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AN ISOLATED STERNUM OF *EUDIMORPHODON* (REPTILIA, PTEROSAURIA) FROM THE NORIAN (LATE TRIASSIC) OF THE BERGAMO PREALPS (LOMBARDY, NORTHERN ITALY)

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Key-words: *Eudimorphodon* (Reptilia, Pterosauria), Norian (Late Triassic), Sternum, Description, Taphonomy.

Riassunto. Viene descritto uno sterno di Pterosauro, rinvenuto nel Calcare di Zorzino (Norico, Triassico Superiore), nella località fossilifera di Endenna, vicino a Zogno (Bergamo). Le dimensioni e le caratteristiche del fossile sono molto simili a quelle dello sterno dell' olotipo di *Eudimorphodon ranzii* Zambelli, 1973. Per analogia con quanto si verifica negli uccelli marini attuali, si può supporre che lo sterno si sia staccato da una carcassa galleggiante e sia affondato isolatamente, finendo indisturbato sui fondali anossici, dove venne sepolto dai sedimenti. Finora solo in un esemplare di *Eudimorphodon ranzii*, l'olotipo, era possibile osservare uno sterno completo e ben conservato.

Abstract. An isolated pterosaur sternum is described. It has been collected in the Zorzino Limestone (Norian, Late Triassic), at the locality of Endenna (Bergamo Prealps, Lombardy, Northern Italy). The shape and size of the bone are very similar to those of the sternum preserved in the holotype of *Eudimorphodon ranzii* Zambelli, 1973, collected from the same formation at the locality of Cene (Imagna valley, Lombardy, Northern Italy), and it is ascribed to this species. It represents the second well preserved *Eudimorphodon* sternum so far collected.

Introduction.

The scientific interest of Norian vertebrate fauna collected from the Zorzino Limestone and Riva di Solto Shales formations in Northern Italy has already been established (Tintori et al., 1985). The findings consist mainly of fishes, but reptiles, with at least 10 genera, often endemic, are also of great importance, since they give informations of the environment surrounding the depositional area. The main fossiliferous unit, the Zorzino Limestone, was deposited in intraplatform basins, surrounded by the huge Dolomia Principale carbonate platform. Those basins were deep

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and several kilometers wide; their centre was anoxic, but their margins yielded the oxic environment (Jadoul, Berra & Frisia, 1992; Tintori, 1992). Despite the depositional environment, terrestrial reptiles are more common than marine ones, suggesting the existence of carbonatic islands, perhaps with freshwater reservoirs (as already suggested by Tintori et al., 1985) surrounding these basins.

Aquatic reptiles are represented by the placodont *Psephoderma alpinum* (Pinna, 1979; Pinna & Nosotti, 1989) and by the thalattosaur *Endennasaurus acutirostris* (Renesto, 1984, 1992). Among non marine reptiles, fragments of the armour of the thecodont *Aetosaurus* (Wild, 1991) and an isolated skull probably belonging to the phytosaur genus *Mystriosuchus* (Pinna, 1987) have been collected. The most interesting findings however are some endemic genera, like the small archosauromorph *Megalancosaurus* (Calzavara et al., 1980; Renesto, in press) and the enigmatic diapsid *Drepanosaurus unguicaudatus* (Pinna, 1980, 1984), along with the oldest known pterosaurs (Zambelli, 1973; Wild, 1978; Padian, 1980). Among pterosaurs three distinct genera, representing three different families have been described so far: the dimorphodontid *Peteinosaurus* (Wild, 1978), the eudimorphodontid *Eudimorphodon* (Zambelli, 1973; Wild, 1978) and the ramphorhynchyd genus *Preondactylus* (Wild, 1983). During field work at the small quarry of Endenna, near Zogno (Bergamo Prealps, Lombardy, Northern Italy), where the upper part of the Zorzino Limestone crops out, a small fragment of bone was collected by Dr. A. Tintori of the Dipartimento di Scienze della Terra dell' Università di Milano. Further preparation revealed that it was part of an isolated sternum of a pterosaur. The size and shape of the preserved portions of this bone are very similar to the corresponding ones of the sternum of the holotype of *Eudimorphodon ranzii* Zambelli, 1973 (Wild 1978), collected from the same formation at the locality of Cene (Imagna valley, Lombardy, Northern Italy). The slight differences existing between the two bones do not justify the erection of a new species, thus the fossil is considered as belonging to *Eudimorphodon ranzii* Zambelli, 1973.

Palaeontological description

Class **Reptilia**

Subclass **Archosauria** Cope, 1869

Order **Pterosauria** Kaup, 1834

Suborder **Ramphorhynchoidea** Plieninger, 1901

Family *Eudimorphodontidae* Wellnhofer, 1978

Genus *Eudimorphodon* Zambelli, 1973

Type species: *Eudimorphodon ranzii* Zambelli, 1973

Eudimorphodon ranzii Zambelli, 1973

Pl. 1; Text fig. 1, 2

1973 *Eudimorphodon ranzii* Zambelli, pp. 1-24, fig. 1, 2.
1978 *Eudimorphodon ranzii* - Wild, pp. 177-220, fig. 1-29, pl. 1-10.
1978 *Eudimorphodon ranzii* - Wellnhofer, pp. 32-33, fig 2, 10.

Horizon and locality. Upper part of the Zorzino Limestone, Norian (Late Triassic), Endenna, near Zogno (Bergamo, Lombardy, Northern Italy).

Material. An isolated sternum, signed as n. 7039 of the catalogue of the Museo di Paleontologia del Dipartimento di Scienze della Terra dell' Università degli Studi di Milano (acronym: MPUM), where the fossil is stored.

Description.

The bone is exposed on its ventral side and it is incomplete, since the posterior portion of the left half is lacking. Its length, from the tip of the cristospina to the posterior end of the preserved portion is of about 5.6 cm.

The bone (Pl. 1; Fig. 1) shows an approximately pentagonal outline, with an elongate and keeled anterior process, the cristospina. The anterior third of the bone is very stout and thick, becoming thin and flat more posteriorly. The cristospina is 1.9 cm long; it is rather thick and tapers gradually toward its anterior end. This structure continues posteriorly as a small ventral keel, gradually decreasing its height; it runs along the medial axis of the sternum till the end of the preserved portion of the bone. On each side of the sternum, just at the base of the anterior projection of the cristospina, a deep notch can be observed, the articular area for the coracoid. On the right lateral margin of the sternum, four notches and five laterally projecting processes for the insertion of the sternal ribs can be observed, the fifth one is about two times the length of the others; another small process can be detected near the right end of the posterior margin of the bone, along with a small notch. The presence of these processes, which ossify later during growth, testifies that the bone belonged to an adult specimen. Medially to these structures the preserved portion of the posterior margin shows a gently convex outline. The surface of the flattened posterior portion of the sternum is rather rough, with very small tubercles and grooves, that represent the traces of the insertion of strong muscles.

Discussion and conclusions.

An incomplete wing finger (Padian, 1980) was the only pterosaur remain previously known from the same locality in which specimen 7039 MPUM was collected. Wild (1983) classified the wing finger as cf. *Preondactylus buffarinii* Wild, 1983, on the basis of the relative proportions of the phalanges. The sternum of *Preondactylus*, unfortunately is not known, thus a direct comparison is impossible. The sternum of *Peteinosaurus* is also poorly known, but the size of the specimens ascribed to this genus is too small with respect to that of specimen 7039 MPUM. As can be pointed out from the description, there are very few differences between the bone described here and the sternum of the holotype of *Eudimorphodon ranzii* Zambelli, 1973 (specimen 2888 MCSNB; Zambelli 1973, Wild, 1978; here Fig. 2a, b). This latter specimen was also

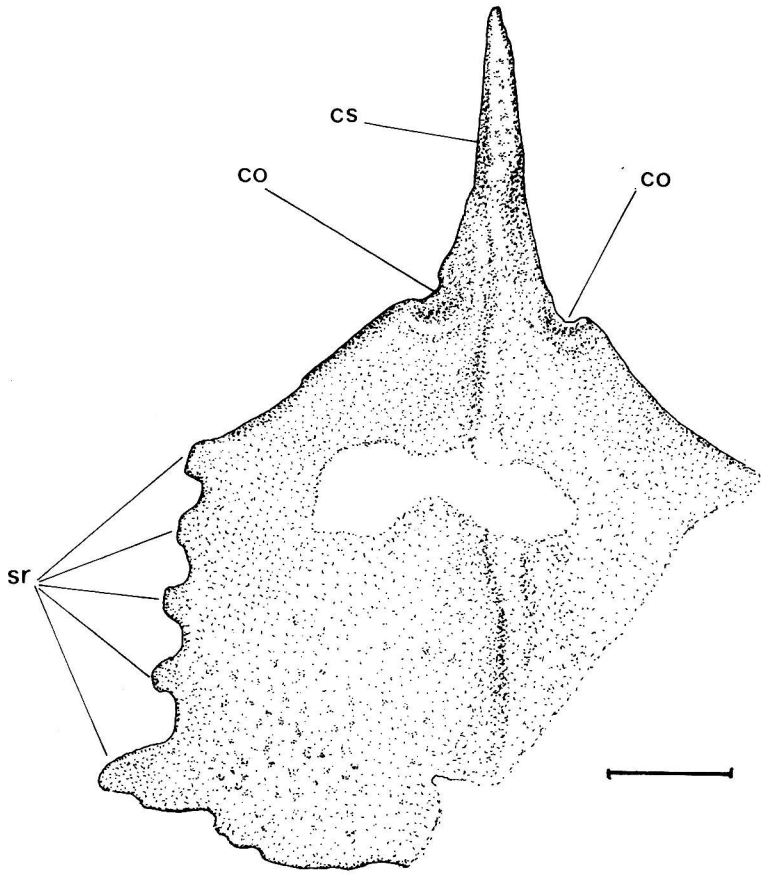

Fig. 1 - *Eudimorphodon ranzii* Zambelli, 1973, specimen 7039 MPUM. Isolated sternum, ventral view. Drawing of the specimen as preserved. Abbreviations are: sr) articular areas for the sternal ribs; co) notches for the coracoids; cs) cristospina. Scale bar equals 1 cm.

collected in the Calcare di Zorzino formation at Cene (Valle Seriana, Lombardy, Northern Italy), and it is the only specimen so far described in which this structure is well preserved enough to allow a detailed comparison (Fig. 2). The cristospina of specimen 7039 MPUM is slightly longer and stouter (Wild, 1978) and, according to Wild' (1978) restoration, a very small lateral process for the sternal ribs is present in the holotype, just anterior to the more enlarged one. This latter is apparently lacking in specimen 7039 MPUM. On the other hand, the general outline, the position of the processes for the sternal ribs, and of the notches for the insertion of the coracoids are almost identical to those of the holotype of *Eudimorphodon*. It has to be said, in addition, that in the holotype the anterior end of the cristospina was overlapped by radius and ulna, thus its very end cannot be observed. In conclusion, specimen 7039 MPUM is considered as belonging to *Eudimorphodon ranzii* Zambelli, 1973.

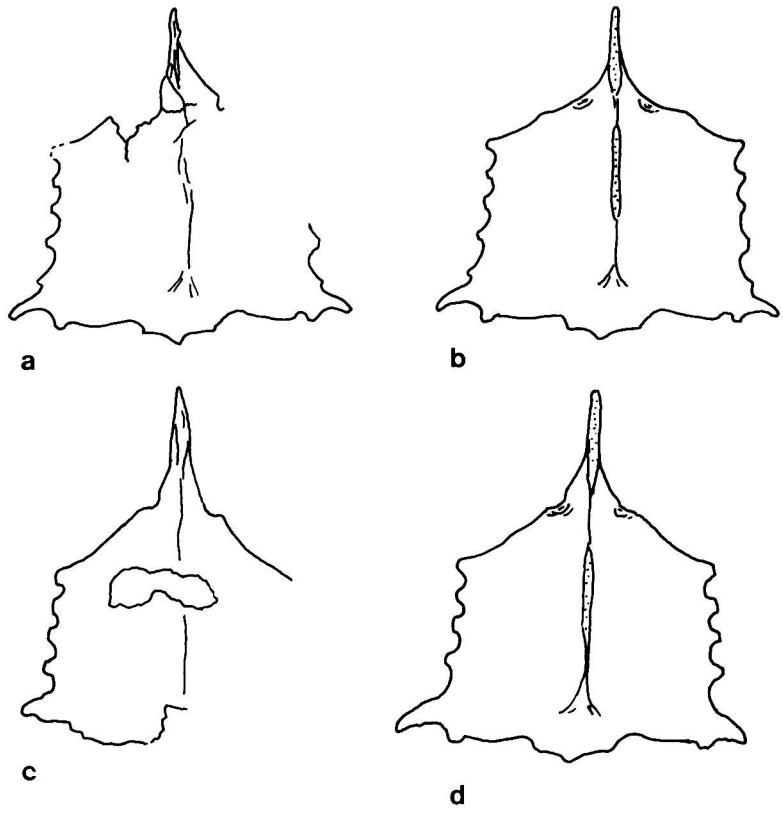

Fig. 2 - Comparison between the sternum of the holotype of *Eudimorphodon ranzii* (specimen 2888 MCSNB, Fig. 2a, b) and specimen 7039 MPUM (Fig. 2c, d). In a and c the bones are figured as preserved; in b and d the same are restored (a and b after Wild, 1978). Drawings not to scale.

Biostratinomy

The damages and the lack of some parts of specimen 7039 MPUM, are due to events occurred during or after its fossilization. In fact, the good conditions of the preserved portions of this thin and delicate bone allow to hypothesize that it reached the bottom undisturbed and was embedded in the sediments on the sea floor as a complete bone. No other bone has been found associated or nearby, thus the sternum must have been separated from the pterosaur body. Active predation (as in the case of the *Preondactylus* remains described in Dalla Vecchia et al., 1988), scavenging, or transportation on the sea floor should be excluded, because, independently from other paleoenvironmental considerations, they would have caused damages to such a delicate structure.

The isolation of the bone, as well as its good conditions may be explained by comparison with actual birds. According to Wild (1978) the size and mode of life of *Eudimorphodon* was very similar to that of actual terns or sea gulls. Like birds,

pterosaurs were very lightly built, and, in addition, the wide wing membrane may have increased buoyancy. After death, the pterosaurs' bodies could well have floated on the sea surface. Birds that die on open sea do not sink rapidly to the bottom as mammals do (these latter reach again the water surface after the development of gas in the belly), but may float for very long time (Schafer, 1972) before reaching the sea floor. During this drift, the portion of the body above the level of the water decays quickly, while the decomposition of the submerged portion tooks a longer time. Usually, in floating bird carcasses, the sternum is among the first structures to become separated from the skeleton. In a short time it sinks, reaching independently the sea floor (in a further moment it does apply also to the posterior limbs; Schafer, 1972). It can be reasonably assumed that the newly discovered sternum followed the same process, becoming separated from a floating *Eudimorphodon* carcass, then reaching rather quickly, the undisturbed anoxic bottom, where it was preserved.

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PLATE 1

Fig. 1 - *Eudimorphodon ranzii* Zambelli, 1973. Specimen 7039 MPUM, isolated sternum, ventral view. Scale bar equals 1 cm.