ORYCTOS, Vol. 1 : 105-112, Octobre 1998

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

Jean LE LOEUFF[1] and Eric BUFFETAUT[2]

[1]Musée des Dinosaures, 11260 Espéraza, France.
[2]Centre National de la Recherche Scientifique, Cour du Liégat, 75013 Paris, France.

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

Un nouveau Théropode dromaeosauridé du Crétacé supérieur du Sud de la France

Résumé : Des nouveaux restes de Dromaeosauridae du Crétacé supérieur du Sud de la France sont décrits. Ce matériel est rapporté à un nouveau genre et une nouvelle espèce, *Variraptor mechinorum*, défini par plusieurs caractères dérivés comme la présence de doubles pleurocoeles sur les vertèbres cervico-dorsales et d'un puissant tubercule médial sur l'humérus. *Variraptor mechinorum* est interprété comme le représentant d'une lignée européenne de Dromaeosauridae ayant connu une évolution endémique à partir de formes euraméricaines du Crétacé inférieur.

Mots clés : Theropoda, Dromaeosauridae, Variraptor, Crétacé supérieur, 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

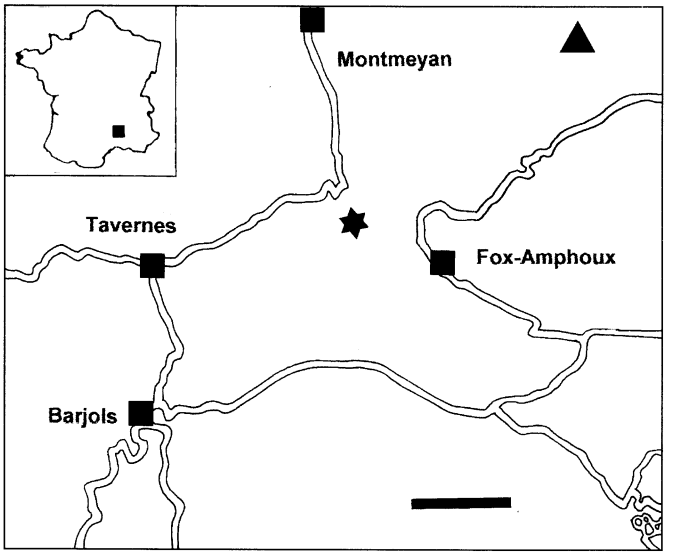

FIG. 1 : Location map; Bastide Neuve is indicated by the star; scale bar : 2.5 km.

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.

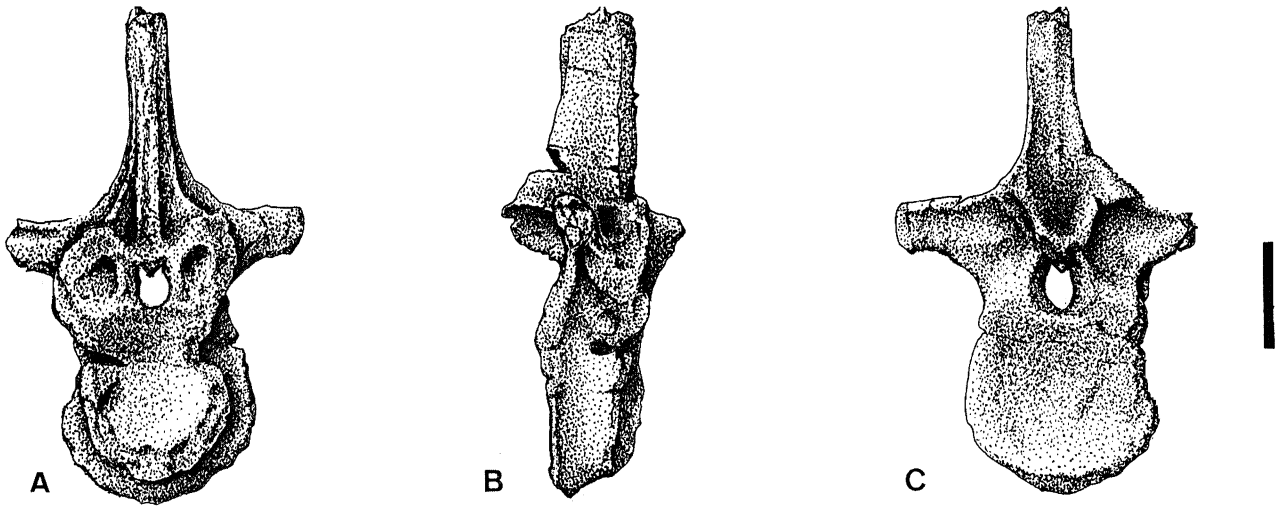

FIG. 2 : *Variraptor mechinorum* gen. et sp. nov., MDE-D168, Bastide Neuve (Var department, France,Maastrichtian) : last dorsal vertebra in cranial (A), lateral (B) and caudal (C) views ; scale bar represents 20 mm.

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 postzygapophysial 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 diapophysis and the prezygapophysis.

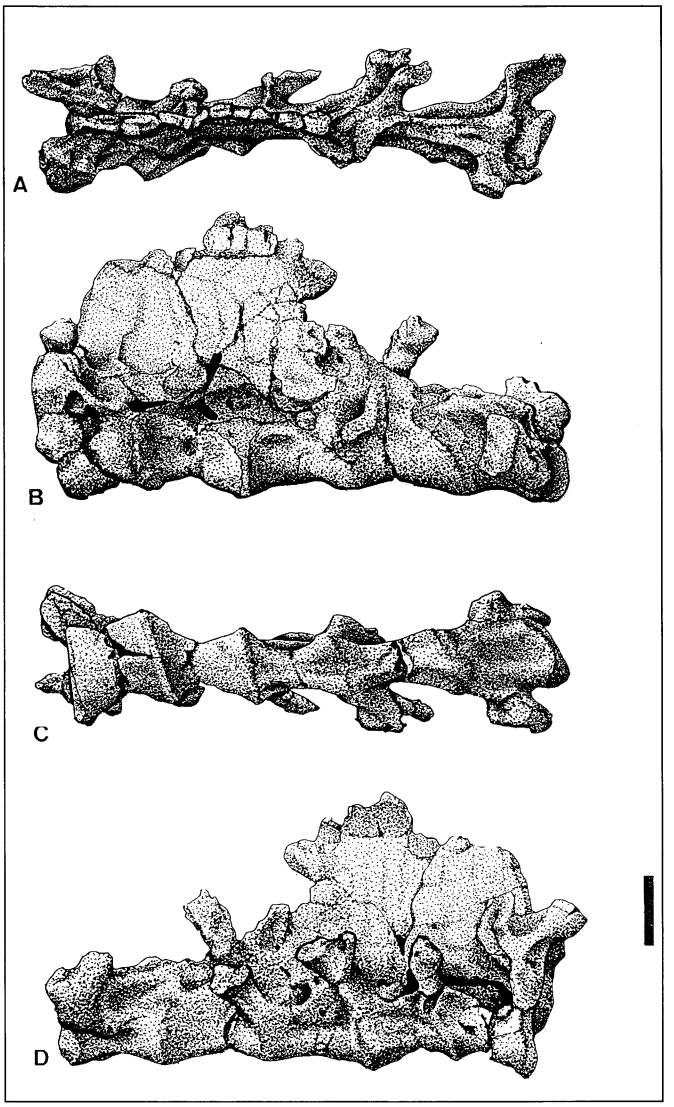

FIG. 3 : *Variraptor mechinorum* gen. et sp. nov., MDE-D169, Bastide Neuve (Var department, France, Maastrichtian): sacrum in dorsal (A), left lateral (B), ventral (C) and right lateral (D) views ; scale bar represents 20 mm.

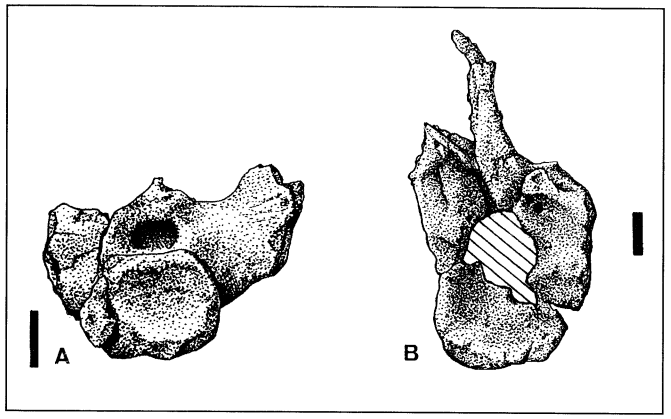

FIG. 4 :
Variraptor mechinorum gen. et sp. nov., MDE-D169, Bastide Neuve (Var department, France,Maastrichtian): sacrum in caudal (A) and cranial (B) views; scale bar represents 10 mm.

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 craniocaudal 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 preceeding 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 theropod, 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 theropod material from the Grès à Reptiles Formation represents a dromaeosaurid. The presence of a prominent

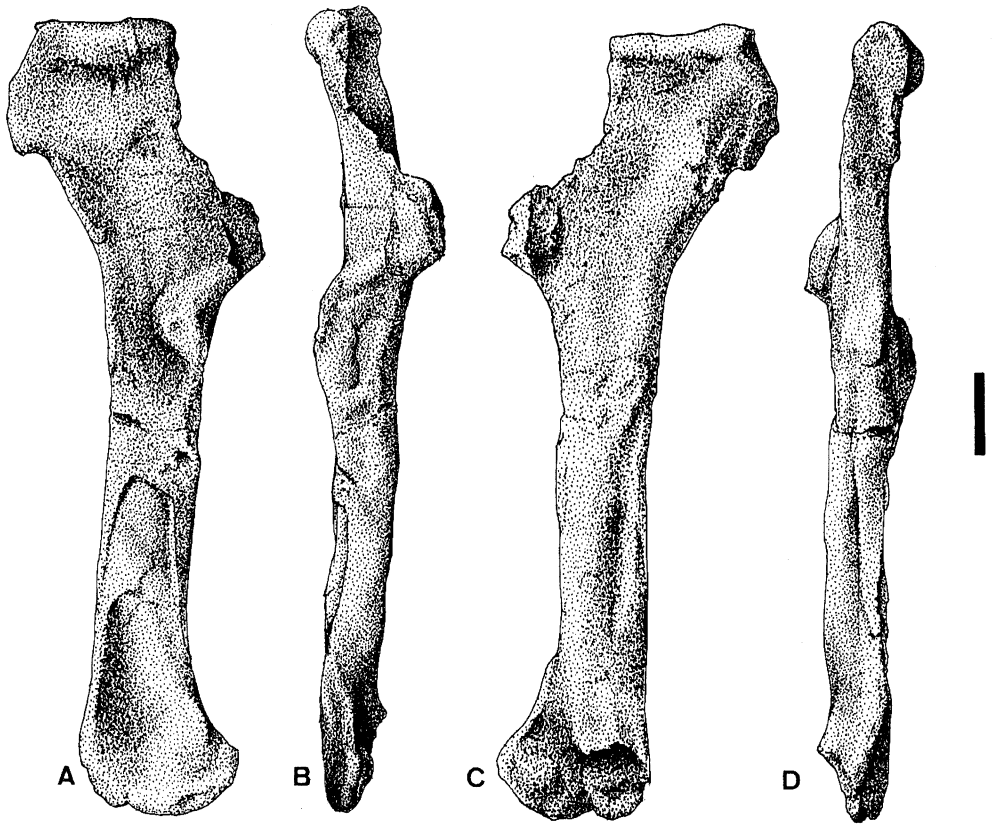

FIG. 5 : *Variraptor mechinorum* gen. et sp. nov, MDE-D158, Bastide Neuve (Var department, France,Maastrichtian) : right humerus in caudal (A), lateral (B), cranial (C) and medial (D) views; scale bar represents 20 mm.

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 *V. 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 ornithomimosaurs 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.

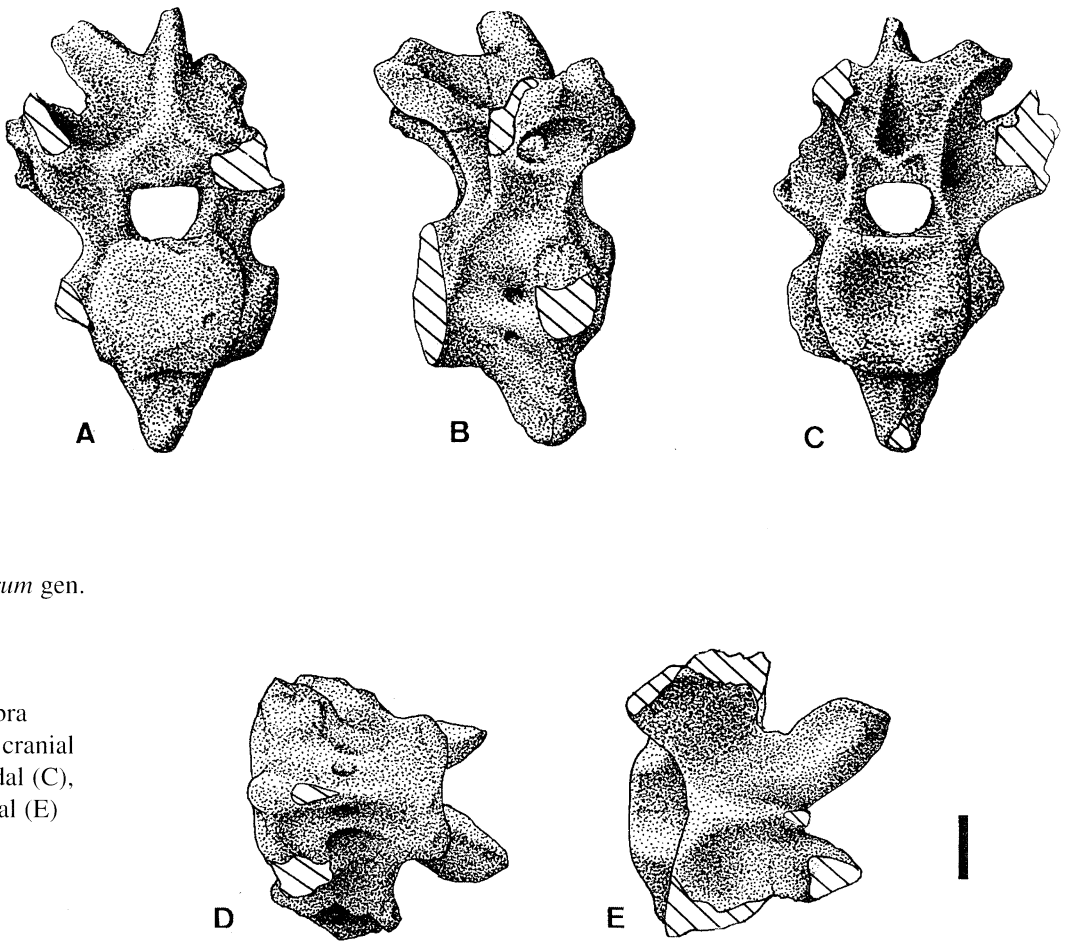

FIG. 6 :
Variraptor mechinorum gen. et sp. nov., Roques-Hautes, ?Maastrichtian : cervico-dorsal vertebra (Cast MDE-D01) in cranial (A), lateral (B), caudal (C), ventral (D) and dorsal (E) views; scale bar represents 10 mm.

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 (Djadochta 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 perlei* 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.

ACKNOWLEDGEMENTS.

We thank the discoverers of the material, Patrick and Annie Méchin, whose field work in Provence has greatly improved our knowledge of Late Cretaceous dinosaurs. We also thank the owners of the land, M. and Mme Patrick Vimont who kindly authorized the excavations, and H.D. Sues (Toronto) who provided illustrations of the *Saurornitholestes* sacrum. Drawings were made by Guy Le Roux at the Musée des Dinosaures, Espéraza. This work was supported by the Association Dinosauria (Musée des Dinosaures, Espéraza) and the Institut National des Sciences de l'Univers.

REFERENCES

ANDREWS, C. W. 1913. On some bird remains from the Upper Cretaceous of Transylvania. *Geological Magazine*, **5** : 193-196.

BARSBOLD, R. 1983. [Carnivorous dinosaurs from the Cretaceous of Mongolia]. *Transactions of the joint Soviet-Mongolian Paleontological Expeditions*, **19** : 1-117. [In Russian].

BROIN, F. de; BUFFETAUT, E.; CAPPETTA, H.; KEROURIO, P.; KOENIGUER, J. C.; RUSSELL, D.; SECRETAN, S.; SIGOGNEAU-RUSSELL, D.; TAQUET, P. & WENZ, S. 1980. Nouvelles découvertes de vertébrés maestrichtiens dans le gisement de Fox-Amphoux (Var). *8ème Réunion Annuelle des Sciences de la Terre* : 83.

BUFFETAUT, E. & LE LOEUFF, J. 1991. Late Cretaceous dinosaur faunas of Europe : some correlation problems. *Cretaceous Research,* **12** : 159-176

———————————MECHIN, P. and MECHIN-SALESSY, A. 1995. A large French Cretaceous bird. *Nature*, **377** : 110.

BUSCALIONI, A. D. & ORTEGA, F. 1995. Crocodylomorpha ; pp. 59-61. *In* NIEVES-MELENDEZ, M. (ed.) Las Hoyas, a lacustrine Konservat-Lagerstätte, Cuenca, Spain, *II International Symposium on Lithographic limestones Field trip guide book.*

CURRIE, P. J. & RUSSELL, D. A. 1988. Osteology and relation ships of *Chirostenotes pergracilis* (Saurischia, Theropoda) from the Judith River (Oldman) Formation of Alberta, Canada. *Canadian Journal of Earth Sciences,* **25** : 972-986.

DOUBLIER, 1842. Ossements de saurien du terrain tertiaire du Var. *Bulletin de la Société géologique de France*, **13** : 449.

GAUTHIER, J. 1986. Saurischian monophyly and the origin of birds. *In* : PADIAN, K. (ed.) The origin of birds and the evolution of flight. *Memoirs of the California Academy of Sciences*, **3** : 1-55.

HOLTZ, T. R. Jr. 1994. The phylogenetic position of the Tyrannosauridae : Implications for theropod systematics. *Journal of Paleontology,* **68** : 1100-1117.

HOWSE, S. C. B. & MILNER, A. R. 1993. *Ornithodesmus* - a Maniraptoran theropod dinosaur from the Lower Cretaceous of the Isle of Wight, England. *Palaeontology*, **36** : 425-437.

LAPPARENT, A. F. de 1947. Les Dinosauriens du Crétacé supérieur du midi de la France. *Mémoires de la Société géologique de France*, 26, 4, **56** : 1-54.

LE LOEUFF, J. 1991. The Campano-Maastrichtian vertebrate faunas from Southern Europe and their relationships with other faunas in the world : palaeobiogeographical implications. *Cretaceous Research*, **12** : 93-114.

————————1998. *Evolution paléobiogéographique des faunes de vertébrés continentaux du Jurassique supérieur à la fin du Crétacé.* Mémoire d'habilitation à diriger des recherches, Université Paul Sabatier, Toulouse, Tome 1 : 1-68.

———————BUFFETAUT, E.; MECHIN, P. & MECHIN-SALESSY, A. 1992. The first record of dromaeosaurid dinosaurs (Saurischia, Theropoda) in the Maastrichtian of Southern Europe : palaeobiogeographical implications. *Bulletin de la Société géologique de France,* **163** : 337-343.

MAKOVICKY, P. J. 1995. *Phylogenetic aspects of the vertebral morphology of Coelurosauria (Dinosauria : Theropoda).* Unpublished M. Sc. Thesis, Geological Institute, Copenhagen University.

MARSH, O.C. 1881. Classification of the Dinosauria. *American Journal of Science, Series 3,* **23** : 81-86.

MATHERON, P. 1891. Sur les animaux vertébrés dans les couches d'eau douce crétacées du midi de la France. *Comptes-rendus de l'Association française pour l'Avancement des Sciences*, **20** : 382-383.

MATTHEW, W. D. & BROWN, B. 1922. The family Deinodontidae, with a notice of a new genus from the Cretaceous of Alberta. *Bulletin of the American Museum of Natural History*, **46 :** 367-385.

MILNER, A. R. & EVANS, S. E. 1991. The Upper Jurassic diapsid *Lisboasaurus estesi* - a maniraptoran theropod. *Palaeontology*, **34** : 503-513.

OSBORN, H. F. 1903. The reptilian subclasses Synapsida and Diapsida and the history of the Diaptosauria. *Memoirs of the American Museum of Natural History*, **1** : 449-507.

——————— 1924. Three new Theropoda, *Protoceratops* zone, central Mongolia. *American Museum Novitates,* **144** : 1-12.

OSMOLSKA, H. 1982. *Hulsanpes perlei* n. g. n. sp. (Deinonychosauria, Saurischia, Dinosauria) from the Upper Cretaceous Barun Goyot Formation of Mongolia. *Neues Jahrbuch für Geologie und Paläontologie, Monatshefte* : 440-448.

OSTROM, J. H. 1969. Osteology of *Deinonychus antirrhopus,* an unusual theropod from the lower Cretaceous of Montana. *Bulletin of the Peabody Museum of Natural History,* 30 : 1-165.

——————— 1976. On a new specimen of the Lower Cretaceous theropod dinosaur *Deinonychus antirrhopus. Breviora*, **439** : 1-10.

———————1990. Dromaeosauridae. pp. 269-279. *In* WEISHAMPEL, D.B., DODSON, P. & OSMOLSKA, H. (Eds) *The Dinosauria*, University of California Press.

OWEN, R. 1842. Report on British Fossil reptiles. Part II. *Reports on the British Association for the Advancement of Science*, 1841 : 60-294.

PANESCORSE, F. 1871. *Etude sur les phosphates de chaux et les coprolithes fossiles du Var.* C. & A. Latil, Draguignan : 1-32.

RUSSELL, D. A. 1993. The role of Central Asia in dinosaurian biogeography. *Canadian Journal of Earth Sciences,* 30, 2002-2012.

———————& DONG ZHIMING 1993. A nearly complete skeleton of a new troodontid dinosaur from the Early Cretaceous of the Ordos Basin, Inner Mongolia, People's Republic of China. *Canadian Journal of Earth Sciences*, **30** : 2163-2173.

SUES, H. D. 1978. A new small theropod from the Judith River Formation (Campanian) of Alberta, Canada. *Zoological Journal of the Linnean Society of London*, **62** : 381-400.

WESTPHAL, F. & DURAND, J.P. 1990. Magnétostratigraphie des séries continentales fluvio-lacustres du Crétacé supérieur dans le synclinal de l'Arc (région d'Aix-en-Provence, France). *Bulletin de la Société géologique de France*, (8), **6** : 609-620.

Note reçue le 31-07-1998
acceptée le 15-08-1998