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PLIOSAURS AND PLESIOSAURS FROM THE MIDDLE JURASSIC (CALLOVIAN) OF NORMANDY

by

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KEY-WORDS

Marine reptiles, pliosaurs, plesiosaurs, Middle Jurassic, Callovian, Normandy, palaeobiogeography.

MOTS CLES

Reptiles marins, pliosaures, plésiosaures, Jurassique moyen, Callovien, Normandie, paléobiogéographie.

ABSTRACT

The Middle Jurassic (Callovian) formations of "Marnes d'Argences" and "Marnes de Dives" in Normandy, stratigraphically equivalent to the Oxford Clay of England, have yielded a rich marine reptile fauna. Sauropterygians are abundant and represented by both pliosaurs (*Liopleurodon ferox*, *Liopleurodon* cf. *L. pachydeirus*, *Simolestes vorax*, *Peloneustes philarchus*) and plesiosaurs (*Muraenosaurus leedsii*, *Cryptoclidus eurymerus*, *Tricleidus seeleyi*). These species have been reported previously from the Oxford Clay of England.

RESUME

Pliosaures et plésiosaures du Jurassique moyen (Callovien) de Normandie.- Les formations des Marnes d'Argences et des Marnes de Dives du Jurassique moyen (Callovien) de Normandie, stratigraphiquement équivalentes de l'Oxford Clay d'Angleterre, ont livré une riche faune de reptiles marins. Les Sauroptérygiens sont abondants et représentés à la fois par des pliosaures (*Liopleurodon ferox*, *Liopleurodon* cf. *L. pachydeirus*, *Simolestes vorax*, *Peloneustes philarchus*) et des plésiosaures (*Muraenosaurus leedsii*, *Cryptoclidus eurymerus*, *Tricleidus seeleyi*). Ces espèces étaient connues jusqu'à présent dans l'Oxford Clay d'Angleterre.

INTRODUCTION

Research and discovery of reptiles in the Middle and Upper Jurassic marine sediments of Normandy has a long history, and fossils have been collected over the last century. Unfortunately, a great part of the often fully preserved material, housed in the Museums of Caen and Le Havre, was destroyed by bombing during the Second World War. Since that time much activity by collectors in the region has resulted in the discovery of marine reptiles, dinosaurs and invertebrate fossils, which have increased the collections.

In Normandy, the "Marnes d'Argences" and "Marnes de Dives", equivalent of the Oxford Clay of England (RIOULT *et al.*, 1989) outcrop. This Basin corresponds to a huge paleomudhole which favoured the preservation of specimens so that, both in England and France, these levels have yielded an abundant and rich fauna of plants, invertebrates and vertebrates (MARTILL, 1986; RIOULT, 1978). In Normandy, the vertebrate fauna includes fishes, ichthyosaurs and dinosaurs; but the most abundant groups, qualitatively and quantitatively, are the thalattosuchians and sauropterygians (both plesiosaurs and pliosaurs).

In contrast to the English Oxford Clay fauna (MARTILL & HUDSON, 1991), no global view of the fauna from Normandy has been made. The sauropterygians have been only partially studied or cited in a few papers (BIGOT, 1938; HOFFSTETTER & BRUN, 1958). Recently a review of the old material and the study of new specimens has been undertaken (BARDET *et al.*, 1991; BARDET *et al.*, in press). The aim of this paper is thus to list the taxa found and to place them in a palaeobiogeographical context.

STRATIGRAPHICAL AND GEOGRAPHICAL OCCURRENCES

The Middle Jurassic (Callovian) localities which have yielded sauropterygian material are well exposed East of Caen (Fig. 1). As for the English outcrops, most of the vertebrates comes from the Lower Oxford Clay (Callovian) whereas the fossils are scarcer in the Upper Oxford Clay (Oxfordian). The Callovian units which have yielded the fossils in Normandy are as follows :

The "Marnes d'Argences" are of early Callovian age (zone of *S. calloviense*) (RIOULT *et al.*, 1989). The main outcrops occur at Touffréville and Argences, near the city of Caen. Both were quarries used to make bricks and are now closed. The associated vertebrate fauna is marine and consists of fishes, sauropterygians, thalattosuchians, and a skeleton of the stegosaur *Lexovisaurus* (GALTON *et al.*, 1980). This horizon may correlate with the Kellaways-Beds of the Callovian of England (RIOULT & MOURDON, 1980).

The "Marnes de Dives", of late Callovian age (zone of *Q. lamberti*) (RIOULT *et al.*, 1989) are mainly accessible in the sea-cliffs of Villers-sur-Mer and Bénerville, near Deauville. In Villers, the outcrop is located at beach level whereas in Bénerville it is located higher in the cliff because of the Villers fault. This level is characterised by pyritous fossils (especially ammonites) and abundant remains of lignites and vertebrates. It corresponds to

carbonated muds deposited offshore (RIOULT, 1980).

SYSTEMATICS

Class Reptilia
Order Sauropterygia
Suborder Plesiosauria
Superfamily Pliosauroidae
Family Pliosauridae

Liopleurodon ferox

Material :

Two isolated tooth crowns, Museum of Villers-sur-Mer and Coll. G. & E. PENNETIER.

Provenance :

"Vaches-noires" sea-cliffs, Villers-sur-Mer, Calvados.

Description (Pl. I, fig. 2-3) :

On both teeth the crown is nearly complete and approximatively 10 cm height but the roots have been broken. These two specimens, which were probably large caniniform teeth of the anterior part of the jaw, exhibit the typical ornamentation of the enamel crown of *Liopleurodon ferox*, as described by SAUVAGE (1873) and TARLO (1960). The crown is circular in cross-section. The outer surface is convex and covered by few widely spaced ridges separated by wide smooth areas; the inner surface is concave and bears well spaced coarse ridges.

Liopleurodon is recorded from the Callovian and Kimmeridgian of Europe to the Tithonian of Russia (HALSTEAD, 1971) and Argentina (GASPARINI *et al.*, 1982). The species *L. ferox* was first described from a tooth discovered in the Callovian of the Boulonnais, in Northern France (SAUVAGE, 1873; BARDET *et al.*, in press) and then became known from several incomplete skeletons from equivalent horizons in Cambridgeshire, central England (ANDREWS, 1913; TARLO, 1960).

Liopleurodon cf. L. pachydeirus

Material :

Incomplete mandible, Coll. R. BRUN, Museum of Le Havre, MHNH 1000.

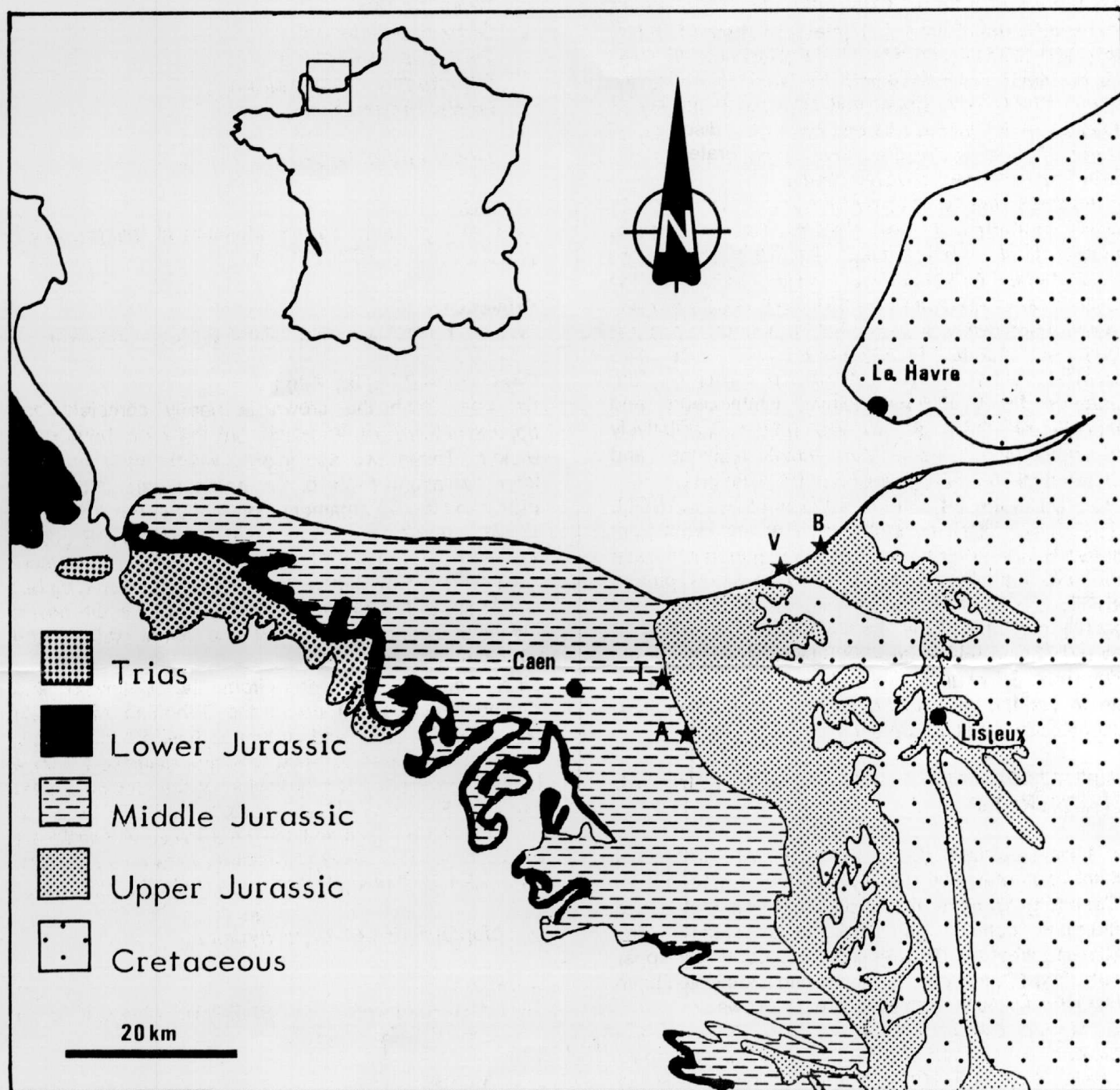
Provenance :

Quarry of Argences, Calvados.

Description (Pl. I, fig. 1) :

This small mandible, about 1 m long, is almost complete except for the anterior part of the symphysis and a part of the right ramus. There are 31 alveolae preserved in each ramus and the symphysis probably bears seven large caniniform teeth. Some replacement teeth are preserved and show a circular cross-section. The inner surface is covered by fine and closed packed ridges but the outer surface is not sufficiently accessible to see the ornamentation. Characters of both the symphysis and the teeth permit this mandible to be referred to *Liopleurodon*, possibly *L. pachydeirus* as defined by TARLO (1960).

Fig. 1 : Geographical and stratigraphical occurrence of sauropterygians from the Callovian of Normandy. A = Argences, B = Bénéville, T = Touffréville, V = Villers-sur-Mer.



The mandible of *L. pachydeirus* was previously known only from one incomplete mandibular symphysis from the Oxford Clay of England (LYDEKKER, 1890; TARLO, 1960).

Simolestes vorax

Material :

Crown of a tooth, Coll. R. BRUN, Museum of Le Havre, MHNH 1001.

Provenance :

Quarry of Argences, Calvados.

Description (Pl. I, fig. 4) :

The tooth is small, 5 cm high, with only the crown preserved, which is circular in cross-section. The outer surface bears fine ridges which always begin some distance from the base, so that the basal part of the crown is devoid of ornament. The inner surface is covered with numerous fine ridges. The characters of the ornamentation of the outer surface of the crown permit this tooth to be assigned to *Simolestes vorax* (TARLO, 1960).

Simolestes, a genus of pliosaur with a very spatulate symphysis, has been reported from the Oxford Clay of England (ANDREWS, 1909), and the Tithonian of India

(BARDET *et al.*, 1991b). *S. vorax* is based on an incomplete skeleton discovered in the Oxford Clay of England (ANDREWS, 1909; TARLO, 1960).

Peloneustes philarchus

Material :

Incomplete pelvic girdle, Coll. J. COUVELARD.

Provenance :

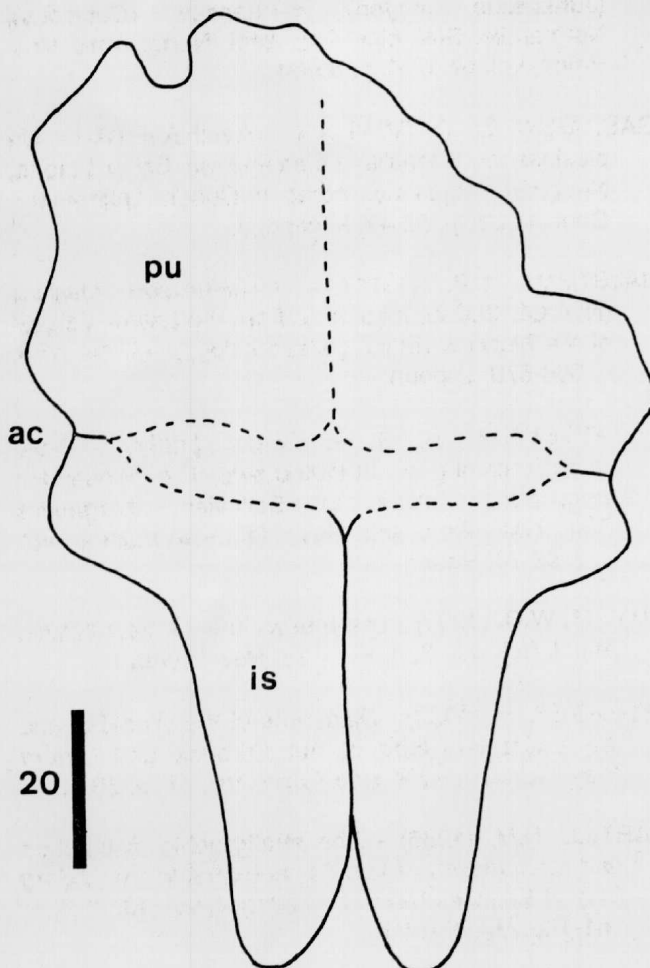
Quarry of "La grande Bruyère", Touffréville, Calvados.

Description (Fig. 2) :

This huge pelvic girdle (dimensions 120 x 80 cm) exhibits complete ischia, whereas the pubes have been damaged. The bones are fused, so that this girdle could have belonged to an "old adult" specimen (*sensu* BROWN, 1981). The ischia are extremely elongated posteriorly, and are narrow with a straight and robust symphysis. The pubes have a slightly concave lateral border. This specimen is very similar to that figured by ANDREWS (1913, p. 59) and is here referred to *Peloneustes philarchus*.

P. philarchus was previously recorded only from the Oxford Clay of England (SEELEY, 1869; TARLO, 1960).

Fig. 2 : Pelvic girdle, *Peloneustes philarchus*, referred specimen, Lower Callovian, Touffréville, Couvelard collection.



Superfamily Plesiosauroidea

Family Elamosauridae

Muraenosaurus leedsii

Material :

An hemipectoral girdle and three associated cervical vertebrae, Coll. G. & E. PENNETIER.

Provenance :

Sea-cliff of Bénerville, Calvados.

Description (Pl. I, fig. 8-9) :

This material has already been described in detail elsewhere (BARDET *et al.*, 1991a). The hemipectoral girdle is nearly complete and about 60 cm long. The ventral ramus of the scapula ends anteriorly in a U-shaped notch. The "cornua" of the coracoid are not very prominent and just exceed the interglenoid width. The postero-medial part of the coracoid is developed posteriorly, so that this border is not straight. The three associated cervical vertebrae are very small and could be part of the most anterior portion of the neck. Their length is greater than their diameter and the lateral surface of the centrum bears a very pronounced keel. The characters of both the girdle and the vertebrae permit the material to be referred to an "adult" specimen of *Muraenosaurus leedsii* (*sensu* BROWN, 1981).

Muraenosaurus is known by two species found in the Oxford Clay of England (ANDREWS, 1911; BROWN, 1981). Fragmentary remains possibly attributable to this genus have been discovered in the Upper Jurassic of Wyoming (MEHL, 1912) and the Callovian of Argentina (GASPARINI, pers. com.).

Family Cryptoclididae

Cryptoclidus eurymerus

Material :

Left humerus, Coll. R. BRUN, Museum of Le Havre, MHNH 1005.

Provenance :

Quarry of Argences, Calvados.

Description (Pl. I, fig. 5) :

This specimen is 35 cm long and is characterised by its robustness. The anterodistal part, which forms the radial facet is greatly enlarged, attesting that this specimen was "adult" (BROWN, 1981). The surface of the bone is roughly striated. The shaft of the bone is reduced compared with the distal extremity. These characters are diagnostic for *Cryptoclidus eurymerus* (BROWN, 1981).

Cryptoclidus is represented by two species from the Callovian of England (ANDREWS, 1911; BROWN, 1981).

Tricleidus seeleyi

Material :

Right humerus and interclavicle, Coll. R. BRUN, Museum of Le Havre, MHNH 1003 & 1004.

Provenance :

Quarry of Argences, Calvados.

the marine reptiles of the Oxford Clay, vol. 2, 206 p.,
Ed. Brit. Mus. Nat. Hist., London.

Description (Pl. I, fig. 6-7) :

A right humerus, 30 cm long is preserved. The bone, relatively short and stout, articulated distally with four elements. The radial facet seems to be the largest. The pisiform and postaxial accessory ossicle facets remain small and posteriorly orientated. The dorsal tuberosity is very well developed. The interclavicle is very large and bears an anterior notch as in *Muraenosaurus*. However, the central part of the bone is strengthened by a T-shaped thickened area consisting of an anterior transverse bar and a median longitudinal bar. The characters of both the humerus and the interclavicle permit them to be assigned to *Tricleidus seeleyi* (BROWN, 1981). On the basis of the structure of the check region and of the anterior cervical vertebrae, *Tricleidus* has been reinterpreted as a cryptoclidid (BROWN, this volume). *Tricleidus* is known only from one species found in the Oxford Clay of England (ANDREWS, 1909; BROWN, 1981). Fragmentary remains belonging possibly to this genus are reported from the Upper Jurassic of Wyoming (KNIGHT, 1900; MEHL, 1912) and Spitzbergen (PERSSON, 1961).

CONCLUSION

Central and Southern England and the North of France were closely related during the Callovian, forming part of the Anglo-parisian Basin and sharing the same epicontinental sea. In consequence the marine faunas show strong similarities. The pliosaurs *Liopleurodon*, *Simolestes* and *Peloneustes*, and the plesiosaurs *Muraenosaurus*, *Cryptoclidus* and *Tricleidus* are represented by the same species in the Callovian of both England and Normandy. The palaeobiogeographical areas of all these species are thus extended.

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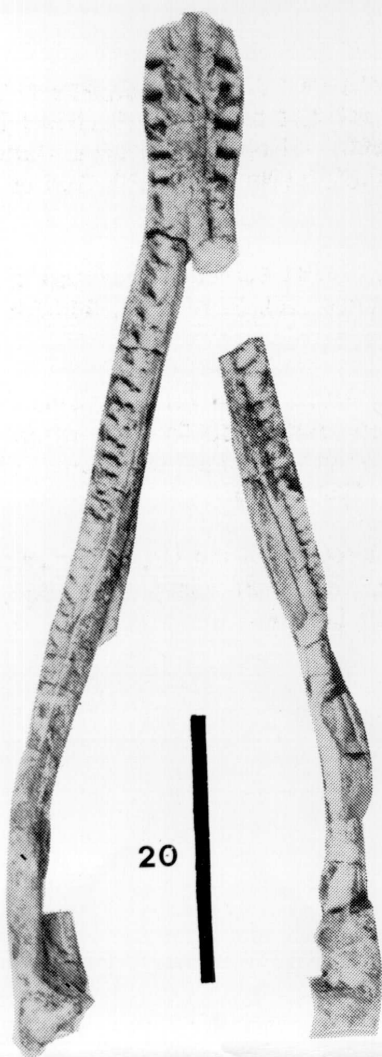
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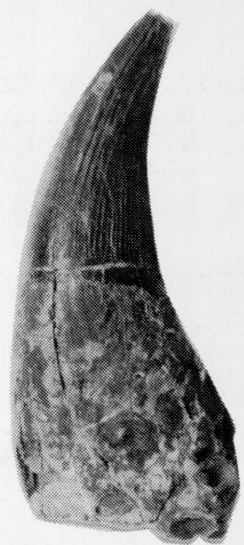
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Plate I

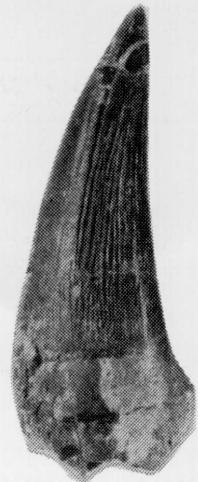
- Fig. 1 : Mandible, *Liopleurodon* cf. *L. pachydeirus*, referred specimen, Lower Callovian, Argences, Museum of Le Havre.
- Fig. 2-3 : Tooth crowns, *Liopleurodon ferox*, referred specimens, Upper Callovian, Villers-sur-Mer, Museum of Villers and Pennefier collection.
- Fig. 4 : Tooth crown, *Simolestes vorax*, referred specimen, Lower Callovian, Argences, Museum of Le Havre.
- Fig. 5 : Left humerus, *Cryptoclidus eurymerus*, referred specimen, Lower Callovian, Argences, Museum of Le Havre.
- Fig. 6-7 : Right humerus and interclavicle, *Tricleidus seeleyi*, referred specimens, Lower Callovian, Argences, Museum of Le Havre.
- Fig. 8-9 : Pectoral girdle and cervical vertebrae, *Muraenosaurus leedsii*, referred specimens, Upper Callovian, Bénerville, Pennefier collection.



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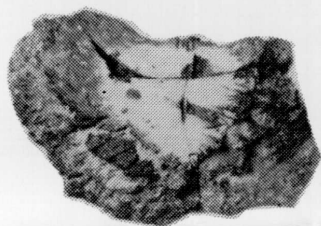
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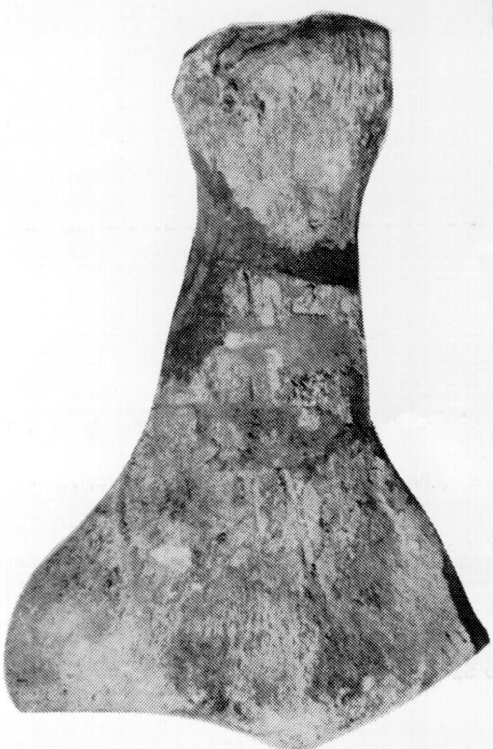
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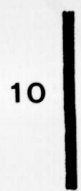
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