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AN ANKYLOSAUR (ORNITHISCHIA: REPTILIA) FROM THE LOWER CRETACEOUS OF SOUTHERN QUEENSLAND

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ABSTRACT

A small ankylosaur, described as a new genus and species *(Minmi paravertebra)*, has been found in the Lower Cretaceous Bungil Fm. near Roma, southeast Queensland. The specimen is unique in the possession of a ventral armour of small ossicles, and possession of bony elements alongside of the neural spines of the dorsals, herein called paravertebrae. This is the first ankylosaur discovered in Australia.

The ankylosaurs include the prominent armoured dinosaurs of Cretaceous times. Well known specimens have been found in Asia, North America and Europe, but little is known of this group in the southern hemisphere (e.g. von Huene 1929, Nopcsa 1929). Two reports of armoured dinosaurs from Australia (Etheridge 1904, Bartholomai 1966a) have proved incorrect. The earlier was due to a misidentification of bivalve steinkerns, and the latter to a misidentification of sauropod limb material. The specimen described herein thus represents the first ankylosaur known from Australia, as well as the most complete material yet described from the southern hemisphere (although admittedly incomplete compared with much northern hemisphere material).

In addition to its geographic significance, this specimen is the first to show extensive regions of the ventral armour. The presence of a series of previously undescribed ossifications alongside of the neural spines of some posterior dorsal vertebrae is also clearly demonstrated.

The specimen consists of eleven dorsal vertebrae and associated elements, an incomplete right pes, and much of the ventral armour, and was collected by Alan Bartholomai in 1964 probably from a gulley 1 km south of Mack Gulley, north of Roma, Queensland. The material was preserved in calcareous concretions, and was articulated when discovered.

STRATIGRAPHY

The site lies on the mapped Minmi Member of the Bungil Formation (Day 1964, Exon and Vine 1970). This member consists of medium to fine sands, silts and muds, with calcareous concretions (Day 1964, Exon 1976), and was deposited under freshwater (Day 1964) or brackish marine conditions (Exon 1976). No other vertebrate material is known from this unit, which is considered of Lower Cretacous age, probably Aptian (Exon and Vine 1970), although dates as early as Neocomian have been suggested (Exon 1976).

OCCURRENCE

At least the trunk and pes of the creature were articulated when it was buried, and the ventral armour was still in position. Some wear, breakage, and displacement of elements did however occur, with one instance of considerable re-orientation. The proximal portion of the left(?) rib associated with the sixth vertebra from the front preserved, was displaced, rotated about 180 degrees and came to rest across the posterior central articular face. The other instances of breakage did not result in such re-orientation, usually with no movement of the detached portion. All of the left ribs, except that fused to the vertebra, have been ventrally displaced as a unit, and some of the vertebrae have also slipped downwards.

In addition to yielding the osseous remains, the matrix of the concretions showed some other structure. The texture of the matrix varied across the pavement of ventral scutes, and was uniformly argillaceous external to the pavement, but with large regions of coarser grain size internal to that layer. These regions formed no discernible pattern within the concretion. Large, lobate masses of clay also occurred between the level of the vertebral column (and ribs) and that of the ventral ossicles. Unfortunately because of the fragmented condition of the concretions no overall pattern of these clay masses was discernible. There appears to have been a sheet of clay below the vertebrae, with other possible isolated masses lying just above the ventral pavement. The sheet is considerably thinned beneath the vertebral column and deflected upwards on either side of the row of centra, as if, after formation of the sheet, the vertebral column had subsided into it. While it is tempting to identify these clay masses with some visceral structure there is no good evidence for this. The obvious structures that might be filled with clay would be the lungs or the gastrointestinal tract. The continuity of the sheet from one side to the other beneath the vertebral column suggests that it does not represent a fill of the lungs, and the great breadth of the sheet, together with the absence of any internal structures that could possibly be attributed to ingested food, suggests that a fill of the gut tract is likewise not represented.

Five ossicles from the ventral pavement, together with one small, water-worn quartz pebble, were found between the ventral pavement and the level of the ribs and vertebrae. This relocation of the ossicles suggests that they fell to these positions from the ventral pavement while the carcase lay upside-down on the substrate.

IDENTIFICATION

Although ankylosaurs have been recovered from marine deposits (e.g. Mehl 1936), the occurrence of an incomplete specimen on a continent not previously known to yield ankylosaurs requires justifying this identification. Eight groups of Mesozoic reptiles are known to have developed extensive dermal armour: chelonians, placodonts, aetosaurs, phytosaurs, crocodilians, sauropods, stegosaurs, and ankylosaurs. Three of these, the placodonts, aetosaurs, and phytosaurs, are not known to have survived the Triassic, and also differed in the form of the ventral armour and vertebrae from the Minmi saurian. Chelonians are characterised by the development of a ventral plastron rather than a pavement of ossicles, and by fusion of the ribs to the carapace, a feature absent in the Minmi saurian. Eusuchian crocodiles have procoelous dorsals, which the Minmi saurian does not, while mesosuchians have more nearly horizontal transverse processes and zygapophyses than the Minmi saurian. When armoured, mesosuchians have broad ventral plates rather than a pavement of small ossicles. Most sauropods apparently did not possess dermal armour, but recently discovered material from Argentina (Bonaparte, Salfity, Bossi and Powell 1977) does exhibit an armour of small ossicles, resembling those of the Minmi saurian. The first sacral of this form is opisthocoelous (Bonaparte and Powell 1978) and this suggests opisthocoelous dorsals, while those of the Minmi saurian are amphiplatyan. Stegosaurs have elongate, elevated dorsal neural arches quite unlike those of the Minmi saurian, and the spines or arches are posteriorly inclined, while those of the Minmi saurian are vertical.

Thus the Minmi saurian may be excluded from seven of these eight groups, the ankylosaurs alone remaining. The Minmi saurian shows several ankylosaurian features, such as a presacral rod, fusion of ribs to vertebra, centra with expanded amphiplatyan articular faces, and transverse processes inclined dorsally (Coombs 1978), and therefore the Minmi saurian is considered an ankylosaur.

In spite of the incompleteness of the specimen, which does not render it ideal type material, the unique features represented (ventral armour and paravertebrae) make it desirable to provide a name for this taxon.

Order ORNITHISCHIA Seeley
Suborder ANKYLOSAURIA Osborn
Family *incertae sedis*
Genus *Minmi* nov.

TYPE SPECIES *Minmi paravertebra* nov.

DIAGNOSIS: Small ankylosaur with paravertebral elements present; ventral armour formed by a pavement of small ossicles; dorsal vertebrae amphiplatyan, without notocordal knobs; transverse processes slender and triangular, not T-shaped, in section; neural canal broad; posterior intervertebral notch shallow.

ETYMOLOGY: *Minmi* from the Minmi Crossing, near the site of discovery. 'Minmi' seems to be of aboriginal origin, but uncertain meaning, either being a corruption of Min Min (a kind of will-o-the-wisp light), or referring to a large lily (Reed 1967).

Justification of the erection of a new genus for this specimen presupposes knowledge of the detailed description. Thus this justification is postponed to the discussion.

Minmi paravertebra nov.

TYPE SPECIMEN: Queensland Museum F10329. Eleven dorsal vertebrae, with associated bases of eleven ribs and three paravertebrae; five incomplete ribs; one incomplete pes; ventral armour; two unidentified elements.

LOCALITY: Probably a gulley about 1 km south of Mack Gulley, on the Injune Road, north of Roma, southeast Queensland.

HORIZON: Minmi Member of the Bungil Formation.

AGE: Lower Cretaceous, probably Aptian.

ETYMOLOGY: The specific name refers to the unique paravertebral elements.

DIAGNOSIS

As there is only a single species attributed to the genus, the specific diagnosis cannot be separated from the generic diagnosis.

DESCRIPTION

VERTEBRAE: Eleven vertebrae are preserved. They were all articulated, but are not demonstrably consecutive. They were collected in two groups of three, and one of five. Most retain both centra and arches, while four retain the transverse processes (of at least one side) and the spines as well. The two most posterior centra of the group of five are fused together with no sign of exostoses or other pathological features, and thus this is identified as the anterior end of the presacral rod.

The centra are uniformly amphiplatyan, without notocordal knobs. They are laterally and ventrally constricted, with expanded articular faces. These faces are subcircular without obvious compression. Slight lateral depressions are found in the centra just below the pedicles of the arches. Only one centrum has a keel, and it is faint. (Plate 1, fig. B).

The neural arches are but slightly elevated (Fig. 1). The neural canals are high but broad, the ratio of breadth to height ranging from 0·76 to 1·02. The transverse processes are slender, dorsally inclined, and triangular (not T-shaped) in cross-section. The diapophyseal facets face ventrolaterally, and are situated just below the ends of the processes, giving the tips an unswept look when viewed from the front or back. These facets are shallowly concave, and just dorsal to them, at the tips appear smooth, shallowly convex surfaces like articular surfaces. The parapophyseal facets are cuplike, and situated on the arches at the level of the top of the neural canal. No variation in this level is apparent, however on the posterior vertebrae a rugose band joins the parapophyseal to the diapophyseal facet, running along the ventral margin of the transverse process. The parapophyseal facets are each backed by a buttress supporting the transverse process and running ventrally onto the centrum. A second buttress runs posteriorly along the top of the postzygapophyseal facet.

The neural spines are uniformly thin, rectangular and anteroposteriorly long. They overhang the posterior ends of the centra. The prezygapophyses are borne on short processes that, however, increase in length posteriorly. The facets are inclined at about 65 degrees to the horizontal and are united along their ventral edges to form a V-shaped trough. The postzygapophyses are borne directly on the overhanging posteroventral portion of the neural spine.

PARAVERTEBRAE: On the left side of the first three of the group of five vertebrae preserved in articulation, are a set of three posteroventrally inclined, elongate bony rods. These rods superficially resemble those identified as ossified tendons, but one may be seen to attach to the

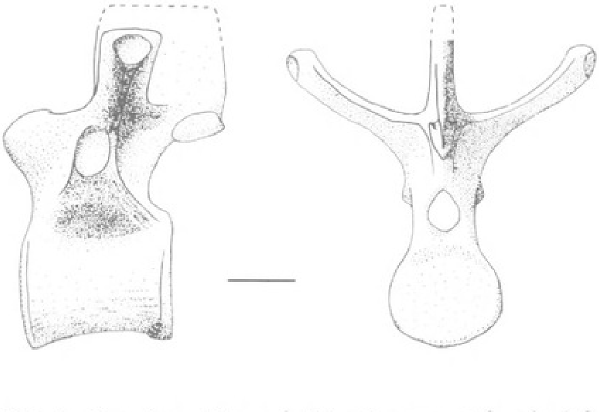

FIG. 1: Dorsal vertebra of *Minmi paravertebra* in left lateral (left) and posterior (right) aspects. Broken line indicates reconstructed portion. Bar represents 2 cm.

posterior margin of one of three elements located between the neural spines and the tips of the right transverse processes. Such elements have not been previously reported, and are here called paravertebrae (Plate 1, figs. C and D). These paravertebrae are flattened and lie in the horizontal plane (Fig. 2). The rod-like processes, all incomplete posteriorly, extend back at least the length of one vertebra, and attach to the posteromedial corner of the paravertebra. The anterior two paravertebrae are triangular in form when viewed from above, with the posteromedial angle a right angle, and the hypotenuse shallowly emarginate around the tip of the transverse process. This margin is serrate. The posteriormost paravertebra is elongate, extending well lateral to the tip of the transverse process, and appears to have been rectangular in form when viewed from above. The medial margins of both this and the middle paravertebra are deflected ventrally to lie along the lateral faces of the neural spines.

The dorsal face of the posteriormost paravertebra is preserved (the others are eroded dorsally) and shows no sign of sculpture as is found in dermal armour. Mantell (1851) reported that *Hylaeosaurus* had a row of small ossicles on either side of the neural spines. In *Euoplocephalus tutus* (the specimen originally described as *Scolosaurus cutleri*) the dorsal tips of the neural spines extend up to the plane of the dorsal armour, as may be seen in Plate 7 of Nopcsa (1928). Thus the paravertebrae may have been situated in the plane of the dorsal armour, since they are at the level of the tops of the neural spines, but there is no evidence that they either formed part of the dorsal armour or supported elements of the dorsal armour.

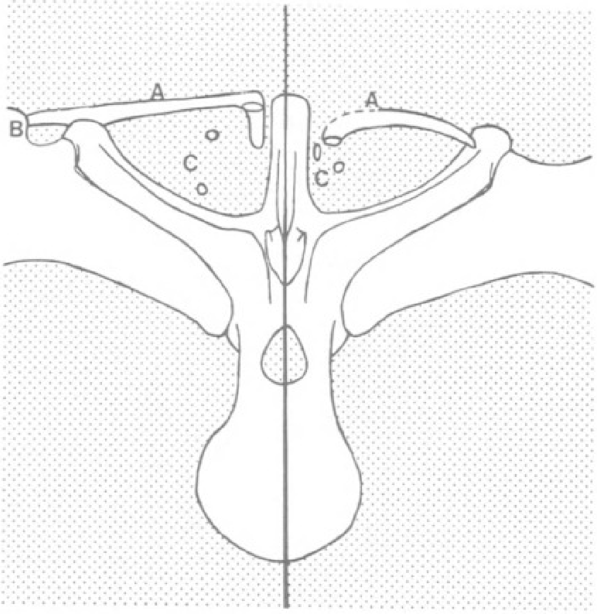

FIG. 2: Posterior dorsal vertebrae, ribs and paravertebrae in posterior aspect: posteriormost vertebra preserved on right, preceding vertebra on left. A, paravertebra; B, dorsal process of rib; C, presumed ossified tendons.

Maryanska (1977) describes a set of plate-like processes attached to the ribs in *Saichania chulsanensis*. These processes, which attach to the posterior margins of the distal portions of the ribs, are obviously not paravertebrae which are found proximal to the tubercles of the ribs and are not known to attach to the ribs at all. Nonetheless these processes, which Maryanska also believes may have been present in *Ankylosaurus* and *Panoplosaurus (= Edmontonia)*, as well as the paravertebrae, exemplify a tendency among the ankylosaurs toward the development of (presumably) dermal plates in the body wall.

The existence of the elongate posterior processes suggests some attachment of the dorsal epaxial muscles to the paravertebral elements, and hence mobility of the paravertebrae relative to the vertebrae. If the paravertebrae were associated with armour this could imply mobile dorsal dermal armour. The adaptive advantage of this is obscure. The posteriormost paravertebra extends sufficiently far laterally to reach the rib, and could thus have contacted it. The other paravertebrae preserved, however, seem not to have reached their respective ribs, so that any arrangement resulting in rib motion would seem to have affected only one pair of ribs. In conclusion while the paravertebrae may well have exhibited some limited motion relative to the vertebrae, the function of this motion cannot be presently stated.

Two short rod-like segments inclining posterodorsally lie against the neural spines medial to the elongate processes: these seem to represent actual ossified tendons.

RIBS: The bases of eleven ribs are preserved along the left side of the dorsals, but only of three on the right, the others having been lost due to erosion. Portions of the more distal regions of five successive ribs are also present.

The bases of the ribs are strongly compressed anterolaterally and the capitulum is bluntly convex and dorsoventrally elongate. The tuberculum is a low, convex facet on the medial side of the low tubercle. On at least one rib these two facets are connected by a thin, shallow trough, suggesting a continuous articulation with the vertebra as is found in some other ankylosaurs (Coombs, pers. comm.). One fragment of rib shows the edge of a marked, medially recurved dorsal process lateral to the tubercular process (Plate 1, fig. E); unfortunately the rib is broken at this point so that the extent of the process is not known. The other proximal portions of ribs are all broken just lateral to the tubercular process.

More distally the ribs take on the characteristic T-shaped cross-section of ankylosaur ribs (also found in some sauropods and some hadrosaurs, Gilmore 1914).

PES: Three metatarsals, four phalanges (including an ungual) and a single tarsal remain of the right pes. (Plate 1, fig. A). The disposition of the metatarsals and phalanges indicates that at least four digits were present. The ventral portions of all of the pedal elements are badly worn. The tarsal could not be identified, and is irregularly quadrangular in form. The metatarsals are robust, expanded proximally, and constricted at mid-shaft. The ungual is blunt and about 1·5 times as long as wide.

VENTRAL ARMOUR: The preserved ventral surface is covered by a pavement of small dermal ossicles. This surface is apparently from the belly just anterior to the pelvis, as the portions of the pavement were preserved on the same blocks as the dorsal vertebrae. The ossicles are uniform in size and shape, small, 6 to 8 mm in diameter and 4 to 5 mm thick. They are cushion-shaped, flattened, roughly hexagonal to roughly square in form from below. The dorsal (internal) surface exhibits the common surface texture of trabeculae running in two mutually perpendicular directions, described for *Nodosaurus* by Lull (1921). The ventral (external) surface is mildly sculptured in a radiate pattern; there is no indication of any keel. The ossicles occur in a single layer and there is no obvious variation in size or form. A flat, roughly triangular, badly weathered element, 6·5 by 5 cm as preserved was found 5 mm above a fragment of rib. This piece may indicate a dorsal armour composed of scutes larger than those found on the venter.

DISCUSSION

COMPARISON: Comparison of *Minmi* with the known taxa of ankylosaurs must be based on vertebral form, since paravertebrae are absent in the other taxa, the ventral armour is either missing or poorly preserved, the ribs seem not to be diagnostic and the pes is incomplete in the only known specimen of *Minmi*. A survey of the available relevant literature (Bohlin 1953, Brown 1908, Bunzel 1871, Coombs 1978, Eaton 1960, Gilmore 1930, Hulke 1881, Huxley 1867, Lull 1921, Maleyev 1952, Maryanska 1977, Moodie 1910, Nopsca 1928, 1929, Ostrom 1970, Owen 1884, Seeley 1879, 1881) reveals that while ankylosaur dorsal vertebrae are similar in form, there are character states that vary from genus to genus; these states are presented in Table 1.

One problem of the comparison of ankylosaurian dorsals is that the complete series of dorsals has been studied in only one form, *Ankylosaurus magniventris* (Coombs pers. comm.). There appears to be almost no progressive variation in the dorsals of that species, with the exception that the posterior intervertebral notch becomes increasingly shallow as one proceeds posteriorly in the series. For the type specimen of *Minmi paravertebra* the group of five vertebrae including the anterior end of the presacral rod must be the most posterior set of dorsals preserved, thus comparison of this group with the other six dorsals can suggest progressive variation. Such comparison suggests that the prezygapophyses become increasingly long posteriorly, and that the centra become increasingly broad. Thus for other taxa for which only dorsals of unknown position are described and figured these characters were not used.

In vertebral form *Minmi* agrees most closely with *Nodosaurus* (*sensu* Coombs 1978), from which it differs in that the diapophyses originate below the zygapophyses in *Nodosaurus textilis* (Lull 1921), but dorsal to them in *Minmi*. *Minmi* differs from *Hylaeosaurus* (*sensu* Coombs 1978) in having amphiplatyan dorsal centra, those of *Hylaeosaurus* being planoconcave (Hulke 1881), and in having relatively shorter prezygapophyseal processes. These processes of the dorsals of *Hylaeosaurus* extend anteriorly to the middle of the preceding centrum (Owen 1884). From *Sauropelta*, *Minmi* differs in lacking notocordal knobs, and having vertically orientated spines. From *Crataeomus* (see note to Table 1) *Minmi* differs in having amphiplatyan centra, in lacking the sulcus between the postzygapophyses described in that form (Seeley 1881), and in lacking the fossa anterodorsal to the parapophysis (Seeley 1881). Differences from other nodosaurids are given in Table 1. Ankylosaurids have neural canals less broad than in *Minmi*, and with the exception of *Talarurus*, parapophyses placed level with the top of the centrum, rather with the top of the neural canal.

Forms for which too little information is available for inclusion in Table 1 may also be distinguished from *Minmi*. *Acanthopholis* has bioconcave centra (Seeley 1879), and a neural canal much higher relative to the central height (Huxley 1867). *Stegosaurides* dorsals are represented by a centrum with a flat ventral surface (Bohlin 1953), quite unlike other known ankylosaur dorsal centra. That attributed to *Princonodon* (Lull 1911) tapers in dorsal view from anterior to posterior, also unlike other known ankylosaur dorsal centra. Dorsals of *Hoplitosaurus* are biconcave and described as having flattened sides (Gilmore 1914). None of these features are found in *Minmi*. *Saichania* (Maryanska 1977) and *Pinacosaurus* (Young 1935) have dorsal neural canals that are strongly compressed from side to side. This seems to be common in the dorsals of Asian Late Cretaceous ankylosaurs, as it is also true of *Talarurus* (Maleyev 1952, Fig. 7) and *Heishansaurus* (Bohlin 1953, Fig. 30b).

Thus *Minmi* can be distinguished from other ankylosaurs by its dorsal vertebral morphology, as well as by its possession of paravertebrae.

Table 1 suggests that *Minmi* agrees more closely with some nodosaurids (e.g. *Nodosaurus*) than with any ankylosaurid. Coombs (1978) gives no firm criterion applicable to the dorsal vertebrae for distinguishing nodosaurids from ankylosaurids. *Minmi* is thus classified as family *incertae sedis*, but may be a nodosaurid.

GEOGRAPHIC CONSIDERATIONS: *Minmi* is the first ankylosaur known from Australia, and one of the few reported from the Gondwana continents. The other reported forms are: *Loricosaurus scutatus* (von Huene 1929), known from armour and referred caudal vertebral centra (von Huene 1931) from north-central Argentina; *Lametasaurus indicus*, known from armour (Matley 1924), *Brachypodosaurus gravis*, known from a humerus (Chakravarti 1934), and undescribed material (Coombs 1978) from India; and undescribed nodosaurid material from Madagascar (Russell, Taquet and Thomas 1976). To this latter are possibly referable teeth described as *Stegosaurus madagascariensis* (Piveteau 1926) and recognised as ankylosaurian by Hoffstetter (1961). None of the described

TABLE 1: DORSAL VERTEBRAL CHARACTER STATES OF *MINMI* AND OTHER ANKYLOSAURS.

Genus	Central form	Notocordal knob	Keel	Neural spine	Neural canal	Transverse process	Parapophyses location	Fused ribs
*Crataeomus**	proc.	absent	absent	vert.	broad	slender	top of centrum	?
Hylaeosaurus	plan.	absent	present	?	narrow	?	top of canal	?
Nodosaurus	amph.	absent	absent	vert.	narrow	?	top of canal	present
Panoplosaurus	amph.	present	present**	post.	broad	broad	varies†	varies†
Sauropelta	amph.	present	absent	post.	broad	?	top of canal	?
Silvisaurus	amph.	absent	absent	post.	broad	broad	top of canal?	absent
Struthiosaurus	plan.	absent	present	post.	narrow	slender	top of canal	?
Minmi	amph.	absent	absent††	vert.	broad	slender	top of canal	present
Ankylosaurus‡	amph.	absent	absent	vert.	narrow	broad	top of centrum	present
Heishansaurus	amph.	absent	present	?	narrow	?	?	?
Talarurus	amph.	present	present	?	narrow	?	top of canal	present

* The genera here used follow Coombs 1978, and Maryanska 1977, with the exception of *Crataeomus*. This genus is treated as valid because of the different position of the pseudacromial process in *Crataeomus pawlowitschii* from that in *C. lepidophorus* (=*Struthiosaurus austriacus*) and *Struthiosaurus transylvanicus*. This difference is comparable to, but greater than, that between the scapulocoracoids of *Ankylosaurus* and *Euoplocephalus*.

** Keel present anteriorly on the centra only (Gilmore 1930).

† Variation between species not within a species.

†† Faint keel present on one of eleven centra.

‡ *Euoplocephalus* does not differ from *Ankylosaurus* in these states (Coombs, pers. comm.), and so this entry represents *Euoplocephalus* as well.

Abbreviations: proc. = procoelous
plan. = planoconcave
amph. = amphiplatyan
vert. = vertical
post. = posteriorly inclined.

forms are represented by material comparable to that of *Minmi*, so taxonomic relationships between them cannot presently be established.

The existence of an ankylosaur in Australia, in the Lower Cretaceous, underscores the widespread distribution of this group soon after its first appearance in the fossil record in the Neocomian (Coombs 1978). It also suggests the existence of a route into Australia during the early Cretaceous, or (accepting the existence of ankylosaurs during the Jurassic as postulated by Coombs 1978) the late Jurassic. Currently accepted dates for the separation of Australia from Antarctica are early Tertiary (Weissel and Hayes 1972, Deighton, Falvey and Taylor 1976), while the breakup of Gondwanaland is usually dated as Jurassic (e.g. Dietz and Holden 1970, Seyfert and Sirkin 1973): Rich (1975) in surveying the possible tetrapod dispersal routes across Antarctica into Australia concluded that any routes from South America would have been archipelagic after the mid-Mesozoic. The discovery of ceratodontid tooth-plates resembling those of *Neoceratodus forsteri*, the living Australian lung-fish, in the Upper Cretaceous Coli-Toro Formation of Argentina (Pascual and Bondesio 1976) suggests that such a route may have existed into the Upper Cretaceous. Molnar (1980) has presented evidence that such a route may have involved a filter, consonant with Rich's conclusion that the route would have been archipelagic.

Routes involving Africa or India are also possible, as these land masses were in connection with Antarctica into the Lower Cretaceous (Dietz and Holden 1970). Ankylosaurs are known from India and it seems that routes from Africa, at least, into the northern continents were open in the Lower Cretaceous (Molnar 1980, Sues and Taquet 1979). The presence of the freshwater plesiosaur *Leptocleidus* in the Lower Cretaceous of Queensland (Bartholomai 1966b), as well as in South Africa and western Europe, suggests that such a route could well have been taken by the ancestors of *Minmi*.

SUMMARY

A small Lower Cretaceous ankylosaur has been discovered in southeast Queensland. This is the first known ankylosaur from Australia. The ankylosaur, *Minmi paravertebra*, derives from the Minmi Mem. of the Bungil Fm. The existence of a presacral rod and fusion of one pair of ribs to the vertebra indicates that it is an ankylosaur. A set of peculiar elements of unknown function lie parallel to the dorsal neural spines, medial to the ribs. These elements, herein named paravertebrae, are preserved with the posterior three dorsals preserved. A fragment of one of the ribs shows a dorsal process just lateral to the tubercular process. *Minmi paravertebra* had a tetradactyl pes, and a ventral armour of small ossicles. Its dorsal vertebrae and ribs closely resemble those of other ankylosaurs.

The sequence of dorsal vertebrae of *Minmi* suggest that ankylosaur dorsals change slightly in form from anterior to posterior; the posterior vertebrae having longer prezygapophyses and broader centra than the anterior.

This specimen, although consisting of little more than the posterior portion of the trunk, minus pelvis, is still the most complete described from the southern hemisphere. It demonstrates that ankylosaurs were quite widespread soon after their first appearance (in the Neocomian) in the fossil record. They probably entered Australia via South America.

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PLATE 1.

FIG. A: The pes of *Minmi paravertebra* as preserved, in dorsal view. Bar represents 2 cm.

FIG. B: The last five dorsal vertebrae preserved, in left lateral aspect. The proximal portions of the ribs are still in place. Note the beginning of the presacral rod at right. Bar represents 5 cm.

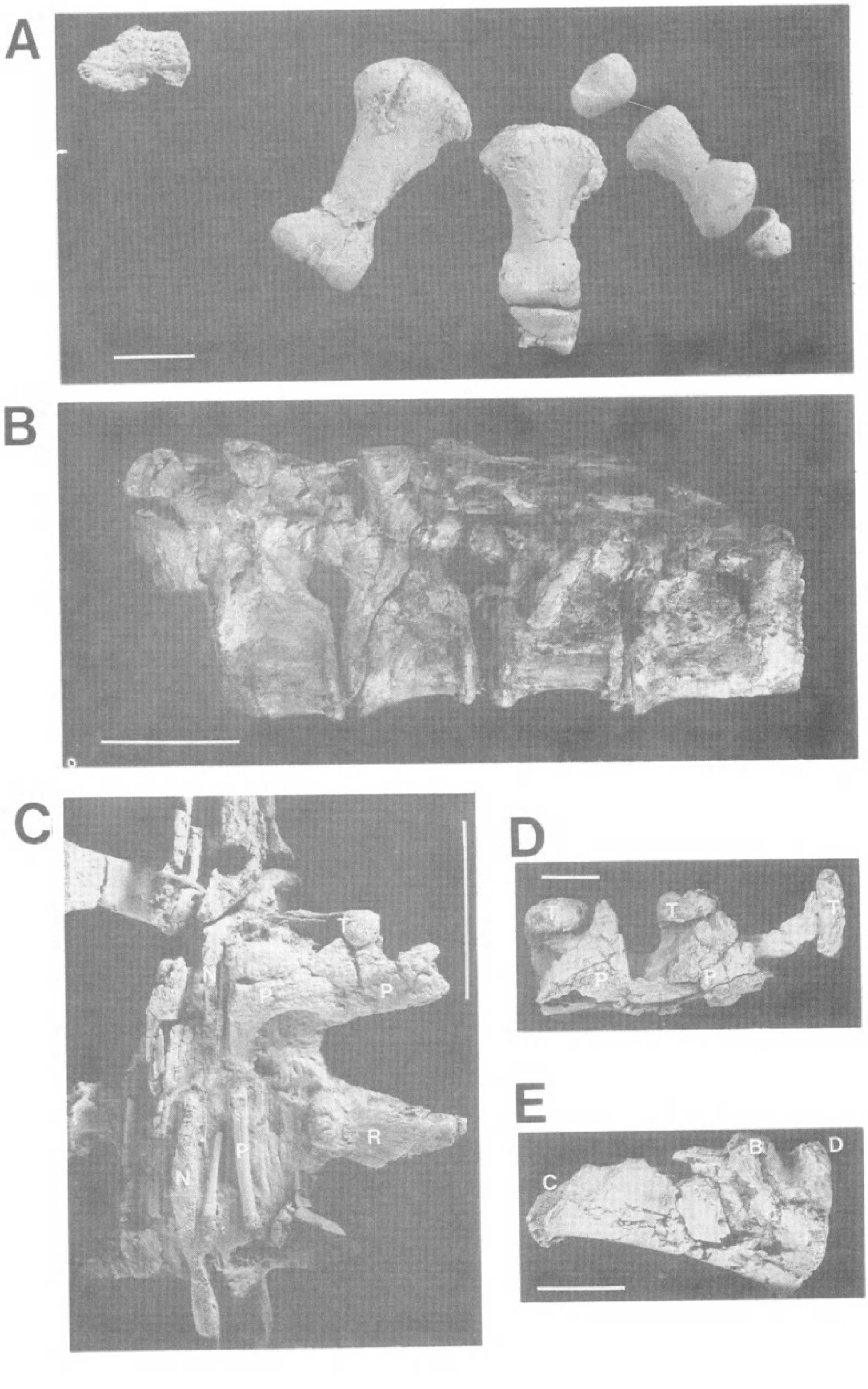
FIG. C: The same, in dorsal aspect. Paravertebrae are visible on the right. Bar represents 5 cm.

FIG. D: Block of matrix with three transverse processes and two paravertebrae adherent. Anterior is to the left. Bar represents 2 cm.

FIG. E: Proximal portion of last left rib present, showing dorsal process just lateral to tubercular process. Bar represents 2 cm.

Abbreviations: B, tuberculum; C, capitulum; D, dorsal process; N, neural spine; P, paravertebra; R, rib; T, transverse process.

PLATE 1



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