 112 | — |
| Ca ₂ | 33 | 45 | — | 100 | 27 | 35 | 80 | — | 39 | 87 | 65 | 106 | — |
| Ca ₃ | 33 | 42 | — | 95 | 25 | — | 70 | 27 | — | 87 | 64 | 100 | — |
| Ca ₄ | 31 | 39 | — | 87 | 22 | — | 61 | 25 | — | — | — | 88 | — |
| Ca ₅ | 31 | 39 | — | 85 | 21 | 28 | 62 | 23 | 31 | 70 | 56 | — | — |
| Ca ₆ | 29 | 39 | — | 85 | 19 | 28 | 59 | — | 30 | 66 | 53 | 78 | — |
| Ca ₇ | 30 | 38 | — | 83 | 19 | 25 | — | 20 | 30 | — | 51 | — | — |
| Ca ₈ | 28 | 38 | — | 87 | 17 | 24 | 55 | 18 | 28 | — | — | — | — |
| Ca ₉ | 28 | 39 | — | 82 | 17 | 24 | 54 | 17 | 26 | 60 | 41 | — | — |
| Ca ₁₀ | 29 | 38 | — | 77 | 16 | 22 | 50 | 16 | 26 | 56 | 41 | — | — |
| Ca ₁₁ | 28 | 38 | — | 77 | 14 | 21 | 52 | 16 | 24 | 49 | 35 | — | — |
| Ca ₁₂ | 28 | 37 | — | 80 | 15 | 21 | 51 | 15 | 24 | 49 | 32 | — | — |
| Ca ₁₃ | 28 | 38 | — | 82 | 15 | 22 | 51 | 14 | 22 | 50 | 32 | 44e | — |
| Ca ₁₄ | 28 | 38 | — | 84 | 15 | 23 | 49 | 13 | 20 | 51 | 29 | 38e | — |
| Ca ₁₅ | 28 | 38 | — | 84 | 16 | 24 | 51 | 12 | 19 | 46 | 25 | 37e | — |
| Ca ₁₆ | 28 | 38 | — | 89 | 17 | 24 | 55 | — | 18 | 44 | 24 | 34 | — |

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|------------------|---|----|----|---|----|----|----|----|----|----|----|----|----|----|
| Ca ₁₇ | | 29 | 40 | — | 89 | 17 | 24 | 52 | 11 | — | 44 | 22 | 33 | — |
| Ca ₁₈ | | 29 | 40 | — | 87 | 16 | 22 | 47 | — | 16 | 42 | 20 | — | — |
| Ca ₁₉ | | 29 | 39 | — | 85 | 15 | 22 | — | 11 | — | 37 | — | 28 | — |
| Ca ₂₀ | | 28 | 39 | — | 83 | 14 | 21 | 44 | — | — | 32 | — | 27 | — |
| Ca ₂₁ | | 26 | 38 | — | 80 | 13 | 19 | — | — | — | 26 | 16 | — | — |
| Ca ₂₂ | | 26 | 37 | — | 73 | 13 | 20 | — | — | 14 | — | 15 | 23 | — |
| Ca ₂₃ | | 25 | 36 | — | 65 | 12 | 18 | 37 | 9 | — | 26 | 14 | 21 | — |
| Ca ₂₄ | | 24 | 32 | — | 59 | 12 | 18 | 33 | 8 | 13 | 24 | 13 | 20 | — |
| Ca ₂₅ | | 22 | 30 | — | 52 | 11 | 17 | 31 | 8 | — | 22 | 11 | 17 | — |
| Ca ₂₆ | | — | 28 | — | — | — | 16 | 28 | — | — | 19 | — | — | — |
| Ca ₂₇ | | — | 26 | — | — | — | 14 | — | — | — | — | — | — | — |
| Ca ₂₈ | | — | 23 | — | 40 | — | 14 | 26 | — | — | 17 | — | — | — |
| Ca ₂₉ | | — | 21 | — | 35 | — | 12 | 23 | — | — | 16 | — | — | — |
| Ca ₃₀ | | — | 19 | — | 30 | — | 11 | 20 | — | — | 14 | — | 13 | — |
| Ca ₃₁ | | — | 17 | — | 26 | — | 11 | 18 | — | — | 13 | — | 12 | — |
| Ca ₃₂ | | — | 16 | — | 22 | — | 10 | 16 | — | — | 11 | — | 12 | — |
| Ca ₃₃ | | — | 14 | — | 20 | — | 9 | 13 | — | — | 10 | — | 10 | — |
| Ca ₃₄ | | — | 13 | — | 17 | — | 8 | 11 | — | — | 10 | — | 9 | — |
| Ca ₃₅ | | — | 11 | — | 15 | — | 6 | 11 | — | — | 9 | — | 9 | — |
| Ca ₃₆ | | — | 9 | — | 13 | — | 5 | 7 | — | — | 8 | — | 5 | — |
| Ca ₃₇ | | — | — | — | 10 | — | — | 6 | — | — | 7 | — | — | — |
| Ca ₃₈ | | — | — | — | 7 | — | — | 6 | — | — | 5 | — | — | — |

depression, this being the deepest between sacrals 2 and 3. The bases of the neural arches of sacrals 2 and 3 are broader transversely than the corresponding centra, thus they overhang them somewhat when viewed ventrally. The neural spines of the sacrals are rectangular, broad (sag.), and much higher than in the preceding dorsals, standing slightly out above the upper margin of the iliac blade, or are at least, equal in height to the latter. They are separated from each other. Diapophyses are directed obliquely upwards, and distally contact the internal surface of the iliac blade. The diapophyses of anterior sacrals are directed anteriorly, while those of posterior sacrals, posteriorly. In comparison with both dorsals and caudals, the sacral diapophyses are differently oriented with respect to the long axis of the body. They narrow in a sagittal direction, and simultaneously the lamina connecting them with the neural spines extends vertically. This results in their being flattened antero-posteriorly instead of dorso-ventrally. The diapophysis of the second sacral is the weakest, while most strongly developed is that of the fifth sacral. Sacral ribs are very short and strong (except that of the third sacral, which is thinner) and attached to the vertebrae in the anterior part of their centra. The rib of the first sacral is not fused with the ilium but contacts it. The rib of the second sacral is placed above the pubic peduncle, and is somewhat shorter and thicker than the others. The fourth sacral rib is fused to the corresponding sacral somewhat intervertebrally, being at the same time closer to the third sacral. Its distal end attaches to the ilium just behind the ischiac peduncle. The fifth sacral rib is the broadest and fuses to the vertebra almost along its whole length. In sacrals 1—4 the expanded diapophysal ends are separated from the distal ends of the sacral ribs; differently in the sacral 5, where they join together, forming a common articular surface for attachment with the ilium.

The neural canal is partly known only in the specimen Z.Pal.No.Mg.D-I/7. Only the bottom of the neural canal of sacrals 2 and 3 is exposed here which allows one to observe

a pair of large and deep pits for the spinal ganglions in the anterior portion of each vertebra. Near the posterior portion of each vertebra, a pair of lateral openings for issue of the spinal nerves is present.

Caudal vertebrae (Pls. XLI—XLIV, Pl. LIII, Figs. 1—3). The number of caudals varies: 36 in the specimen Z.Pal.No.Mg.D-I/1; 38—39 in G.I.No.DPS 100/11. The transition point² between the proximal and distal caudals occurs between vertebra 15 and 16. Several first anterior caudals are weakly procoelic, while all others are amphiplatyan. The centra of anterior caudals 13—15 are spool-shaped, the articular surfaces of the centra in front of the transition point are subcircular but somewhat elongated dorso-ventrally while those of the distal part are distinctly subrectangular and transversely elongated. Articular facets for the chevrons are ventrally situated on the edges of all caudal centra, except the anterior edge of the first caudal. Those on the posterior edge are better developed. There is a broad, shallow groove along the ventral surface of the centra of the posterior caudals, behind the transition point. The relative length of the centra is larger in the posterior caudals than in the anterior ones, except for the very end of the tail. Neural arches are coossified with the centrum, the suture being visible only in the proximal part of the tail. Neural spines are comparatively high and flat, the surface for the attachment of the ligamentum on the posterior edge of the neural spine being expanded backwards. This expansion disappears posteriorly beginning with caudal 10. Neural spines diminish backwards. Beginning with caudal 18, they become ridge-like and only their posterior and anterior edges, which bear the surfaces for the attachment of the ligamentum, are somewhat higher. However, at the very end of the tail they do not protrude. Diapophyses are thin, blade-like, present only in the anterior part of the tail. Prezygapophyses of the most anterior caudals are short and equal in length to the postzygapophyses. Beginning with caudal 11 they become longer. At the transition point and behind it, they reach half the length of the centrum of the preceding caudal, beginning with caudal 20, they occupy three quarters of the preceding centrum. Prezygapophyses along the anterior part of the tail are flattened dorso-ventrally, while along the posterior part they are flattened laterally and become concave outwards and longitudinally. Postzygapophyses are short along the whole length of the tail, being very fine and spine-like in the distal part of the tail. Articular surfaces of the zygapophyses are small, oval in shape, situated obliquely to the vertical plane, developed only in the proximal caudals.

Chevrons. The *chevrons* (Pl. XXXIX, Fig. 3, Test-fig. 10A—D) are Y-shaped when viewed sagittally. They diminish gradually backwards. The first chevron is situated between the first and second caudal. Nine anterior chevrons are narrow and bent gently backwards, when viewed from the side. The chevrons 10 to 13 are strongly shortened, and bent backwards angularly in their ventral part. Beginning with chevron 14 they change their shape entirely becoming subtriangular in lateral profile and strongly elongate (Text-fig. 10C, D).

Ribs. The *ribs* (Text-fig. 10E—H) are present on all presacral vertebrae, except the atlas and the last dorsal. In the cervical region they are fused with the vertebrae, except in the young specimen. The first cervical rib known is that of the axis. It is slender, rod-like and much longer than the axial centrum. Its capitulum and tuberculum are very close to each other forming an almost continuous articular surface. Postaxial cervical ribs have thin and comparatively broad shafts, those in the proximal region being more slender

² In accordance with RUSSELL (1972) the transition point is regarded here as the boundary between „the anterior caudals“ and „the posterior caudals“.

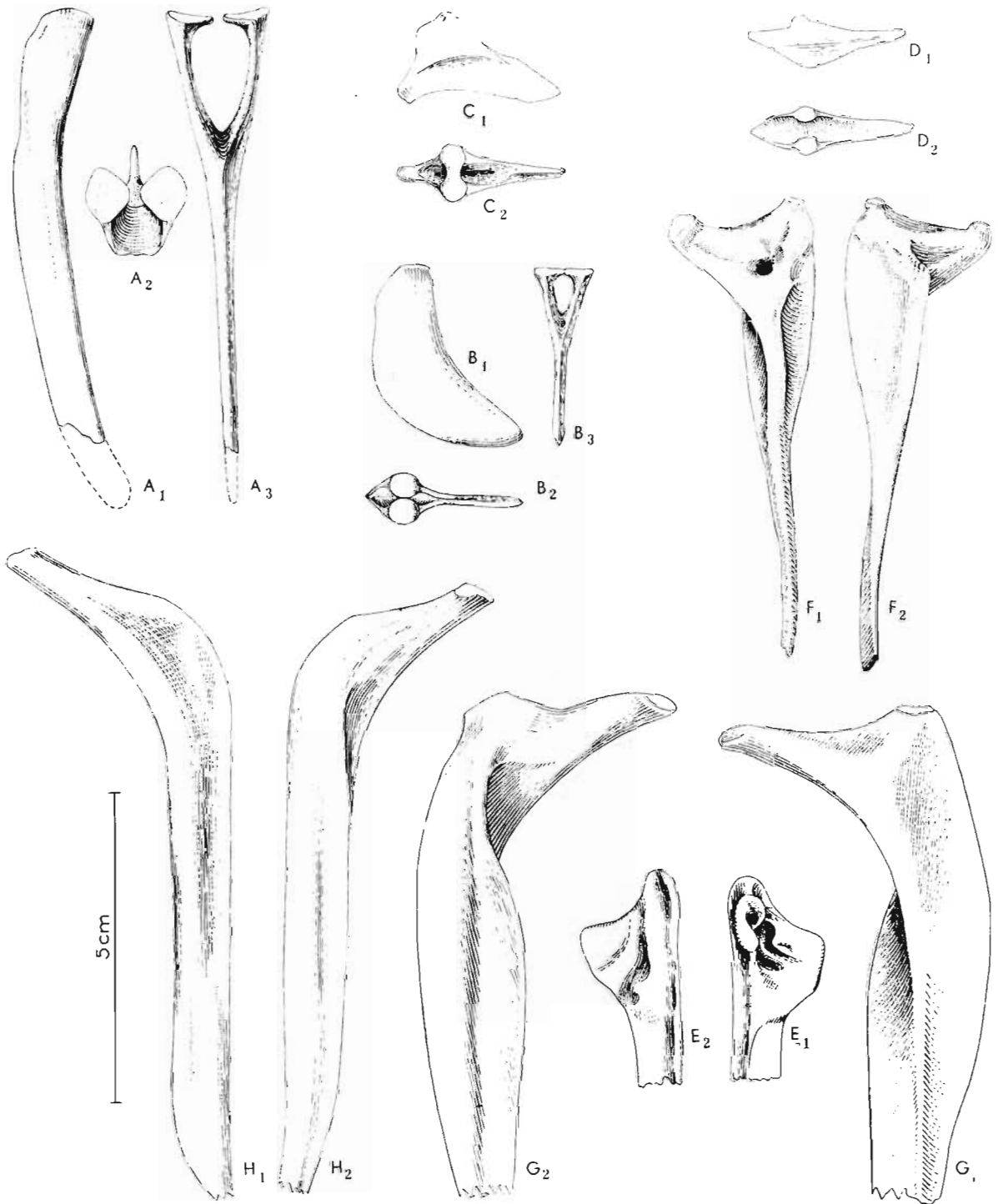


Fig. 10

Gallimimus bullatus n. sp.

A — first chevron, B — twelfth chevron, C — fifteenth chevron, D — sixteenth chevron, in: lateral (1), dorsal (2) and anterior (3) views, E — eighth right cervical rib, F — tenth right cervical rib, G — fourth right dorsal rib, H — eleventh right dorsal rib, in: medial (1) and lateral (2) views (Z.Pal.No.Mg.D-1/94).

while those posterior ones are plough-shaped. Their length is almost equal to the length of the corresponding centra, except the last cervical rib, which is about twice as long. The ventral margins of all cervical ribs are straight. On the inner surface of the ribs corresponding to cervicals 3—10 there is a deep and extensive depression situated dorso-posteriorly to the capitulum. The articular surface of the capitulum is elongated parallelly to the ventral edge of the rib except in the last cervical rib. It is placed on the short, medially directed pedicel. The tuberculum is weakly differentiated, with narrow articular surface, developed along the dorsal margin of the tubercle. Anterior to the capitular head there is a short process, which extends a little in front of the centrum of the corresponding vertebra. The rib corresponding to cervical 10 (Text-fig. 10F) deviates from the pattern typical for the cervical rib, being very like the dorsal ribs, though shorter. It also displays a small depression on its ventral surface, which was developed in other cervical ribs, but is here much shallower and situated posterior to the tuberculum.

The dorsal ribs expose broad and flat dorsal ends with the capitular and tubercular heads widely spaced, separated from each other by a shallow notch which disappears towards the back of the vertebral column. Posteriorly, the capitulum becomes stronger, the tuberculum weaker. The whole shaft, as well gradually curves more gently towards the rear. The proximal part of the shaft is surmounted by an antero-posterior flat extension of bone, which is already weakly-developed in the rib connected with cervical 10, but broadens towards the ribs of dorsals 13—15 where it reaches its climax. The development of so broad and thin a bony extension on the dorsal ribs has never yet been reported in any theropod. Sacral ribs see p. 128.

Pectoral girdle. The scapula and coracoid are relatively weakly connected (Pl. XXXI, Fig. 2, Pl. XXXII, Fig. 3, Text-fig. 11). The scapula is short and curved, somewhat extended and

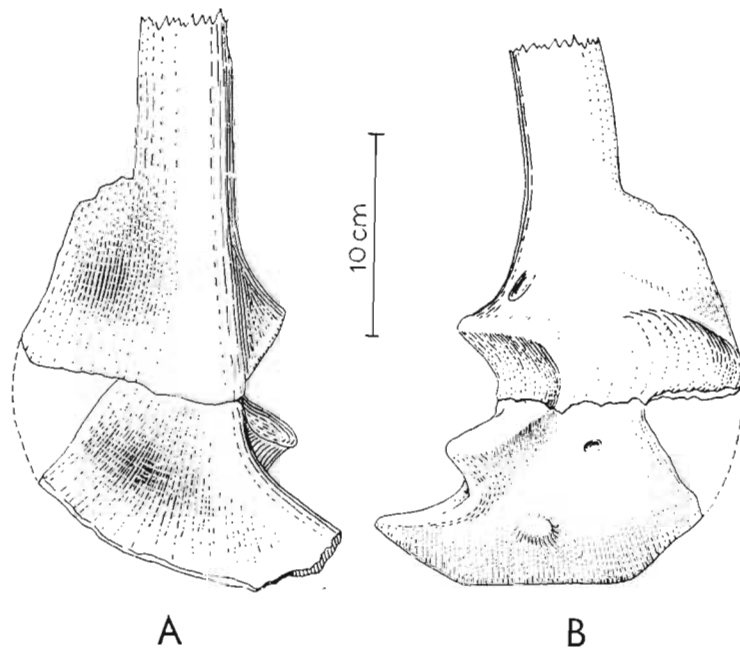


Fig. 11

Gallimimus bullatus n. sp.

Proximal portion of the right scapulocoracoid: *A* — medial view, *B* — lateral view (G.I.No.DPS 100/11).

thin distally, while strongly thickened proximally. The acromion is prominent, bent in the middle, having on the lateral surface a distinctly pronounced ridge, which runs nearly parallel to the scapulocoracoid suture. The latter is straight, exposing a sinus at the glenoid only. There is a deep pit near the glenoid, on the posterior edge of the scapula. The glenoid is a deep notch, relatively narrow, with thick lips.

The coracoid is large and deep dorso-ventrally; its postero-ventral part develops an apex which is prominent and strongly curved inwards. The coracoid foramen is rounded on both surfaces of the coracoid. On the lateral surface a prominent tuber is developed, which is almost centrally situated. A narrow, triangular area is pronounced along the posterior edge of the coracoid apex. It bears a distinct fossa below the glenoid lip. The lateral surface of the scapulocoracoid is marked by some distinct areas of the muscle attachments. One of these is located on the anterior part of the scapulocoracoid, partly covering the coracoid, being limited dorsally by the ridge on the acromion. The other forms a triangle occupying whole ventral portion of the coracoid and extending to the coracoid tuber. It is bordered dorsally

Table 3

Measurements (in mm) of the pectoral girdle and forelimb of *Gallimimus bullatus* n. sp.

| | Z.Pal.No.Mg.D-I/94 | G.I.No.DPS 100/11 |
|---|--------------------|-------------------|
| Scapula: | | |
| length | — | .450 |
| proximal width | — | .140 |
| distal width | — | .900 |
| Humerus: | | |
| length | — | .530 |
| proximal transverse width | — | .100 |
| distal transverse width | — | .065 |
| least shaft diameter | — | .370 |
| Ulna: | | |
| length | .106 | .375 |
| least shaft diameter | .006 | .020 |
| Radius: | | |
| length | .102 | .350 |
| least shaft diameter | .005 | .019 |
| Total length of manus along the digit II | — | .310 |
| Metacarpal I length | — | .098 |
| Metacarpal II length | — | .115 |
| Metacarpal III length | — | .105 |
| Phalanx I ₁ | — | .135 |
| Phalanx I ₂ , ungual * | — | .095 |
| Phalanx II ₁ | — | .053 |
| Phalanx II ₂ | — | .100 |
| Phalanx II ₃ , ungual * | — | .098 |
| Phalanx III ₁ | — | .032 |
| Phalanx III ₂ | — | .036 |
| Phalanx III ₃ | — | .074 |
| Phalanx III ₄ , ungual * | — | .090c |

* along outer curve

by a weak transverse ridge running from the tuber, towards the anterior margin of the coracoid. It was probably a site for the *m. coracobrachialis*. On the medial surface of the scapulocoracoid two extensive depressions can be recognized, one located on the acromion, the other, for the *m. subcoracoideus*, on the coracoid and almost opposite the coracoid tuber on the lateral surface. The supraglenoid buttress is prominent, covered by longitudinal striae.

Forelimb. *The humerus* (Pl. XXXV, Text-fig. 12D) is long and twisted, the distal end being at 25° – 30° to the proximal. The articular surfaces of the proximal and distal ends are rough. Proximal end has the articular head pronounced, rounded and overhanging the posterior face of the humerus. Processus medialis and processus lateralis are well developed. Shaft is subcircular in the cross-section. The deltopectoral crest is relatively small, connected with the processus lateralis, its summit being situated close to the proximal end. Distally it lowers gradually, merging with the shaft. On the distal end, the medial condyle is more prominent than the lateral. The medial epicondyle is distinctly separated from the corresponding condyle. Fossa olecrani is weakly developed or absent. On the ventral side, above the articular surface, there is a deep fossa, located between the two condyles.

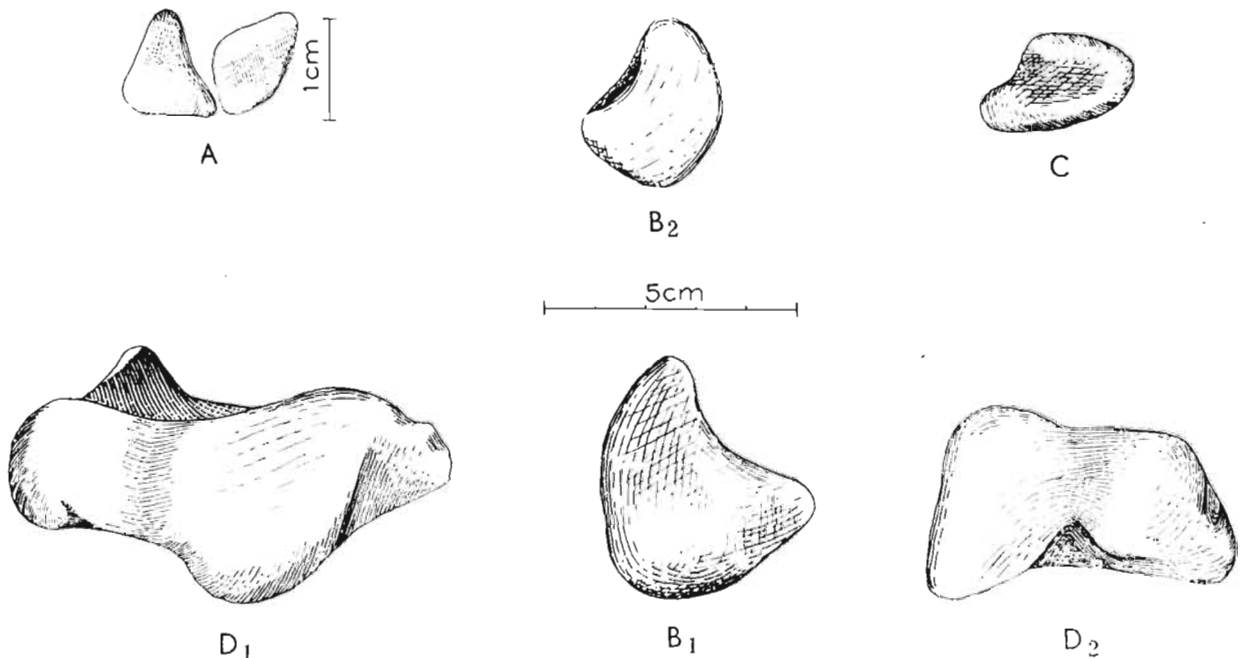


Fig. 12

Gallimimus bullatus n. sp.

A — proximal articular surfaces of the right ulna and radius in natural position (Z.Pal.No.Mg.D-1/94), B — right ulna: proximal (1) and distal (2) articular surfaces. C — distal articular surface of the left radius. D — right humerus: proximal (1) and distal (2) articular surfaces (G.1.No.DPS 100/11).

The ulna (Pl. XXXVI, Figs. 2, 3, Pl. XIV, Fig. 3. Text-fig. 12A, B) is slender and long. The bone is weakly curved, being convex towards the radius. The olecranon is prominent in the full-grown specimen, while indistinctly developed in younger ones. The shaft is subtriangular in cross-section. The distal end is weakly expanded and flattened latero-medially, with the triangular articular surface. The apex of this triangle faces posteriorly. The anterolateral edge of the distal end is pronounced in the form of a short, longitudinal ridge.

The *radius* (Pl. XXXVI, Fig. 4, Pl. XLV, Fig. 3, Text-fig. 12A, C), is very slender and long, the proximal end being more expanded than the distal one. Its articular surface is suboval in outline. The anterior face of the shaft is somewhat flattened. The articular surface on the distal end is divided by a shallow groove running antero-medially. A short ridge extends upwards along the lateral edge of the distal end.

Carpus. Only one carpal bone is preserved (Pl. XXXVI, Fig. 1, Text-fig. 13A) attached to the proximal articular surface of the metacarpal I, near its lateral edge. Thus, it presumably represents a distal carpal 1 or 2.

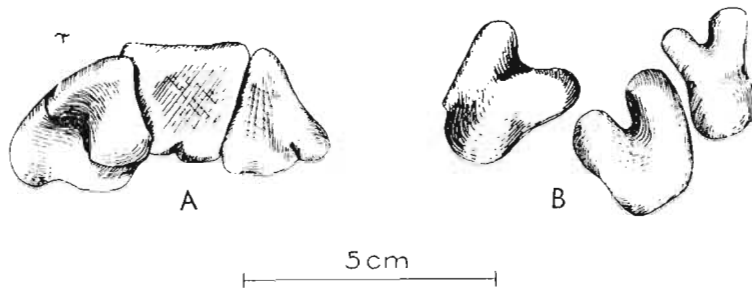


Fig. 13

Gallimimus bullatus n. sp.

Right metacarpus: A — proximal articular surfaces of the metacarpals I-III, B — distal articular surfaces of the metacarpals I-III, r — radiale (G.I.No.DPS 100/11).

Manus (Pl. XXXVI, Fig. 1, Text-figs. 13, 14, 18). The manus is tridactyl with all digits almost equally developed, the metacarpal I and digit I being the strongest, the metacarpal and digit III — the weakest. Digit II is somewhat longer than adjacent digits.

The *metacarpus* (Text-figs. 13, 14) is weakly arched transversely, the metacarpals being proximally strongly adherent to each other, but diverging slightly distally. Metacarpal I is the shortest and triangular in cross-section. Along two thirds of its lateral edge it attaches closely to metacarpal II, its distal third deviating from the latter. The surface of the attachment is concave. In palmar aspect, on the medial side and near the proximal articular surface, there is a shallow fossa which constitutes an attachment site of the tendon of m. flexor carpi radialis. The caput of metatarsal I is asymmetric, with the lateral condyle more strongly developed. There is a deep fossa on the palmar side of the caput. The lateral fovea ligamentosa is much stronger than the medial one. Metacarpal II is curved laterally. It articulates with metacarpal I over more than half of its medial surface, and contacts metacarpal III over a quarter of the length of its lateral edge. Its base is quadrangular; the caput has a somewhat larger lateral condyle; the shaft is flattened dorso-ventrally. There is a small pit on the palmar side, below the medial condyle. The lateral fovea ligamentosa is deeper than the medial one. Metacarpal III is almost as long as metacarpal II. It is weakly bent laterally. Its base is triangular, the shaft rounded in the cross-section, the caput is strongly flattened laterally. The lateral condyle is larger, foveae ligamentosae comparatively weakly developed.

Digits (Text-fig. 14). Phalangeal formula: 2, 3, 4. The first digit is strongly divergent medially, while digit III is somewhat divergent laterally. Phalanges I of the digits II and III are short, that of digit I being much longer (2.5 times longer than in digit II, 3.5 times longer than in digit III). All the bases of phalanges I have concave articular surfaces, that of digit I facing somewhat laterally. All the articular surfaces of other phalanges are more or less sym-

metrical. Phalanx 2 of digit II is almost three times longer than that of digit III. Foveae ligamentosae of phalanges 1 and 2 of digit III are extremely weakly developed, nearly absent, while those of the penultimate phalanges are very deep in all digits. The unguals are strong, somewhat curved and almost equally developed, the third being somewhat smaller. They are laterally compressed, with deep grooves along both sides. Their articular surfaces are developed in the form of a narrow triangle, with a weak sagittal ridge. The sites for the distal attachments of the ligamenta collateralia are weakly elevated, the tubers for the tendons of *m. flexor profundus* are large, and spaced from the proximal margin of the ungual at about a third of its total length.

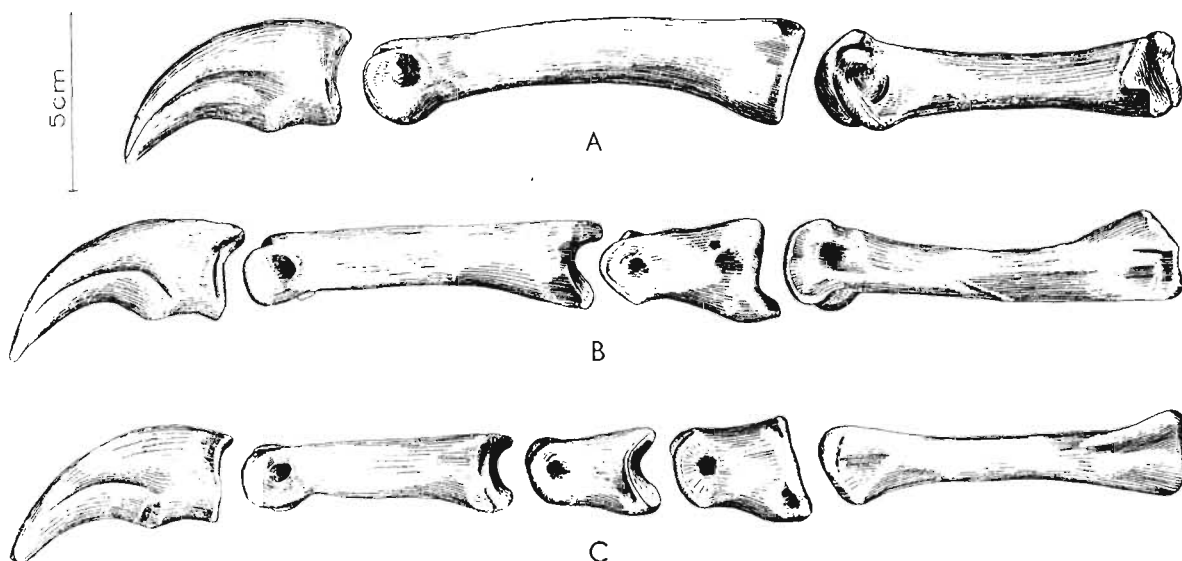


Fig. 14

Gallinimus bullatus n. sp.

Digits and metacarpals of the right manus in medial views: *A* — digit I, *B* — digit II, *C* — digit III (G.I.No.DPS 100/11)

Pelvic girdle. *The ilium* (Pl. XLV, Figs. 1, 2, Pl. L, Fig. 1). The pubic peduncle is very low; its surface for attachment with the pubis is triangular, developed parallel to the axis of the ilium and facing antero-ventrally. The ischiac peduncle is shorter than the pubic peduncle and strong; its surface for attachment with the ischium is developed transversely to the axis of ilium. The acetabulum is situated opposite the second and third sacral, its anterior margin located just in front of the junction between the first and second sacral, its posterior margin — in front of the juncture between the third and fourth sacral (Text-fig. 9A). The acetabular lip is very prominent and strong. On the lateral surface of the iliac blade muscle scars of the *mm. ilio-tibialis*, *ilio-femoralis*, *ilio-fibularis* and *flexor tibialis* are visible. On the medial side of the ilium two sharp ridges are developed which support the sacral ribs (Pl. L, Fig. 1). The anterior ridge runs parallel to the axis of the iliac blade in prolongation of the pubic peduncle. It ends some distance from the anterior margin of the iliac blade and bears attachment sites for the ribs of sacra 1 and 2. The second ridge, running ventro-dorsally and bearing the attachment of the rib of sacral 3, is developed just in front of the ischiac peduncle. The attachment site of the rib of sacral 4 is located behind the ischiac peduncle, near the ventral edge of the posterior portion of the ilium. The common site of attachment of the rib and diapophyses of sacral 5 is extensive.

Table 4

Measurements (in mm) of the pelvic girdle of *Gallimimus bullatus* n. sp.

| | G.I.No. DPS 100/10 | Z.Pal.No.Mg.D-I/ | | | G.I.No. DPS 100/11 |
|---------------------------|-----------------------|------------------|-------|------|--------------------------|
| | | 94 | 1 | 7 | |
| Length of ilium | .197 | .270 | — | .630 | — |
| Length of antilium | .078 | .088 | — | .150 | — |
| Length of pubis | .182 | .255 | .300e | .620 | .620e |
| Length of pubic foot | .070 | — | .120 | .300 | .300 |
| Proximal width of pubis | — | .065 | .900e | .176 | .160 |
| Length of ischium | .137 | .200 | .235 | .465 | — |
| Proximal width of ischium | — | .060 | .077 | .165 | — |

The pubis (Pl. XLVI, Fig. 3, Pl. L, Fig. 2) is long and slender (only somewhat shorter than the ilium) with a distal „foot” typical of the ornithomimids. The surface for attachment with the ischium is short while that for the pubic peduncle of the ilium is much more extensive. The pubic contribution to the boundary of the acetabulum is very small, the smallest of the three bones surrounding the acetabulum. The ventral margin of the proximal end of pubis is weakly concave and sharp. On the lateral surface, at the anterior edge, a rough thickening is present corresponding to the origin of *m. ambiens* in Tyrannosaurs (ROMER, 1923). This muscle scar is not so strong as in the representative of the genus mentioned, nevertheless it is quite distinct, which contradicts RUSSELL's (1971) opinion that it is feeble in the ornithomimids. The proximal end of the pubis narrows rapidly downwards and passes into the shaft, which is transversely suboval in cross-section, its medial margin being thin and sharp, its lateral margin — rounded. The distal „foot” of the pubis has its ventral margin faintly convex in outline; the posterior portion of the „foot” is pointed forming a triangle, the anterior portion is shorter, thickened, bending slightly dorsally and outwards. The axis of the shaft is inclined to the sagittal axis of the „foot” at an angle of about 50°. Along the ventral edge of the „foot” a distinct rim is developed, which corresponds to the origin of the *m. pubo-ischio-femoralis externus*. The distal (ventral) fusion of both pubes is complete in the posterior portion of the „foot”, no trace of the junction being left. In the anterior portion the two components are easily recognizable. The ventral surface of the pubic symphysis is comparatively narrow and flat. Above the „foot”, a narrow, elongate aperture separates the two pubes, when viewed anteriorly. Above this aperture, along the middle third, the two bones are co-ossified, and this part is somewhat concave anteriorly. Along the upper third of their length, the proximal ends of the pubes are comparatively close to each other and free.

Ischium (Pl. XLVI, Fig. 4, Pl. L, Fig. 3). The proximal end of the ischium has very short iliac and pubic peduncles, the acetabular rim between them being only weakly concave. Beneath the iliac peduncle a large oval area is developed for the origin of the *m. ischio-caudalis* (according to RUSSELL, 1972) or the *m. flexor tibialis internus pars 3* (according to ROMER, 1923). Both ischia are coalesced distally and along the upper half of their shafts, including the ventral edge of the obturator process. The common ventral surface of both coalesced ischia is strongly broadened and flat.

Hind limb. *The femur* (Pl. XLVI, Figs. 1, 2, Pl. XLII, Figs. 1, 2, Pl. XLVIII, Figs. 1, 2, Pl. LI, Fig. 1, Text-fig. 15A) is almost straight, long and slender, its shaft being flattened laterally. The articular head of the femur in adult specimens bears a small tubercle, bounded

posteriorly by a deep notch. As comparisons with the young specimens have proved (Pl. XLVI, Fig. 2, Pl. XLVIII, Figs. 1, 2), this tubercle represents in fact an additional, separate ossification, developed presumably within the ligamentum teres, which in later growth stages co-ossified with the caput femoris. The trochanter major is indistinctly separated from the head, the surface between them being smooth, slightly concave and slanting backwards. The lesser trochanter is blade-like, situated somewhat below the trochanter major and separated from the latter by a deep incision. A faintly pronounced fourth trochanter is located on the upper third of the femur. A large, oval scar, corresponding to the insertion of the mm. pubo-ischio-femorales is visible anterior to the fourth trochanter, on the medial side of the femur. On the postero-medial surface of the lower third of the femur, a rough, oval convexity is pronounced, which according to RUSSELL (1972), corresponds to the insertion of the muscular complex of the mm. caudi-femorales longus and gastrocnemius. The condyles on the distal end of the femur are unequally developed and flattened laterally. The lateral condyle is larger and bears a crescent articular surface for the fibula. Above the lateral condyle there is a rough convexity which represents the site of origin of m. extensor digitis communis. Posterior to it, an extensive concavity is developed. The intercondyloid fossa is very deep posteriorly. Above the medial condyle, on the anterior side of femur, there is an oblonge, deep depression which is bordered medially by a sharp crest. Within this depression there is an oval rugosity for the m. femoro-tibialis.

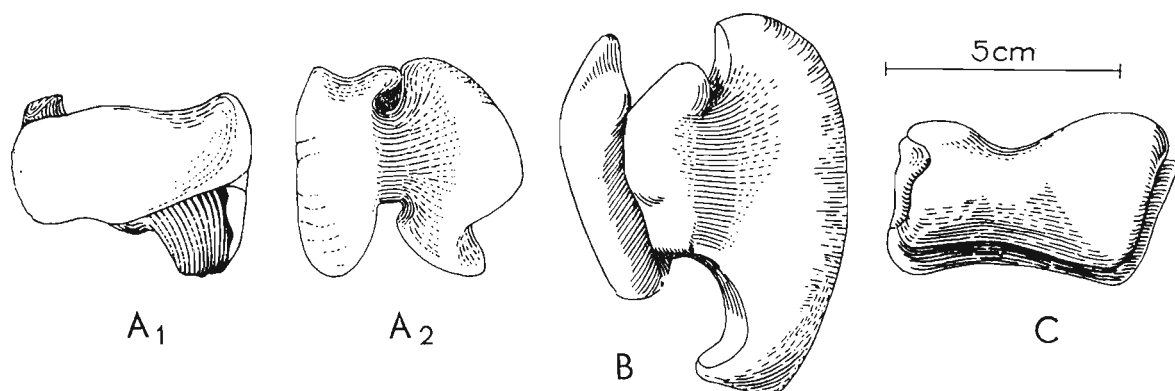


Fig. 15

Gallimimus bullatus n. sp.

A — left femur: proximal (1) and distal (2) articular surfaces, B — proximal articular surfaces of the right tibio-fibula, C — distal articular surfaces of the right astragalus and calcaneum (articulated with tibio-fibula) (Z.Pal.No.Mg.D-I/94).

The tibia (Pl. XLVII, Fig. 3, Pl. XLVIII, Fig. 3, Pl. LI, Fig. 2, Text-fig. 15B) is straight and long, with two well developed condyles on the proximal end. They are separated by a deep, narrow groove. The lateral one is rounded, the medial one being more conspicuous when seen posteriorly. The tibial crest (= cnemial crest of ROMER, 1923, not cnemial crest of GILMORE, 1920) is very prominent, strongly curved outwards, its apex no higher than the level of the articular surface. Beneath the lateral condyle, along the antero-lateral edge of the shaft, a sharp ridge for attachment with the fibula is developed. It occupies the upper third of the shaft. The latter is flattened antero-posteriorly, bearing along its anterior surface a line, which merges upwards with the ridge for the fibular attachment, meeting down the ascending process of the astragalus. Just at the fibular ridge, on the postero-lateral surface of the upper third of the tibia a nutrient foramen is visible. The distal end of the tibia is strongly flattened antero-

Table 5
Measurements (in mm) of the hind limb of *Gallimimus bullatus* n. sp.

| | G.I.No. DPS 100/10 | Z.Pal.No.Mg.D-1/ | | | | | G.I.No. DPS 100/11 |
|-----------------------------------|-----------------------|------------------|-------|------|------|------|--------------------------|
| | | 94 | 1 | 24 | 32 | 8 | |
| Femur: | | | | | | | |
| Length | .192 | .270 | .360e | — | — | .635 | .665e |
| Proximal transverse width | — | .053 | .066 | — | — | .132 | .130 |
| Distal transverse width | — | .047 | .060e | — | .075 | .130 | .125 |
| Least shaft diameter | — | .022 | .030 | — | — | — | .062 |
| Tibia: | | | | | | | |
| Length | .218 | | | | | | |
| Length with astragalus | — | .306 | .390 | — | — | — | .740 |
| Proximal antero-posterior width | — | .056 | .070 | — | .100 | .145 | .163 |
| Proximal transverse width | — | .037 | .045 | — | .062 | .092 | .105 |
| Distal transverse width | — | .045 | .058 | — | — | .114 | .120 |
| Least shaft diameter | — | .018 | .025 | — | — | .045 | .043 |
| Fibula: | | | | | | | |
| Length | .208 | .267 | .360e | — | — | — | .675 |
| Proximal width | — | .042 | .053 | — | .071 | .118 | .125 |
| Distal width | — | .010 | .011 | — | .016 | .025 | .028 |
| Least shaft diameter | — | .007 | .009 | — | .012 | — | .020 |
| Total length of pes | | .340 | — | .505 | — | — | .770e |
| Metatarsal II length | .144 | .205 | .264 | — | — | .463 | .480 |
| Metatarsal III length | .157e | .220 | .280 | — | — | .510 | .530 |
| Metatarsal IV length | .148 | .210 | .270 | .320 | — | .470 | .500 |
| Metatarsal V length | — | — | — | .090 | — | — | — |
| Phalanx II ₁ | .032 | .045 | — | — | .072 | — | .102 |
| Phalanx II ₂ | .015 | .023 | — | .033 | .035 | .051 | .052 |
| Phalanx II ₃ , ungual | .021 | .024 | — | .035 | .037 | — | .050 |
| Phalanx III ₁ | .031 | .044 | — | .063 | .065 | .097 | .090 |
| Phalanx III ₂ | .024 | .035 | — | .050 | .050 | .075 | .070 |
| Phalanx III ₃ | — | .024 | — | .035 | .034 | .050 | .050 |
| Phalanx III ₄ , ungual | .018 | .025 | — | .035 | — | — | — |
| Phalanx IV ₁ | .018 | .026 | — | .040 | .044 | — | .062 |
| Phalanx IV ₂ | .013 | .019 | — | .027 | .033 | .050 | .043 |
| Phalanx IV ₃ | .010 | .017 | — | .018 | .022 | — | .032 |
| Phalanx IV ₄ | .009 | .012 | — | — | .020 | — | .030 |
| Phalanx IV ₅ , ungual | .014 | .023 | — | .032 | .031 | — | .043 |

posteriorly, the distal attachment surface for the astragalus being flat also. The medial malleolus has a very sharp anterior edge for articulation with the ascending process of the astragalus. The lateral face of the distal end has a flat groove for fibula, bordered anteriorly by a ridge contacting the astragalus, and posteriorly by an angular extension of the distal end.

The fibula (Pl. XLVII, Fig. 3, Pl. XLVIII, Fig. 3, Pl. LI, Fig. 2, Text-fig. 15B) is flat, partly in contact with the tibia. Its proximal end is very thin and broad, rapidly narrowing downwards. The ad-tibial side of the upper fourth of the fibula is deeply hollowed and here fits the fibular ridge of the tibia. The upper half of the fibula runs laterally to the tibia, distally directing somewhat forward, contacting the latero-anterior edge of the latter. On the anterior edge of the proximal end of the fibula, well below the articular surface, a small rugosity is

developed, the significance of which remains unclear. The distal end of the fibula is thin, with a rounded extremity fitting closely into the notch of the calcaneum.

Tarsus (Pl. XLVII, Fig. 3, Pl. XLVIII, Fig. 3, Text-figs. 15C, 16A_{1, 2}). *Astragalus*. The intercondylar sulcus is very shallow. The medial condyle of the astragalus is distinctly larger than the lateral one. The lateral margin of the latter condyle is deeply notched, for the cor-

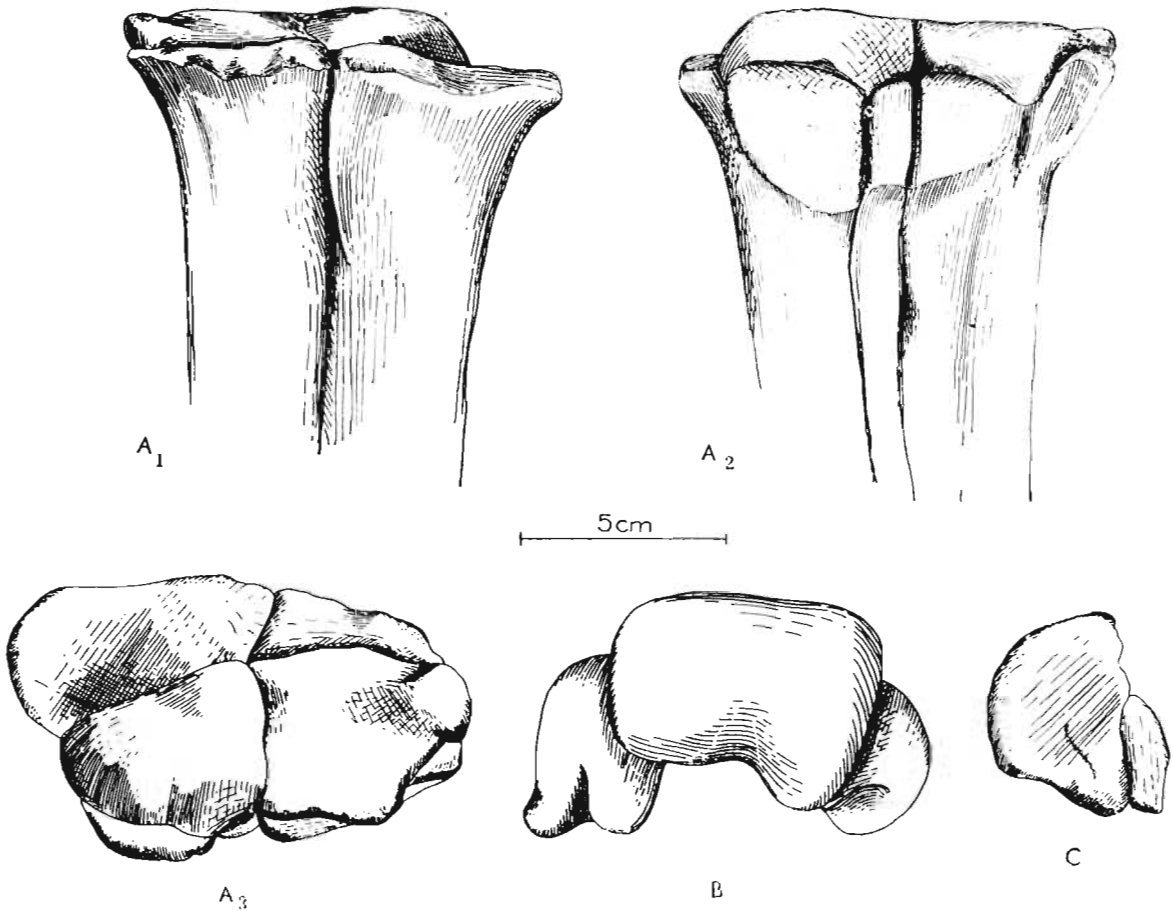


Fig. 16

Gallimimus bullatus n. sp.

A — proximal end of the right metatarsus with distal tarsals III and IV, in: anterior (1), posterior (2) and proximal (3) views (Z.Pal.No.Mg.D-I/8), *B* — distal articular surfaces of the right metatarsals II-IV, (G.I.No.DPS 100:11). *C* — proximal articular surfaces of the left metatarsals II and III (Z.Pal.No.Mg.D-I/24).

responding medial protuberance of the calcaneum. The ascending process of the astragalus occupies the lower fourth of the tibia; a deep depression is present on its anterior face, just above the articular surface. The *calcaneum* is thin, with a flat lateral surface. Its upper margin bears a notch for articulation with the fibula. The antero-medial edge of the calcaneum shows a protuberance, which fits into a corresponding notch on the astragalus. *Distal tarsals* III and IV are similar in shape to those in *Archaeornithomimus asiaticus* (GILMORE, 1933, fig. 7a), where however, they do not cover the whole distal surface of metatarsal III as is the case in *G. bullatus*.

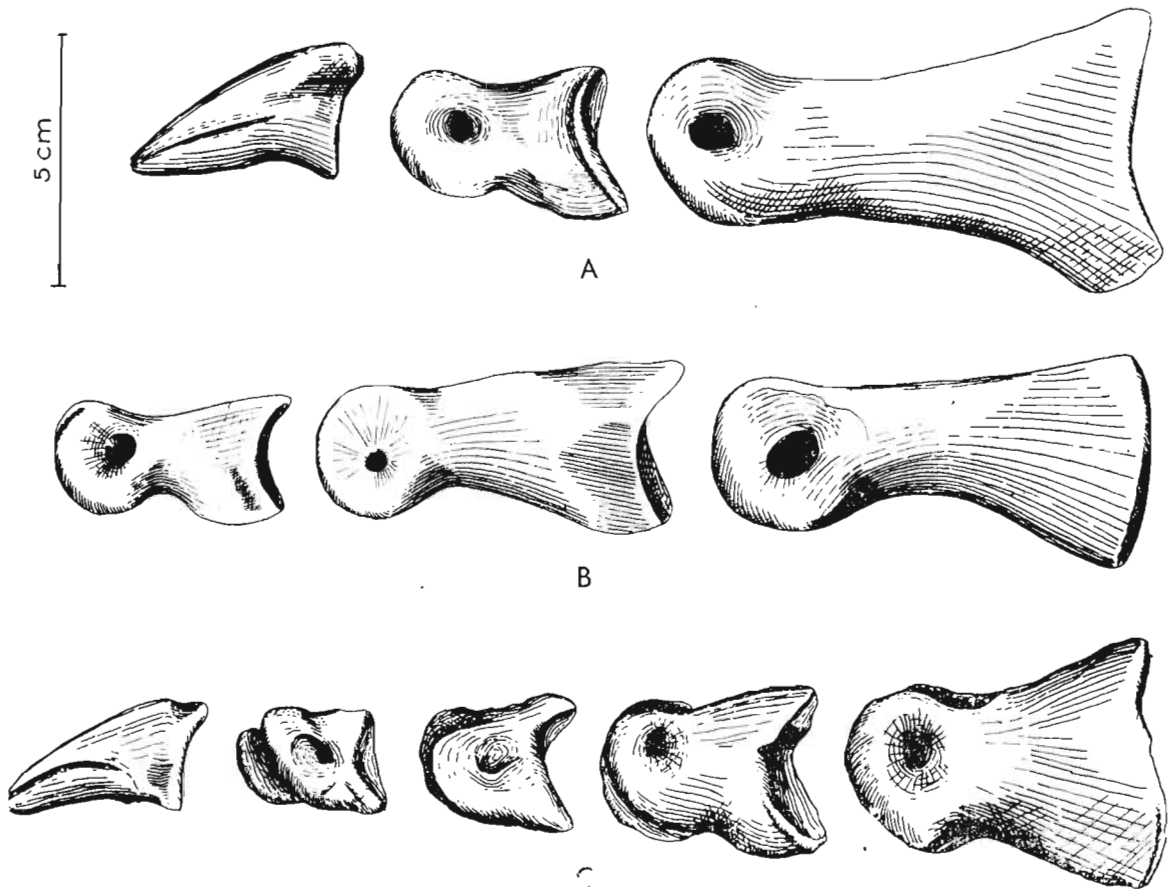


Fig. 17

Gallimimus bullatus n. sp.

Digits of the right pes in medial views: A — digit II, B — digit III, C — digit IV (G.I.No.DPS 100/11).

Pes (Pl. XLIX, Pl. LI, Fig. 3, Text-figs. 16, 17). The metatarsus (Text-fig. 16A₁, A₂, B, C) is very long, equal 72% of the length of the crus and almost 80% of that of the femur (tables 6, 7). Metatarsal II is almost as long as metatarsal IV (97% of the latter). Metatarsal III, when viewed anteriorly, is broad in its distal half, partly covering the sides of adjoining metatarsals II and IV. In its mid-length it narrows abruptly and wedges between these bones, and, therefore is not visible, or only partly visible along the proximal half. Metatarsal V is about a third of the length of metatarsal IV. It is proximally subtriangular in cross section, distally being flat and deviating outwards. Metatarsals II and IV diverge somewhat in their distal fifth from the inner one. Judging from the extension and shape of the distal articular surfaces

of the metatarsals and those of the first phalanges of digits, the natural position of these latter was also divergent. The proximal articular surfaces of all phalanges 1 are shallowly concave, the articular surfaces between the phalanges of digits II and IV are divided nearly symmetrically by the sagittal crest (base) or sagittal groove (caput). The articular surfaces between the phalanges of digit III are undivided, broad laterally, except the caput of the penultimate phalanx and the base of the ungual, which have a weakly pronounced sagittal groove and crest respectively. The unguals of digits II and IV are somewhat declined outwards in respect to the longitudinal axis of the corresponding digits. The ventral surface of the unguals is flat without any tuber. Instead, a semicircular depression is situated in its mid-length, which is bordered at the sides by the sharp edges of the ungual. Each of these edges ends abruptly before reaching backwards the proximal fourth of the ungual, which results in a small „spur” on either side of the ungual. The structure of the ungual is similar in *S. altus* and presumably this structure is characteristic of all ornithomimids. Differently, in other theropods known to date on the ventral side of the pedal unguals there is a tuber for the tendon of the flexor muscle.

DISCUSSION

Gallimimus bullatus n. gen., n. sp., described here, exhibits some features in its post-cranial skeleton which are regarded by RUSSELL (1972) as characteristic of the genus *Struthiomimus* OSBORN, 1917. It shows the same relation in the structure of the caudal portion of the vertebral column, similar structure of the manus, the same relation between the length of the forelimb and hind limb. However, it is different from *Struthiomimus* in three of the characteristics considered by RUSSELL (1972) to be of generic value: the length of the presacral vertebral column, which is equal to the length of the hind limb (the pedal digits excluding) in *Gallimimus* n. gen. while it is more than that in *Struthiomimus*; the scapula, which is shorter than the humerus in *Gallimimus*, while the contrary is the case in *Struthiomimus*; the ungual of the third digit of the manus, which is shorter than the penultimate phalanx of this digit in *Gallimimus*, instead of being longer than the latter, as it is in *Struthiomimus*. The two latter features are, according to RUSSELL (1972), characteristic of the genus *Ornithomimus* MARSH, 1890. Though the manus of *G. bullatus* is generally comparable with that of *S. altus* in its structure, it is strikingly short, in which respect it differs from not only this species but all the Ornithomimidae as well (p. 138). The most striking feature of *G. bullatus* n. gen., n. sp. is its large size (the skeletal fragments of several large specimens have been found in the Upper Nemegt Beds), in which it differs from all known ornithomimids.

Detailed comparisons of *G. bullatus* with other ornithomimids are difficult, owing to insufficient descriptions and illustrations. *G. bullatus*, however, seems to be most similar to *S. altus*. The comparable data for both species (and in all the ornithomimids as well) are those of the forelimb and hind limb, as well as the pelvic girdle. The skull and the vertebral column may be compared only in some fragments.

COMPARISONS OF THE SKULL AND MANDIBLE

Skulls of the ornithomimids are rarely satisfactorily preserved and only these of three species: *Struthiomimus altus* LAMBE, 1902, *Dromiceiomimus samueli* (PARKS, 1928), *D. breviventrius* (PARKS, 1926)³ may be here compared with the skull of *G. bullatus* n. sp.

³ The postero-dorsal region of skull of this species was recently illustrated by RUSSELL (1972, Fig. 5A—B).

If the largest skull of our species is compared with those of the species above mentioned, the difference in its shape is striking, none of the latter having so long a snout, drawn dorsally by so gently sloping a line. These differences are not at all distinct, when the younger skulls of *G. bullatus* are compared with the skulls of other representatives of the family. Otherwise, the snout of *G. bullatus* does not differ much in its structure, except that, when seen laterally (Pls. XXIX, XXX, Text-fig. 3A) it does not narrow forwards in its distal half and the lower margin of the premaxilla rises upwards anteriorly instead of being horizontal as it is in *S. altus* and *D. samueli*. In dorsal view (Pl. XXXI, Fig. 1, Text-fig. 2B) the distinct differences with these species concern only the anterior part of the snout, which in *G. bullatus* is not narrowed distally and is moreover bluntly ended. Similar blunt snout occurs in the skull of „*Struthiomimus currelli*“ (= *Ornithomimus edmontonicus* STERNBERG, 1933) described and illustrated by PARKS (1926, pl. 2), this however has been crushed vertically, thus it is not possible to decide whether the resemblance is not due to the state of preservation.

It is reasonable to accept that all the ornithomimids had the same feeding habits, and thus the same structure of the snout. In birds, representatives of different genera within the same family frequently have very similar structure of the bill. Two of the three skulls of *G. bullatus* studied by us seem to be very alike in the structure of the snout to the ornithomimids known to date from North America, and it is only in the holotype skull, which is perfectly preserved, that the true structure of the snout could be recognized.

As compared with *S. altus*, the infratemporal fossa in *G. bullatus* is reduced, subtriangular in shape, bordered by the postorbital, squamosal, the prequadrate process of the latter and the very end of the ascending process of the quadrato-jugal. The infratemporal fossa in *S. altus* is larger, rectangular and bordered by the jugal, both branches of the quadrato-jugal, squamosal (with its prequadrate process) and postorbital. *D. samueli* shows comparably small infratemporal fossa, but it is here bordered ventrally (similarly as in *S. altus*) by the quadrato-jugal only. The latter bone has a different shape in *D. samueli* than in *G. bullatus*, having developed an additional forward extension of its ascending process, which lies medially to the posterior margins of the postorbital and jugal.

According to RUSSELL (1972) the supratemporal fossa in *D. brevetertius* is bordered laterally and medially as well, by alae of the squamosal, but he states simultaneously that the sutures are poorly visible there. Judging from the relations between the bones of the temporal region which are clear in *G. bullatus*, the medial wall of the supratemporal fossa was in *D. brevetertius* also formed by the lateral flange of the parietal (p. 111).

The structure of the anterior portion of the basisphenoid (p. 111) in *G. bullatus* is unique among Theropoda known to date. Some resemblances may be indicated in the basicranial portion of the skull of *Dromaeosaurus albertensis* (COLBERT & RUSSELL, 1969, Figs. 6, 9) where a large depression is pronounced anterior to the basal tubera, bordered frontally by a transverse crest, which joins the basiptyergoid processes. In *G. bullatus*, instead of the depression, there is an extensive opening which leads antero-ventrally to the cavity inside the „bulbous structure“, opening postero-dorsally just behind the latter and in front of the pituitary fossa (Text-figs. 2A, 7A).

It would seem at first glance that *G. bullatus* differs from all other representatives of the Ornithomimidae (as well as from all hitherto known dinosaurs) in the presence of the „bulbous structure“. However, in our opinion there is some evidence that this feature may have been present in other ornithomimids (at least in *Dromiceiomimus samueli*) and certainly outside this family, as well (the „bulbous structure“ was noted in the hitherto undescribed

specimen of *Saurornithoides* sp. from Mongolia). Thus, it seems probable that the „bulbous structure” is a character of a higher than specific value.

A significance of the „bulbous structure” remains still unclear to us. Its connection with Rathke’s pouch would suggest that it located the hypophysis, were not the presence of the pituitary fossa developed according to the usual theropod pattern on the anterior wall of the brain case, below the exit for the second nerve and infundibulum. It should be however emphasized here, that presumably a communication between the pituitary fossa and the „bulbous structure” existed, the base of the skull being pierced vertically between them (p. 112). At first glance, the slightly resemblant parasphenoid to that in *G. bullatus* occurs in the phytosaurs (CAMP, 1930, Fig. 37). This resemblance may, however, be superficial, for the parasphenoid there is solid instead of being hollowed as in *G. bullatus*, and closer to the pituitary fossa, its base constituting the anterior wall of the sella turcica.

Observation of the outer walls of the brain case in *G. bullatus* leads us to suggest that the brain was more steeply placed than in *Tyrannosaurus rex* (OSBORN, 1920, Pl. 4), the horizontal olfactory tract being at a significant angle to the main body of the brain. Similarly strong flexure of the brain was described by CAMP (1930, Fig. 46) in phytosaurs.

The pterygoid in *G. bullatus*, which exhibits an additional, medial wing overlapping over a significant distance the medial portion of the basisphenoid (Text-figs. 5A, 8) is different than those known in other theropods. The anterior portion of the pterygoid is developed very similarly in *D. samueli* (PARKS, 1926, Pl. 4), and strongly suggests that there also it underlined the bulbous structure, which is not preserved. The interpterygoid vacuities are extremely narrow in both compared species. Presumably the structure of the pterygoid, which was described in *G. bullatus* was characteristic of the representatives of the Ornithomimidae s. s. and was related to the presence of the „bulbous structure”.

The ectopterygoid in *G. bullatus* strongly resembles in shape that of *Dromaeosaurus albertensis* MATTHEW & BROWN, 1922, except that its lateral process is more delicate and overlaps the jugal over an extensive distance. The subsidiary fenestra, which occurs in *G. bullatus* between the palatine and pterygoid was so far reported, among the theropods, only in the Dromaeosauridae. Quite unique, however, is the presence of an additional, transverse bony lamina of the palatine (in its maxillary portion), which is directed dorsally, and situated perpendicularly to the plane of the palatine. It may be homologous with one of the dorsal „struts”, which were described by OSTROM (1969) in the palatine of *Deinonychus antirrhopus*, but it is evidently overgrown in *G. bullatus*.

The relation between the jaws in the most anterior part of the snout, with a gap between them when the mouth was shut, can be only compared with that between the jaws in *Oviraptor philoceratops* OSBORN, 1924. The retroarticular process of the mandible in *G. bullatus* is similarly constructed as in *S. altus*, but not as in *D. samueli*, where it is more delicate.

COMPARISONS OF THE POSTCRANIAL SKELETON

The differences between *G. bullatus* n. sp. and other ornithomimids in the postcranial skeleton deal with the somewhat different shape of some bones and with the proportions of particular bones, or portions of the limbs.

The vertebral column consists of a similar number of vertebrae in *G. bullatus* and *S. altus*, which is 64—66 and 67 respectively, the difference being due to a lesser number of caudals in *G. bullatus*. The neck is longer in relation to the trunk (approximately 85% of

the latter in *G. bullatus*) than in other ornithomimids (approx. 76% in *S. altus*). The atlas of *G. bullatus* deviates very strongly from those known in other theropods. The main difference involves the intercentrum, which has a surface for articulation with the occipital condyle slightly slanting downwards posteriorly, instead of being concave and facing antero-dorsally. It probably gave little support to the skull. Cervicals 3 and 4 are very long in *G. bullatus* in comparison with the corresponding cervicals of *S. altus* and *D. brevetertius* (RUSSELL, 1972, Figs. 1, 4). The neural arches of the cervicals are lower than in *S. altus* and *D. samueli*. The anterior cervicals expose an oblique angling of the centre (Pl. LII, Figs. 2b, 3b). The angling of the centra is a character of a rank higher than a specific one, and as though not yet reported in any ornithomimid, it seems to be present in the cervicals of *S. altus* (OSBORN, 1917, Pl. 24) and *D. samueli* (PARKS, 1928, Pl. 1). Slight angling is evident also on the centra of the last dorsals in *G. bullatus*. Dorsal 13, which differs from the other dorsals (p. 119) i. e. in lacking ribs (similarly as dorsal 13 in *Ceratopsaurus nasicornis* MARSH 1884 in GILMORE, 1920), cannot be compared with that in other ornithomimids owing to insufficient data. RUSSELL (1972) includes dorsal 13 in the sacral series; thus, according to him the sacrum numbers six vertebrae. We differ here with RUSSELL's interpretation, on the basis of the fact that the centrum of dorsal 13 is not fused to the sacrum and its structure remains typical for the dorsals, with some characters transitional to the sacrals (lack of the postzygapophyses, development of the vertical lamina of bone connecting the diapophysis with the neural spine).

It should be emphasized here, that in the literature dealing with ornithomimids, there is some divergence of opinion as to the number of sacral vertebrae. GILMORE (1920, 1933) stated that there were four sacrals in *Ornithomimus sedens* and „*Ornithomimus*” *asiaticus*, while OSBORN (1917) counted five sacrals in *S. altus*. PARKS (1926, 1933) considered that six sacral vertebrae were in „*Struthiomimus*” *brevetertius* and „*Struthiomimus currelli*”. Comparison of illustrations of the pelvis of *Ornithomimus sedens* and *Archaeornithomimus asiaticus* with the perfectly preserved pelvis of *G. bullatus* proves that these species also have but five sacrals. Contrary to RUSSELL's opinion (1972) that only sacrals 3—5 (ours 2—4) are provided with ribs, our specimens prove that the latter are present on all sacrals (Text-fig. 9). The sacrum of *G. bullatus* is somewhat longer than that of other ornithomimids. It is 76% of the femur length, while in *Ornithomimus edmontonicus* and *Dromiceiomimus brevetertius* (= „*Struthiomimus currelli*” and „*Struthiomimus ingens*” in PARKS 1933, table on p. 14, S₃—S) it is 74% and 75%, respectively. In contrast with *S. altus* and *O. sedens*, where the neural spines of sacrals are fused, forming a continuous plate, those in *G. bullatus* are separated, even in fully-grown individuals.

The transition point in the tail of *G. bullatus* occurs between caudals 15 and 16, as it is in *S. altus*. The structure of the caudal portion of the vertebral column does not differ greatly from that in other ornithomimids.

Judging from RUSSELL's (1972, Figs. 1, 4) reconstructions of *S. altus* and *D. brevetertius* there are some differences in the ribs of *G. bullatus*. The axial rib deviates in its shape from those of other cervicals, being long, thin and rod-like, while the axial ribs of the species mentioned are similar to those of the remaining cervicals⁴; cervical 10 is provided with the rib, which differs in its shape from other cervical ribs, being comparable to the dorsal ribs, though about half as long as that of dorsal 1. The ribs of dorsals 3 and 4 are much broader proximally than the same ribs in *S. altus* and *D. brevetertius*.

⁴ According to Dr A. D. RUSSELL's personal communication, the axial rib is not preserved in any American ornithomimid.

The scapula is somewhat less expanded distally than in other theropods, with the possible exception of *Deinonychus antirrhopus* OSTROM, 1969, in which it is typically ornithomimid-like. It is stouter in *G. bullatus* than the scapula of *D. samuelli*, especially just above the acromion, the region which in the species compared is distinctly narrowed (PARKS, 1928, Pl. 1). The humerus in *G. bullatus* is longer than the scapula, just as it is the case of *Ornithomimus edmontonicus* STERNBERG, 1933. In comparison with the humerus in *Deinocheirus mirificus* OSMÓLSKA & RONIEWICZ, 1970, that of the species here described was feeble, its delto-pectoral crest being much smaller and situated closer to the articular head (p. 126). The relation of the radio-ulnar segment to the humerus (table 7) is very variable in Ornithomimidae s. s. It equals 66% in *G. bullatus* as compared with 70% in *S. altus* and *O. edmontonicus* and 91% in *D. samuelli*. The same proportion between the two segments as in *G. bullatus* occurs in the forelimb of *Deinocheirus mirificus*. The forelimb as a whole, does not differ much from those known in other representatives of the family (table 7), being also comparatively weak. Its total length equals 50% of that of the hind limb, the same as in *S. altus* (51%). There is a striking difference between both species compared in the proportions within the forelimb itself: the manus in *G. bullatus* is only 26% of the total forelimb length⁵, while in *S. altus* the manus represents 37% of the total forelimb length. It should be emphasized here that the manus of *G. bullatus* is the shortest not only among the known ornithomimids, where it ranges 35–38% of the total length, but also as compared with that of *Deinocheirus mirificus* (32%) and *Deinonychus antirrhopus* (34%). Though the manus in *G. bullatus* is shorter than that of *Deinocheirus mirificus*, both are very similarly constructed, differing in the following details: metacarpal II is the longest one in *G. bullatus*, while metacarpal III is the longest one in *Deinocheirus mirificus*; phalanx III₂ is less than 1/2 the length of phalanx III₃ in *G. bullatus*, while in *D. mirificus* phalanx III₂ is longer than half of phalanx III₃; the unguals in *G. bullatus* are less curved and shorter in relation to the corresponding penultimate phalanges than in *D. mirificus*; digit III has a lesser degree of flexion and extension in *G. bullatus* than in the species compared.

There are several differences in the structure of the pelvis in *G. bullatus* as compared with that of *S. altus*. The iliac and pubic peduncles in *G. bullatus* are shorter. In lateral view, the ventral outline of the pubic „foot” in *G. bullatus* is nearly flat, similar to that of *Archaeornithomimus asiaticus* (GILMORE, 1933, Fig. 6), while that of *S. altus* is bent angularly at the front, having a shorter posterior extension.

The structure of the hind limb in *G. bullatus* shows but slight differences in comparison with that of *S. altus*. Recently RUSSELL (1972) calculated some indices i. e. for the hind limb of *S. altus* and *D. brevetertius*, which allowed us to make some comparisons. They show that the third pedal digit of *G. bullatus* is much shorter than those in the Ornithomimidae hitherto known (p. 133). The length of the crus in *G. bullatus* in relation to the length of the femur is comparable to that of *S. altus*, but shorter than that in *D. brevetertius*. Attention should be drawn to the structure of the astragalus — calcaneum unit (p. 132). It makes the union of the two bones very strong. A very similar relation is found in the tarsus of *Ornithomimus velox* MARSH, and presumably is characteristic of all ornithomimids. It is also found in the Carnosauria — *Tyrannosaurus*, *Tarbosaurus*, *Albertosaurus* and *Allosaurus* — though lacking in *Ceratosaurus* and the Dromaeosauridae. In the structure of the metatarsus *G. bullatus* differs from *S. altus* in having a somewhat longer metatarsal II in relation to metatarsal IV. Metatarsal III in the latter species narrows more gradually upwards than that in *G. bullatus*, wedging between the adjoining metatarsals only in its upper third.

⁵ Including the length of the manus.

GROWTH CHANGES

Measurements of the skulls and postcranial skeletons (tables 1—5) taken for several specimens of *G. bullatus* in different growth stages have allowed us to calculate some indices (table 6). Though based on scanty material (for statistical purposes) they provide still general information about the growth process.

Table 6

Selected anatomic ratios illustrating the growth changes in *Gallimimus bullatus* n. sp.

| Mus.Cat.Nos. | PoL/Cr* | AoL/Cr | Or/Cr | Cr/F | R/F | R/T | T/F | Mt.III/F | Mt.III/T | |
|--------------------|---------|--------|-------|------|------|------|------|----------|----------|-------|
| G.I.No.DPS 100/10 | 0.15 | 0.49 | 0.32 | 0.62 | — | — | 1.14 | 0.80 | 0.71 | Young |
| Z.Pal.No.Mg.D-1/94 | — | — | — | — | 0.40 | 0.33 | 1.11 | 0.80 | 0.71 | |
| Z.Pal.No.Mg.D-1/1 | 0.15 | 0.55 | 0.32 | 0.50 | — | — | 1.08 | 0.77 | 0.72 | ↓ |
| G.I.No.DPS 100/11 | 0.11 | 0.67 | 0.23 | 0.50 | 0.53 | 0.47 | 1.11 | 0.78 | 0.72 | Adult |

* For abbreviations see the text below.

The following four indices have been calculated for the skulls: postorbital length (PoL) to the maximum length of skull (Cr) ratio; antorbital length (AoL) to maximum length of skull ratio; orbital length (Or) to maximum length of skull ratio; maximal length of skull to length of femur (F). They show that the proportions and shape of the skull change significantly during individual growth. In the largest specimen, the posterior region of the skull (measured to the posterior margin of orbit) is 11% of the total skull length, while in two younger specimens it is 15%. The orbits relatively decrease during the growth. The case is different with the snout, which shows a constant relative increase in length during individual growth. These data are in accordance with observations of the growth process in contemporary crocodiles (KRAMER & MEDEM, 1955/56), where the young specimens have larger orbits and shorter snouts than the adults and the snout increases in length more quickly than the posterior region of the skull. The skull as contrasted with the hind limb growth (femur), is larger in the smallest specimen than in the two older ones.

Unfortunately, due to the fragmentary nature of the material, it was not possible to obtain full information concerning the changes of the forelimb to hind limb ratio. The only indices, which could be calculated for this purpose show that the radius (R) becomes slightly longer during growth in relation to both the femur (F) and tibia (T). Thus, presumably, the length of the forelimb relatively increased during the life time. The indices calculated for obtaining information concerning the mutual relations of particular sections within the hind limb show that the proportions change here very slightly.

KINETICISM AND STREPTOSTYLISM

We were able to observe in the skulls at our disposal, that there are, in many places, loose connections between the adjacent bones, which could have promoted a high degree of intracranial mobility in *Gallimimus bullatus*. It should be emphasized here that most

of these loose connections were observed in the skulls of two young specimens (one of them — Z.Pal.No.Mg.D-I/1 — representing probably a young adult) but some were still clearly detectable in the holotype specimen, which is the largest known ornithomimid individual and certainly represents a late adult stage.

In all skulls considered the metakinetic condition is distinctly recognizable (p. 111), and in addition to the loose contact between the supraoccipital and parietals, there exists a condylar articulation between the supraoccipital and squamosal, the latter being observed, however, in the younger skull (Z.Pal.No.Mg.D-I/1). A similar relation between these two bones was described by GILMORE (1937) in a hadrosaurian cranium. It was discussed by OSTROM (1961) who believed it to be due to the juvenal stage of the individual growth. In the undoubtedly adult specimen (G.I.No.DPS 100/11) of *G. bullatus* the squamosal-supraoccipital relation cannot be investigated because of the state of preservation. However, taking into account the fact that even in this species the loose connection between the supraoccipital and parietal cannot be doubted, it seems probable that some degree of mobility should also exist between the squamosal and supraoccipital.

Basal articulation in *G. bullatus* is well pronounced, laterosphenoids are loosely attached to the cranial roof (p. 113) and consequently, the occipital segment forms a distinct unit consisting of the supraoccipital, paroccipital processes, prootics, basioccipital, basisphenoid, parasphenoid and laterosphenoids.

The maxillary segment, at least in young skulls, does not form a consolidated, rigid structure and, just as may be observed in many birds (i. e. in *Anser*) it shows that some of its elements are more loosely bound to the others. However, at present it is difficult to state whether the separate units could be distinguished within the segment in question. In addition to the basal articulation and the metakinetic joint, the maxillary segment contacts the occipital segment posteriorly in the squamosal-opisthotic junction (very loose in young skulls), and also medially where the medial wings of the pterygoids cover to an extensive degree the dorsal surface of the basisphenoid along both sides of the pituitary fossa (p. 116). This junction is free though close and was observed in the largest skull (holotype). It is possible that some independence of the cranial roof within the maxillary segment was the case in *G. bullatus*. It may be noticed that between the prefrontal and frontal in young skulls as well as between the lacrimal and nasal, palatine and maxilla in young and adult skulls the sutures were very loose and most probably some sliding movements could take place there. On the other hand, no true mesokinetic joint was observed across the skull of the largest specimen in which it was possible to investigate. Whether there was any flexibility of the bone on the boundary between the frontals and nasals, which is the case with some birds (unless they have a joint here) cannot be stated, though it is not improbable, and this possibility has already been considered by RUSSELL (1972).

The pterygoid-quadrate articulation demands attention, as it seems to be comparatively loose in the „young adult” skull, while almost rigid in the largest one. The quadrate-squamosal articulation in the ornithomimids has already been discussed by RUSSELL (1972), who proposes that the quadrate was capable of limited antero-posterior movement. Streptostylysm was also considered in connection with the hadrosaurian skull by OSTROM (1961), who came, however, to the conclusion that the prequadratic process of the squamosal developed there did not allow any forward movement of the quadrate. In *G. bullatus*, as in other known ornithomimids the quadrate is also bounded anteriorly by the prequadratic process of the squamosal, as well as antero-laterally by a thin, dorsal extension of the quadrato-jugal. Thus, it seems that in the ornithomimids as well forward movements of the quadrate were not possible.

GENERAL CONSIDERATIONS

In the literature on the ornithomimids hitherto known (OSBORN, 1917; RUSSELL, 1972) their supposed adaptations and mode of life were widely discussed. We agree with RUSSELL's conclusions concerning the feeding habits and cursorial adaptations (RUSSELL, 1972). We would like simply to draw attention to some adaptations which are pronounced in the structure of the neck and have not yet been described in ornithomimids.

The proximal cervical region of *G. bullatus* exhibits a distinct angling of the articular surfaces of the vertebral centra (p. 118). This phenomenon was reported first by OSTROM (1969) in *Deinonychus antirrhopus*, though it seems to be quite common among the theropods. In

Table 7

Selected anatomic ratios in some ornithomimids as compared with *Deinocheirus mirificus* and *Deinonychus antirrhopus*

| Species | Manus/forelimb | Manus/humerus | Forelimb/hind limb | Skull/forelimb | Radius/humerus | Tibia/femur | Mt. III/femur | Mt. III/tibia | Pes/femur | Pes/hind limb |
|--|----------------|---------------|--------------------|----------------|----------------|-------------|---------------|---------------|-----------|---------------|
| <i>Gallimimus bullatus</i> n. sp. | 0.26 | 0.58 | 0.50 | 0.27 | 0.66 | 1.08—1.14 | 0.77—0.8 | 0.71—0.72 | 1.15 | 0.35 |
| <i>Struthiomimus altus</i> OSBORN | 0.37 | 1.00 | 0.55 | 0.28 | 0.70 | 1.08—1.13 | 0.75—0.79 | 0.68 | 1.06 | 0.33 |
| <i>Ornithomimus edmontonicus</i> STERNBERG | 0.35—0.38 | 0.94 | 0.51 | 0.27 | 0.69 | 1.46 | — | 0.65? | 1.20 | 0.38 |
| <i>Dromiceiomimus samueli</i> (PARKS) | — | — | — | — | 0.91 | — | — | — | — | — |
| <i>Dromiceiomimus breviventris</i> (PARKS) | — | — | — | — | — | 1.18—1.24 | 0.76—0.86 | 0.69? | 1.29 | 0.37 |
| <i>Deinocheirus mirificus</i> OSMÓLSKA & RONIEWICZ | 0.32 | 0.82 | — | — | 0.66 | — | — | — | — | — |
| <i>Deinonychus antirrhopus</i> OSTROM | 0.34 | 1.23 | 0.70 | 0.45 | 0.76 | — | — | — | — | — |

G. bullatus the angling occurs in cervicals 2—6 (thus including the axis), the angles being 58°—83°, while in *Deinonychus antirrhopus* — in cervicals 3—7, the angles being 58°—85° to the level of the neural canal. The natural curvature of the neck in *G. bullatus*, caused by the angling mentioned, can be reconstructed rather precisely, as the whole series of the cervicals is preserved in one of the specimens (Z.Pal.No.Mg.D-I/94). The neck was held slightly obliquely, declining up at an angle of about 35° to the line of the anterior dorsals (Text-fig. 1). It should be noted here that the head was very small and light in relation to the vertebral column. May be, the structure of the atlas (p. 117) with the slightly ventrally directed articular facet for contact with the occipital condyle, resulted from the head's being light or from the peculiar natural curvature of the neck. Attention should be drawn to the fact, that the proximal portion

of the neck was very mobile in *G. bullatus*, having short and broad zygapophyses with extensive articular surfaces. The structure of the neural arches in this region is strikingly similar to that in the chicken and some other Galliformes, which may suggest that feeding habits were also comparable. In the posterior portion, the neck was more rigid, the articular surfaces of zygapophyses being much more limited. In the structure of the snout, RUSSELL (1972) sees similarities with the insectivorous birds, while in *G. bullatus* it recalls rather the bill of a duck or goose. We presume that the animal fed on small, living prey, swallowed whole. The mobile neck was very useful in looking for the prey on the ground, because the eyes were very lateral in position.

In 1969 OSTROM presented the functional analysis of the forelimb mainly of *Deinonychus antirrhopus*, but also of the ornithomimids. We fully accept his view; that the polex in ornithomimids cannot be regarded as a truly opposable digit, nor can the manus be regarded

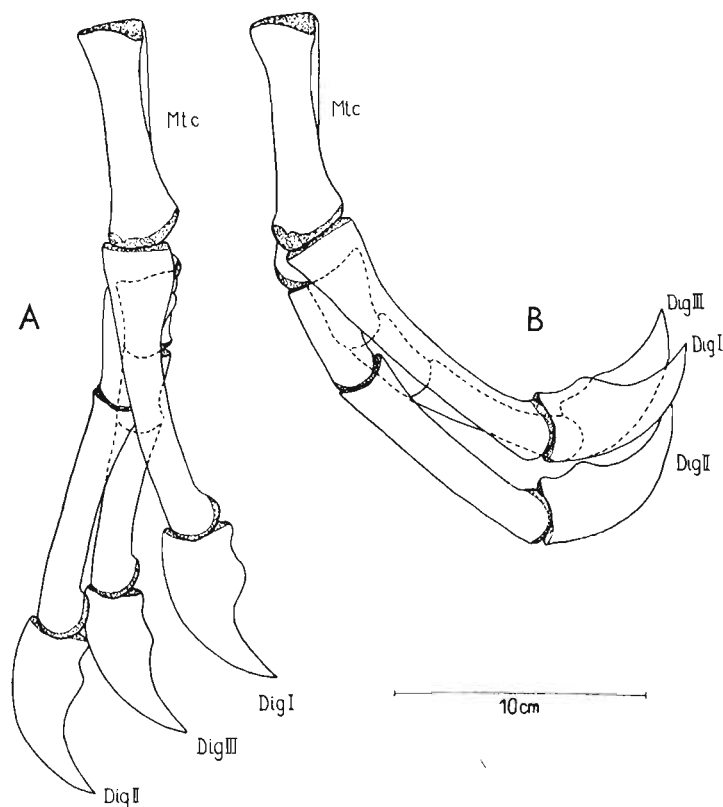


Fig. 18

Gallimimus bullatus n. sp.

Sketch drawing of the right manus in medial view: *A* — maximal extension, *B* — maximal flexion of digits, based on type specimen (G.I.No.DPS 100/11).

as a prehensile or grasping organ. This paper presents an illustration (Text-fig. 18) analysing the maximum flexion and extension possibilities for the manus of *G. bullatus*. It shows that these movements were very limited. The forelimbs of *Deinonychus mirificus* (OSMÓLSKA & RONIEWICZ, 1970, Fig. 3) exhibit a similar adaptation, but in this latter animal they were adapted rather to tearing the prey asunder, being much stronger than in the ornithomimids. The humerus

of *G. bullatus* was feeble in comparison with that of *D. mirificus*, the delto-pectoral crest being much smaller, thus providing less surface for the insertion of mm. coracobrachialis and pectoralis, which are responsible for the adduction and pronation of the humerus. It was, moreover, situated closer to the articular head of the humerus and consequently the effect of the action was less powerful in *G. bullatus*. The forelimbs of *G. bullatus* with their short manus presumably were not used for carrying food to the mouth, but more probably for „raking” or digging light material on the ground in order to get access to food.

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Warszawa, November 1971*

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Ulan Bator, November 1971*

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PLATES

H. OSMÓLSKA, E. RONIEWICZ & R. BARSBOLD: *GALLIMIMUS BULLATUS* N. SP.

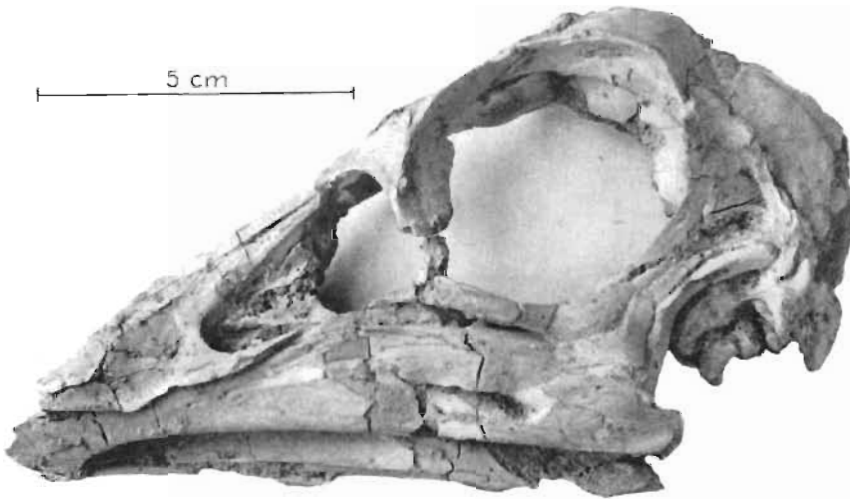
PLATE XXIX

| | Page |
|--|------|
| <i>Gallimimus bullatus</i> n. sp. | 105 |
| Upper Cretaceous, Upper Nemegt Beds, Gobi Desert | |

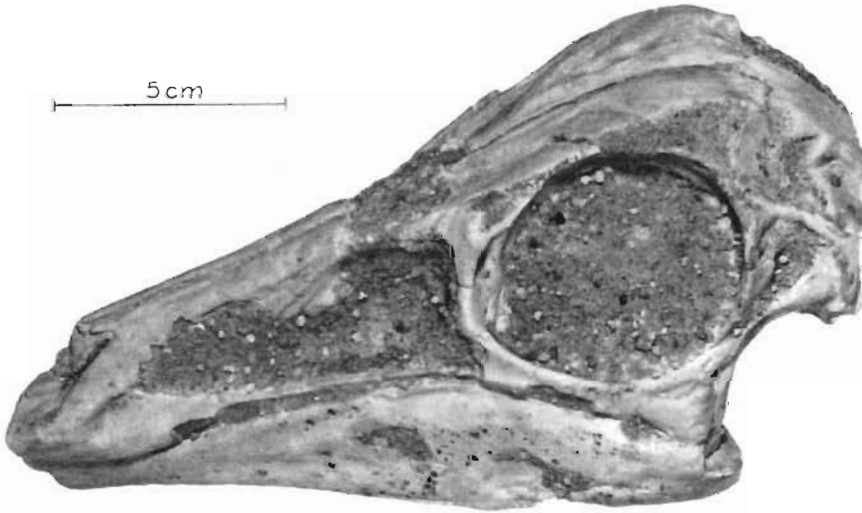
- Fig. 1. Skull of the smallest specimen. Bugeen Tsav. G.I.No.DPS 100/10. See also Plate XXX, Fig. 1.
Fig. 2. Plaster cast of the skull with mandible of the young specimen, before preparation. Photograph inverted.
Tsagan Khushu, Nemegt Basin. Z.Pal.No.Mg.D-I/1. See also Plate XXX, Fig. 2.
Fig. 3. Skull with mandible of the type specimen. Tsagan Khushu, Nemegt Basin. G.I.No.DPS 100/11. See
also Plates XXXI-XXXIV.

Photo: W. Skarżyński





1



2



3

H. OSMÓLSKA, E. RONIEWICZ & R. BARSBOLD: *GALLIMIMUS BULLATUS* N. SP.

PLATE XXX

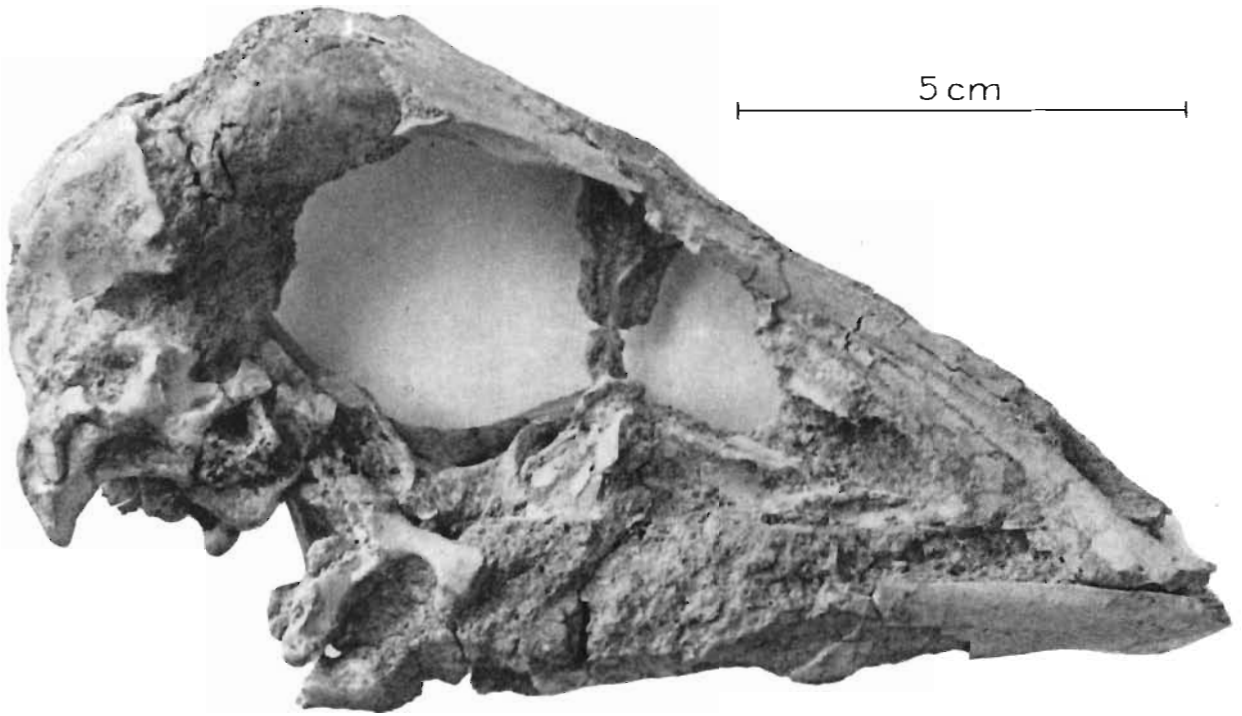
| | Page |
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| <i>Gallimimus bullatus</i> n. sp. | 105 |
| Upper Cretaceous, Upper Nemegt Beds, Gobi Desert | |

Fig. 1. Right side of the skull with mandible of the smallest specimen found. The left side of the same specimen is figured on Plate XXIX, Fig. 1. Bugeen Tsav. G.I.No.DPS 100/10.

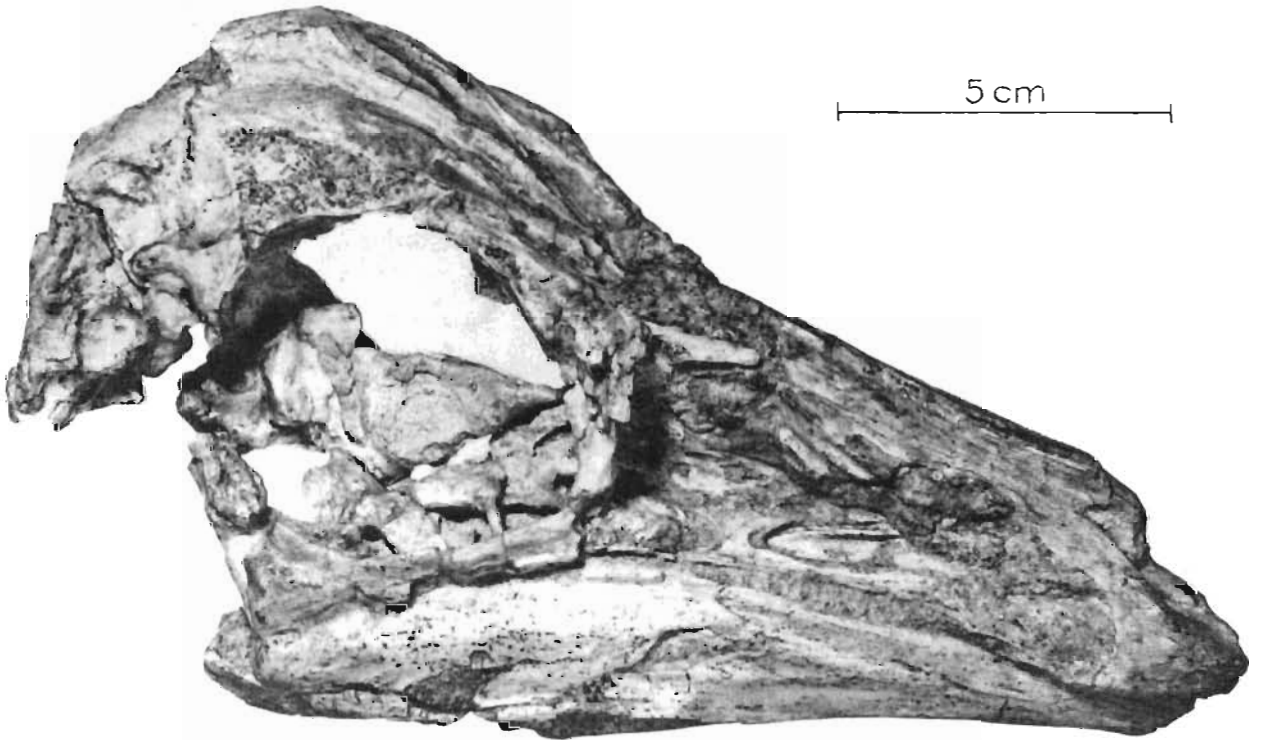
Fig. 2. Skull with mandible of the young specimen, after preparation. The plaster cast of the same specimen before preparation is figured on Plate XXIX, Fig. 2. Tsagan Khushu, Nemegt Basin. Z.Pal.No.Mg.D-I/1.

Photo: W. Skarżyński





1



2

H. OSMÓLSKA, E. RONIEWICZ & R. BARSBOLD: *GALLIMIMUS BULLATUS* N. SP.

PLATE XXXI

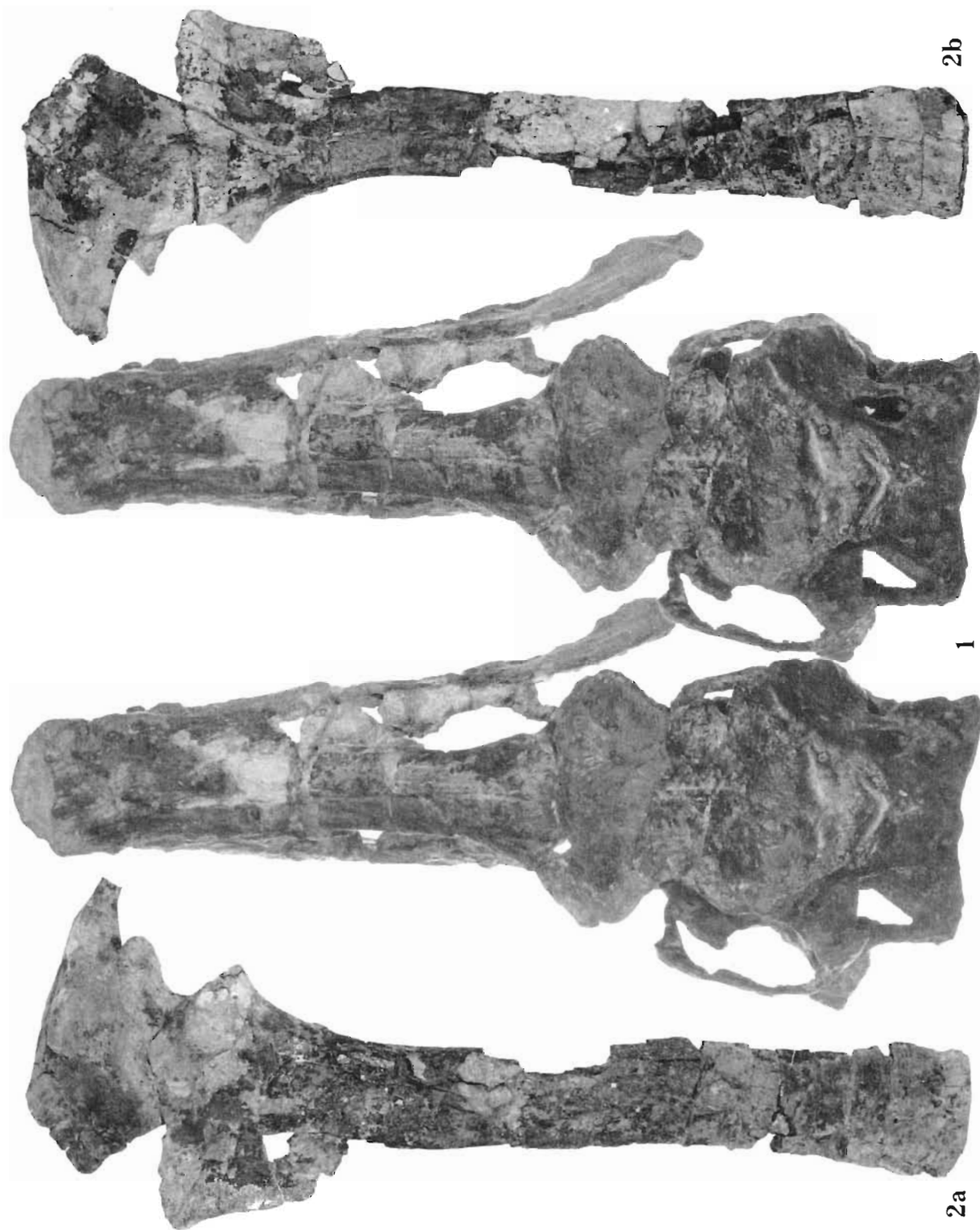
| | Page |
|--|------|
| <i>Gallimimus bullatus</i> n. sp. | 105 |
| Upper Cretaceous. Upper Nemegt Beds, Tsagan Khushu, Nemegt Basin, Gobi Desert. Type specimen, G.I.No.DPS 100/11 | |

Fig. 1. Stereo-photograph of the skull, dorsal view: $\times 0.5$. See also Plates XXIX, XXXII-XXXIV.

Fig. 2. Right scapulo-coracoid, *a* — lateral view, *b* — medial view: $\times 0.25$. See also Plate XXXII, Fig. 3.

Photo: W. Skarżyński





H. OSMÓLSKA, E. RONIEWICZ & R. BARSBOLD: *GALLIMIMUS BULLATUS* N. SP.

PLATE XXXII

| | Page |
|--|------|
| <i>Gallimimus bullatus</i> n. sp. | 105 |
| Upper Cretaceous, Upper Nemegt Beds, Tsagan Khushu, Nemegt Basin, Gobi Desert. Type specimen, G.I.No.DPS 100/11 | |

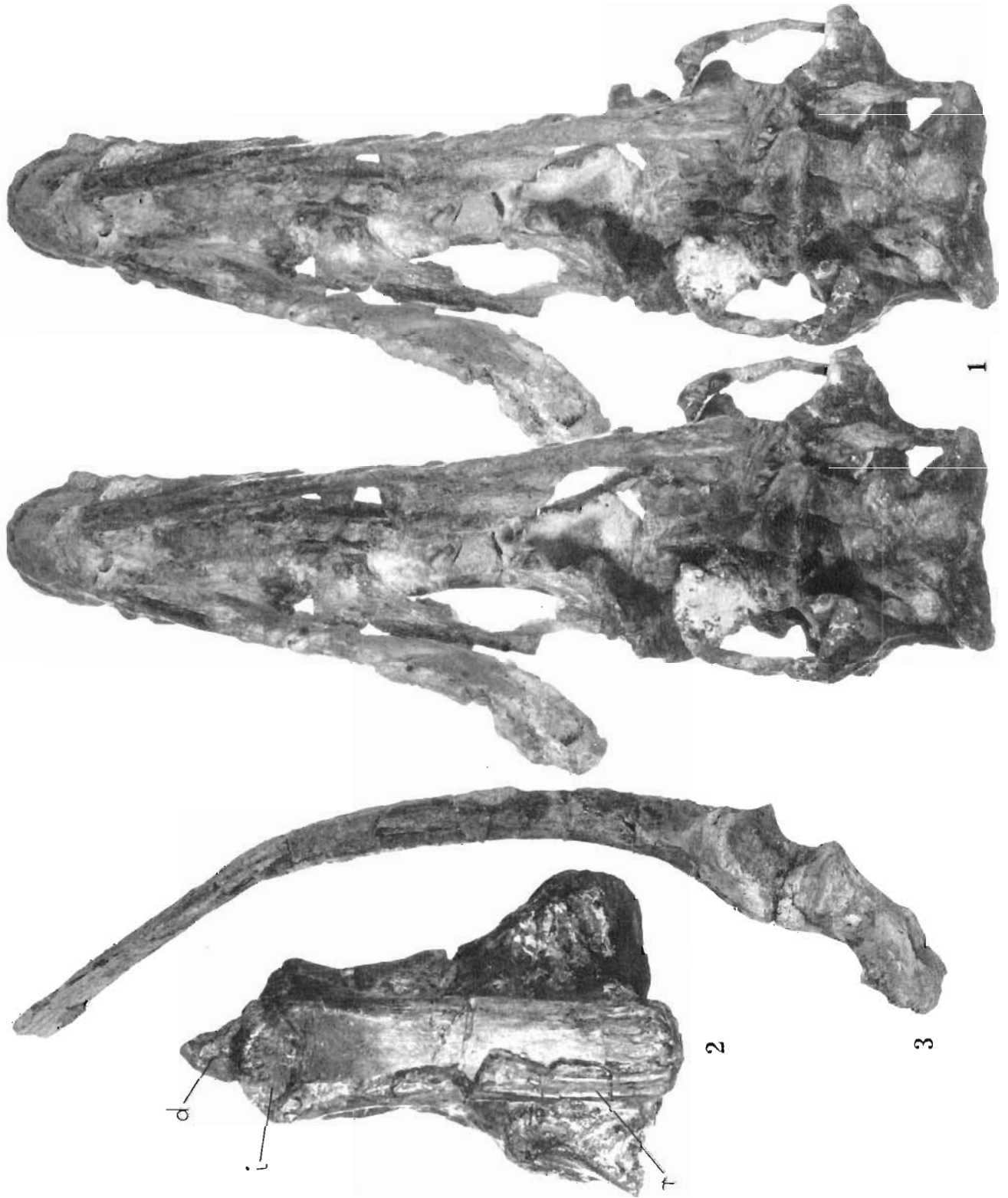
Fig. 1. Stereo-photograph of the skull with mandible, ventral view; $\times 0.5$. See also Plates XXIX, Fig. 3, XXXI, Fig. 1, XXXIII, XXXIV.

Fig. 2. Axis with the right axial rib attached, ventral view: *d* — dens, *i* — intercentrum, *r* — rib; $\times 1$.

Fig. 3. Right scapulocoracoid, posterior view; $\times 0.25$. See also Plate XXXI, Fig. 2.

Photo: W. Skarżyński





H. OSMÓLSKA, E. RONIEWICZ & R. BARSBOLD: *GALLIMIMUS BULLATUS* N. SP.

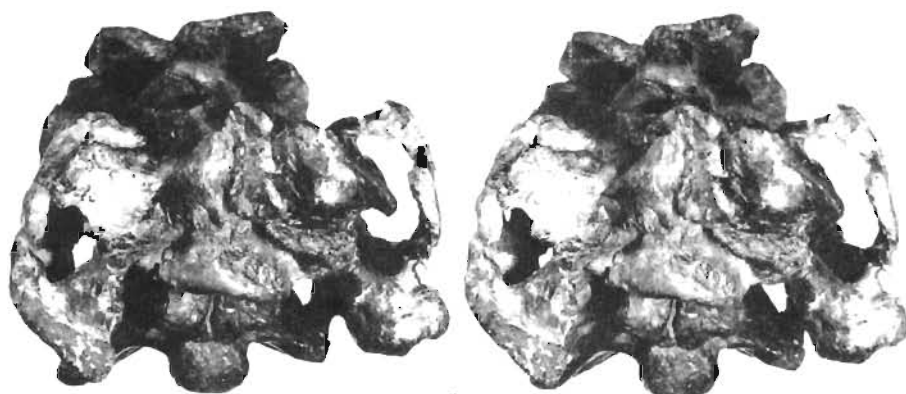
PLATE XXXIII

| | Page |
|--|------|
| <i>Gallimimus bullatus</i> n. sp. | 105 |
| Upper Cretaceous, Upper Nemegt Beds, Tsagan Khushu, Nemegt Basin, Gobi Desert. Type specimen, G.I.No.DPS 100/11 (See also Plates XXIX, Fig. 3, XXXI, Fig. 1, XXXII, XXXIV) | |

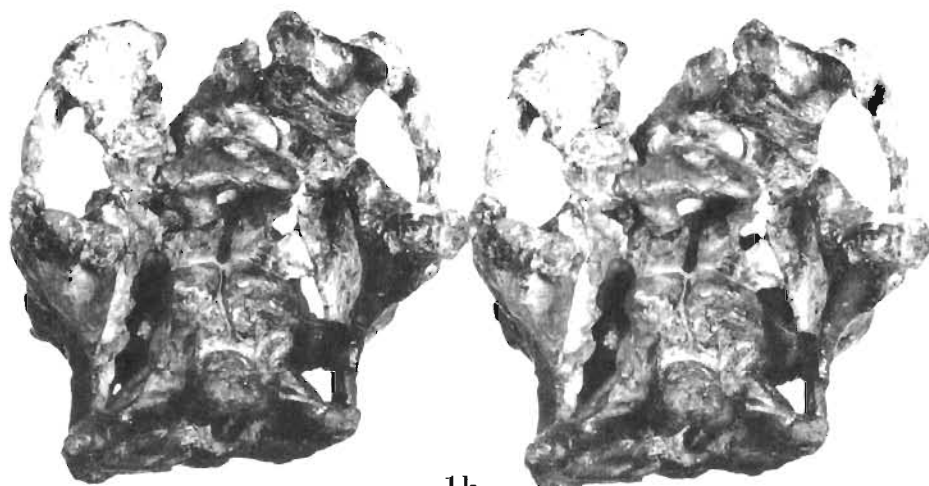
Fig. 1. Stereo-photograph of the brain case, *a* — ventral view, *b* — postero-ventral view, *c* — posterior view, exposing the entrance to the „bulbous structure“ (Rathke's pouch); $\times 0.5$.

Photo: W. Skarżyński

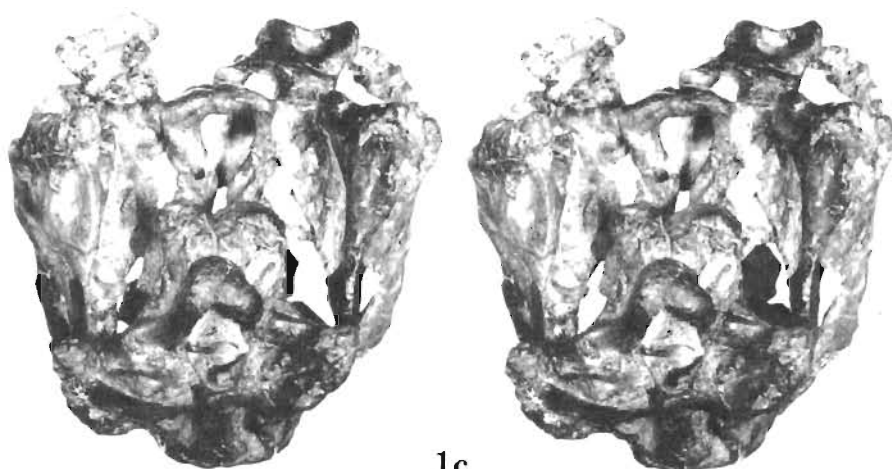




1a



1b



1c

H. OSMÓLSKA, E. RONIEWICZ & R. BARSBOLD: *GALLIMIMUS BULLATUS* N. SP.

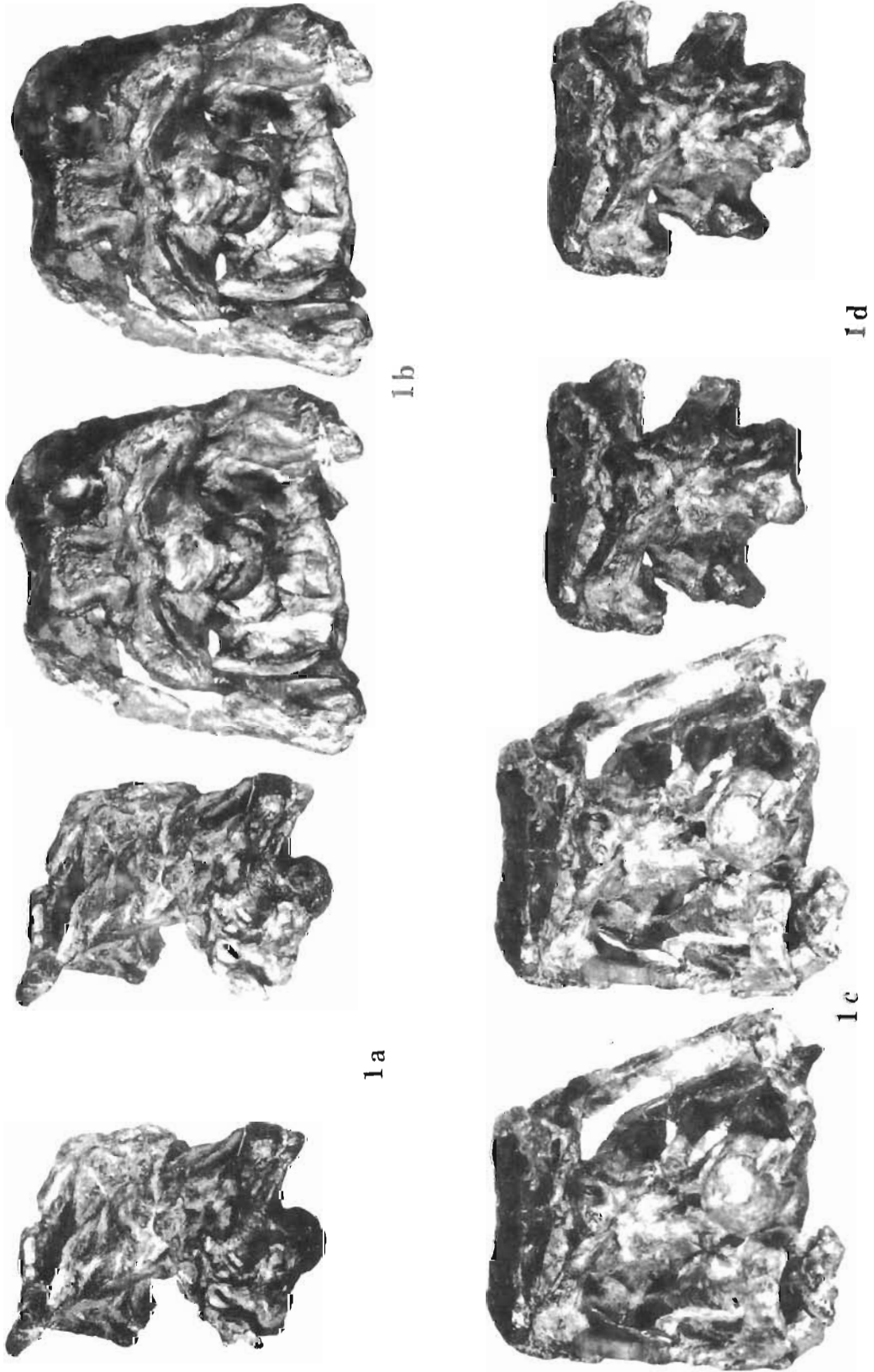
PLATE XXXIV

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|---|------|
| <i>Gallimimus bullatus</i> n. sp. | 105 |
| Upper Cretaceous, Upper Nemegt Beds, Tsagan Khushu, Nemegt Basin, Gobi Desert. Type specimen, G.I.No.DPS 100/11 (See also Plates XXIX, Fig. 3, Pl. XXXI, Fig. 1, XXXII, XXXIII) | |

Fig. 1. Stereo-photograph of the brain case, *a* — lateral (somewhat oblique) view, *b* — occipital view, *c* — anterior view with the „bulbous structure“, *d* — anterior view, the „bulbous structure“, pterygoids and postorbitals removed; $\times 0.5$.

Photo: W. Skarżyński





H. OSMÓLSKA, E. RONIEWICZ & R. BARSBOLD: *GALLIMIMUS BULLATUS* N. SP.

PLATE XXXV

| | |
|--|------|
| | Page |
| <i>Gallimimus bullatus</i> n. sp. | 105 |
| Upper Cretaceous, Upper Nemegt Beds, Tsagan Khushu, Nemegt Basin, Gobi Desert. Type specimen, G.I.No.DPS 100/11 | |

Fig. 1. Left humerus, *a* — anterior view, *b* — medial view, *c* — lateral view, *d* — posterior view; $\times 0.33$.

Photo: W. Skarżyński





H. OSMÓLSKA, E. RONIEWICZ & R. BARSBOLD: *GALLIMIMUS BULLATUS* N. SP.

PLATE XXXVI

| | Page |
|---|------|
| <i>Gallimimus bullatus</i> n. sp. | 105 |
| Upper Cretaceous, Upper Nemegt Beds, Tsagan Khushu, Nemegt Basin, Gobi Desert. Type specimen, G.I.No.DPS 10011 | |

- Fig. 1. Right manus with a carpal, dorsal view; $\times 0.5$.
Fig. 2. Right ulna, *a* — anterior view, *b* — posterior view, *c* — lateral view; $\times 0.33$.
Fig. 3. Left ulna, somewhat damaged, *a* — anterior view, *b* — posterior view, *c* — lateral view; $\times 0.33$.
Fig. 4. Left radius. *a* — anterior view, *b* — posterior view, *c* — lateral view; $\times 0.33$.

Photo: W. Skarżyński



1



2a

2b

2c

4a

3a

4b

3b

4c

3c

H. OSMÓLSKA, E. RONIEWICZ & R. BARSBOLD: *GALLIMIMUS BULLATUS* N. SP.

PLATE XXXVII

| | Page |
|---|------|
| <i>Gallimimus bullatus</i> n. sp. | 105 |
| Upper Cretaceous, Upper Nemegt Beds, Nemegt, Nemegt Basin, Gobi Desert. Z.Pal.No.Mg.D-1/94. | |

Young specimen, before the final preparation. Distal segments of the hind limbs and part of the tail removed.

Photo: W. Skarżyński





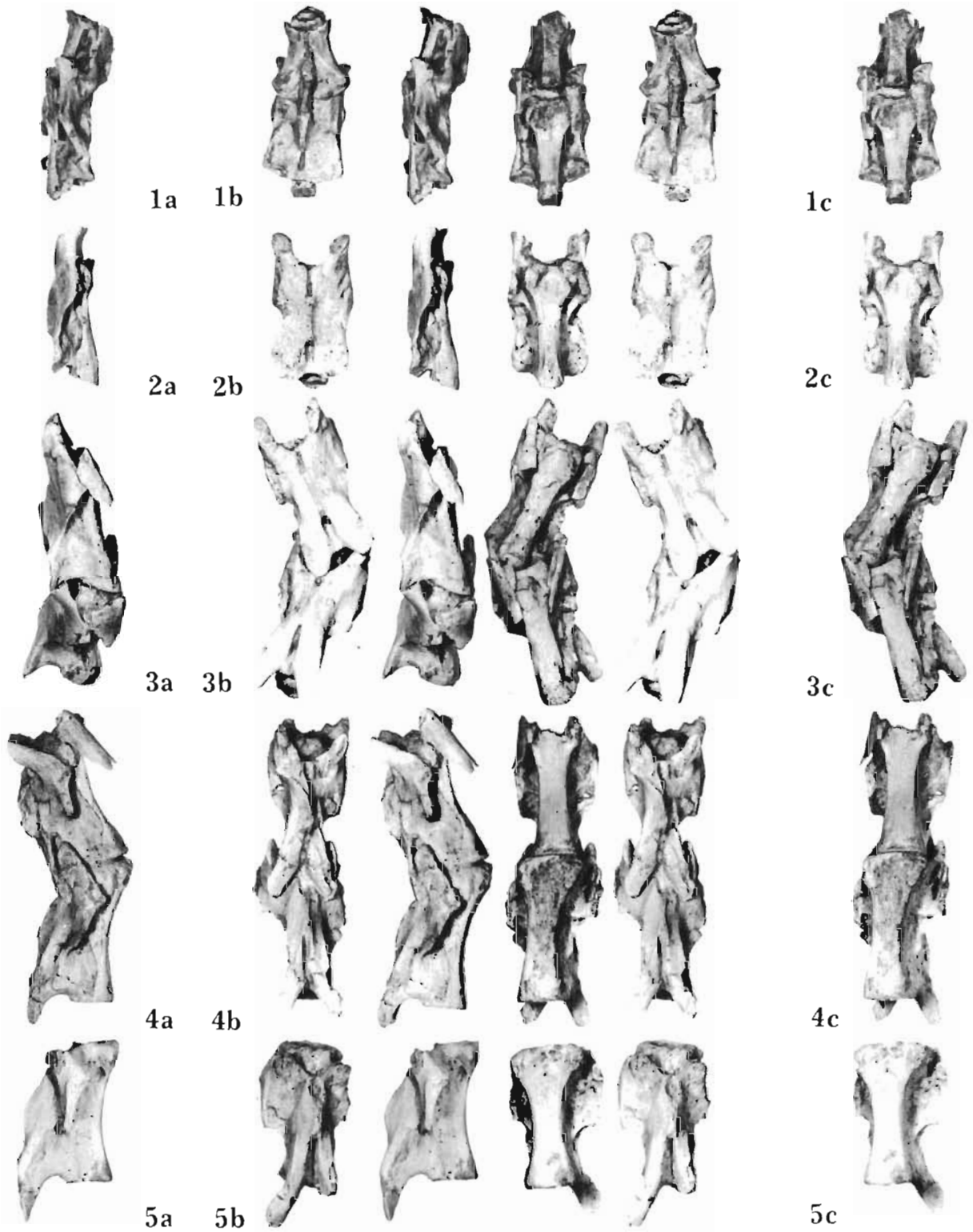
H. OSMÓLSKA, E. KONIEWICZ & R. BARSBOLD: A NEW DINOSAUR *GALLIMIMUS BULLATUS*

H. OSMÓLSKA, E. RONIEWICZ & R. BARSBOLD: *GALLIMIMUS BULLATUS* N. SP.

PLATE XXXVIII

| | Page |
|--|------|
| <i>Gallimimus bullatus</i> n. sp. | 105 |
| Upper Cretaceous, Upper Nemegt Beds, Nemegt, Nemegt Basin, Gobi Desert. Z.Pal.No.Mg.D-1/94 | |
| Fig. 1. Stereo-photograph of the axis and third cervical vertebra, <i>a</i> — lateral view, <i>b</i> — dorsal view, <i>c</i> — ventral view; × 0.5. See also Plate LII, Fig. 1. | |
| Fig. 2. Stereo-photograph of the fourth cervical vertebra, <i>a</i> — lateral view, <i>b</i> — dorsal view, <i>c</i> — ventral view; × 0.5. See also Plate LII, Fig. 3. | |
| Fig. 3. Stereo-photograph of the fifth and sixth cervical vertebrae, with ribs attached, <i>a</i> — lateral view, <i>b</i> — dorsal view, <i>c</i> — ventral view; × 0.5. | |
| Fig. 4. Stereo-photograph of the seventh and eighth cervical vertebrae, the former with right rib attached, <i>a</i> — lateral view, <i>b</i> — dorsal view, <i>c</i> — ventral view; × 0.5. See also Plate LII, Fig. 4. | |
| Fig. 5. Stereo-photograph of the ninth cervical vertebra (inverted negative), <i>a</i> — lateral view, <i>b</i> — dorsal view, <i>c</i> — ventral view; × 0.5. | |

Photo: W. Skarżyński



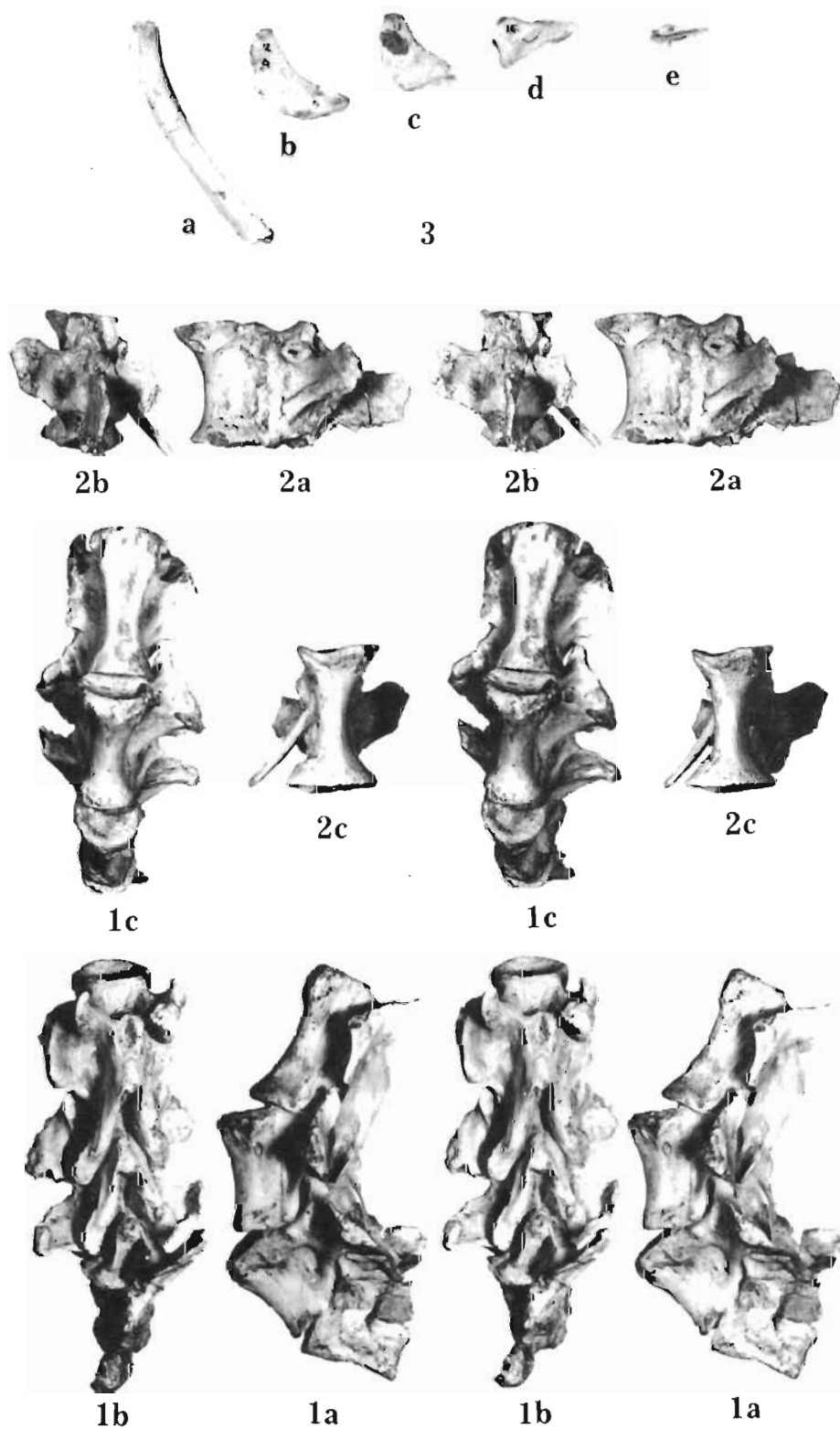
H. OSMÓLSKA, E. RONIEWICZ & R. BARSBOLD: *GALLIMIMUS BULLATUS* N. SP.

PLATE XXXIX

| | Page |
|---|------|
| <i>Gallimimus bullatus</i> n. sp. | 105 |
| Upper Cretaceous, Upper Nemegt Beds, Nemegt, Nemegt Basin, Gobi Desert. Z.Pal.No.Mg.D-I/94 | |
| Fig. 1. Stereo-photograph of the tenth cervical and first to third dorsal vertebrae, <i>a</i> — lateral view, <i>b</i> — dorsal view, <i>c</i> — ventral view; × 0.5. | |
| Fig. 2. Stereo-photograph of the twelfth dorsal vertebra. <i>a</i> — lateral view, <i>b</i> — dorsal view, <i>c</i> — ventral view; × 0.5. | |
| Fig. 3. Lateral view of the caudal chevrons, <i>a</i> — first, <i>b</i> — twelfth, <i>c</i> — thirteenth, <i>d</i> — sixteenth, <i>e</i> — nineteenth; × 0.5. | |

Photo: W. Skarżyński





H. OSMÓLSKA, E. RONIEWICZ & R. BARSBOLD: *GALLIMIMUS BULLATUS* N. SP.

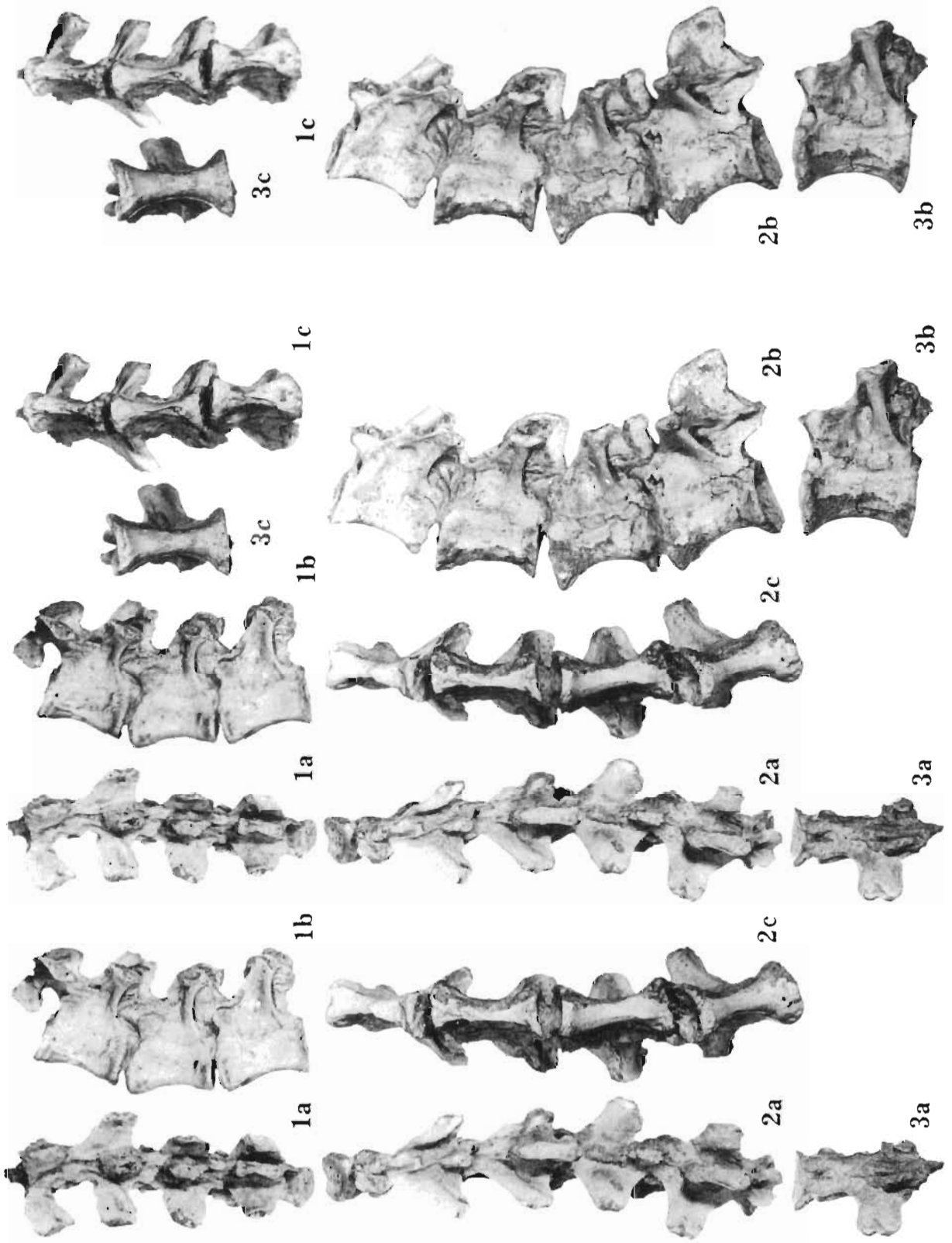
PLATE XL

| | |
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| | Page |
| <i>Gallimimus bullatus</i> n. sp. | 105 |
| Upper Cretaceous, Upper Nemegt Beds, Nemegt, Nemegt Basin, Gobi Desert. Z.Pal.No.Mg.D-1/94 | |

- Fig. 1. Stereo-photograph of the fourth to sixth dorsal vertebrae (with fragments of the neural arch of the preceding dorsal), *a* — dorsal view, *b* — lateral view, *c* — ventral view; $\times 0.5$.
- Fig. 2. Stereo-photograph of the seventh to tenth dorsal vertebrae, *a* — dorsal view, *b* — lateral view, *c* — ventral view; $\times 0.5$.
- Fig. 3. Stereo-photograph of the eleventh dorsal vertebra, *a* — dorsal view, *b* — lateral view, *c* — ventral view; $\times 0.5$.

Photo: W. Skarżyński





H. OSMÓLSKA, E. RONIEWICZ & R. BARSBOLD: *GALLIMIMUS BULLATUS* N. SP.

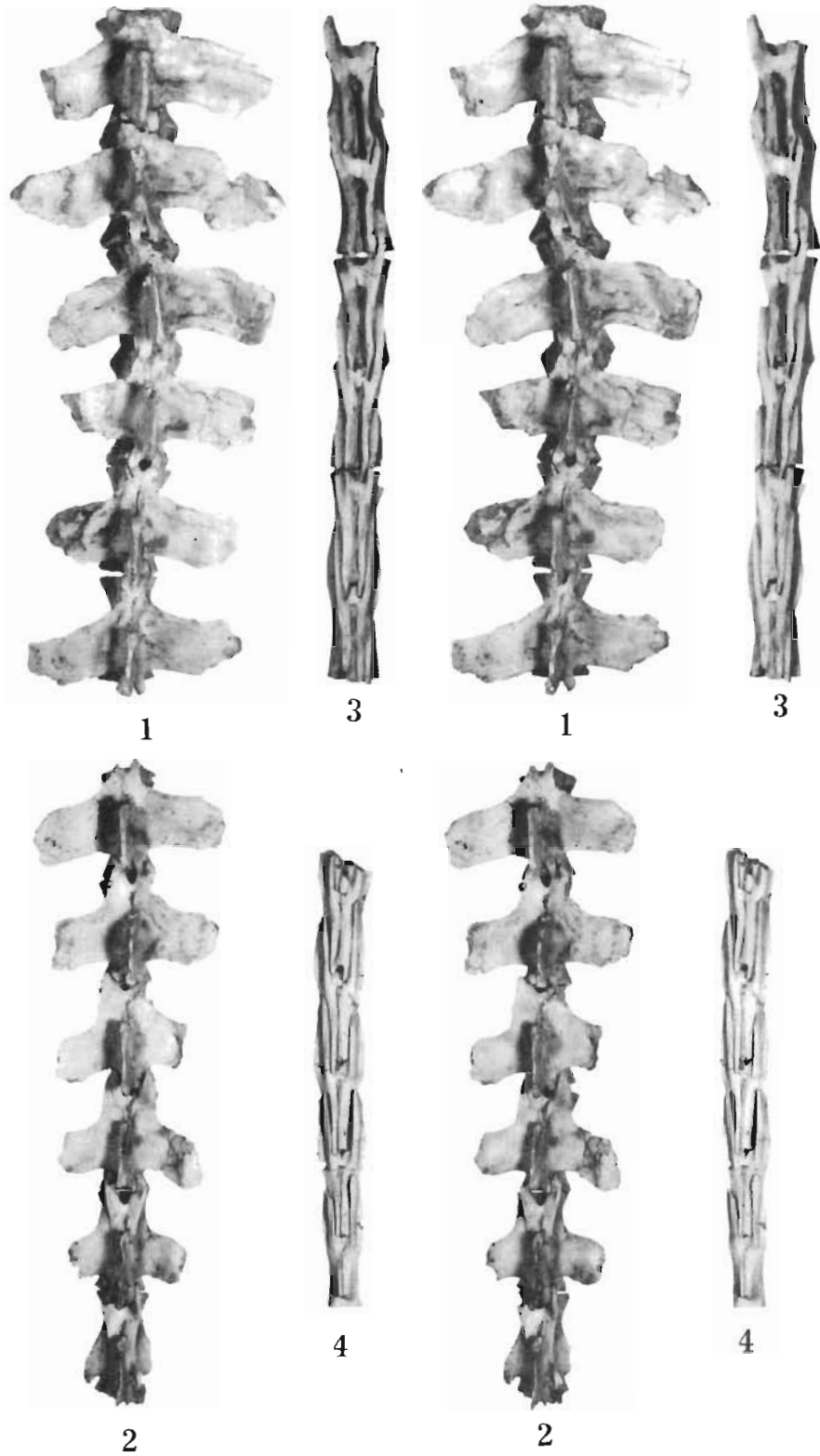
PLATE XLI

| | Page |
|---|------|
| <i>Gallimimus bullatus</i> n. sp. | 105 |
| Upper Cretaceous. Upper Nemegt Beds, Nemegt, Nemegt Basin. Gobi Desert. Z.Pal.No.Mg.D-1/94 (See also Plates XLII, XLIII) | |

- Fig. 1. Stereo-photograph of the third to eighth caudal vertebrae, dorsal view; $\times 0.5$.
- Fig. 2. Stereo-photograph of the ninth to fourteenth caudal vertebrae, dorsal view; $\times 0.5$.
- Fig. 3. Stereo-photograph of the fifteenth to twentieth caudal vertebrae, dorsal view; $\times 0.5$.
- Fig. 4. Stereo-photograph of the twenty-first to twenty-fifth caudal vertebrae, dorsal view; $\times 0.5$.

Photo: W. Skarżyński





H. OSMÓLSKA, E. RONIEWICZ & R. BARSBOLD: *GALLIMIMUS BULLATUS* N. SP.

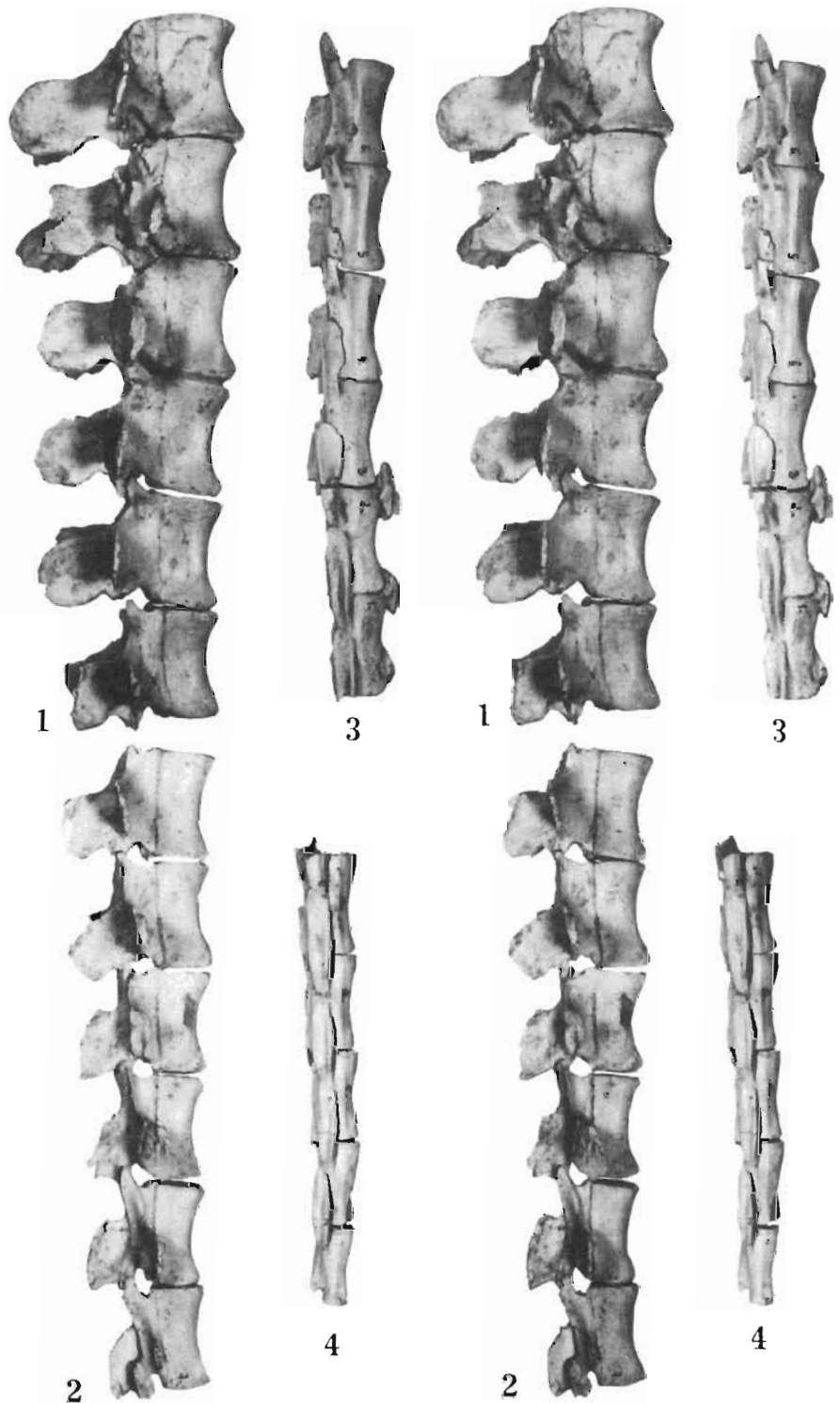
PLATE XLII

| | Page |
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| <i>Gallimimus bullatus</i> n. sp. | 105 |
| Upper Cretaceous, Upper Nemegt Beds, Nemegt, Nemegt Basin, Gobi Desert. Z.Pal.No.Mg.D-I/94 (See also Plates XLI, XLIII) | |

- Fig. 1. Stereo-photograph of the third to eighth caudal vertebrae, lateral view; $\times 0.5$.
- Fig. 2. Stereo-photograph of the ninth to fourteenth caudal vertebrae, lateral view; $\times 0.5$.
- Fig. 3. Stereo-photograph of the fifteenth to twentieth caudal vertebrae, lateral view; $\times 0.5$.
- Fig. 4. Stereo-photograph of the twenty-first to twenty-fifth caudal vertebrae, lateral view; $\times 0.5$.

Photo: W. Skarżyński





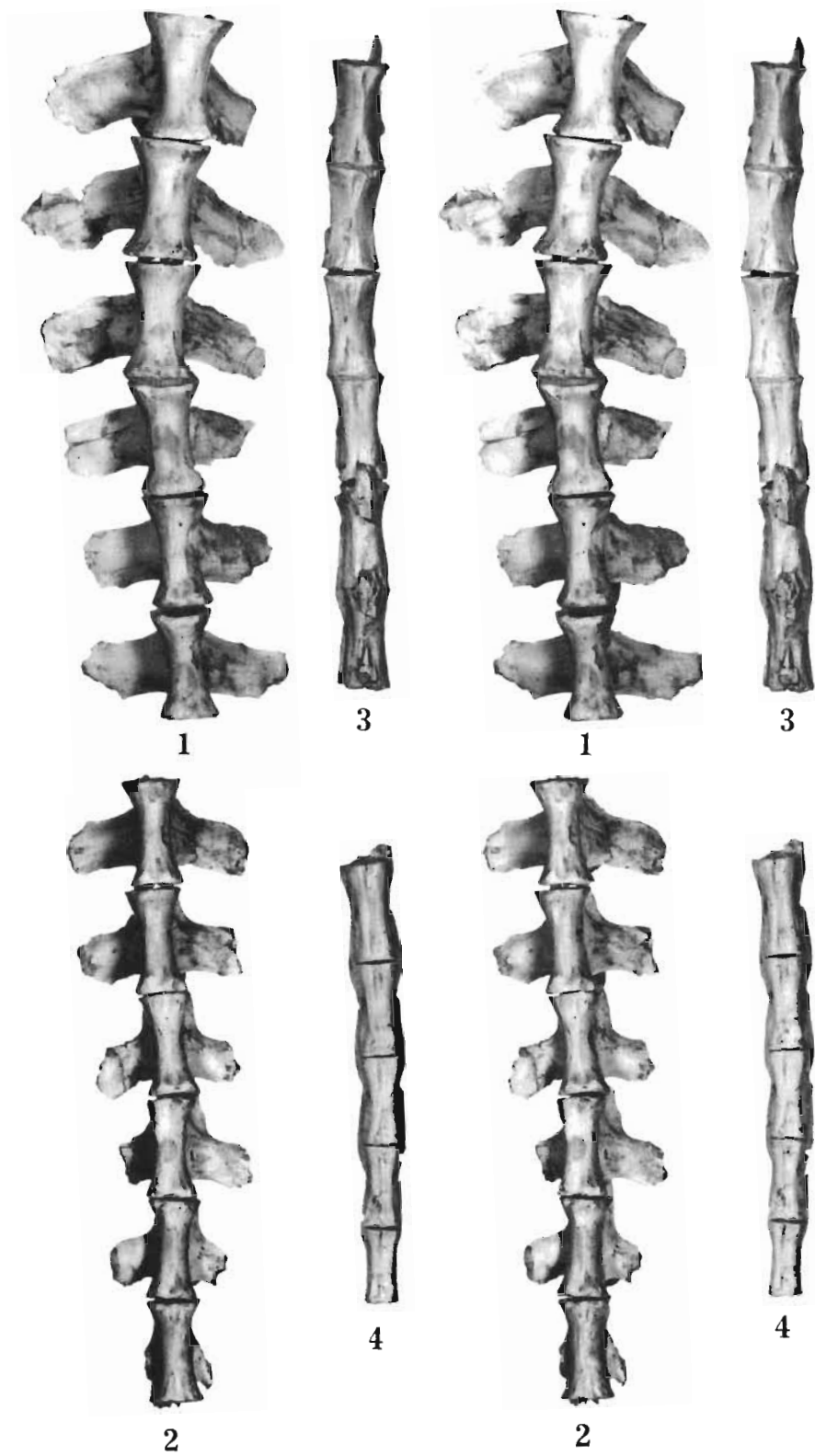
H. OSMÓLSKA, E. RONIEWICZ & R. BARSBOLD: *GALLIMIMUS BULLATUS* N. SP.

PLATE XLIII

| | Page |
|---|------|
| <i>Gallinimus bullatus</i> n. sp. | 105 |
| Upper Cretaceous. Upper Nemegt Beds, Nemegt, Nemegt Basin, Gobi Desert. Z.Pal.No.Mg.D-I/94 (See also Plates XLI, XLII) | |

- Fig. 1. Stereo-photograph of the third to eighth caudal vertebrae, ventral view; $\times 0.5$.
- Fig. 2. Stereo-photograph of the ninth to fourteenth caudal vertebrae, ventral view; $\times 0.5$.
- Fig. 3. Stereo-photograph of the fifteenth to twentieth caudal vertebrae, ventral view; $\times 0.5$.
- Fig. 4. Stereo-photograph of the twenty-first to twenty-fifth caudal vertebrae, ventral view; $\times 0.5$.

Photo: W. Skarżyński



H. OSMÓLSKA, E. RONIEWICZ & R. BARSBOLD: *GALLIMIMUS BULLATUS* N. SP.

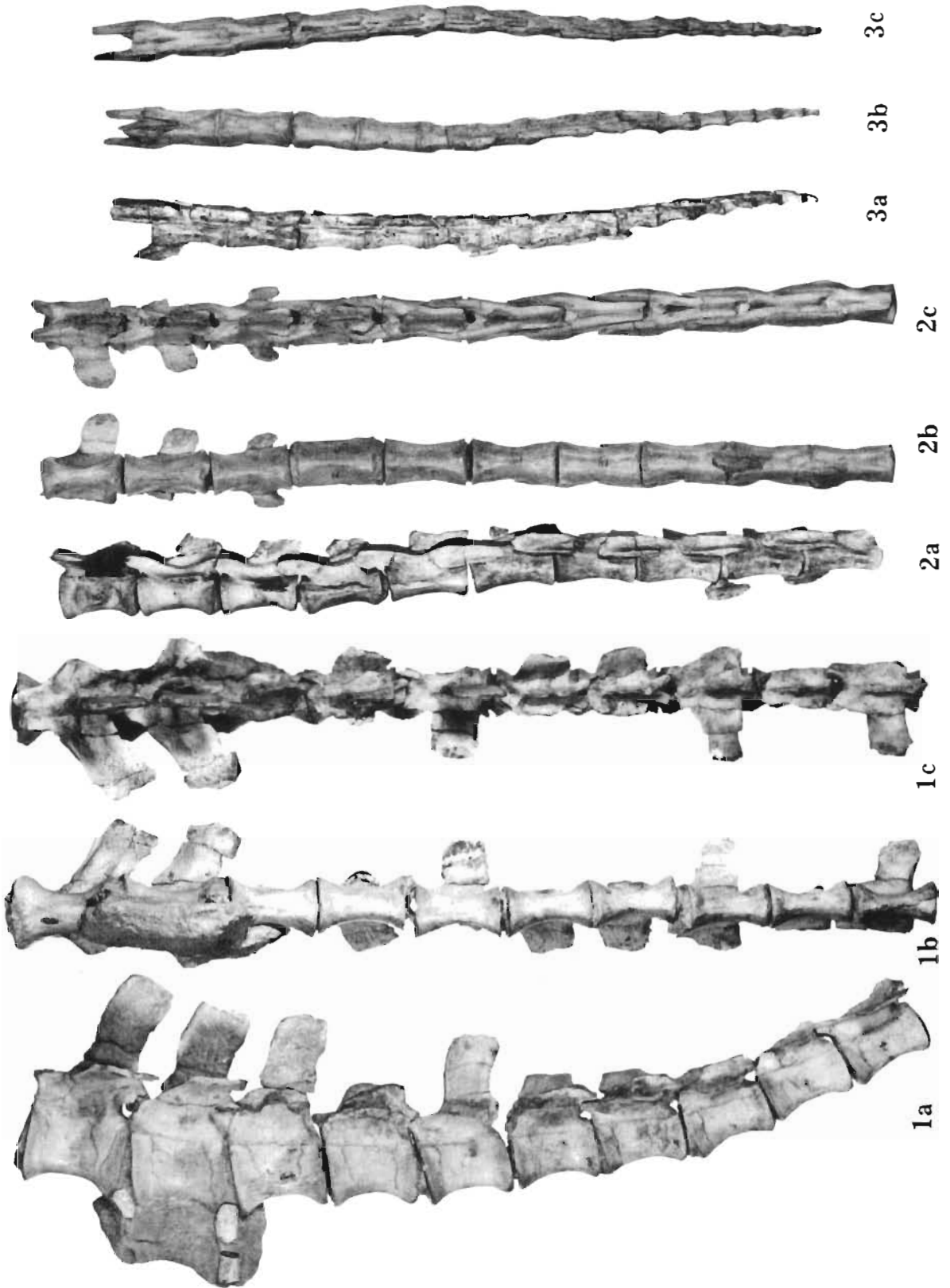
PLATE XLIV

| | |
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| | Page |
| <i>Gallimimus bullatus</i> n. sp. | 105 |
| Upper Cretaceous, Upper Nemegt Beds, Tsagan Khushu, Nemegt Basin, Gobi Desert. Z.Pal.No.Mg.D-I/1 | |

- Fig. 1. Second to eleventh caudal vertebrae, *a* — lateral view, *b* — ventral view, *c* — dorsal view; $\times 0.33$.
Fig. 2. Twelfth to twenty-first caudal vertebrae, *a* — lateral view, *b* — ventral view, *c* — dorsal view; $\times 0.33$.
Fig. 3. Twenty-second to thirty-sixth caudal vertebrae, *a* — lateral view, *b* — ventral view, *c* — dorsal view;
 $\times 0.33$.

Photo: W. Skarżyński





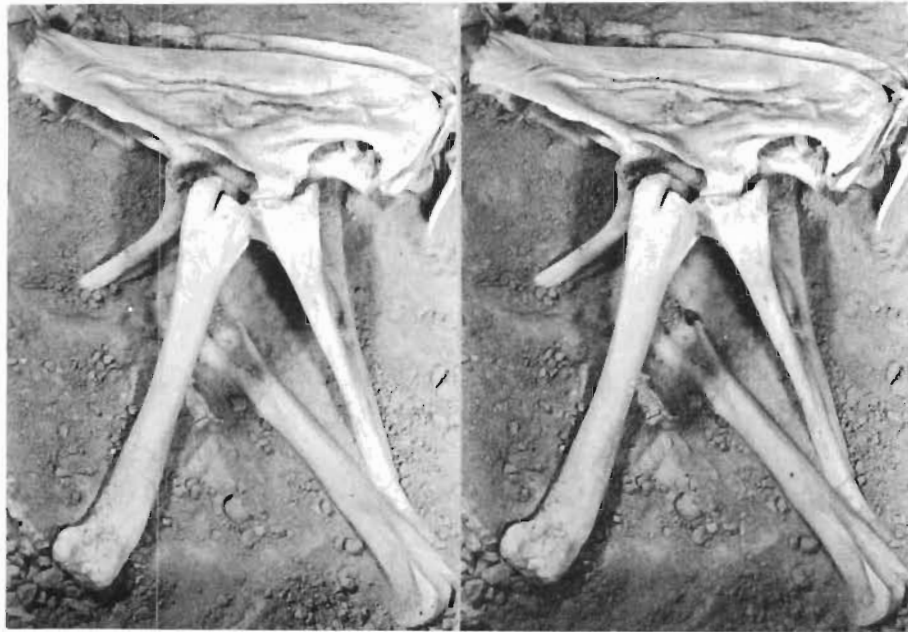
H. OSMÓLSKA, E. RONIEWICZ & R. BARSBOLD: *GALLIMIMUS BULLATUS* N. SP.

PLATE XLV

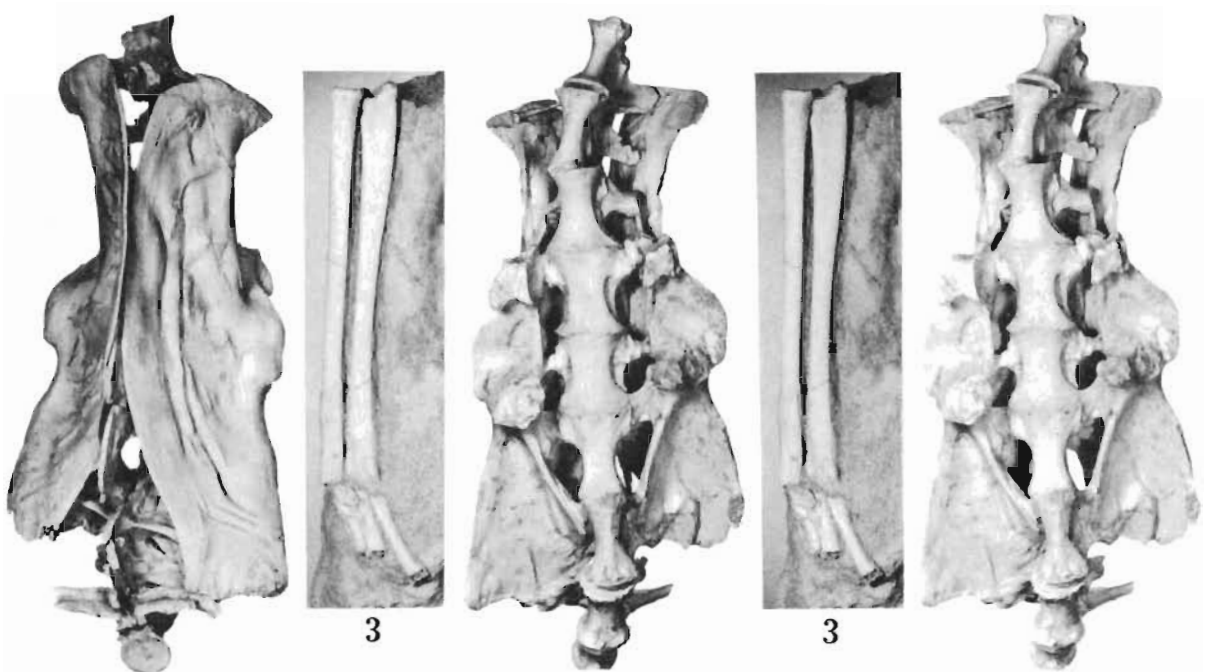
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| <i>Gallimimus bullatus</i> n. sp. | 105 |
| Upper Cretaceous, Upper Nemegt Beds, Nemegt, Nemegt Basin, Gobi Desert. Z.Pal.No.Mg.D-I/94 | |
| Fig. 1. Stereo-photograph of the pelvis and both femora in original arrangement, lateral view; $\times 0.2$. See also Plate XLVI. | |
| Fig. 2. Iliia with sacrum, distal dorsals and proximal caudals, <i>a</i> — dorsal view, <i>b</i> — stereo-photograph of the same specimen in ventral view; $\times 0.25$. | |
| Fig. 3. Stereo-photograph of the right ulno-radius with fragments of the metacarpals, medial view; $\times 0.5$. | |

Photo: W. Skarżyński





1



2a

3

2b

3

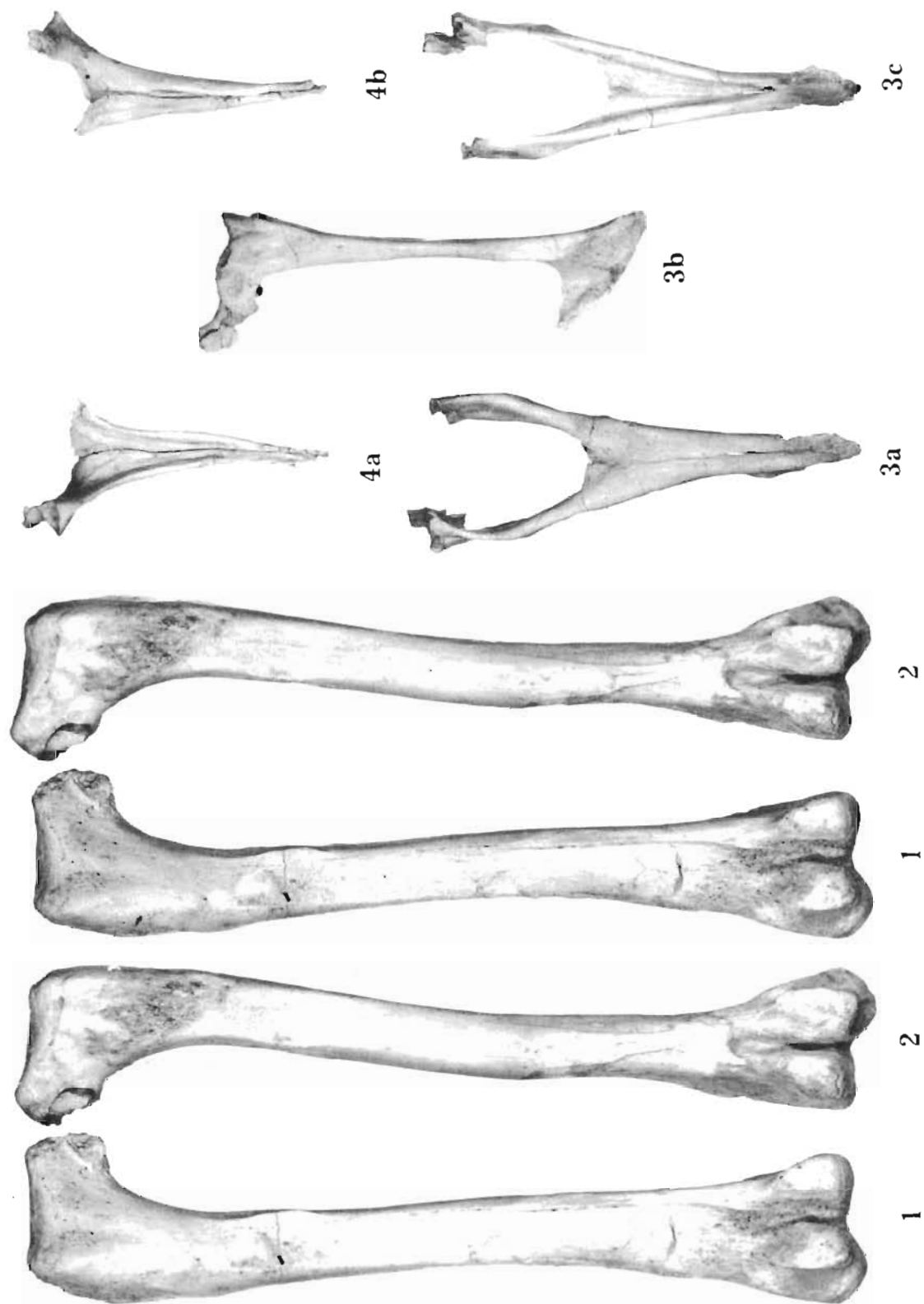
2b

H. OSMÓLSKA, E. RONIEWICZ & R. BARSBOLD: *GALLIMIMUS BULLATUS* N. SP.

PLATE XLVI

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|---|------|
| <i>Gallimimus bullatus</i> n. sp. | 105 |
| Upper Cretaceous, Upper Nemegt Beds, Nemegt, Nemegt Basin, Gobi Desert. Z.Pal.No.Mg.D-1/94 | |
| Fig. 1. Stereo-photograph of the left femur, posterior view: $\times 0.5$. See also Plates XLVII, Fig. 2, XLVIII, Fig. 2. | |
| Fig. 2. Stereo-photograph of the right femur, posterior view: $\times 0.5$. See also Plates XLVII, Fig. 1, XLVIII, Fig. 1. | |
| Fig. 3. Pubis, <i>a</i> -- anterior view, <i>b</i> -- lateral view, <i>c</i> -- posterior view: $\times 0.25$. | |
| Fig. 4. Ischium, <i>a</i> --- posterior view, <i>b</i> — anterior view; $\times 0.25$. | |

Photo: W. Skarżyński



H. OSMÓLSKA, E. RONIEWICZ & R. BARSBOLD: *GALLIMIMUS BULLATUS* N. SP.

PLATE XLVII

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|--|------|
| <i>Gallimimus bullatus</i> n. sp. | 105 |
| Upper Cretaceous, Upper Nemegt Beds, Nemegt, Nemegt Basin, Gobi Desert. Z.Pal.No.Mg.D-I/94 | |

- Fig. 1. Stereo-photograph of the right femur, anterior view; $\times 0.5$. See also Plates XLVI, Fig. 2, XLVIII, Fig. 1.
Fig. 2. Stereo-photograph of the left femur, anterior view; $\times 0.5$. See also Plates XLVI, Fig. 1, XLVIII, Fig. 2.
Fig. 3. Stereo-photograph of the right tibio-fibula with astragalus and calcaneum, *a* — anterior view, *b* — posterior view; $\times 0.5$. See also Plate XLVIII, Fig. 3.

Photo: W. Skarżyński



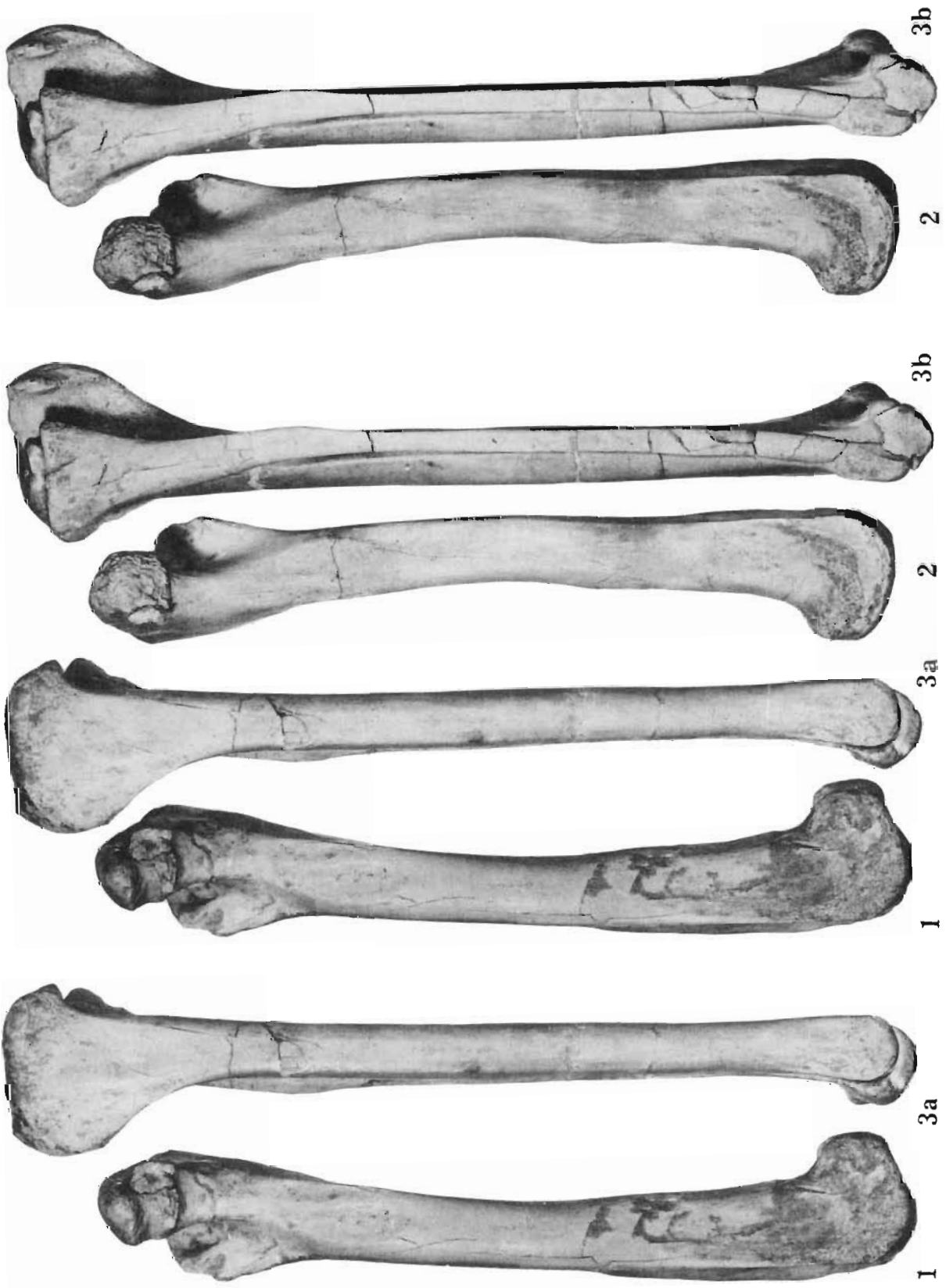
H. OSMÓLSKA, E. RONIEWICZ & R. BARSBOLD: *GALLIMIMUS BULLATUS* N. SP.

PLATE XLVIII

| | Page |
|--|------|
| <i>Gallimimus bullatus</i> n. sp. | 105 |
| Upper Cretaceous. Upper Nemegt Beds, Nemegt. Nemegt Basin. Gobi Desert. Z.Pal.No.Mg.D-I/94 | |

- Fig. 1. Stereo-photograph of the right femur, medial view; $\times 0.5$. See also Plates XLVI, Fig. 2, XLVII, Fig. 1.
Fig. 2. Stereo-photograph of the left femur, medial view; $\times 0.5$. See also Plates XLVI, Fig. 1, XLVII, Fig. 2.
Fig. 3. Stereo-photograph of the right tibio-fibula with astragalus and calcaneum. *a* — medial view, *b* — lateral view; $\times 0.5$. See also Plate XLVII, Fig. 3.

Photo: W. Skarżyński



H. OSMÓLSKA, E. RONIEWICZ & R. BARSBOLD: *GALLIMIMUS BULLATUS* N. SP.

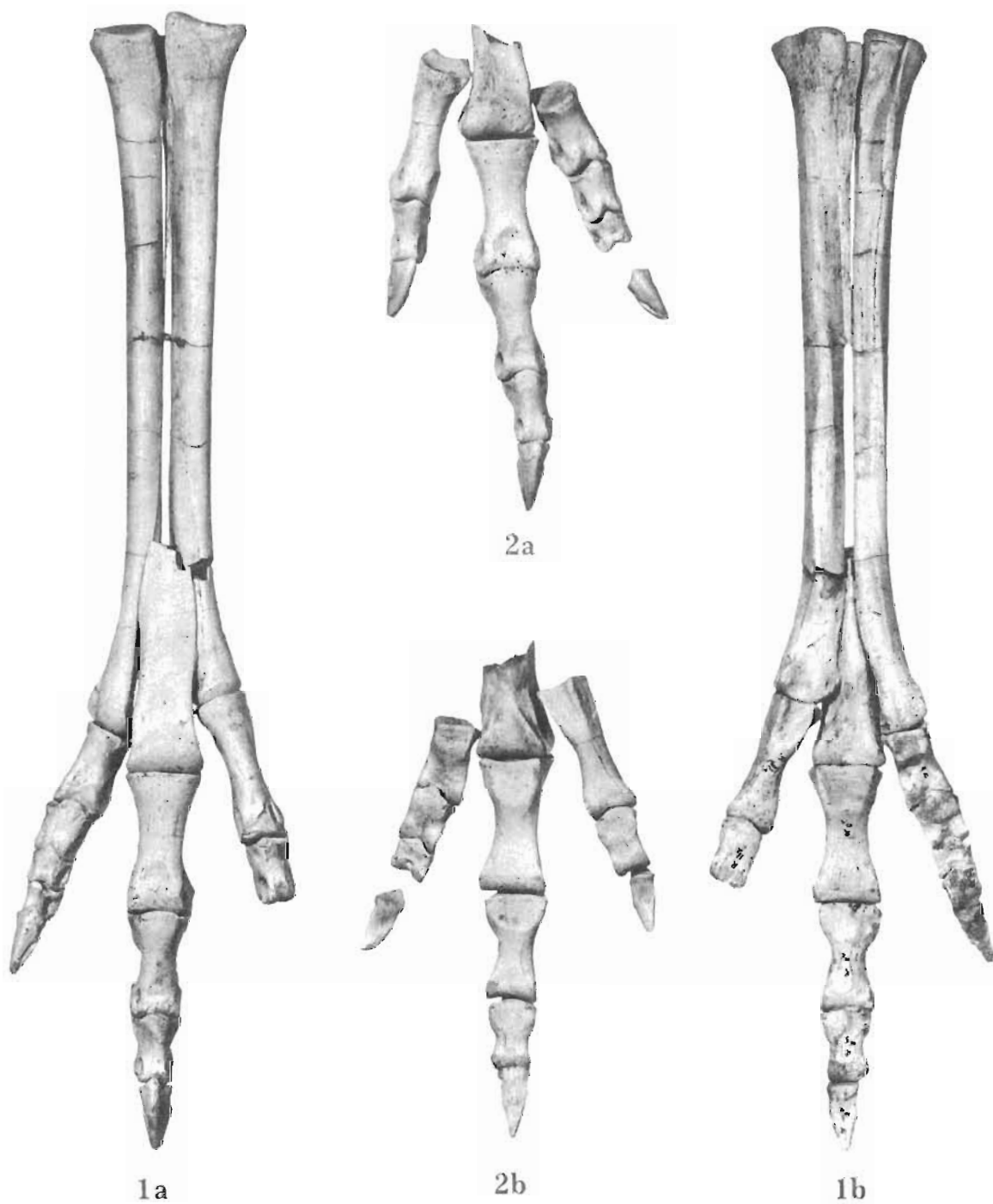
PLATE XLIX

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|--|------|
| <i>Gallimimus bullatus</i> n. sp. | 105 |
| Upper Cretaceous, Upper Nemegt Beds, Nemegt, Nemegt Basin, Gobi Desert. Z.Pal.No.Mg.D-1/94 | |

Fig. 1. Right pes (metatarsal IV somewhat displaced), *a* — dorsal view, *b* — ventral view; . . 0.5.

Fig. 2. Fragments of the left pes, *a* — dorsal view, *b* — ventral view; . . 0.5.

Photo: W. Skarżyński



H. OSMÓLSKA, E. RONIEWICZ & R. BARSBOLD: *GALLIMIMUS BULLATUS* N. SP.

PLATE L

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|--|------|
| <i>Gallimimus bullatus</i> n. sp. | 105 |
| Upper Cretaceous, Upper Nemegt Beds, Bugeen Tsav, Gobi Desert. G.I.No.DPS 100/10 | |

- Fig. 1. Right ilium with sites of attachments of the sacral ribs marked (S_1 - S_3), above, a disarticulated ?third sacral vertebra visible, medial view; $\times 1$.
- Fig. 2. Pubis, left lateral view; $\times 1$.
- Fig. 3. Ischium, left lateral view; $\times 1$.

Photo: W. Skarżyński





H. OSMÓLSKA, E. RONIEWICZ & R. BARSBOLD: *GALLIMIMUS BULLATUS* N. SP.

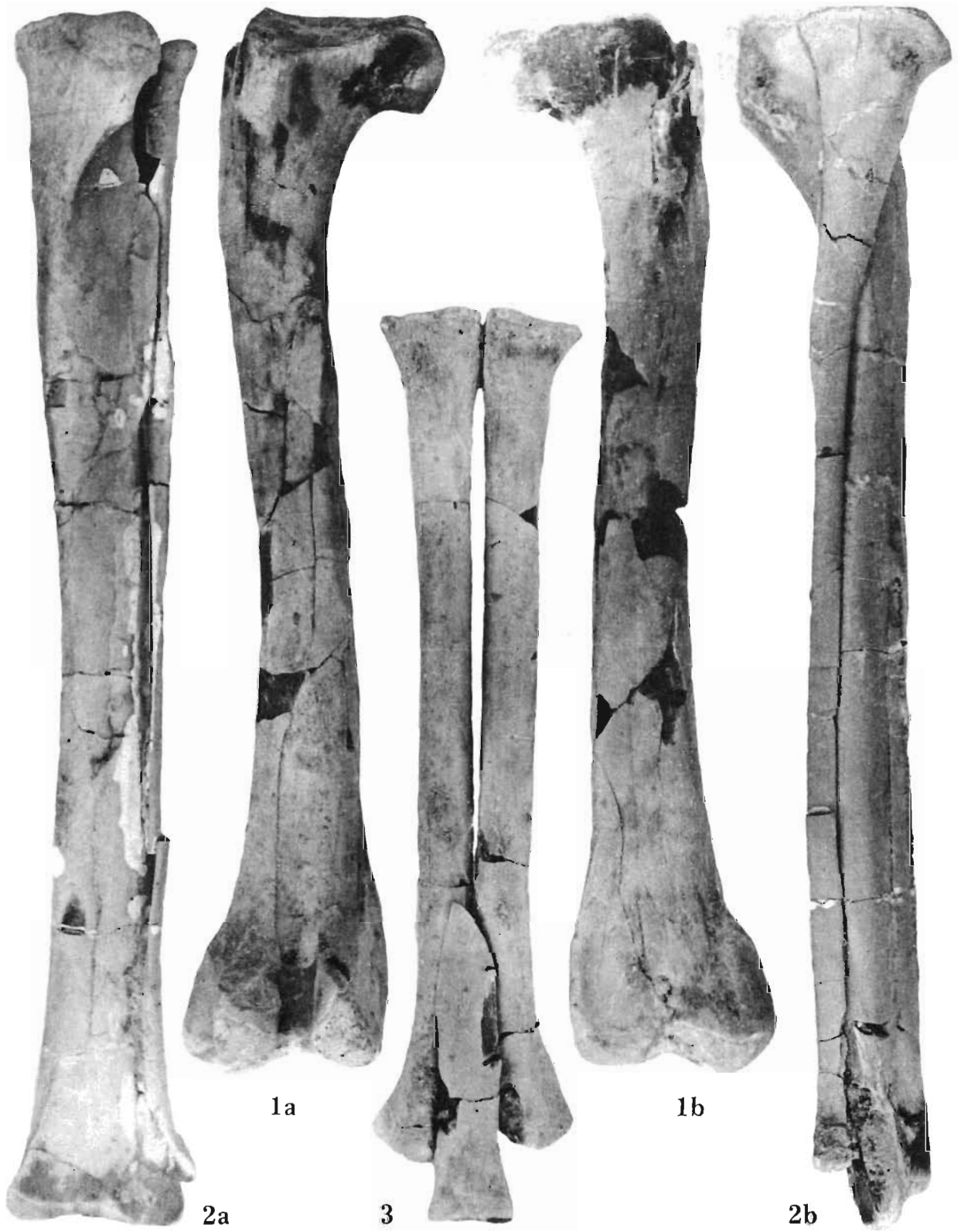
PLATE LI

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|--|------|
| <i>Gallimimus bullatus</i> n. sp. | 105 |
| Upper Cretaceous, Upper Nemegt Beds, Bugeen Tsav, Gobi Desert. G.I.No.DPS 100/10 | |

- Fig. 1. Left femur, *a* — posterior view, *b* — anterior view; × 1.
- Fig. 2. Left tibio-fibula, *a* — anterior view, *b* — lateral view; × 1.
- Fig. 3. Right metatarsus, dorsal view; × 1.

Photo: W. Skarżyński





H. OSMÓLSKA, E. RONIEWICZ & R. BARSBOLD: *GALLIMIMUS BULLATUS* N. SP.

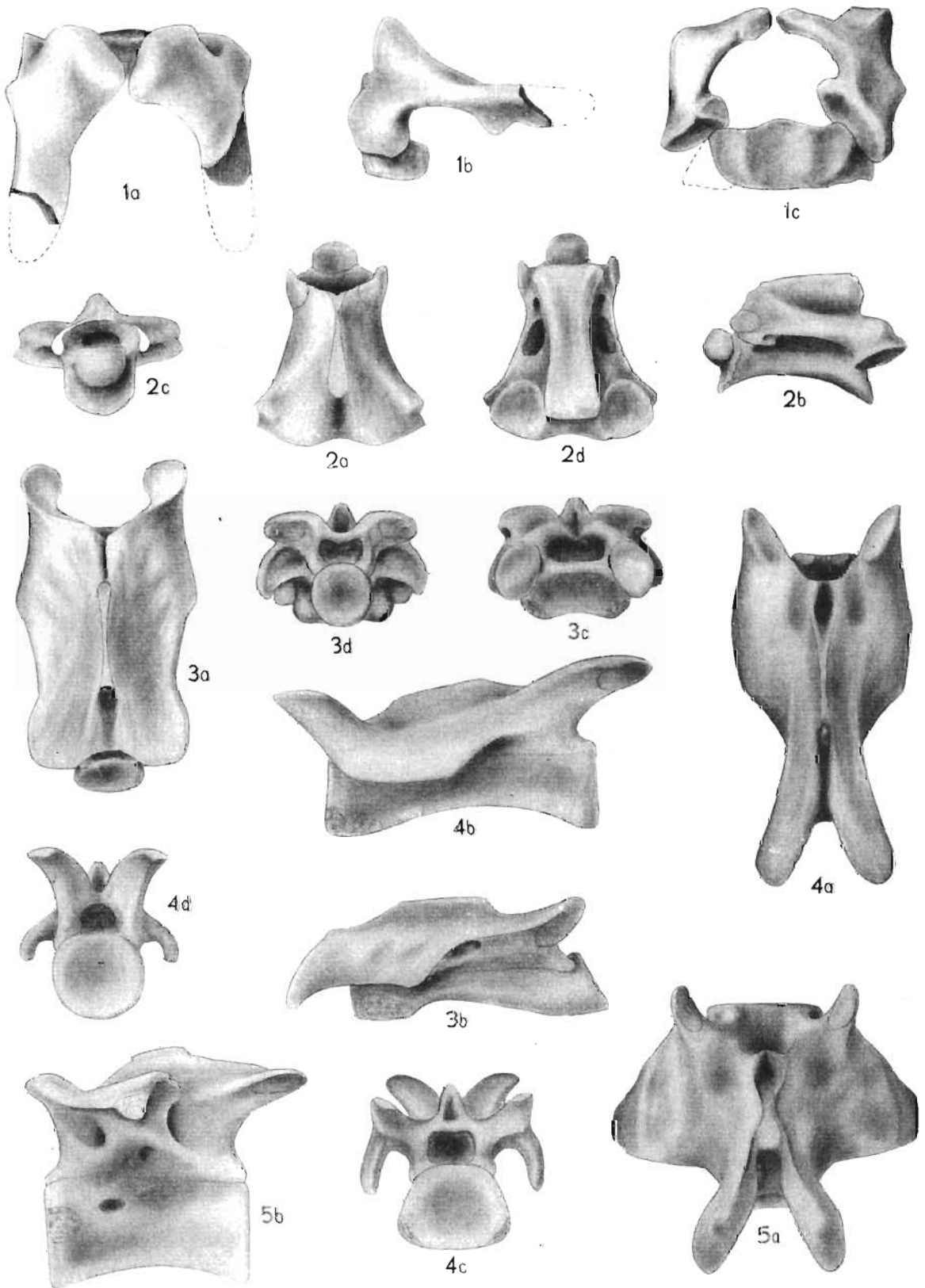
PLATE LII

| | Page |
|--|------|
| <i>Gallimimus bullatus</i> n. sp. | 105 |
| Upper Cretaceous, Upper Nemegt Beds, Nemegt Basin, Gobi Desert | |

- Fig. 1. Atlas, *a* — dorsal view, *b* — lateral view, *c* — anterior view. Tsagan Khushu. Type specimen. G.I.No. DPS 100/11; $\times 1$.
- Fig. 2. Axis. *a* — dorsal view, *b* — lateral view, *c* — anterior view, *d* — ventral view; $\times 1$. See also Plate XXXVIII, Fig. 1.
- Fig. 3. Fourth cervical vertebra, *a* — dorsal view, *b* — lateral view, *c* — anterior view, *d* — posterior view; $\times 1$. See also Plate XXXVIII, Fig. 2.
- Fig. 4. Eighth cervical vertebra, *a* — dorsal view, *b* — lateral view, *c* — anterior view, *d* — posterior view; $\times 1$. See also Plate XXXVIII, Fig. 4.
- Fig. 5. First dorsal vertebra. *a* — dorsal view, *b* — lateral view; $\times 1$. See also Plate XXXIX, Fig. 1.

Figs. 2-5: Nemegt. Z.Pal.No.Mg.D-1/94

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H. OSMÓLSKA, E. RONIEWICZ & R. BARSBOLD: *GALLIMIMUS BULLATUS* N. SP.

PLATE LIII

| | Page |
|---|------|
| <i>Gallimimus bullatus</i> n. sp. | 105 |
| Upper Cretaceous, Upper Nemegt Beds, Nemegt, Nemegt Basin, Gobi Desert. Z.Pal.No.Mg.D-I/94 | |
| Fig. 1. Twenty-second caudal vertebra, <i>a</i> — dorsal view, <i>b</i> — lateral view, <i>c</i> — anterior view, <i>d</i> — posterior view; × 1. See also Plates XLI, Fig. 4, XLII, Fig. 4, XLIII, Fig. 4. | |
| Fig. 2. Thirteenth caudal vertebra, <i>a</i> — dorsal view, <i>b</i> — lateral view, <i>c</i> — anterior view, <i>d</i> — posterior view; × 1. See also Plates XLI, Fig. 2, XLII, Fig. 2, XLIII, Fig. 2. | |
| Fig. 3. Seventh caudal vertebra, <i>a</i> — dorsal view, <i>b</i> — lateral view, <i>c</i> — anterior view, <i>d</i> — posterior view; × 1. See also Plates XLI, Fig. 1, XLII, Fig. 1, XLIII, Fig. 1. | |
| Fig. 4. Twelfth dorsal vertebra, <i>a</i> — dorsal view, <i>b</i> — lateral view, <i>a</i> — anterior view, <i>d</i> — posterior view; × 1. See also Plate XXXIX, Fig. 2. | |

Drawn by K. Budzyńska

