# A NEW THEROPOD DINOSAUR MATERIAL FROM THE HAȚEG BASIN (LATE CRETACEOUS, WESTERN ROMANIA) – A PRELIMINARY STUDY

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Although remains of Late Cretaceous theropods are known from Europe, they are the rarest of all dinosaurs from this time interval. Most consist of vertebrae and teeth which are at best questionably determinable to higher taxa (Coelurosauria, ?Dromaeosauridae, ?Abelisauridae, ?Troodontidae; Grigorescu 1984, Buffetaut et al. 1986, 1988, Osmólska and Barsbold 1990, Norman 1990, Weishampel 1990, Weishampel et al. 1991, Le Loeuff et al. 1992). However, new skull material from the Hațeg Basin is sufficiently well preserved to be incorporated into a phylogenetic analysis to determine its taxonomic placement within Theropoda. Given this opportunity, the new Hațeg material yields new information on the affinities of members of the European theropod faunas which had not been previously possible and at the same time provides insights into the biostratigraphy and paleobiogeography of island habitation in Europe during the Late Cretaceous.

## Material

MCDRD 254; left frontal.

MCDRD 454; fused parietals.

Both specimens were collected by the senior author in 1992 from Gârjobel, a locality south of the village of Sânpetru. This locality is situated in the Sânpetru Formation (viz., Grigorescu 1992).

Although not found in articulation, it is very likely that the two specimens come from the same individual because they were found along the same horizon and can be tightly articulated with each other.

## Description

### Frontal

The frontal (MCDRD 254) is missing the rostral tip of the nasal process and thus would have been considerably longer than preserved. The lateral extremity of the postorbital process has been eroded to a rounded prominence. In dorsal view (Fig. 1a), the preserved portion of the frontal is roughly isosceles in shape, while in lateral view, it is relatively thin and sigmoidal. As preserved, MCDRD 254 is 41 mm long; from the rostral tip to the preserved portion of the postorbital process, it is 38.5 mm and the distance from this point to the caudal extreme of the interfrontal suture is 46 mm. Maximum width of the frontal is 40 mm and the interorbital width is estimated to be 68 mm.

The dorsal surface of MCDRD 254 is smooth and vaulted. This doming above the cerebral region of the endocranium rises from a trough that extends from behind the orbital margin obliquely to the frontonasal suture. Rostrally, the nasal facet consists of a small, narrow depression immediately adjacent to the sagittal suture of the frontal. Laterally, there is a large, deep, and very distinct depression for reception of the upper part of the lacrimal. The floor of the facet is marked by ridges and grooves for the attachment of sutural ligaments between the two elements. Farther laterally and caudally is the base of the postorbital process. The rear margin of the frontal provides a broad articulation with the parietal and, with the lateral processes of the parietal, marks the rostal margin of the supratemporal fossa.

Ventrally (Fig. 1b), MCDRD 254 is marked by the dorsal margin of the orbit, the traces of the olfactory tract and bulb, and the cerebral impression. The orbital rim is sharp, rugose, and no more than 15 mm long; the smooth, ovate orbital surface is pierced by a few small foramina. The dorsal aspect of the orbit is separated from the olfactory impressions by the eroded remains of the articulation for the presphenoid. This region also appears to be marked by the articulation for ventral portion of the lacrimal as it contacts the frontal (creating the so-called "slotted" articulation seen in dromaeosaurids; Currie 1987, 1995).

The impression of the olfactory bulb and tract are marked by raised margins between the wall supporting of the presphenoid and the midline of the frontal. The tract is short, while the bulb is relatively large and ovate. The division between the orbit and endocranium is marked by the eroded remains of the 7 mm-wide vertical ridge that articulated with the caudal portion of the presphenoid. Medial to this wall, the heart-shaped cerebral impression is long, wide, and nearly smooth, although there are faint vascular traces caudally and laterally.

## Parietal

MCDRD 454 consists of fused parietals that are hour-glass shaped in dorsal view and roughly triangular in lateral view (Figs. 2a, 3a). It is missing the extremities of the lateral and occipital processes. Maximum length of the preserved element is 45 mm, length to the back of the sagittal crest is 32 mm, maximum height is 24.5 mm, maximum width is 33 mm, rostral width is 32.5 mm, and minimum width is 22 mm.

The parietals contact the frontal via a centrally-placed rostral process, which fits between the caudal aspect of the paired frontals, and paired lateral processes that contact much of the back surface of the frontal. In dorsal view, the diamond-shaped rostral process is flat and contains a small pit. The rostral process fits into a groove in the frontal and there is a curved groove on the rostral surface of the lateral process of the parietal into which fits a modestly developed ridge on the caudal aspect of the frontal.

MCDRD 454 is longitudinally and transversely concave, due to the very high and downwardly sloping sagittal crest. This crest is 1 mm across at its narrowest point and rises 20 mm above the ventral midline of the specimen, thus making up almost 12.5% of its height.

Ventrally, the fused parietals are saddle-shaped (Fig. 2b). Rostrally, the internal surface consists of the smooth, conical cerebellar impression that narrows from a rostral width of 28.5 mm to a caudal width of 15 mm. Caudally, there is an oval pit slightly displaced to the left of the midline which may be due to pathologies in underlying meningeal or cerebellar tissue (perhaps as a fistula from the capitis dorsalis vein).

The ventral margins of the fused parietals are roughened to accommodate the dorsal surfaces of both prootic (rostrally) and opisthotic (caudally), although it is impossible to discern the border between these two sutures. Nevertheless, it is expected that the majority of the preserved ventral parietal margin was for the prootic based on comparison with other theropods.

## Articulated Skull Roof

In articulation, the dorsal surface of the frontal and parietal form an angle of approximately 60° (Fig. 3), paralleling the high cephalic angle between the endocranial surfaces of these elements.

## Systematics

The cranial material described here clearly comes from a theropod dinosaur, based on the presence of a relatively large cerebral impression on the undersurface of the frontal bone. In fact, we regard the Haţeg theropod as a member of Maniraptora, a clade of theropods that includes the small and aggressive dromaeosaurids and troodontids, the ostrich-mimicking ornithomimids, and true birds (Fig. 4; Gauthier 1986, Holtz 1994), due to the presence of a high cephalic flexure, apomorphic for Maniraptora.

Within this maniraptoran clade, an unnamed group consisting of dromaeosaurids, *Archaeopteryx lithographica*, Aves, oviraptorids, and arctometatarsalians together share narrow nasal bones, a condition also found in the Haţeg theropod. However, the latter shares no unique features with oviraptorids or arctometatarsalians. Instead, it shares derived characters with members of the clade composed of dromaeosaurids, *Archaeopteryx lithographica*, and remaining birds, including (1) a longitudinal trough and dome on the dorsal surface of the frontals and (2) relatively large impressions of olfactory bulbs at the end of short olfactory tracts. The Haţeg theropod shares with dromaeosaurids a separation of the frontals by a rostral process of the parietals, a "slotted" articulation between the frontal and lacrimal, and a high, downward-sloping sagittal crest. Finally, among dromaeosaurids, only *Saurornitholestes langstoni* and the Haţeg theropod have a frontal that

contributes only a small portion to the orbital margin, sugugesting a close relationship with this species. On the basis of the distribution of these features, we regard the Haţeg theropod as a member of Dromaeosauridae, perhaps most closely related to *Saurornitholestes langstoni.*

## Discussion

The remains of small, bird-like animals have long been known from the Late Cretaceous of Transylvania, having been collected by Nopcsa in the early part of this century. Described by Andrews (1913) and Harrison and Walker (1975), this material formed the holotypes and referred material of *Bradycneme draculae* and *Heptasteornis andrewsi* (considered the oldest owls), and *Elopteryx nopcsai* (thought to be a pelecaniform). Additional material was subsequently referred to *E. nopcsai* by Grigorescu and Kessler (1980). Brodkorb (1978) rejected the avian affinities of these three species, suggesting that they instead were small theropod dinosaurs of uncertain affinity and his work has largely been followed ever since. Three exceptions include Paul (1988), Osmólska and Barsbold (1990) and Le Loeuff et al. (1992). Paul (1988) regarded all these Transylvanian taxa as troodontids, retaining *B. draculae*, but tentatively referring both *E. nopcsai* and *H. andrewsi* to *Troodon* as *T.? andrewsi.* Osmólska and Barsbold (1990) considered *B. draculae, E. nopcsai*, and *H. andrewsi* to be indeterminate troodontids. Finally, Le Loeuff et al. (1992) suggested that *H. andrewsi* and *B. draculae* are junior synonyms of *E. nopcsai.*

Regardless of the ultimate taxonomic resolution of these taxa (which requires a phylogenetic analysis), it is very likely that they fall within Maniraptora, the same large clade of small theropods as the individual comprised of MCDRD 254 and 454. What distinguishes the new Haţeg theropod is that it has been phylogenetically placed within Dromaeosauridae, a clade of at least six species of agile, small to medium-sized theropods, with an obligate bipedal limb posture, estimated live weight ranging from 30 to 80 kg, and distinctive foot construction featuring a large, sickle-shaped claw on the second digit. Thus far, named dromaeosaurids come from either North America or central and eastern Asia.

Unfortunately, the phylogeny of dromaeosaurid species is not yet resolved, so how the Haţeg dromaeosaurid would affect the pattern of relationships among these theropods is hard to say. Should it be positioned somewhere high within the dromaeosaurid tree, then it is likely that the Haţeg dromaeosaurid evolved from a non-European ancestor that itself was not the common ancestor of all dromaeosaurids and that it thereafter immigrated to Europe (Fig. 5). Whether this migration was from North America or Asia is presently unknown given the lack of information about the topology of the dromaeosaurid tree.

However, if the Haţeg dromaeosaurid is linked at the base of the dromaeosaurid tree (Fig. 7b), it may be that dromaeosaurids had a European

origin (fig. 9). In order for this to be true, it must be demonstrated that successive outgroups to Dromaeosauridae (with the Haţeg dromaeosaurid positioned as the basal taxon) also have a European distribution. This appears to be true for the clade consisting of *Archaeopteryx lithographica* and all remaining birds (regarded as the immediate sister group of dromaeosaurids). Whether the next outgroup has a European distribution depends on the phylogenetic placement of the Late Jurassic diapsid *Lisboasaurus estesi* from the Guimarota complex of lignitic marls in central Portugal. Milner and Evans (1991) argued that *L. estesi* was a maniraptoran. If it can be demonstrated that it is not only a member of the clade consisting of Dromaeosauridae and birds but also the stem species positioned just after the split between the two groups, then dromaeosaurids must have had a European origin, with later migration to North America and Asia.

Clearly we are far from a solution to these alternative phylogenetic and paleobiogeographic questions. One part of this solution will come from continued research on existing material, including all known dromaeosaurids and other maniraptorans (Jianu and Weishampel in prep.). Another will come from the additional recovery of dromaeosaurid specimens in the Haţeg Basin and elsewhere in Europe. Thus, it may eventually be possible to determine whether the Haţeg theropod is a distinctly new species. New material and the study of existing specimens will, at the very least, provide new and much needed character information about these important theropod dinosaurs and hence their evolutionary and paleobiogeographic relationships.

There is more to say about the biostratigraphic significance of the new Haţeg material. Among dromaeosaurids, the earliest known member of the clade is *Deinonychus antirrhopus* from the upper Aptian Cloverly Formation of Wyoming and Montana in the United States (Ostrom 1969, 1990).

Elsewhere in North America, dromaeosaurids appear to survive until the late Campanian (*Dromaeosaurus albertensis*, *Saurornitholestes langstoni).* Three dromaeosaurid species are also known from China and Mongolia, from strata that are though to be late Santonian to early Maastrichtian in age. These include *Adasaurus mongoliensis*, *Hulsanpes perlei,* and *Velociraptor mongoliensis.* Ostrom (1990) noted that dromaeosaurids apparently became extinct by the end of the early Maastrichtian.

However, the Haţeg dromaeosaurid extends the duration of this clade by as much as 10 million years to the end of Maastrichtian (Fig. 10; Weishampel et al. 1991; Grigorescu 1992). Thus, it may turn out that the ,,Haţeg Island" may have acted as a refugium for the last dromaeosaurids and in doing so this clade may have suffered its ultimate extinction at the close of the Cretaceous.

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## *UN NOU MATERIAL DE DINOSAUR THEROPOD DIN BAZINUL HAȚEG (CRETACIC TÂRZIU, VESTUL ROMÂNIEI), STUDIU PRELIMINAR*

### *REZUMAT*

Noi resturi de dinozauri din Cretacicul superior al Bazinului Hațeg (V. României) constă din fragmente craniene aparținând unui dinosaur theropod dromaeosaurid.

Aceste piese sunt descrise pe scurt și discutate din punct de vedere filogenetic, biostratigrafic și biogeografic.

În cadrul grupului Dromaeosauridae, noul theropod din Hațeg pare să fie înrudit îndeaproape cu *Saurornitholestes langstoni*. În plus, extinde răspândirea stratigrafică a grupului până în Cretacicul terminal.

Implicațiile paleobiogeografice ale dromaeosauridului din Hațeg sunt încă obscure, dar insulele Cretacic târzii ale Europei ar fi putut acționa ca un refugiu pentru ultimii dromaeosaurizi.

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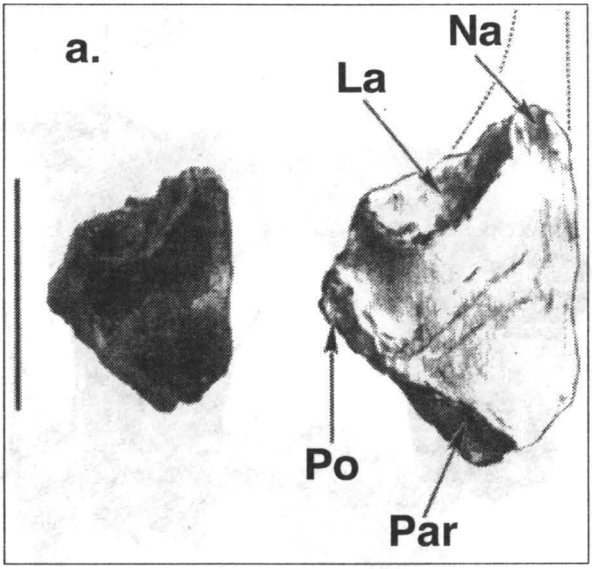


*Fig. 1.a. – Dorsal view of the new Haţeg frontal, MCDRD 254*

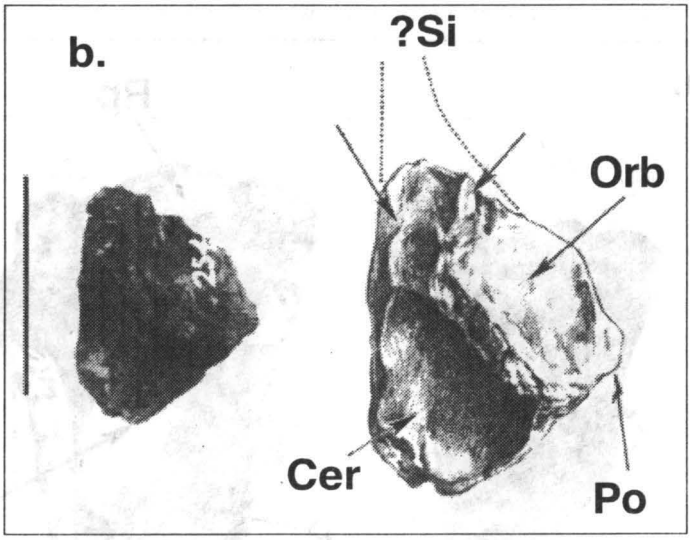


*Fig. 1.b. – Ventral view of the new Haţeg frontal, MCDRD 254.*
*Abbreviations-I: impression of the olfactory tract and bulb: Cer: cerebral impression; La: articulation for the lacrimal; Na: articulation for the nasal; Orb: dorsal orbital surface; Par: articulation for the parietal; Po: base of the postorbital process; ? SI; ? slot for the ventral process of the lacrimal. Scale=5 cm.*

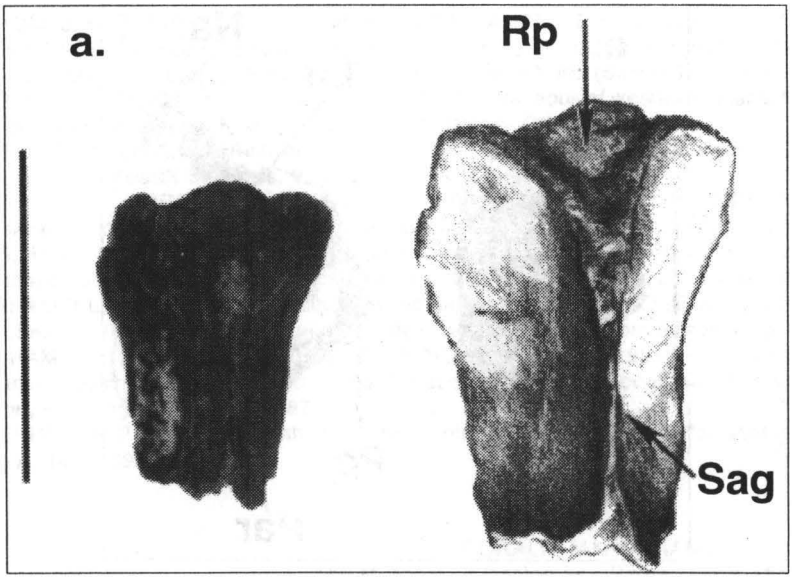


*Fig. 2.a. – Dorsal view of the new Haţeg parietal, MCDRD 454.*

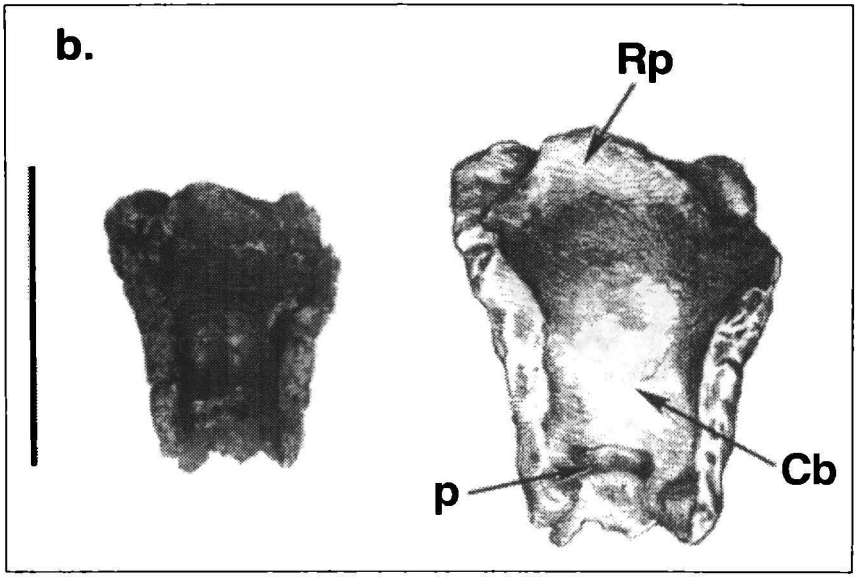


*Fig. 2.b. – Ventral view of the new Haţeg parietal, MCDRD 454.*
*Abbreviations: Cb: cerebellar impress; p: pit; Rp: rostral process; Sag: sagittal crest. Scale =5cm*

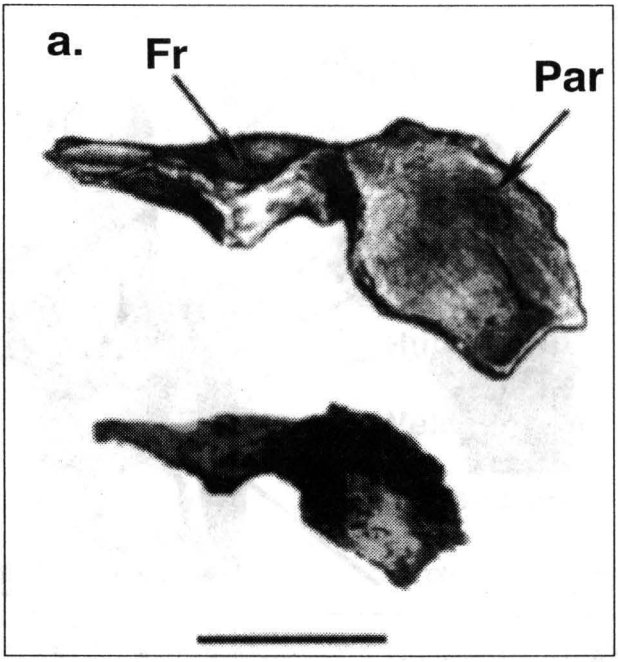


*Fig. 3.a. – Lateral view of the articulated frontal and parietal (MCDR 254 and 454, respectively)*

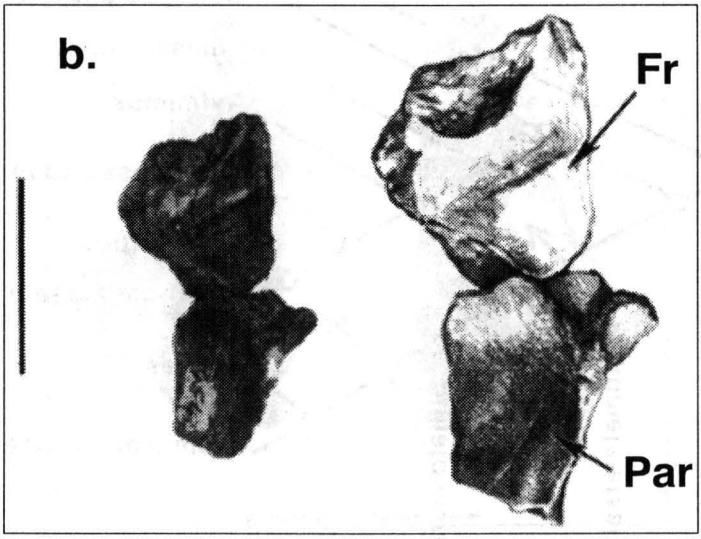


*Fig. 3. b. – Dorsal view of the articulated frontal and parietal (MCDRD 254 and 454 respectively)*

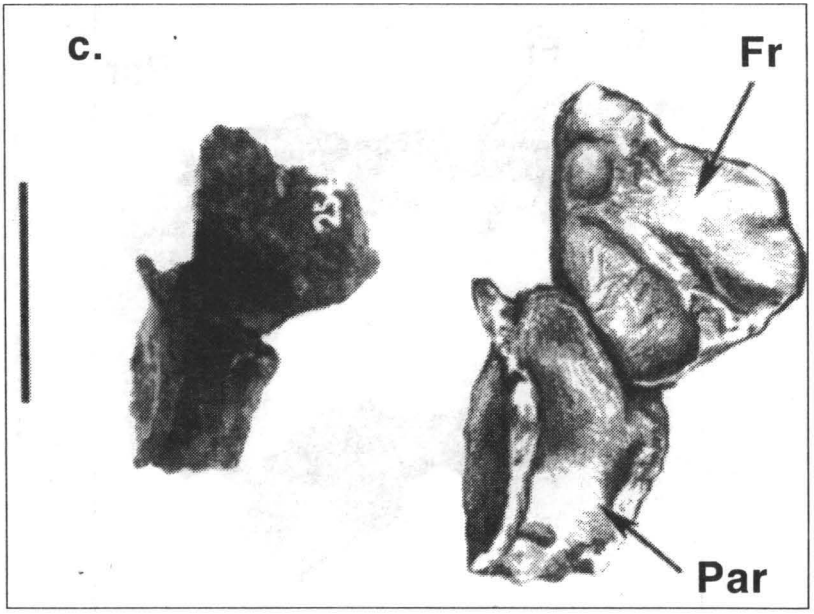


*Fig. 3.c. – Ventral view o the articulated frontal and parietal (MCDR 254 and 454, respectively). Abbreviations: Fr: frontal; Par: parietal. Scale=5 cm.*

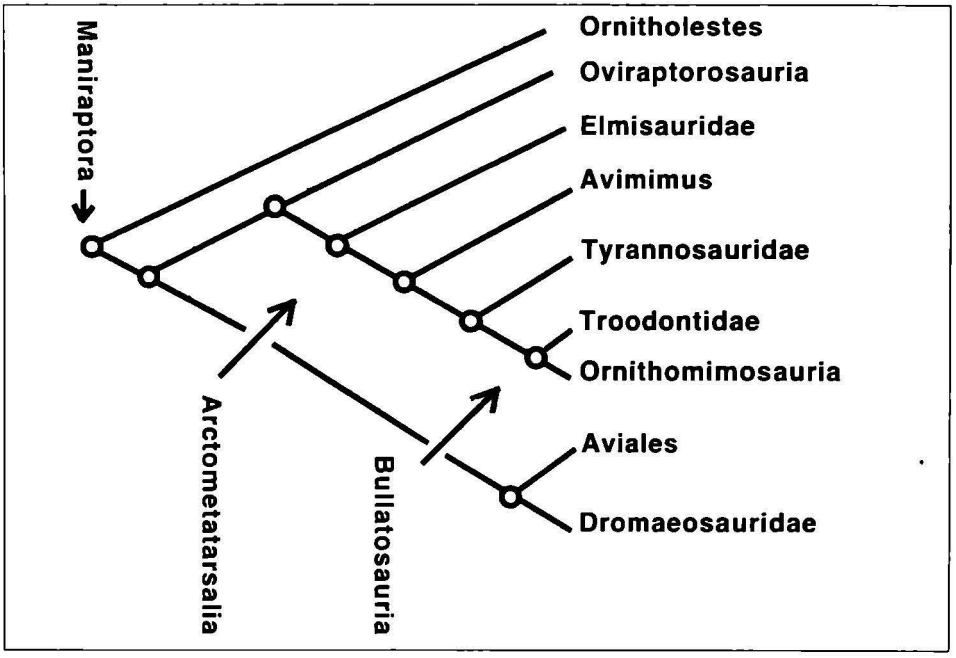


*Fig. 4. Cladogram of Maniraptora (after Holtz 1994)*

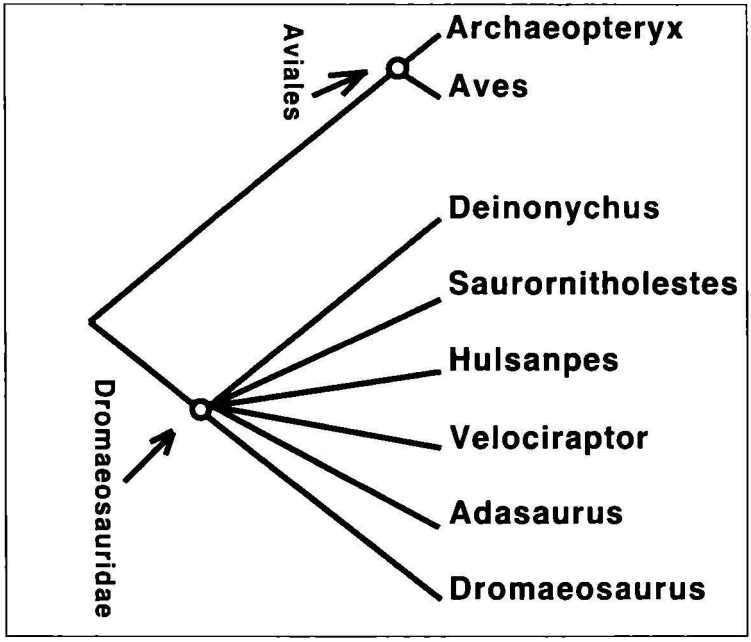


*Fig. 5. – Cladogram of Dromaeosauridae and Aviales*

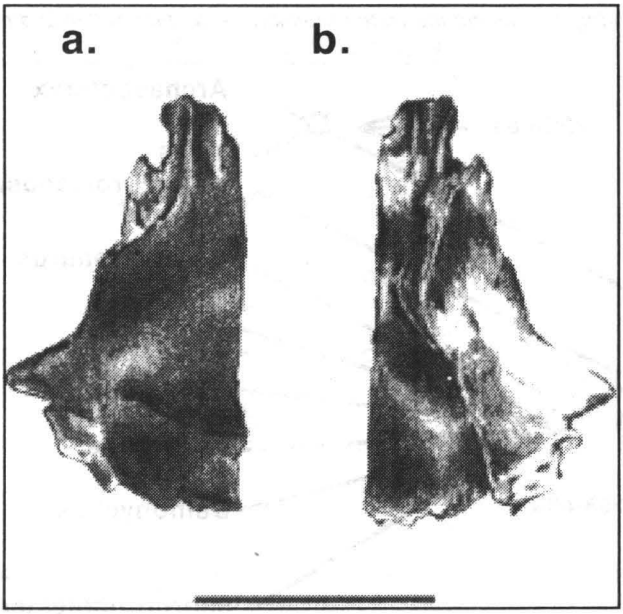


*Fig. 6. – Dorsal (a) and ventral (b) views of the right frontal of Saurornitholestes langstoni (Royal Tyrrell Museum of Paleontology P 74.T10. T 5). Scale=3 cm.*

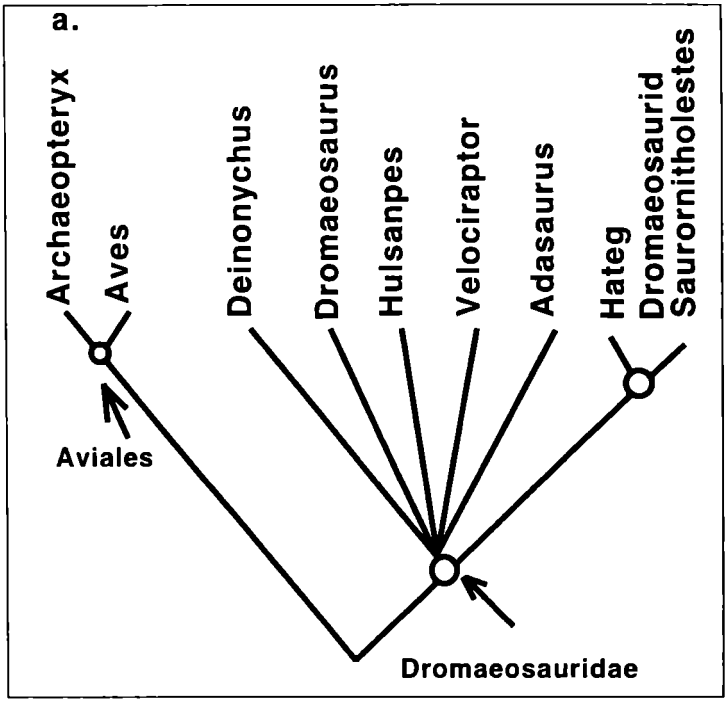


*Fig. 7.a. – Cladogram placing the Haţeg dromaeosaurid high within Dromaeosauridae*

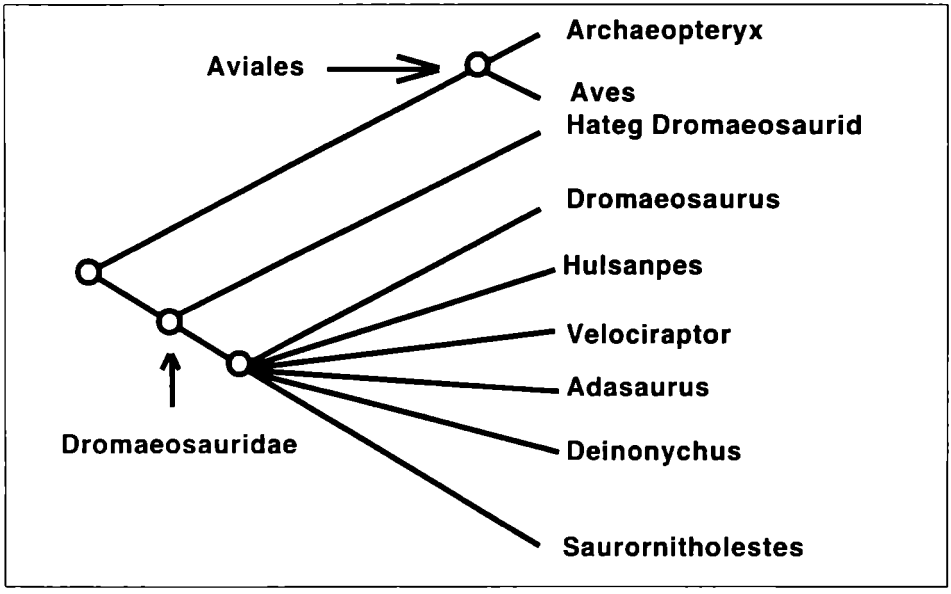


*Fig. 7.b – Cladogram placing the Haţeg dromaeosaurid at the base of Dromaeosauridae*

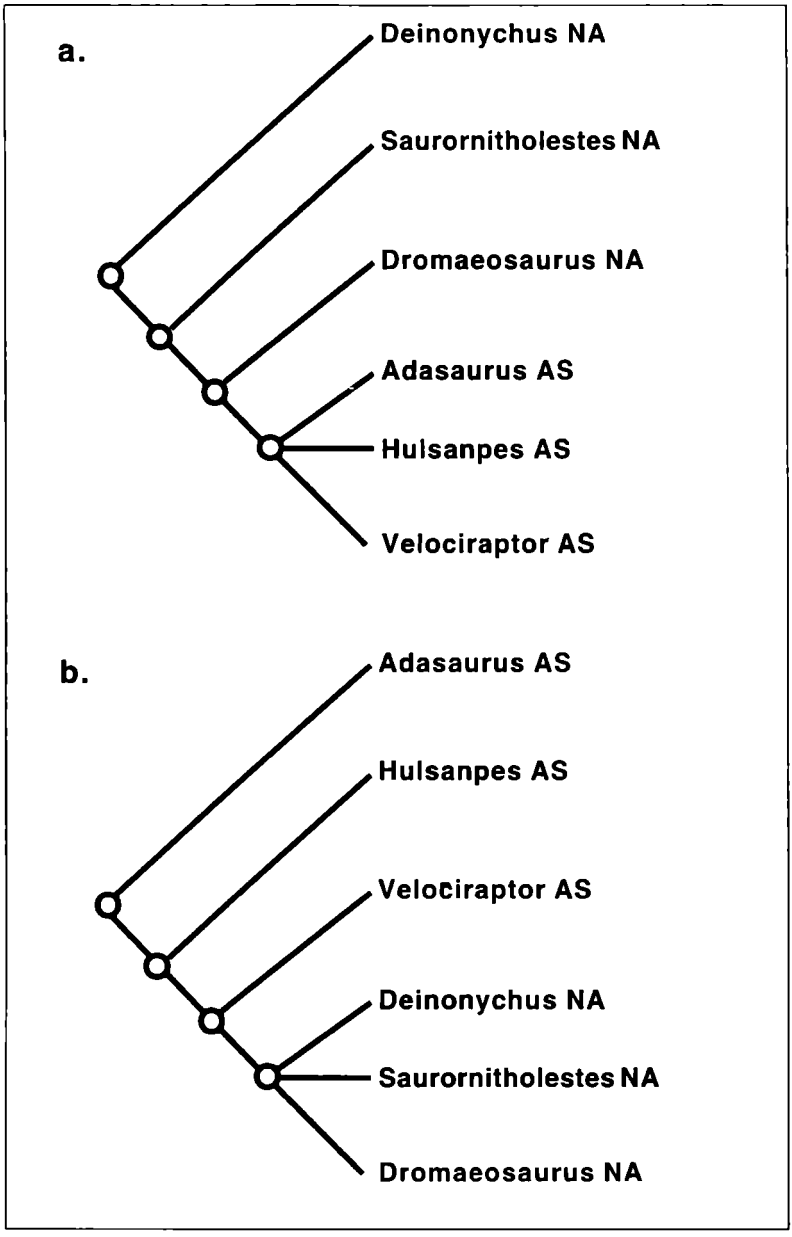


*Fig. 8. – Biogeographic implications of dromaeosaurid phylogeny.*
*a. North American origin of the clade if Deinonychus, Saurornitholestes, and Dromaeosaurus are basal members of Dromaeosauridae (order of these taxa is hypothetical).*
*b. – Asian origin of the clade if Adasaurus, Hulsanpes and Velociraptor are basal members of Dromaeosauridae (order of these taxa is hypothetical). Abbreviations–AS: Asia; NA: North America.*

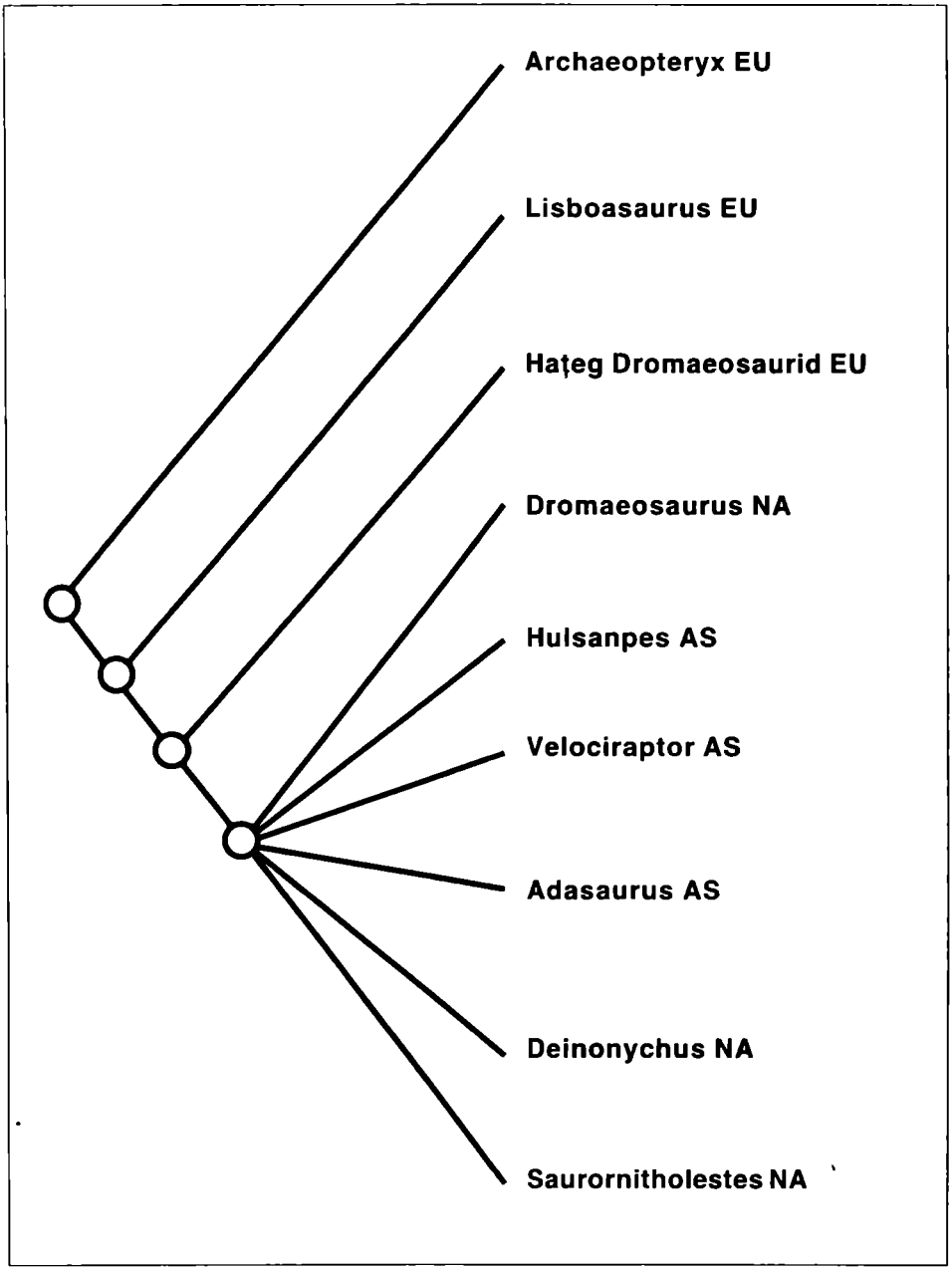


*Fig. 9. – European origin of Dromaeosauridae if Lisboasaurus and the Haţeg dromaeosaurid have the indicated phylogenetic relationships . Abbreviations – AS: Asia; EU: Europe; NA: North America.*

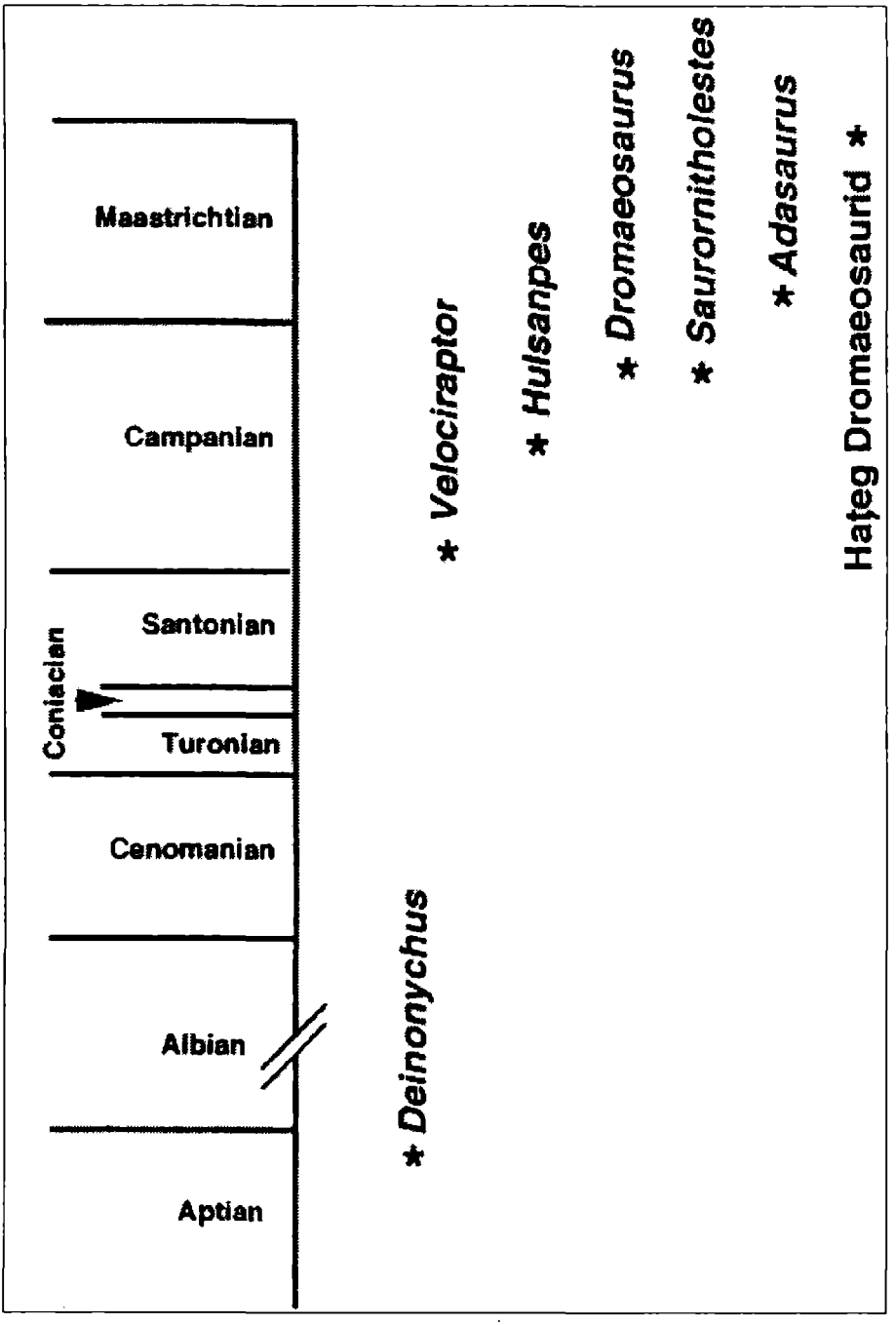


*Fig. 10. – Dromaeosaurid stratigraphic distribution during the Cretaceous.*