A NEW DROMAEOSAURID THEROPOD
FROM THE UPPER CRETACEOUS OF SOUTHERN FRANCE.

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Abstract : New dromaeosaurid remains from the Upper Cretaceous of southern France (Var Department, Fox-Amphoux syncline) include vertebrae and a right humerus. This material belongs to a new genus and species of dromaeosaurid, described as Variraptor mechinorum. Among its derived features are double pleurocoels on the cervico-dorsal vertebrae and a strong medial tubercle on the humerus. Variraptor mechinorum is interpreted as a representative of an isolated European lineage of dromaeosaurids which evolved from an Early Cretaceous Euramerican ancestral stock.

Key words : Theropoda, Dromaeosauridae, Variraptor, Late Cretaceous, France

INTRODUCTION

The new dromaeosaurid remains described here were discovered by Patrick and Annie Méchin at the Bastide Neuve locality, in the Fox-Amphoux syncline, 35 km west of Draguignan (Var Department, France, figure 1). The locality exposes sediments belonging to the Grès à Reptiles Formation, which is Late Campanian or Early Maastrichtian in age (Westphal & Durand 1990; Buffetaut & Le Loeuff 1991). The Fox-Amphoux syncline localities were discovered during the first half of the nineteenth century and were mentioned by Doublier (1842), Panescorse (1871) and Matheron (1891). The first systematic excavations near Fox-Amphoux were conducted by Lapparent in 1939 (Lapparent 1947) at the farm of Métisson. Further excavations were undertaken at Métisson in the late 1970s by a team from the Museum National d'Histoire Naturelle of Paris and the University of Paris (Broin et al. 1980). The new Bastide Neuve locality has yielded a rich vertebrate fauna comprising chelonians (Podocnemididae), crocodiles (Alligatoridae, Crocodylidae), dinosaurs (Dromaeosauridae, Titanosauridae, Ornithopoda, Ankylosauria) and birds (cf. Buffetaut et al. 1995).

Museum repositories are indicated as follows : MDE = Musée des Dinosaures, Espéraza, France.
SYSTEMATIC PALAEONTOLOGY

Subclass DIAPSIDA Osborn, 1903
Megaorder DINOSAURIA Owen, 1842
Order THEROPODA Marsh, 1881
Infraorder MANIRAPTORA Gauthier, 1986
Family DROMAEOSAURIDAE Matthew et Brown, 1922

Genus VARIRAPTOR gen. nov.

Type species.
Variraptor mechinorum sp. nov.

Derivation of name.
From the French Var (a river and an administrative department) and the Latin raptor (thief).

Diagnosis.
As for the type and only species.

Variraptor mechinorum sp. nov. figures 2-6

Derivation of name.
After Patrick and Annie Méchin, who collected the material and kindly presented the holotype to the Musée des Dinosaures, Espéraza.

Holotype.
An articulated posterior dorsal vertebra (MDE-D168) and sacrum (MDE-D169).

Type horizon and locality.
Grès à Reptiles Formation; Late Campanian to Early Maastrichtian (Buffetaut & Le Loeuff 1991); La Bastide Neuve (Fox-Amphoux, Var, France).

Referred material.
A right humerus (MDE-D158), a cervico-dorsal vertebra (Méchin Collection; cast MDE-D01), a sacro-caudal vertebra (Méchin Collection), and a femur (Méchin Collection; cast MDE-D49). Le Loeuff et al. (1992) referred the cervico-dorsal (fig. 6) and the sacro-caudal discovered at Roques-Hautes (Bouches-du-Rhône Department, Grès à Reptiles Formation, Campanian-Maastrichtian) to an undetermined dromaeosaurid. Sacral five from Bastide Neuve (see below) has exactly the same shape as the sacrocaudal from Roques-Hautes (cf. Le Loeuff et al. 1992, p. 341 : fig. 2), and it is likely that both belong to the same species. Therefore, the Roques-Hautes material is used to augment the diagnosis of the French maniraptoran described here.

Diagnosis. The cervico-dorsal vertebrae have a prominent epipophysis and very developed hypapophysis; the cervico-dorsals bear two pleurocoels; the cervico-dorsals to the last dorsal bear a hyposphen-hypantrum articulation; the centra shorten from the anterior to the posterior dorsals; the sacrum consists of five coossified sacral vertebrae; the sacrocaudal vertebra has a trapezoidal centrum; the transverse processes of the sacrocaudal are aliform; the humerus has a well-developed deltopectoral crest and internal tubercle and also bears a strongly developed medial tubercle.
DESCRIPTION

The new material from Fox-Amphoux consists of a last dorsal vertebra which was found articulated with a complete sacrum and an isolated humerus.

The posterior dorsal (MDE-D168; fig. 2) lacks both prezygapophyses, the left postzygapophysis and the extremities of the neural spine and diapophyses. In addition, the parapophyses are broken. The short centrum is amphicoelous and bears a small pleurocoel. The preserved postzygapophyseal facet is concave, the medial part (hyposphene) vertical, and the external face subhorizontal. The neural spine is short cranio-caudally with prominent cranial and caudal ridges representing attachment scars for the interspinous ligament. In lateral view, a deep fossa is limited by the infradiapophysial laminae and the parapophyses. An upper fossa is present above the horizontal lamina between the diaphysis and the prezygapophysis.

FIG. 2 : Variraptor mechinorum gen. et sp. nov., MDE-D168, Bastide Neuve (Var department, France, Maastrichtian): last dorsal vertebra in cranial (A), lateral (B) and caudal (C) views; scale bar represents 20 mm.

FIG. 3 : Variraptor mechinorum gen. et sp. nov., MDE-D169, Bastide Neuve (Var department, France, Maastrichtian): sacrum in dorsal (A), left lateral (B), ventral (C) and right lateral (D) views; scale bar represents 20 mm.
The sacrum (MDE-D169; figs 3-4) is 160 mm long and composed of five fused vertebrae. In ventral view the junctions between the centra are marked by conspicuous ridges. The first centrum is the shortest (25 mm) and the deepest (anterior height: 25 mm). Sacral two is 27 mm long, while sacrals three and four are 32 mm and sacral five is 30 mm long. The ventral face of the first centrum is concave from front to back and transversely rounded, with two deep and thin fossae. Small foramina open at the bottom of these fossae. The succeeding centra also show a cranio-caudal concavity in lateral view. Centra two to four are transversely shorter than centrum one. At the junction between sacral three and four there is a deep longitudinal ventral groove. Sacral five is caudal-like and its box-like centrum bears a shallow ventral groove.

In cranial view sacral one retains the appearance of a dorsal vertebra, with a slightly concave articular face of the centrum. A foramen opens below the prezygapophyses, the facets of which are oblique. In caudal view, the centrum of sacral five has a slightly concave trapezoidal articular face. Aliform transverse processes arise from the junction between the centrum and neural arch.

In lateral view sacral one though damaged clearly retains a large pleurocoel. Sacral two also bears a small pleurocoel in a deep fossa while sacral three retains only a slight lateral excavation. No pneumatic foramen is visible on the lateral faces of sacrals four and five.

The transverse processes of sacral one were situated near the cranial end of the vertebra and are not preserved. In sacrals two, three and four, the transverse processes overlap the junctions between sacrals one and two, two and three, and three and four respectively. The transverse processes are directed laterally, caudally and slightly upward. Sacral five has wide aliform transverse processes originating from the middle of the centrum and oriented in the same direction as the preceding processes. The neural spines of sacrals one to three are partially preserved: they are completely coossified and form a thin, blade-like structure.

The humerus (MDE-D158; fig. 5) is 195 mm long. Although somewhat crushed, it is almost complete except for the thin deltopectoral crest which lacks its proximal tip. The delto-pectoral crest expands for about 70 mm below the head and laterally meets a prominent ridge which separated the insertion area of the M. brachialis from that of the M. humero-radialis (Ostrom 1969). This conspicuous protuberance is the most remarkable character of the bone and is more developed than in any other thero-pod, including Deinonychus. As suggested by Ostrom (1969), it 'would indicate that these muscles were unusually large' and suggests a raptorial function for the forearm. The internal tubercle is also very developed (comparable again to Deinonychus), projecting backward from the medial caudal surface of the head, whereas in Deinonychus it forms only a short rugose crest. At the distal end of the humerus, the radial condyle was larger than the, now broken, ulnar condyle. The size of the humerus indicates an animal slightly smaller than Deinonychus.

**COMPARISONS**

Various lines of evidence suggest that the thero-pod material from the Grès à Reptiles Formation represents a dromaeosaurid. The presence of a prominent
epipophysis and a well-developed hypapophysis on the cervico-dorsals are synapomorphies of the Maniraptora (Gauthier 1986). Within this group, it seems that only the Dromaeosauridae retained five sacral vertebrae, although there is some uncertainty in this regard. Ostrom (1976) briefly described the sacrum of *Deinonychus antirrhopus* as having five coossified vertebrae, but also noted that “a sixth centrum, presumably representing the last dorsal, seems to be fused to the first sacral”. In this case, the sacrum of *Variraptor mechinorum* would appear to be more conservative when compared with that of *Deinonychus*. However, Ostrom (1990) mentioned the occurrence of only three or four sacral vertebrae in dromaeosaurids. In the dromaeosaurid *Saurornitholestes*, there are five sacral vertebrae (Makovicky 1995). Howse and Milner (1993) described a sacrum from the Late Cretaceous of Canada as a troodontid sacrum. This sacrum comprises five vertebrae and probably belongs to a dromaeosaurid, because the last vertebra has distinctive aliform processes, and a trapezoidal caudal articulation of the centrum. H. D. Sues (pers. comm.) notes that this centrum is almost identical to the undescribed sacrum of *Saurornitholestes* and may (according to its origin) belong to this taxon. As far as we know, troodontid sacra, which have six fused vertebrae (Currie & Russell 1988; Howse & Milner 1993; Russell & Dong 1993) are significantly different from the sacrum of *Saurornitholestes*. Oviraptorids, elmisaurids and ornithomimosaurids have more than five sacral vertebrae (Holtz 1994).

Other dromaeosaurid characters of the French material include: the sacrocaudals have the same trapezoidal centrum as the anterior caudals of *Deinonychus antirrhopus* (cf. Ostrom 1969) and the last dorsal from Bastide Neuve with its hyposphene-hypantrum articulation is also reminiscent of the posterior dorsals of *Deinonychus*. The humerus from Bastide Neuve, with its well-developed deltopectoral crest and medial tubercle, is also reminiscent of that of *Deinonychus* but the medial tubercle is much stronger. From these comparisons, it appears that the maniraptoran material from Southern France belongs to a dromaeosaurid. Further comparisons with described dromaeosaurids necessitate a review of the available data, given in a chronological order, from oldest to youngest.
**Deinonychus antirrhopus** Ostrom, 1969 has been described from the Cloverly Formation of Wyoming, Montana, USA (Aptian-Albian). Significant resemblances to *Variraptor* include the epipophysis and hypapophysis of the cervico-dorsal, five coossified sacrals, the trapezoidal sacrocaudal centrum, and the well-developed deltopectoral crest and internal tubercle of the humerus. The main differences are the two pleurocoels of the cervico-dorsal, and the very strongly developed medial tubercle of the humerus.

*Saurornitholestes langstoni* Sues, 1978 from the Judith River Formation (Campanian) of Alberta, Canada, is known from well-preserved skeletons, but only the skull material has been published so far. Vertebral material has been described in Makovicky’s unpublished thesis (1995).

*Velociraptor mongoliensis* Osborn, 1924 (Djadocha Formation, Mongolia, Campanian) is not adequately described and cannot be compared with the French dromaeosaurid.

*Dromaeosaurus albertensis* Matthew and Brown, 1922 from the Judith River Formation is known from a partial skull and foot elements and thus cannot be compared with the French form. The same is true for *Hulsanpes perle* Osmolska, 1982 known from a partial foot from the Barun Goyot Formation of Mongolia (Campanian), and *Adasaurus mongoliensis* Barsbold, 1983, of which a fragmentary skull, a pelvis and manus and foot elements have been described from the Nemegt Formation of Mongolia (Campanian or Maastrichtian).

*Elopteryx nopcsai* Andrews, 1913, from the Late Maastrichtian of Romania may be a dromaeosaurid (cf. Le Loeuff *et al.* 1992), but it is known only from a femur and metatarsals.

From these comparisons, it seems possible to differentiate the French dromaeosaurid from *Deinonychus antirrhopus*, and consider it as a new genus and species, *Variraptor mechinorum*. The phylogenetic relationships of dromaeosaurid taxa are still
poorly understood, owing largely to the fact that many of them are incompletely described, hence the position of *Variraptor mechinorum* among dromaeosaurids is uncertain.

**CONCLUSIONS**

From a palaeobiogeographical point of view, the presence of dromaeosaurid theropods in Europe at the end of the Cretaceous is not unexpected. They can be considered as vestigial taxa from an Early Cretaceous Euramerican palaeobioprovince, which broke up during the Aptian following transgression by epicontinental seas. Early Cretaceous dromaeosaurids have not yet been identified in Europe, but a maniraptoran, possibly a troodontid, has been reported from the Early Cretaceous of the Isle of Wight (Howse and Milner 1993), suggesting that this clade could be of Euramerican origin. *Lisboasaurus* from the Upper Jurassic of Portugal, once considered as a maniraptoran by Milner and Evans (1991), seems to be a peculiar crocodilian (Buscalioni and Ortega 1995). Dromaeosaurids are known from the Early Cretaceous of North America (*Deinonychus, Utahraptor*) and the Late Cretaceous of North America (*Dromaeosaurus, Saurornitholestes*), Europe (*?Elopteryx, Variraptor*) and Asia (*Velociraptor, Adasaurus, Hulsanpes*). They probably evolved in Euramerica at the beginning of the Cretaceous, and then dispersed into Asia via a land route across the Bering region which appeared between North America and Asia in the Late Early Cretaceous (Russell 1993). By this time, Europe and North America had possibly become distinct palaeobioprovinces (cf. Le Loeuff 1991; 1998) and the European dromaeosaurids subsequently evolved in isolation.

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