A new specimen of *Struthiomimus altus* from Alberta, with comments on the classificatory characters of Upper Cretaceous ornithomimids

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A new specimen of *Struthiomimus altus* is described from the Oldman Formation of Alberta. Ossified xiphisternal structures are present, which are similar to the posterolateral processes of the sternum of some birds. The gastralia are found to consist of two, rather than three, overlapping segments.

Four genera of Upper Cretaceous ornithomimids are recognized: *Struthiomimus*, *Ornithomimus*, *Dromiceiomimus*, and *Gallimimus*. The structure of the manus is found to be the most reliable character suite distinguishing them. *Dromiceiomimus*, however, can still be distinguished only on the basis of limb proportions, and its recognition remains tentative until further material is forthcoming.

On décrit un nouveau spécimen de *Struthiomimus altus* provenant de la formation d'Oldman en Alberta. On observe des structures xiphisternales ossifiées semblables aux excroissances postérolatérales du sternum de certains oiseaux. On observe aussi que les gastralia sont formées de deux plutôt que trois segments qui se recouvrent.

On a reconnu quatre genres d'ornithomimidés dans le Crétacé supérieur: *Struthiomimus*, *Ornithomimus*, *Dromiceiomimus* et *Gallimimus*. Il semble que la structure de la manus fournit le groupe de caractères les plus fiables pour distinguer ces genres. Toutefois, *Dromiceiomimus* ne peut encore être distingué qu'à partir des proportions des membres et son identification demeure problématique jusqu'à ce qu'on trouve d'autres spécimens.

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Introduction

Ornithomimids were small theropods and their remains are known from the Cretaceous of both North America and Mongolia. With long necks, small edentulous heads, and long, cursorial hind limbs, they structurally resemble ratite birds and have often been compared with ostriches (Osborn 1916; Russell 1972). Five genera of ornithomimids are generally recognized: *Ornithomimus* March 1890, *Struthiomimus* Osborn 1916, and *Dromiceiomimus* Russell 1972 from the Upper Cretaceous of North America; *Gallimimus* Osmólska, Roniewicz and Barsbold 1972 from the Upper Cretaceous of Mongolia; and *Archaeornithomimus* Russell 1972 from the Lower Cretaceous of both North America and Mongolia.

Only two complete specimens of ornithomimids are known from North America. Generally remains are disarticulated and fragmentary and the light, hollow bones badly crushed. Due to the crushed condition of the skulls and the very slight variability in the shape of individual elements, taxonomic determination of the North American genera has been based upon relative proportions of selected parts of the postcranial skeleton (Russell 1972). The incomplete nature of much of the material has often made it impossible to compute the necessary skeletal ratios, especially those of the front and hind limbs. Consequently most of our knowledge of the North American genera is based on the two complete specimens described by Osborn (1916) and Parks (1933). For this reason, any well-preserved, articulated ornithomimid material is worthy of comment.

We herein provide some descriptive details of a new, relatively complete ornithomimid specimen from the Upper Cretaceous of Alberta. These are presented in order to further our understanding of ornithomimids and to provide the basis for a reexamination of the validity of the characteristics employed to distinguish between the Upper Cretaceous ornithomimid genera.

Abbreviations

AMNH	American Museum of Natural History, New York
GI	Geological Institute, Academy of Sciences, Ulan Bator, Mongolian People's Republic
NMC	National Museum of Natural Sciences, National Museums of Canada, Ottawa, Ontario
ROM	Royal Ontario Museum, Toronto, Ontario
UA	University of Alberta, Edmonton, Alberta
UCMZ	Museum of Zoology, University of Calgary, Calgary, Alberta
YPM	Peabody Museum of Natural History, Yale University, New Haven, Connecticut
Z. PAL.	Palaeozoological Institute, Polish Academy of Sciences, Warsaw

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Systematic palaeontology

Family Ornithomimidae Marsh 1890
Genus *Struthiomimus* Osborn 1916
(Emend Russell, 1972)
Struthiomimus altus (Lambe 1902)

UCMZ (VP) 1980.1 Judith River Formation. South side of Red Deer River at Jenner Ferry Crossing, approximately 18 km east of Dinosaur Provincial Park, Section 11, Township 22, Range 9 W4M, Alberta.

Remarks

The specimen consists of both scapulocoracoids, the complete left forelimb, the gastralia and parts of the dorsal ribs, the pelvic girdle, sacrum, and both hind limbs. The right forelimb and left pes are fragmentary. The skull and most of the vertebral column had been eroded away before discovery.

The specimen was found articulated, lying on its left side. The left hind limb was extended and the right hind limb folded up against the body. It was found in a bed of sandstone with little or no cross-bedding. Plant debris and a broken hadrosaur rib were associated with it. This corresponds to the typical channel deposit described by Dodson (1971) for Dinosaur Provincial Park.

Measurements of UCMZ (VP) 1980.1 and relevant limb proportions are given in Table 1. Essentially it compares with *S. altus* (AMNH 5339) as described by Osborn (1916) and Russell (1972), although it is considerably larger than that specimen. Compared with AMNH 5339, the front limb is slightly longer relative to the hind limb, and the metatarsus and digit III of the pes are a little longer relative to the femur. The anterior extension of the ilium (antilium) is slightly longer relative to the total length of the ilium.

The increased length of the front limb is due primarily to the greater length of the humerus and manus relative to the length of the femur. In the increased relative length of the humerus UCMZ (VP) 1980.1 resembles *Dromiceiomimus* and to a lesser extent *Gallimimus*. *Gallimimus*, however, has an exceptionally short manus (see Table 2 for comparative limb proportions of ornithomimid genera). The manus of *Dromiceiomimus* is poorly known, but it does not appear to be elongated (Parks 1928, p. 24).

UCMZ (VP) 1980.1 is identified as *S. altus* primarily on the structure of the manus, and also on the length of the tibia relative to the femur. UCMZ (VP) 1980.1 lacks the elongate tibia of *Dromiceiomimus*, and the structure of the manus distinguishes it from all other genera of ornithomimids (see Fig. 2 and Discussion). The manus of *Struthiomimus* is known in only one other specimen (AMNH 5339), and this agrees with the manus of UCMZ (VP) 1980.1 in all important features.

Because of the similarity between this specimen and AMNH 5339, a complete description is not necessary. Only structures that differ from those of AMNH 5339 or were inadequately described by Osborn (1916) will be described here.

Gastralia

The gastralia of the left side are preserved in their natural position along with fragments of the right gastral ribs. These resemble the gastralia in the type of *O. edmontonicus* (NMC 8632). Fifteen gastralia are present, compared with the 13 described by Osborn (1916) for *S. altus*. As in *O. edmontonicus*, the gastral ribs consist of two segments—a thin, tapering dorsal splint, and a longer, stouter ventral splint (see Fig. 1). The dorsal splint is a little more than half the length of the ventral splint and lies along the anterior edge of the latter. The ventral splint is flattened and faintly grooved where the two overlap. At the midline each ventral segment ends in a rugose, club-like expansion, which meets, and sometimes overlaps, its mate from the other side. There is no fused median piece.

The total length of the gastralia along the ventral midline is 458 mm. There is no anterior co-ossified double rib as described by Lambe (1917) for *Albertosaurus*. The anterior gastralia are very slender. They are only slightly curved and have a strong anteroposterior inclination. The more posterior gastral ribs curve laterally. The fourteenth and fifteenth gastral ribs are the thickest and lack the dorsal splint.

Such details differ from those presented by Osborn (1916) for the gastralia of *S. altus*. He described three segments in the gastral ribs of AMNH 5339. Consequently, Sternberg considered the presence of two overlapping segments in *O. edmontonicus* to be a "progressive character" (Sternberg 1933, p. 81). However, the presence of only two segments in the gastral ribs of UCMZ (VP) 1980.1 and a careful examination of Osborn's figure (Osborn 1916, Fig. 6) suggest that Osborn may have misinterpreted some of the broken gastral segments. The gastral ribs of *Struthiomimus*, like those of *Ornithomimus*, appear to consist of only two overlapping segments.

Sternum

The sternum is usually not preserved in theropods, although an ossified sternal plate has been found in *Albertosaurus* (Lambe 1917). No sternum has ever been reported in the Ornithomimidae. The long gap between the coracoids and the gastralia, however, suggests that a cartilaginous sternum was present. In UCMZ (VP) 1980.1 this gap measures 125 mm along the ventral midline.

At the anterior extremity of the gastralia in UCMZ

TABLE 1. Measurements and relative limb ratios of UCMZ (VP) 1980.1 compared with AMNH 5339 (*S. altus*)

	UCMZ (VP) 1980.1		AMNH 5339[1]	
	Length[2] (mm)	Percent of femur length	Percent of femur length	Length (mm)
Humerus	362	72	65	310
Radius	239	47	47	228
Ulna	256	51	51	246
Manus, total length[3]	388	77	70	336
Metacarpal I	102	20	19	89
Phalanx I-1	127	25	24	114
Phalanx I-2*	95	19	18	85
Metacarpal II	109	22	21	103
Phalanx II-1	40	8	9	44
Phalanx II-2	113	23	19	89
Phalanx II-3*	127 (e)	25	21	100
Metacarpal III	109	22	21	103
Phalanx III-1	24	5	6	28
Phalanx III-2	29	6	6	28
Phalanx III-3	89	18	14	68
Phalanx III-4	98 (e)	20	18	87
Ilium	463	92	93	447
Antilium	157	31	27	127
Pubis	471	94	99	475
Ischium	364	73	70	335
Femur	502	100	100	480
Tibio-tarsus	556	111	111	535
Fibula	518	103	—	—
Astragalus height	133	26	—	—
Right pes	252 (e)	50	46	223
Metatarsal III	398 (e)	79 (e)	76	365
Phalanx II-1	92	18	18	85
Phalanx II-2	48	10	7	35
Phalanx II-3*	55	11	12	56
Phalanx III-1	83	17	16	78
Phalanx III-2	64	13	11	54
Phalanx III-3	52	10	8	39
Phalanx III-4*	53 (e)	11	11	52
Phalanx IV-1	46	9	10	47
Phalanx IV-2	32	6	5	26
Phalanx IV-3	25	5	4	19
Phalanx IV-4	26	5	4	18
Phalanx IV-5*	52	10	10	50
Front limb length	990			874
Hind limb length	1708			1603
Front limb / hind limb (%)	58			54
Antilium / ilium (%)	34			28

[1] Data from Osborn (1916), Russell (1972).
[2] Unless otherwise stated, measurements are of left element.
[3] Length of manus measured along digit II.
*Ungual phalanx. Length measured along outside curve.
(e) = Estimated.

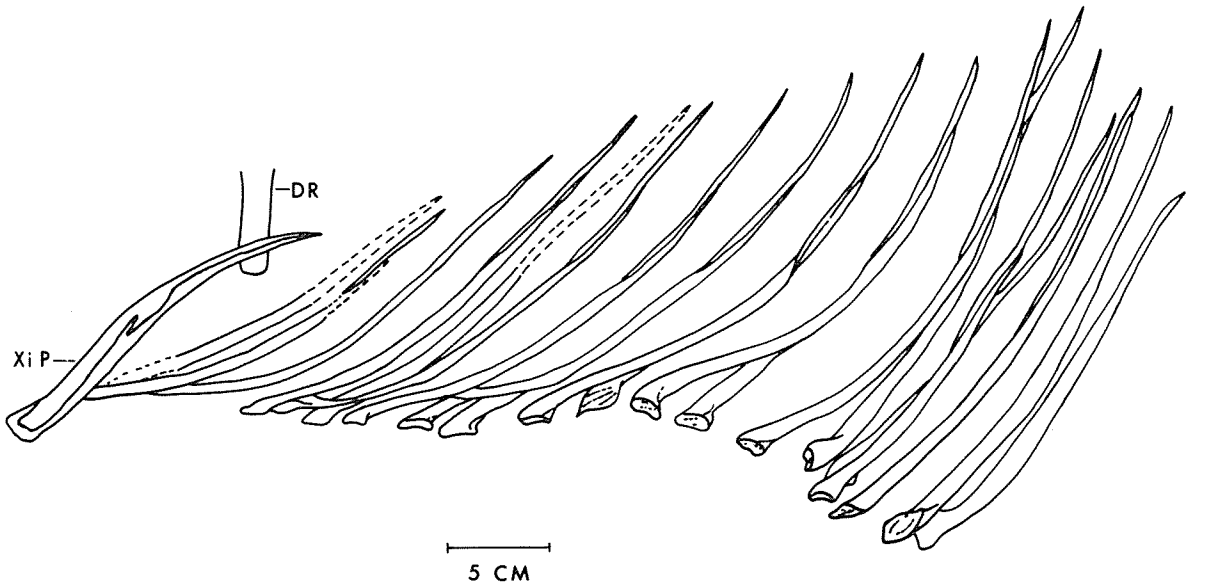

FIG. 1. Gastralia of UCMZ (VP) 1980.1 (*S. altus*). Lateral view of left side. Ventrally, the proximal ends of some ribs from the right side are visible. DR = fifth dorsal rib; Xi P = xiphisternal process.

(VP) 1980.1, on the left side, are two elongate bony rods, which we interpret as xiphisternal structures. These rods lie one on top of the other and are held together by an anteriorly directed uncinate process on the shaft of the dorsal rod (see Fig. 1, Xi P). While the two rods are not fused, they are very closely applied to each other. The ventral rod extends farther anteriorly and is 156 mm long. The dorsal rod is 150 mm long and its anterior end overlaps the anterior end of the ventral rod. Both rods are flattened anteriorly with bluntly rounded anterior ends. Posteriorly, the rods are oval in cross section and taper to a fine point.

These rods overlap the ventral surface of the anterior end of the gastral rib series. At the level of the second gastral rib the rods curve dorsally and laterally away from the gastralia. At their posteriormost extremity they overlap the tip of the fifth dorsal rib, but are not attached to it.

These rods cannot be part of the gastralia. They lie in a more ventral plant than the gastral ribs and curve dorsolaterally away from them. They cannot be sternal ribs, attaching the dorsal ribs to the sternum. Sternal ribs have an articular surface at each end. While the anterior ends of these rods may have an articular surface, the posterior ends do not.

Etheridge (1965) has described the inscriptional ribs in some iguanid lizards. These lie in the myocommata posterior to the xiphisternum and may be free of attachment at either end. It is unlikely that the rods in *Struthiomimus* could have developed in the myocommata as they extend anteroposteriorly (that is, they lie in the parasagittal plane) and bear no relationship to the dorsal ribs.

The most likely explanation is that these are xiphisternal structures that articulated with the sternum at their anterior ends, the posterior ends being free.

Elaborate posterolateral processes of this sort are found as part of the sternum of many birds. In galliforms these posterolateral processes of the sternum overlap the sternal ribs. Apparently a similar condition existed in *Struthiomimus*.

Discussion

The type species of the family Ornithomimidae, *Ornithomimus velox*, was described by Marsh (1890) from the Denver Formation of Colorado. It consists of three metacarpals and fragments of the left hind limb. Osborn (1916) described an essentially complete ornithomimid skeleton and created for it a new genus, *Struthiomimus*. His bases for the erection of this new taxon were the older age of the material (Campanian) and the presence of a reduced fifth metatarsal. *O. velox* is Maestrichtian and reputedly lacked the fifth metatarsal.

Since Osborn's contribution additional material, much of it fragmentary, has been described by Gilmore (1920), Parks (1926, 1928, 1933), and Sternberg (1933). The only other complete specimen from North America was originally described by Parks (1933) as *S. currelli*, but was later referred to *O. edmontonicus* by Sternberg (1934).

Gilmore (1920) indicated that the fifth metatarsal of

TABLE 2. Skeletal proportions of ornithomimid genera showing the range of variation within each genus (the number in brackets after each value indicates the number of specimens on which the range is based)

	Struthiomimus AMNH 5339 AMNH 5257 UCMZ (VP) 1980.1*	*Ornithomimus* ROM 851 NMC 12441* UA 16182* NMC 8632*	*Dromiceiomimus* NMC 12228* ROM 797, 852, 840 AMNH 5201	*Gallimimus* GI. No. DPS 100/10 GI. No. DPS 100/11 Z. Pal. No. Mg D–I/1 Z. Pal. No. Mg D–I/94
Femur length (mm)	480–513 (3)	435–500 (3)	378–468 (4)	192–665 (4)
		Percent of femur length		
Skull length	50 (1)	54 (1)	51 (1)	50–62 (2)
Neck length	149 (1)	124 (1)	135 (1)	137 (1)
Scapula length	73 (2)	60–63 (2)	—	68 (1)
Humerus length	65–72 (3)	63–64 (2)	75 (1)	80 (1)
Radius length	48–51 (3)	45 (1)	—	38–53 (2)
Ulna length	51 (2)	47–51 (2)	—	39–56 (2)
Manus length†	70–77 (2)	64 (1)	—	47 (1)
Tibio-tarsus length	109–111 (3)	108–109 (3)	119–124 (4)	108–113 (3)
Metatarsal III length	75–79[e] (3)	71–76 (2)	78–86 (3)	78–81 (4)
Ilium length	92–93 (2)	95 (1)	82–102 (3)	100–102 (2)
Antilium length	26–31 (2)	29 (1)	35 (2)	33–40 (2)
Pubis length	94–99 (2)	94 (1)	91–106 (2)	—
Ischium length	70–72 (2)	74–75 (2)	73–84 (3)	65–74 (3)
Pes length‡	46–50[e] (2)	49 (1)	50–56 (3)	38–47 (2)
		Percent of humerus length		
Scapula length	104–113 (2)	94 (1)	108 (1)	85 (1)
		Percent of presacral vertebral column length		
Length of hind limb – pes	93 (1)	104 (1)	107 (1)	100 (1)
		Percent of ilium length		
Antilium	28–34 (2)	31 (1)	34–35 (2)	33–40 (2)
		Percent of hind-limb length		
Length of front limb	55–58 (2)	53 (1)	—	53 (1)

*Specimens measured personally. Data for other specimens are from Osborn (1916), Parks (1926, 1928, 1933), Russell (1972), and Osmólska *et al.* (1972).
†Measured along metacarpal II.
‡Measured along digit III.
[e]Estimated.

O. velox was probably not absent, as reported by Marsh (1890) and Osborn (1916), but rather missing. Concomitant with this he expressed his doubts that the older geologic age of *Struthiomimus* was sufficient basis for the recognition of a separate genus. Since this time *Struthiomimus* has generally been regarded as a junior synonym of *Ornithomimus*.

In his review of North American ornithomimids, Russell (1972) recognized three genera from the Canadian Upper Cretaceous: *Ornithomimus*, *Struthiomimus*, and *Dromiceiomimus*. He redefined *Struthiomimus*, characterizing the genus on limb and vertebral proportions and the structure of the manus. The combination of characters he used to distinguish the three genera were: (1) length of the presacral vertebral column relative to the length of the hind limb excluding the pes; (2) length of the scapula relative to the length of the humerus; (3) length of antebrachium relative to the length of femur; (4) lengths of anterior extension of ilium (antilium), metatarsus, and tibia relative to femur; (5) width of anterior caudal centra relative to their length; and (6) structure of the manus, including relative length of the three metacarpals, the relative lengths of the last two phalanges in digit III, and the length and degree of curvature of the ungual claws.

The fourth ornithomimid genus known from the Upper Cretaceous is *Gallimimus*. This genus is known from three nearly complete skeletons from the Upper Nemegt beds (Lower Maestrichtian) of Mongolia. Osmólska *et al.* (1972) differentiated it from the North American genera primarily on skull structure and limb proportions.

Skeletal proportions of the four Upper Cretaceous genera and the range of variation within each genus are indicated in Table 2. The range of variation between each genus is shown graphically in Fig. 2.

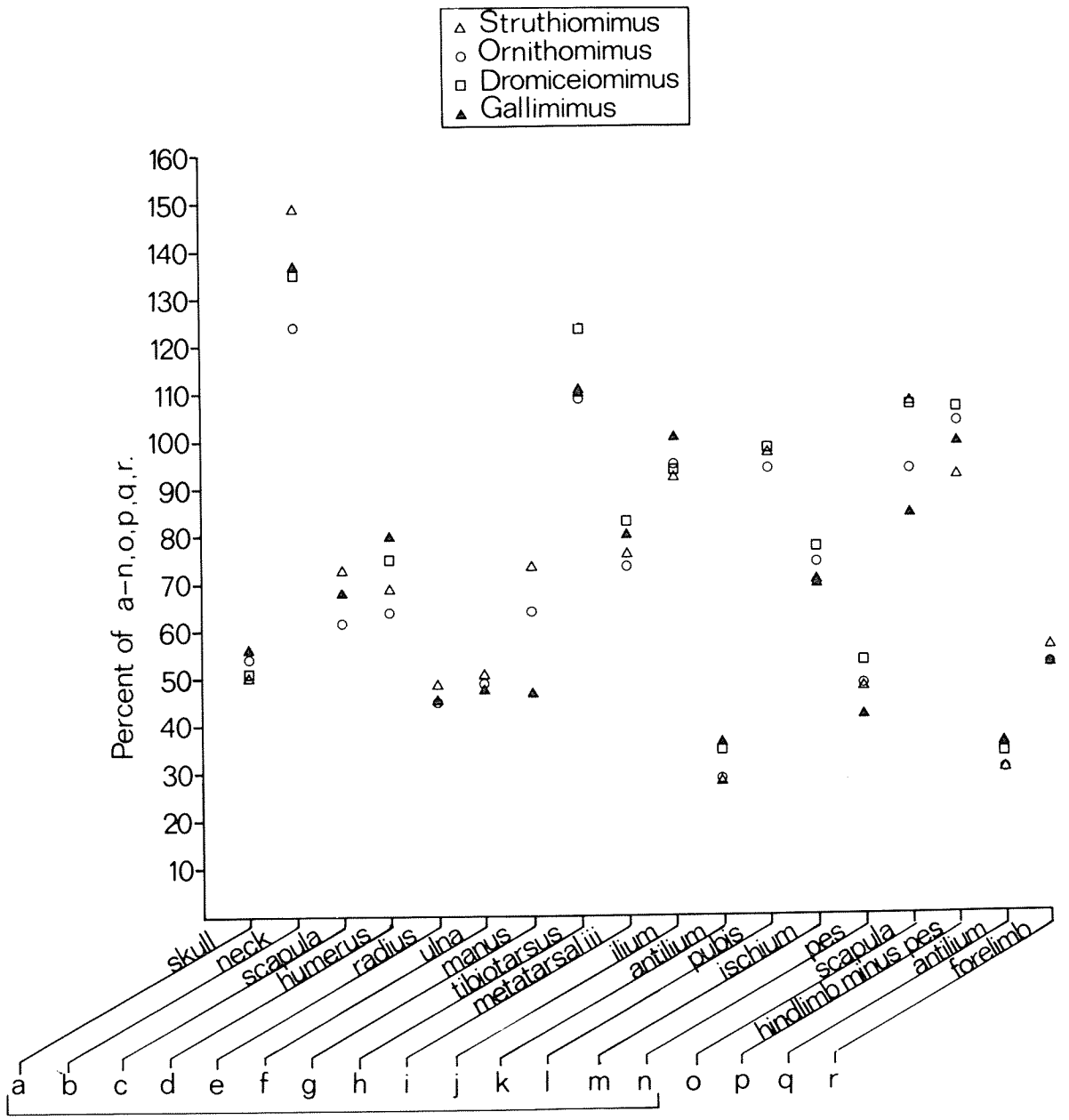

FIG. 2. Graphic representation of skeletal proportions that have been used as classificatory features in the Ornithomimidae. The symbols represent the means of the ranges for these measurements given in Table 2. It should be noted that when ranges are considered the overlap between genera is even greater. The lengths of the elements concerned are expressed as percentages of the length of the femur (a-n), humerus (o), presacral vertebral column (p), ilium (q), and hind limb (r).

Comparisons between ornithomimid genera are difficult owing to the incomplete nature of much of the North American material (see Russell 1972 for a list of North American ornithomimid material). The structure of the manus, which distinguishes *Ornithomimus*, *Struthiomimus*, and *Gallimimus*, is inadequately known in *Dromiceiomimus*. The width of the anterior caudal centra, which distinguishes *Dromiceiomimus* from both *Struthiomimus* and *Gallimimus*, is undescribed in *Ornithomimus*.

Gallimimus is the only genus with well-preserved skull material. Within the three North American genera, all of the skull material is either fragmentary, or so crushed that few differences can be seen between them.

TABLE 3. Comparative measurements of mani in ornithomids (all measurements in mm)

	Digit I	Digit II	Digit III
Ornithomimus edmontonicus ROM 851 (from Russell 1972)			
Metacarpal	107	100	98
Phalanx 1	116	36	23
Phalanx 2	64*	90	31
Phalanx 3		67*	74
Phalanx 4			63*
Struthiomimus altus UCMZ (VP) 1980.1			
Metacarpal	102	109	109
Phalanx 1	127	40	24
Phalanx 2	95*	113	29
Phalanx 3		127 (e)*	89
Phalanx 4			98 (e)*
Gallimimus bullatus G.I. No. DPS 100/11 (from Osmólska *et al.* 1972)			
Metacarpal	98	115	105
Phalanx 1	135	53	32
Phalanx 2	95*	100	36
Phalanx 3		98*	74
Phalanx 4			90 (e)*
Archaeornithomimus asiaticus AMNH 6569 (from Gilmore 1933)			
Metacarpal	46	54	50
Phalanx 1	58 (e)	27	—
Phalanx 2	—	57	17
Phalanx 3		—	43
Phalanx 4			—

*Measurements of unguals taken along outside curve.
(e) = Estimated.

Struthiomimus, as figured by Osborn (1916, Fig. 5) has an anteroventral extension of the quadrate, which meets the jugal ventral to the quadrato-jugal. A similar arrangement is present in *Gallimimus*, but appears to be absent in *Ornithomimus* and *Dromiceiomimus*. The supratemporal fenestra in the only skull of *Ornithomimus* is very short (Russell 1972, p. 382), and the skull is relatively larger than in *Struthiomimus* or *Dromiceiomimus*. This, however, could be reflective of a juvenile condition. The small size of the specimen (ROM 851) and the incomplete fusion between the scapula and coracoid (Parks 1933) suggest that the specimen was a juvenile.

The only comparable data for all species are the relative proportions of the vertebral column, limbs, and girdles. Within each species, the range of variation in the ratios utilizing the pelvic girdle suggests that the pelvic girdle is too variable to use as a standard of measurement (see Table 2). In *Gallimimus* the length of the front limb is known to increase relative to the length of the hind limb with increasing size, while there is a corresponding decrease in the size of the head (Osmólska *et al.* 1972, p. 139). This could explain the relatively larger skull size and shorter front limbs of *Ornithomimus* (ROM 851), which is probably a juvenile (see above).

The relative lengths of vertebral column to hind limb and scapula to humerus may well be valid characters. In almost every case, however, the available data are based on single specimens. Since the specimens vary in size it is possible that the differences are due to allometric factors rather than being differences of a generic nature. Only additional material will help solve this problem.

Both Osmólska *et al.* (1972) and Russell (1972) have shown that there is little change in hind limb proportions with increasing size. Consequently the elongate tibiae and metatarsals of *Dromiceiomimus* may be indicative of definitive generic characteristics. The application of analytical techniques such as those employed by Dodson (1975) and Coombs (1975) would be of great assistance in this case, but sufficient material is not yet available for such a venture (see Table 2). Since *Dromiceiomimus* can be distinguished from other forms on the relative length of the tibiae, it is best to accept the difference as a generic one until more complete material can be found.

The structure of the manus is a more reliable characteristic. It is different in all of the Upper Cretaceous genera in which it is adequately known. Measurements of the manus of ornithomimid genera are given in Table 3.

In *Ornithomimus* the manus is preserved in two specimens of *O. edmontonicus* (ROM 851, NMC 8632) and in the fragmentary specimen of *O. velox* (YPM 548). In *Ornithomimus* (Fig. 3*A*) metacarpal I is the longest and is only slightly divergent. Metacarpals II and III are subequal in length. The unguals are relatively short, each one being shorter than the penultimate phalanx of its own digit. The unguals are not strongly curved, and the tubercle for the flexor tendon is very low and weakly developed.

In *Struthiomimus* (Fig. 3*B*) the manus is known in only two specimens (UCMZ (VP) 1080.1, AMNH 5339). Here metacarpal I is the shortest and diverges sharply from metacarpal II at its distal end. Metacarpals II and III are of equal length. The unguals are very long and strongly curved, with well-developed flexor tubercles. In digits II and III, the ungual phalanx is considerably longer than the penultimate one.

Unfortunately the manus is very poorly known in *Dromiceiomimus*. It is preserved only in one specimen (*D. samueli* ROM 840) and is so fragmentary and smashed that little can be determined regarding the relationships of the metacarpals. The unguals, however, resemble those of *Ornithomimus* in being short and not strongly curved (Parks 1933, p. 24).

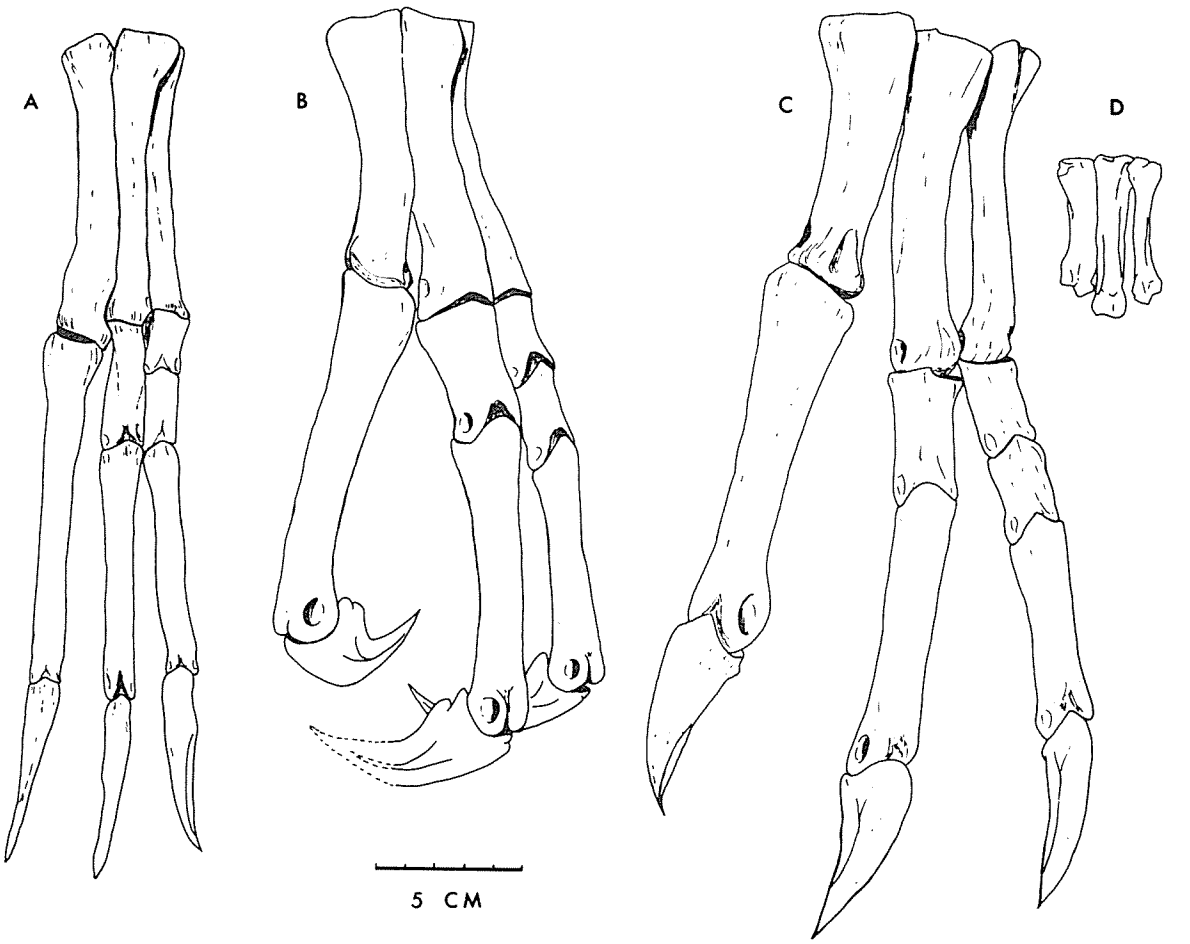

FIG. 3. All figures are of the lateral view of the left manus, except *D*, which is the palmar view of the right manus. All figures are drawn to the same scale. A measurement of elements can be obtained by referring to Table 3. (*A*) *Ornithomimus edmontonicus*. ROM 851. (After Parks 1933.) (*B*) *Struthiomimus altus*. UCMZ (VP) 1980.1. (*C*) *Gallimimus bullatus*. G.I. No. DPS 100/11. (After Osmólska *et al.* 1972.) Right manus reversed. (*D*) *Archaeornithomimus asiaticus*. AMNH 6569. (After Gilmore 1933.)

The manus of *Gallimimus* is known in only one specimen (G.I. No. DPS 100/11) (Fig. 3*C*). Here the manus is very short relative to the total arm length, and it differs from the other two genera in that metacarpal II is the longest. Metacarpal I is the shortest and, as in *Struthiomimus*, is sharply divergent distally. The unguals are strongly curved, as in *Struthiomimus*, and they bear large flexor tubercles. They are considerably shorter, however, and only the ungual of digit III is longer than its penultimate phalanx.

In the structure and relationships of the metacarpals, *Gallimimus* resembles *Archaeornithomimus asiaticus* (Gilmore 1933) from the Iren Dabasu Formation of Mongolia (AMNH 6569) (Fig. 3*D*). In this genus, as in *Gallimimus*, metacarpal II is the longest and metacarpal I the shortest. Metacarpal I diverges distally although it does not adhere as closely to metacarpal II at its proximal end as it does in other genera (Gilmore 1933, p. 31). Unfortunately, no unguals were associated with AMNH 6569, but disassociated unguals from the same locality are straight, rather than strongly curved.

As pointed out by Russell (1972, p. 378) the shortness of metacarpals I and III relative to metacarpal II in *Archaeornithomimus* is probably a primitive characteristic. It is the usual condition in theropods. This condition has been retained in *Gallimimus*, upon which the derived features of an overall relatively shorter manus have been superimposed.

The principal differences between the manus of *Struthiomimus* and *Ornithomimus* are the relative length of metacarpal I and the length and degree of curvature of the unguals. All of the specimens of *Ornithomimus* in which the manus is preserved are small. It is unlikely, however, that these differences are a result of age. The

manus of *Archaeornithomimus* (AMNH 6569) is that of a juvenile (Gilmore 1933) and this differs from the condition in *Ornithomimus*. The length and shape of the unguals in ROM 840 (a large *Dromiceiomimus*) suggest that relatively short, straight unguals were characteristic of adults, at least in this genus.

In view of the cautionary advice offered by Dodson (1978) on the use of ratios and associated growth and allometric effects, it would seem desirable to employ descriptive morphological features wherever possible in the distinction between such nominal genera until sufficient material is at hand for assessment of morphometric distinctness. That ratios may be fraught with complex statistical and conceptual difficulties (Atchley and Anderson 1978) also suggests that such data as the basis for generic and specific differentiation between specimens are best avoided at this time for material of this type and relative scarcity. The structure of the manus provides descriptive data, which are appreciable without resort to the complexities of statistical analysis. The differences are qualitative but discrete and discontinuous when currently known specimens are compared. This means, however, that fragmentary material that lacks remains of the manus can only be tentatively assigned to a genus at present.

Conclusions

New material of *Struthiomimus altus* has provided more details about this species, especially with respect to the gastralia and sternum. In the absence of well-preserved skull material, generic identification has been based on limb and vertebral proportions and the structure of the manus. It is suggested that the structure of the manus is the most reliable characteristic with respect to generic differentiation. Relative limb proportions are inconclusive, except possibly in the case of *Dromiceiomimus*, the manus of which is poorly known. Some features, which have been advanced as generic characteristics, cannot yet be used with complete confidence owing to poor sample size, and may possibly be indicative of allometric factors.

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