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# Further records of plesiosaurian reptiles of Jurassic and Cretaceous age from Western Australia

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**Abstract** – Isolated vertebrae, limb bones and a tooth of plesiosaurian reptiles are described from the Middle Jurassic Colalura Sandstone, near Geraldton, Perth Basin; the Early Cretaceous Barrow Group (subsurface, near Exmouth), Carnarvon Basin; and the Late Cretaceous Molecap Greensand, near Dandaragan, Perth Basin. The first records of elasmosaurid plesiosaurians are described from Western Australia, including the oldest record of the group in Australia.

## INTRODUCTION

Plesiosaurian reptiles were first discovered in Western Australia in the early 1940s, represented by isolated bones and teeth recovered from a test pit dug into the base of the Molecap Greensand, near the township of Dandaragan (Teichert and Matheson 1944). This material was briefly mentioned but not properly described nor identified beyond ordinal level.

Since then only a few bones have been mentioned in the literature or figured in popular field guides (Molnar 1991; Long 1993; McNamara *et al.* 1993). In 1992 and 1993 three partial skeletons of pliosaurids were recovered from the Early Cretaceous (Hauterivian-Barremian) Birdrong Sandstone exposed near Kalbarri, and these have recently been described by Cruickshank and Long (1997) as a new species, *Leptocleidus clemai*. These remains constitute the first associated partial skeletons of any Mesozoic reptiles from Western Australia. During the course of this work other isolated bones of plesiosaurians found from various sites in Western Australia were studied and are here summarised to complete the known record of the group for the State. Figure 1 shows a map indicating localities mentioned in this paper for all known Mesozoic reptile remains throughout Western Australia.

Specimens are reposited in the palaeontological collections of the Western Australian Museum (WAM) and in the Geology Department of the University of Western Australia (UWA).

## MIDDLE JURASSIC COLALURA SANDSTONE

The Colalura Sandstone is exposed at Bringo railway cutting about 20 km to the east of Geraldton. Over the past three decades it has yielded scant vertebrate remains, including at least two dinosaur bones (Long 1992; Long and Molnar 1998) and the isolated bones of plesiosaurians described below. It conformably underlies the Bringo Shale and Newmarracarra Limestone, both of which contain marine invertebrate fossils of Middle Bajocian age (Playford *et al.* 1975).

### Pectoral vertebra WAM 86.10.707

This specimen (Figures 2A–C, E; 3) which was previously figured by Long (1993: 53), has a very wide centrum, being 63 mm across by 42 mm high in the midline. It shows a large area where the articulation surface for the attachment of the pectoral rib was situated high up on the lateral faces of the centrum. The anterior zygapophysis is identified by the roughened area of bone on the anterior face of the neural arch (Figure 3A, a.z). The pectoral rib facet (Figure 3B, p.r) lies on both the neural arch and the centrum. It is very large, being of equivalent length as the midline height of the centrum. The neural arch is well-preserved (n.pr) with the base of the neural spine shown (Figure 3A, n.sp), enclosing the high, narrow opening for the spinal cord (n.c). There are widely spaced (c. 35 mm) but clearly visible subcentral foramina (Figure 3B, sc.f) on the ventral surface.

The wide proportions of the bone suggest it is

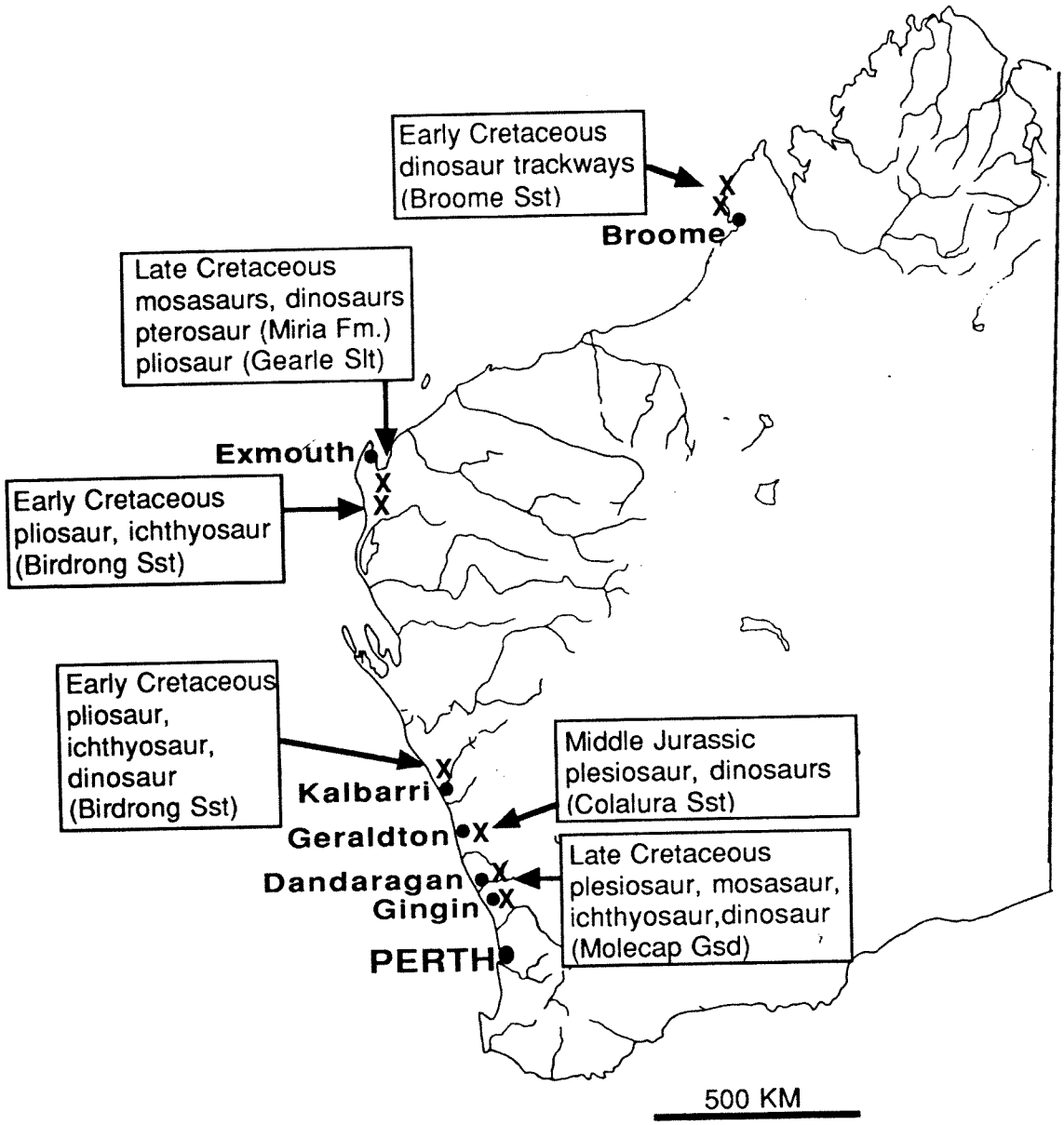


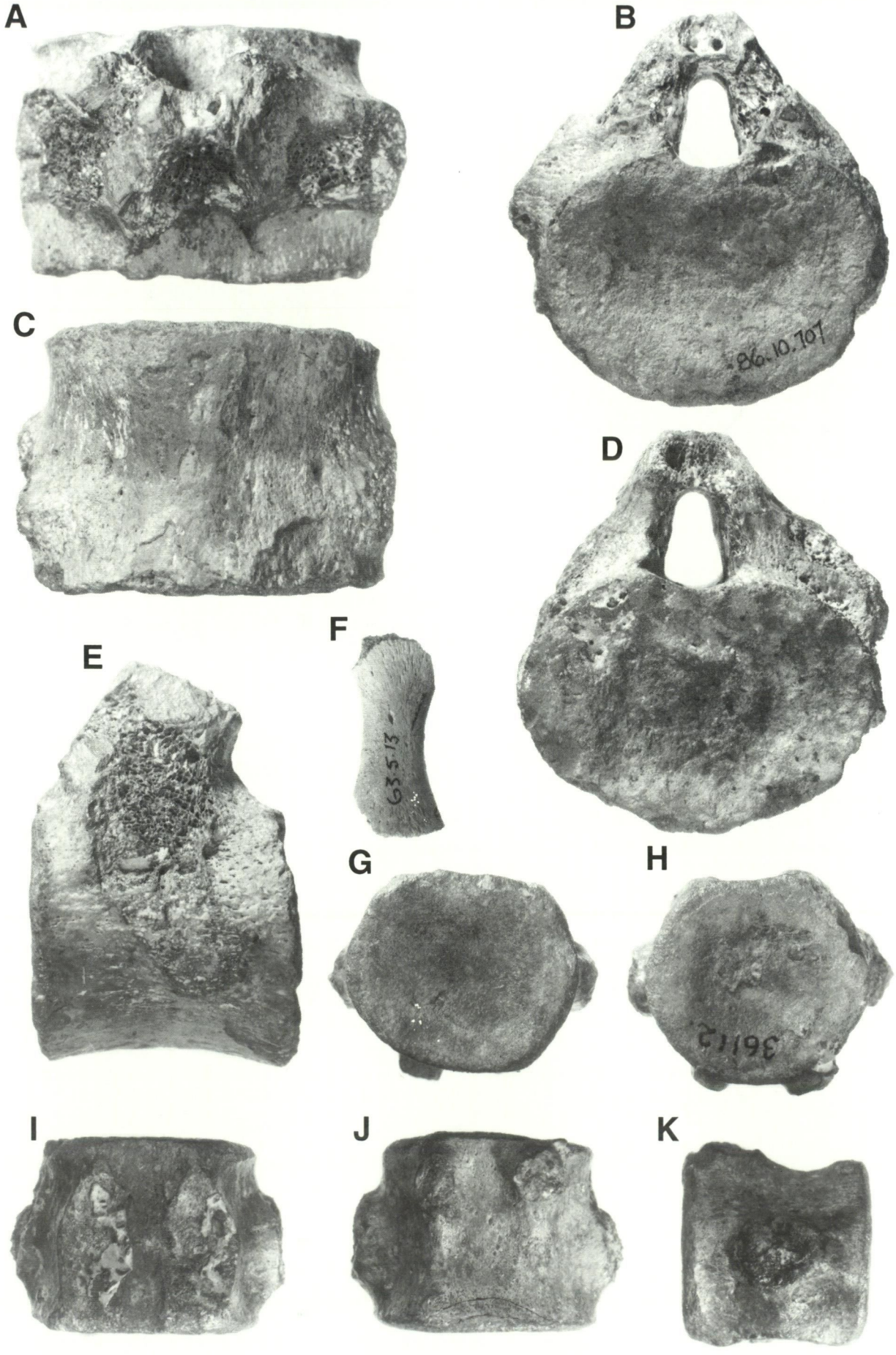

**Figure 1** Map showing the location of Mesozoic reptile remains found in Western Australia.

most likely an elasmosaurid, and if so, constitutes the oldest record of the family in Australia. The only other elasmosaurid known from Australia is *Woolungasaurus glendowerensis* from the Early Cretaceous (Albian) of Queensland (Perrson 1960). The oldest elasmosaurids are from the Liassic (Lower Jurassic) of Europe (*Microcleidus*, Brown 1981).

### Caudal vertebra UWA 36112

This is a very weakly preserved small vertebra (Figure 2F–J) showing the prominent haemal arches and well developed transverse processes (Figure 2F, G, I), and is probably a proximal caudal vertebra. It is 32 mm long, by 41 mm wide and 34 mm high in the midline. The neural arch was not firmly fused to the centrum as shown by the large attachment scars (Figure 2H), suggesting that the specimen came from a juvenile. The central faces are slightly concave and almost circular in form (Figure 2F, G), suggestive of typical plesiosaurid morphology without any specific family affiliation.

**Figure 2** Plesiosaurian remains from the Middle Jurassic (Bajocian) Colalura Sandstone exposed at Bringo Cutting, near Geraldton. All natural size. A–C, E, ?elasmosaurid pectoral vertebra,WAM 86.10.707, in dorsal (A), anterior (B), ventral (C), posterior (D) and left lateral (E) views. F, plesiosaurian phalange bone in dorsal view, WAM 63.5.13. G–K, plesiosaurian proximal caudal vertebra, UWA 36112, in anterior (G), posterior (H), dorsal (I), ventral (J) and left lateral (K) views. ▶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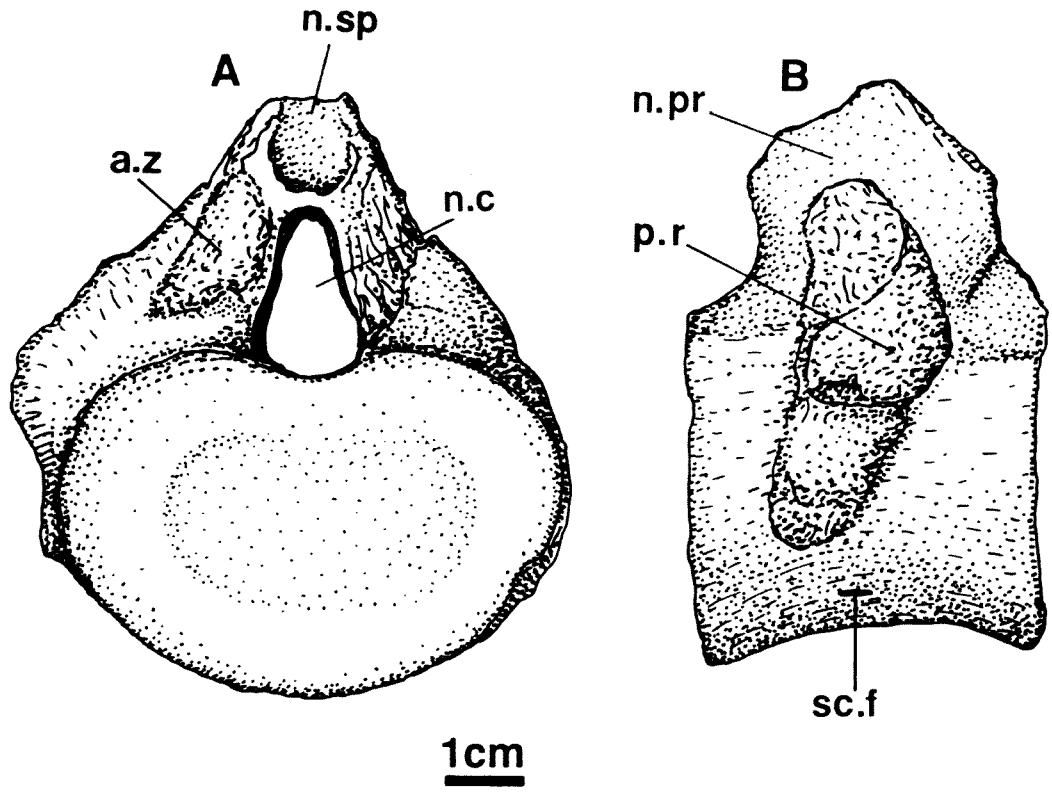



**Figure 3** Sketch of possible elasmosaurid pectoral vertebra, WAM 86.10.707, showing main features, in anterior (A) and right lateral (B) views. a.z., anterior zygapophysis; n.c, neural canal; n.pr, neural process; n.sp, neural spine; p.r, pectoral rib attachment; sc.f, subcentral foramen.

It has well-developed posterior ventral processes for the chevron attachments (Figure 2I).

### Plesiosaur phalange WAM 63.5.13

This bone (Figure 2F) was collected in 1963 by Mr Lindsay Peet, from the same site as the other two, at Bringo Cutting. It is typically plesiosaurian in having well rounded yet flattish cross-section through the shaft. It is 34 mm long by 17 mm wide at its proximal end, 12 mm high at the same end. It is distinguished from a dinosaur bone by its flatter shape. It gives no indication of familial placement within the Plesiosauria.

## EARLY CRETACEOUS (BERRIASIAN) BARROW GROUP

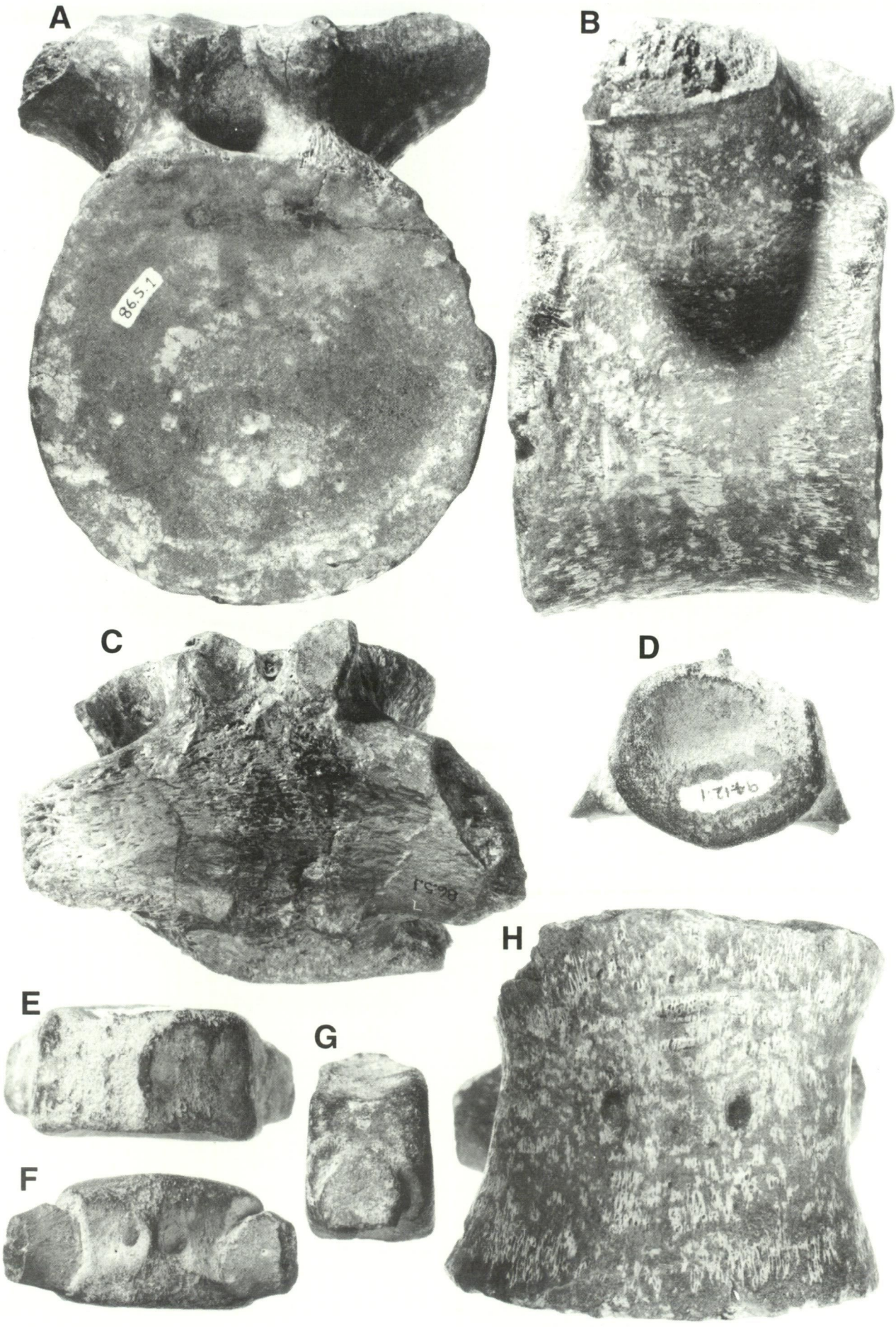
### Cervical vertebra WAM 95.12.1

One well-preserved specimen of a pliosaurid vertebra was found from a drill core (Macedon 3) by BHP Australia, and donated to the Western Australian Museum in 1995. The specimen (Figure 4D–G) is an anterior cervical with cervical ribs attached low on the lateral face of the centrum. It has clear foramina at the bases of the ribs indicating it had double headed ribs. The centrum measures 24 mm long, by 34 mm high in the midline, and 40 mm wide. Both anterior and posterior centrum faces are strongly concave. The bases for the neural arches are poorly defined remnants and the ribs are not fully fused to the centrum, suggesting it is from a subadult. The subcentral fossae are large, closley spaced and separated by a median ridge, a feature characteristic of plesiosaurians. We provisionally identify it as belonging to the genus *Leptocleidus* because it is very similar to material described as *Leptocleidus clemai* (Cruickshank and Long 1997).

## LATE CRETACEOUS MOLECAP GREENSAND

Fossil vertebrates were first recorded from the Molecap Greensand by Teichert and Matheson

**Figure 4** Cretaceous plesiosaurian remains from Western Australia. A–C, H, elasmosaurid dorsal vertebrae, WAM 86.5.1, from the Molecap Greensand, Late Cretaceous, Dandaragan, 3/4 nat. size. A, anterior view, B, left lateral view; C, dorsal view; H, ventral view (see also Figs, 5, 6B). D–G, ?*Leptocleidus* sp. cervical vertebra, WAM 94.12.1, from the Barrow Group, subsurface near Exmouth, natural size. D, anterior, E, dorsal, F, ventral and G, right lateral views. ▶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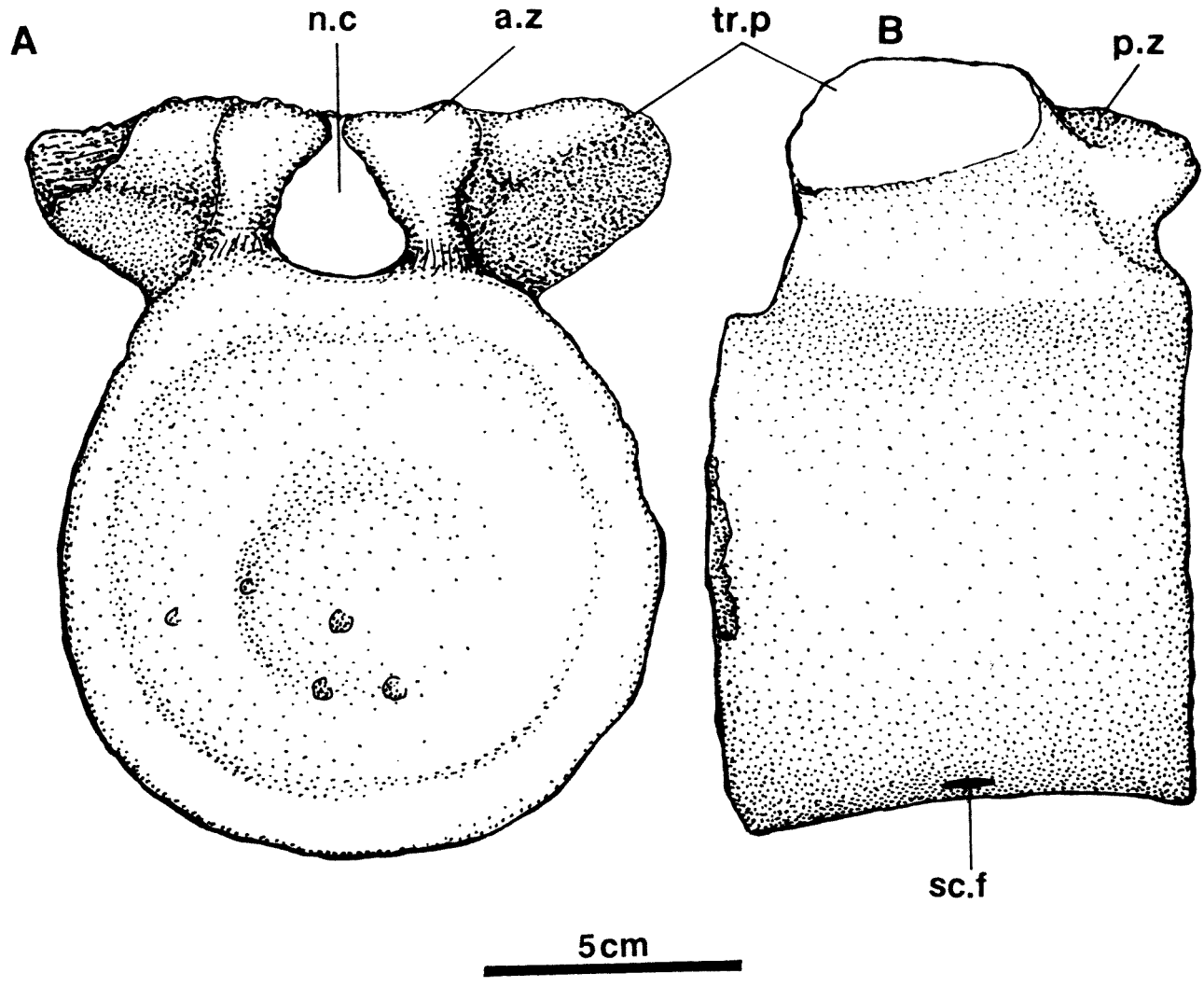


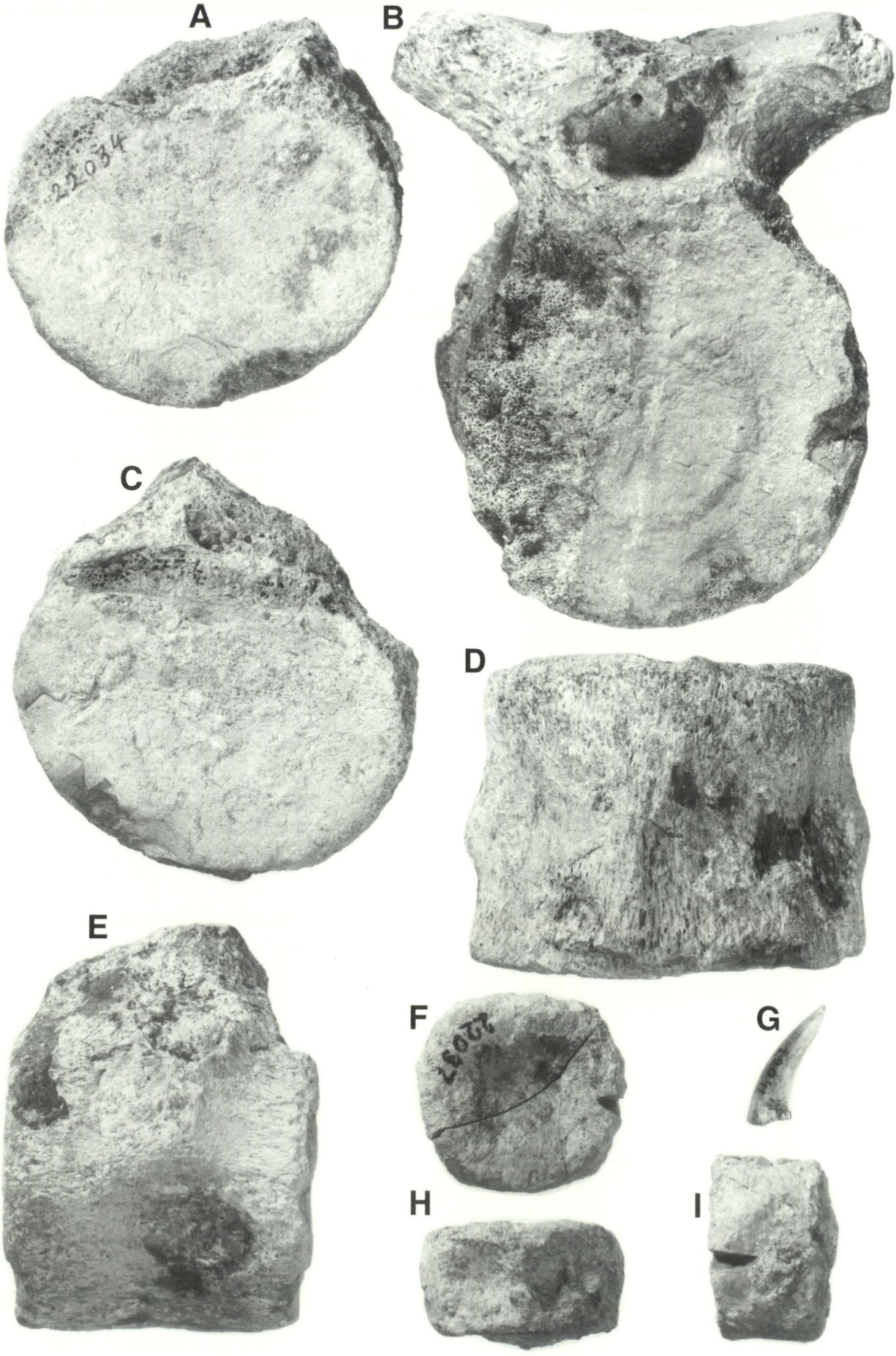

**Figure 5** Elasmosaurid vertebra, WAM 86.5.1, from the Molecap Greensand near Dandaragan, showing main features in anterior (A) and left lateral (B) views. a.z., anterior zygapophysis; n.c, neural canal; p.z., posterior zygapophysis; sc.f, subcentral foramen; tr.p, transverse process.

(1944) who reported the occurrence of ichthyosaurs and plesiosaurs, based on isolated vertebrae, rib fragments and teeth. The exact age of the Molecap Greensand vertebrates is in doubt because they occur at the base of the sequence in a phosphatic lag deposit which most likely includes reworked material. The shark tooth fauna associated with these reptile remains includes wide ranging forms from the Albian through to the end Cretaceous. A possible Cenomanian-Turonian age range for the Molecap Greensand is based on the overlying Gingin Chalk which contains the shark *Squalicorax kaupi*, of known Coniacian to Campanian age (M. Siverson, pers. comm. 1996).

**Dorsal vertebra WAM 86.5.1**

This specimen is the largest Mesozoic reptile bone so far found in the state, discovered by Mr Ivor Davies of Dandaragan in 1986 in a paddock ("fossil rise") near the township, where low outcrops of the Molecap Greensand are known to occur. It has been figured previously in McNamara

**Figure 6** Late Cretaceous plesiosaurian remains from the Molecap Greensand near Dandaragan. A, C–E, ? elasmosaurid vertebra, UWA 22034, 3/4 nat. size, A, anterior, C, posterior, D, ventral and E, left lateral views. B, elasmosaurid dorsal vertebra, WAM 86.5.1, in posterior view (see also Figures 4A–C, H; 5). F, H, I, caudal vertebra cf. *Leptocleidus* sp., UWA 22037, F, anterior, H, ventral and I left lateral views, natural size. G, plesiosaurian tooth, UWA 22041, natural size.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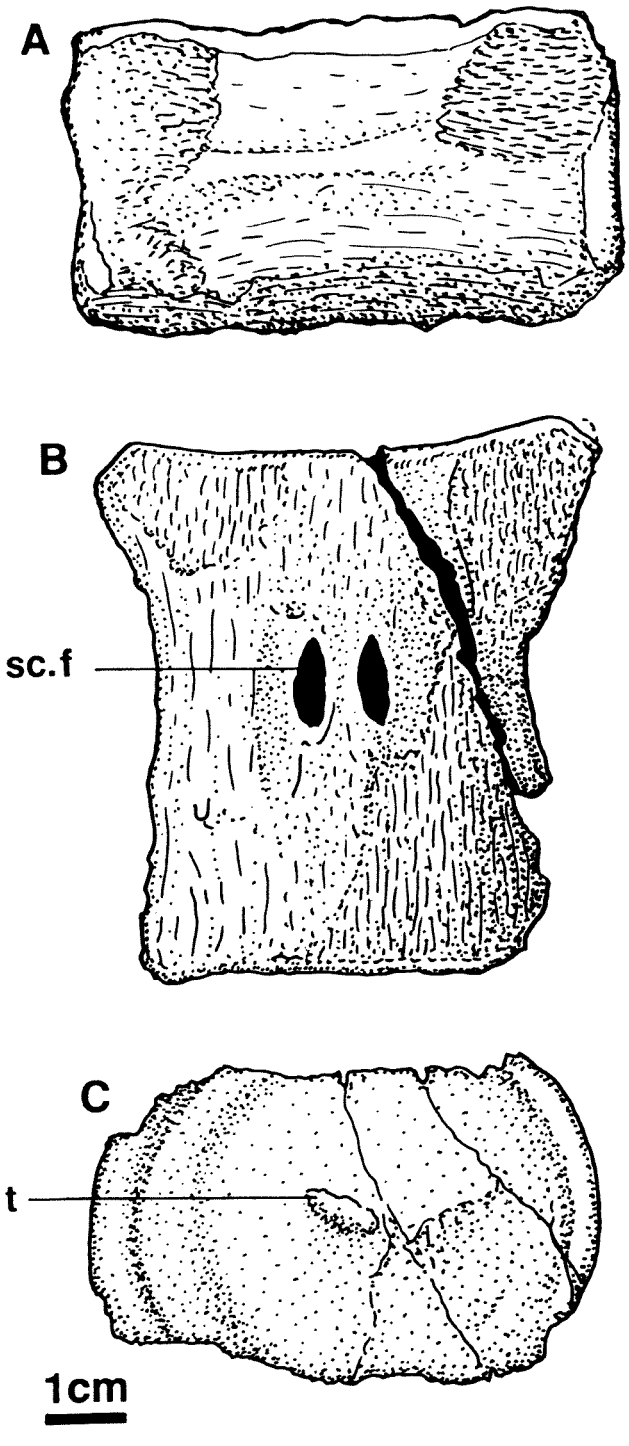


**Figure 7** Late Cretaceous elasmosaurid damaged ?cervical vertebra from the Molecap Greensand near Dandaragan, UWA 22036, showing main features in left lateral (A), ventral (B) and anterior (C) views. sc.f, subcentral foramen; t, thickening on centrum face.

*et al.* (1993, figure 74–75). The specimen (Figures 4A–C, H; 5, 6B) is a dorsal vertebra having a centrum measuring 96 mm long, the anterior face is 110 mm high in the midline by 117 mm wide. The neural arches are well preserved and firmly ossified to the centrum. The anterior and posterior zygapophyses (Figure 5, a.z, p.z) are well defined as are the wide transverse processes (Figure 5, tr.p), but the neural spine is missing. The cavity for the spinal cord (Figure 5, n.c) is wider than high. The centrum faces are weakly concave with a well-defined, slightly raised rim. The subcentral foramina (Figure 4H, 5, sc.f) are large, and closely situated to each other. The specimen resembles the dorsal vertebra of *Mauisaurus haasti*, an elasmosaurid from the Late Cretaceous of New Zealand (Wiffen and Moisley 1986, figure 32) in having similar centrum proportions, but differs in the absence of the central raised swelling with median pit characteristic of that genus.

**?Cervical vertebra UWA 22034**

This large bone (Figure 6A, C–E) is a posterior cervical possibly from an elasmosaurid due to its wide centrum which is markedly wider than its height and its length. The centrum measures 74 mm long, 102 mm wide and is 75 mm in midline height. The neural arch was well ossified to the centrum but only poorly defined remants remain. There are large, moderately well-spaced apart subcentral foramina present (Figure 6D).

**?Cervical vertebra UWA 22036**

This specimen (Figure 7) is a poorly preserved part of a centrum that nonetheless shows the elongated shape typical of the cervical vertebra of elasmosaurids. The centrum is 72 mm long by 65 mm wide, but the midline height cannot be acurately restored. The subcentral foramina (Figure 7B, sc.f) are large and closely situated to each other. The centrum faces are weakly concave with a median tuberosity in the centre on one face (Figure 7C, t). This appears to be an age related feature (Brown 1981).

**Plesiosaurian caudal vertebra UWA 22037**

This plesiosaurian caudal vertebra (Figure 6F, H,I) measures 20 mm long by 36 mm wide by 35 mm high in the midline of the centrum. It lacks neural arches but their attachment bases are clearly defined. The centra are deeply concave. It closely resembles the posterior caudal vertebrae of *Leptocleidus clemai* from the Early Cretaceous Birdrong Sandstone (Cruickshank and Long 1997).

**Tooth UWA 22041**

This isolated tooth (Figure 6G) is a well-preserved specimen showing numerous fine striations (about 14 on the lingual side) and has a large pulp cavity. The buccal side is much smoother. The shape is sigmoidal, recurved, being typical of elasmosaurid teeth (e.g., Brown 1981). It is 26 mm long and 8 mm broad across the base. Another specimen (WAM 79.8.10) from Cooks

Property at Dandaragan, is also a small piece of reptile tooth showing enamel and the pulp cavity yet we are not able to identify it as plesiosaurian, so mention it here only for the sake of recording it in the literature.

### Pectoral rib, UWA 22038

There two fragments of thick, well-ossified ?plesiosaurian pectoral rib, hardly worthy of illustration, but are included here to complete the list of known material. One fragment measures 30 mm across its widest section by 21 mm thick, the other being slightly less robust. There are cell spaces in the middle indicating that they were not pachyostotic as occurs in some bottom dwelling plesiosaurians such as in the Lower Jurassic plesiosaurs from Mt Morgan in Queensland (Cruickshank, pers. observ.) first described by Bartholomai (1966), and in an undescribed new genus from the Oxford Clay (Callovian) of England (Cruickshank *et al.* 1996).

## SUMMARY AND CONCLUSIONS

Isolated bones of plesiosaurians from the Middle Jurassic Colalura Sandstone (Bajocian) near Geraldton include the oldest possible elasmosaurid known from Australia, based on a well-preserved pectoral vertebra, as well as a caudal vertebra and an isolated phalange of more typical plesiosaurians.

The only known Mesozoic vertebrate of Berriasian age known from Australia is represented by a single cervical vertebra of cf. *Leptocleidus* sp. from the subsurface Barrow Group offshore near Exmouth, Western Australia.

Late Cretaceous vertebrae, teeth and rib fragments from the ?Turonian Molecap Greensland indicate the presence of large elasmosaurid plesiosaurs from Western Australia, having similar size range to that of *Mauisaurus* from New Zealand (up to 14 metres length).

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