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Study of the late Paleocene fauna of Cernay

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The Wouters collection IG 26857 has been present in the Royal Belgian Institute for Natural Sciences (RBINS) in Brussels since 1984, but had not been studied in detail yet. This small collection contains mainly mammal material coming from the 'Conglomérat de Cernay', a late Paleocene fossiliferous level in the Lemoine Quarry (Cernay-lès-Reims), on the 'Mont de Berru' (Paris Basin, France). Previously larger collections from Cernay were already excavated and studied resulting in Russell's 'Les mammifères paléocènes d'Europe' from 1964, the most complete review of late Paleocene fauna from Cernay. This fauna existed between two important periods of faunal turnover, the Cretaceous-Paleocene and the Paleocene-Eocene boundary. The former boundary indicates the start of the age of mammals, while the latter, which is characterized by the Paleocene Eocene Thermal Maximum (PETM), marked the end of the primitive fauna of Cernay and the beginning of all modern orders with living descendants (Rose, 2006). Studying this fauna gives a perspective on a unique episode of mammal evolution.

The study can be divided into three parts: first an elaborate morphological identification of all the specimens in the collection was conducted, secondly the paleogeography around 'Mont de Berru' in the late Paleocene was assessed, and finally the faunal ecology was studied to infer insights regarding the influence of the PETM on the faunal decimation in the early Eocene.

Morphological identification

Dental morphology forms the start of any study in the mammal paleontology, as it allows identification up to the highest possible level, preferably species-level. After the identification, images were taken with a scanning electron microscope (< 1cm) or a reflex camera (> 1 cm).

In total, 423 teeth were identified up to species-level, 43 were tentatively referred to species-level, 8 up to genus-level and 9 up to family-level, resulting in a total of 25 species, 8 families and 7 orders. The morphological study leads to some new insights, especially in the families of the Plesiadapidae, Pleuraspidotheridae and Arctocyonidae. The finding of two specimens of *Platychoerops antiquus* is important, as it is the first time this species was observed in material from Cernay. *Plesiadapis tricuspidens* and *Plesiadapis remensis* were rigorously compared, based on dental morphology and size: *Plesiadapis remensis* has the tendency to be slightly smaller, e.g. m1 Log (crown area) < 1.1 while *Plesiadapis tricuspidens* appears larger. Moreover, the measurements of *Plesiadapis tricuspidens* from Cernay are provided for the first time, as Russell (1964) did not distinguish between both species and Gingerich (1976) measured only *Plesiadapis tricuspidens* from Berru. Finally, the description, measurements and images of deciduous teeth belonging to *Plesiadapis remensis*, *Chiromyoides campanicus*, *Pleuraspidotherium aumonieri*, *Orthaspidotherium edwardsi* and *Arctocyonides* were not provided in detail before. Next to these families, also Louisinidae (6 species), Adapisoricidae (1 species), Adapisoriculidae (2 species), Pantolestidae (1 species) and Neoplagiaulacidae (5 species) were identified and studied.

Comparing the findings presented in this work with Russell (1964) indicates that both faunal lists are very similar. However, the species diversity in Russell (1964) is more extended (29 species belonging to 25 genera), which is reasonable, as his collection was four times larger than that of the Wouters collection. Remarkably, the size of *Arctocyonides* and *Landenodon* appears to be smaller in the Wouters collection, e.g. M2 of *Arctocyonides trouessarti* and *Arctocyonides arenae* is 13 % and 10 % smaller, respectively. As the same locality of Cernay is considered in both collections, a methodological or change factor must be involved. In both collections the pleuraspidotheriids and plesiadapids make up the largest part of the fauna (around 43% and 34% respectively), while almost no very small taxa were found (adapisoriculids only account for 0.46% of the fauna), plausibly due to overlooking during the sampling. Also striking was the low abundance of *Arctocyon* (0.45% of the collection) in the Wouters collection, while this species is abundantly present in Russell (1964). Russell probably had sampled most of the larger teeth of *Arctocyon*, leaving only some fragments for later excavations. Finally, the large amount of high-resolution SEM images represents an important contribution for further study, complementing the figures in Russell (1964).

Paleogeography

After identification of all the individual specimens, the fauna of Cernay can be considered in total. The fauna belongs to the MP6 reference level, indicating a late Paleocene age (Smith & Smith, 2003). In the second part of the study the fauna was compared with other localities of this reference level, based on taphonomy and depositional environment.

The late Paleocene faunas of Cernay and Berru, located on the eastern side of 'Mont de Berru', are often considered together, due to their proximity and similarity in fauna. However, there is a lack of *Plesiadapis remensis* in Berru, while it is abundantly present in Cernay. Moreover, the pleuraspidotheriids and the genus *Plesiadapis* show a remarkable smaller size compared to Berru, e.g. in Berru *Plesiadapis tricuspidens* has a maximum m1 Log (crown area) between 1.20 and 1.22, while Log (crown area) of m1 in Cernay show a maximum between 1.18 and 1.20. This was also observed in the 'Lentille', a second fossiliferous layer in the Mouras Quarry. These findings combined with a different sedimentology i.e. Cernay represents delta deposits, while deposits in Berru are more riverine (Russell, 1964; Laurain and Meyer, 1986), suggest that the 'Lentille' is probably older than Cernay, while Berru seems younger (Russell, 1964; Gingerich, 1976). Consequently size differences within the same species can be explained by the

fact that towards the Eocene, species show a trend of becoming bigger, as the diet consists of more leafs.

The taphonomy of the fossil fauna also clearly differs: the 'Conglomérat de Cernay' comprises smaller, more isolated and worn material with respect to the material of Berru, indicating almost no postmortem transport in Berru, while the material of the 'Conglomérat de Cernay' was probably transported over a longer distance. These small isolated teeth were likely swept away by a river and became concentrated in a low energetic gully on the delta plain.

In more southwestern direction of the 'Mont de Berru', the 'Marnes de Montchenot' and the 'Marnes de Rilly' are located. Although these closely related fossil localities comprise no different species with respect to Cernay, the fossil fauna is remarkably different: a taphonomical bias towards micromammals is observed, most likely caused by hydrodynamic sorting and selective predation. This latter can also explain the high abundance of acid-etched and deciduous teeth (Jehle et al., 2012; Russell et al., 1966). The material is well preserved, indicating in-situ deposition, most probably in freshwater lake or swamp sediments (Laurain & Meyer, 1986), which can also explain the presence of predators like crocodiles.

No complete succession of the late Thanetian MP6 reference level has been found in a single site, but faunal and sedimentological evidence suggests that the 'Lentille de Berru' is the oldest site, followed by the 'Conglomérat de Cernay', the main level of Berru and finally the 'Marnes de Montchenot' and 'Marnes de Rilly' (e.g. Russell, 1964, 1966; Gingerich 1976). Consequently, the environment around 'Mont de Berru' through the late Paleocene, evolved in the context of a regressing sea, from a deltaic-estuarine brackisch environment (Cernay/Berru) to eventually freshwater lakes ('Marnes de Rilly/Montchenot'). This was also suggested in Laurain and Meyer (1986).

Faunal ecology

Fossil mammal teeth can also be used as a proxy to evaluate the faunal ecology. As there is a link between molar size and body mass, the paleoenvironment was interpreted from a cenogram analysis (Gingerich, 1989: Legendre 1989). Moreover, highly specialized mammal teeth allow an estimation of the diet. Consequently, every species was classified in dietary, locomotary and size classes according to Hooker and Collinson (2012).

Russell (1964, 1975) stated that the paleoenvironment of Cernay in the late Paleocene could be described as a dense forest with the presence of a nearby river. This statement was empirically confirmed in this work by a cenogram analysis. From the resulting cenogram, slope and offset parameter were assessed and compared with the values in Gingerich (1989): the slope value of the medium mammals (0.4282) and the slope difference between the small and the medium mammals (0.1299) show most support for a forest environment, with a subhumid climate. As this is the first cenogram analysis of the late Paleocene in Europe, there are currently no other cenograms available for comparison. In the future including the collection of Russell will definitely extend and improve this cenogram. This latter is currently located in the Muséum National d'Histoire Naturelle in Paris. Comparing the paleoenvironment of the late Paleocene in Europe with the humid (sub)tropical forests in the early Eocene (e.g. Fairon-Demaret & Smith, 2002, Hooker, 2010), indicates no dramatic environmental change from the late Paleocene to the early Eocene. Furthermore, the ecology was only slightly altered in the early Eocene with the appearance of some new niches: big browsing herbivores, carnivores and real arboreal types (Hooker & Collinson, 2012).

Conclusively, the environment and inherently coupled ecology in Europe do not change dramatically during the PETM. This study of the fauna in Cernay thus makes it fair to conclude that the changing climate is apparently not the direct, or at least not the only reason for the dramatic faunal turnover observed in Cernay. Most likely another phenomenon, occurring during the PETM, is responsible for the faunal decimation. The early Eocene mammal dispersal event can be put forward as the main trigger (Hooker & Dashzeveg, 2003): warmer climate and lower sea levels probably enabled immigration of several North American and Asian taxa, which eventually outcompeted the fauna of Cernay.

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