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Royal Belgian Institute of natural Sciences, **Brussels, Belgium**

PalEurAfrica

International symposium

Evolution and Paleoenvironment of Early Modern Vertebrates during the Paleogene

Field guide

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Field Guide of the excursion on Friday 13th September 2019

By Thierry Smith & Richard Smith

Of the 38 million specimens housed in the collections of the Royal Belgian Institute of Natural sciences three millions are paleontological specimens. Among these are well-known Paleogene specimens, such as the mammals of Hainin, Dormaal, and Hoogbutsel (European MP reference levels of the European mammalian biochronological scale or MP associated), Thanetian champsosaurs of Erquelinnes, Ypresian crocodiles and turtles of Leval and Orp-le-Grand, Casier's Lutetian sharks, and Leriche's Rupelian fishes…

Today, thanks to the logistic support of local authorities, we are able to visit the vertebrate localities of Maret (middle Paleocene, MP1-5 equivalent), Dormaal (earliest Eocene, MP7 reference-level), and Hoogbutsel-Boutersem (early Oligocene, MP21 equivalent), all located in eastern Belgium, in the Brabant province (Figure 1).

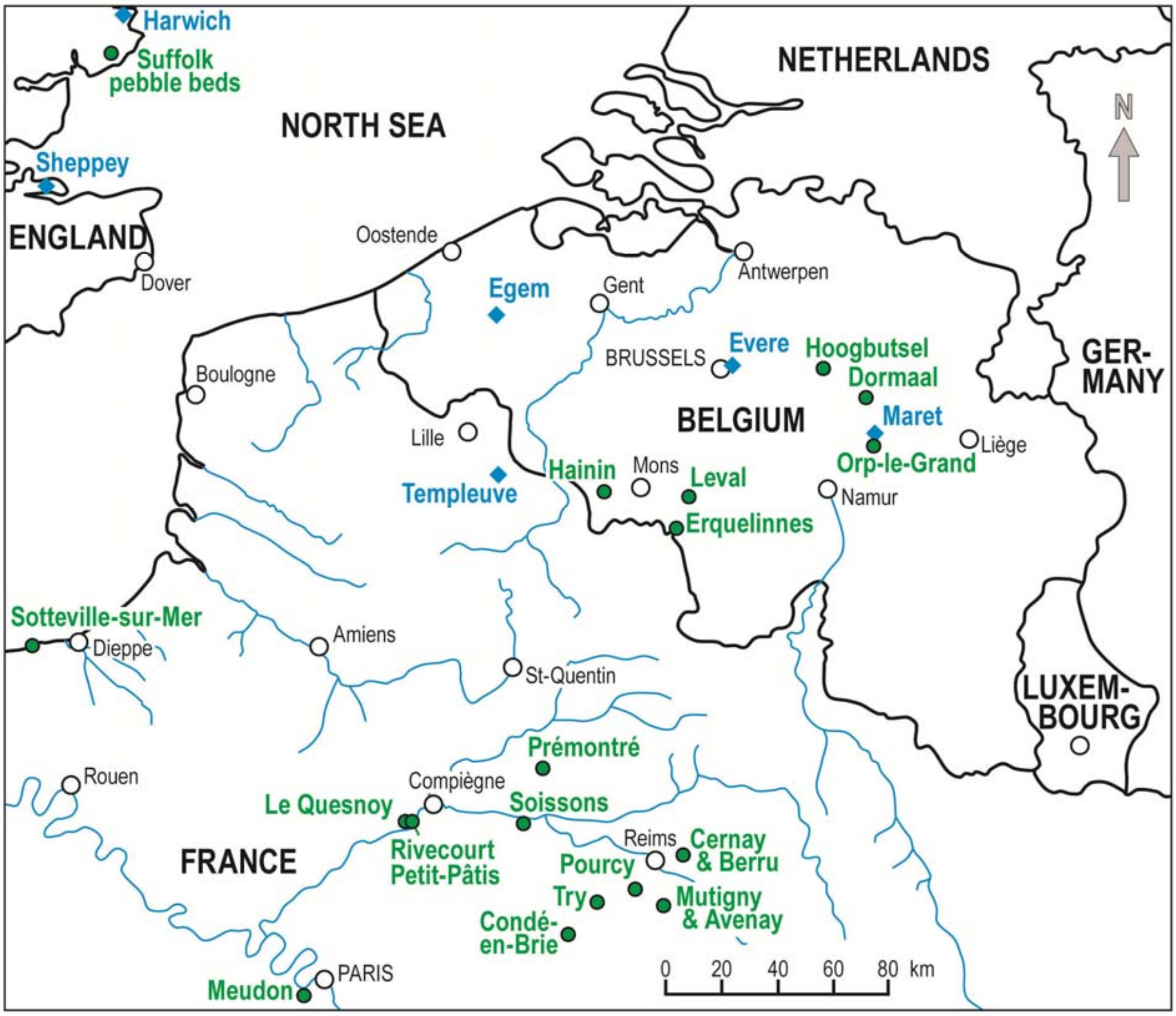

Figure 1. Map of Belgium and surrounding areas with Paleogene localities having delivered terrestrial vertebrate fossils. Green circles indicate terrestrial localities, whereas blue diamonds indicate marine levels in which terrestrial mammals were discovered.

On the road to Maret

Along the Brussels – Liege E40 highway, we see on the right side the railway line of the high speed train (TGV). At the level of the exit number 24 'Boutersem' was the early Oligocene fossil site called 'Boutersem-TGV' where one of us (RS) collected seven tons of fossiliferous sediments (Smith, 2003).

Stop 01: Maret (Paleocene)

The hamlet of Maret belongs to the township of Orp-Jauche in Walloon Brabant. The Paleocene fossil site of Maret that is located near the old train station is the stratotype for the Orp-Sand Member. The latter is characterized by mid-Paleocene sands renowned for their rich marine elasmobranch fauna, which represent the locus typicus and stratum typicum of one genus and several species of sharks (Herman, 1973, 1977; Cappetta & Nolf, 2005; Figure 2).

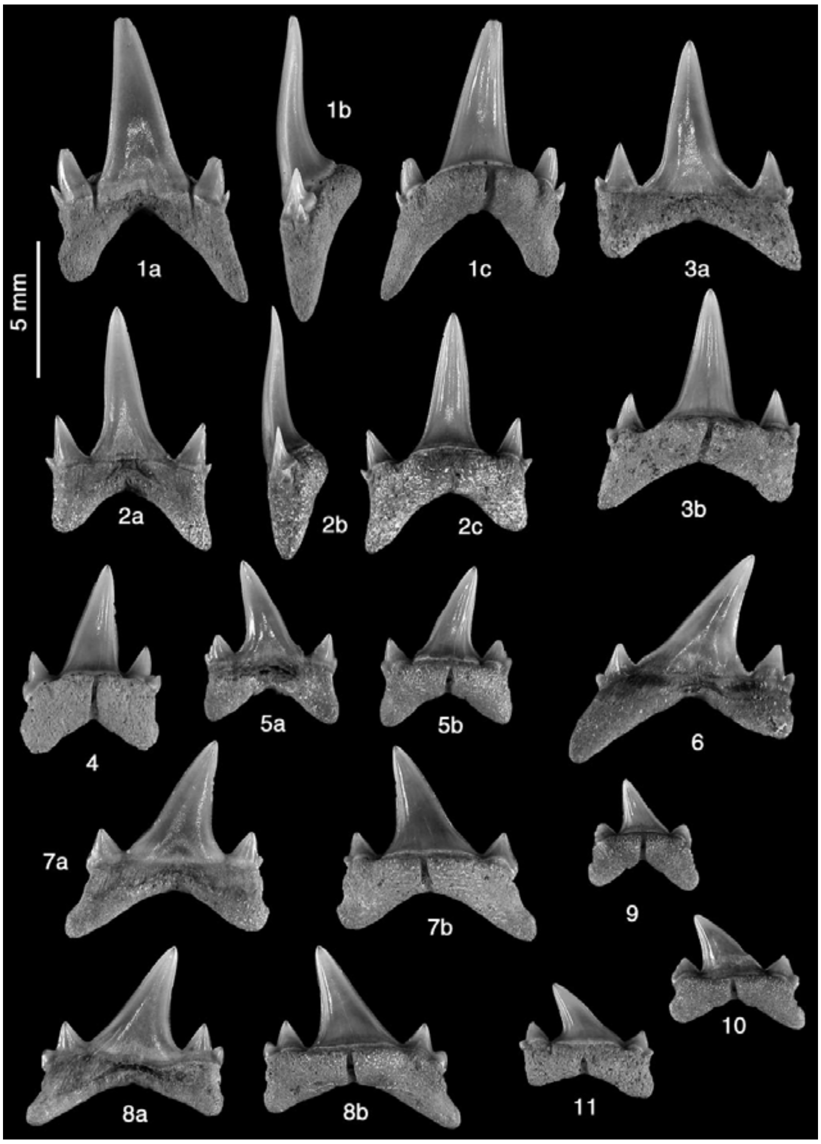

Figure 2. Odontaspid shark Orpodon heersensis (Herman, 1973) from Maret (from Cappetta & Nolf, 2005). 1-2. Anterior lower teeth IRSNB P 5741 and P 5741. 3. Latero-anterior lower tooth P 5754. 4. Lateral upper tooth P 5755. 5. Latero-anterior lower tooth P 5753. 6. Lateral upper tooth P 5746. 7-8. Lateral lower tooth P 5745 and P 5744. 9. Very lateral lower tooth P 5750. 10-11. Very lateral upper tooth P 5747 and P 5748.

Vertebrates have been collected at Maret since the end of the 19th century (Daimeries, 1888, Leriche, 1902, see Herman & Sigé, 1975 for an overview). Extremely rare terrestrial vertebrate remains have been found in association with the marine vertebrates (Dollo, 1890; Herman, 1973), among which are a few mammal specimens (Quinet et al., 1971; Herman & Sigé, 1975; De Bast et al., 2013). The dentary IRSNB M2017 of *Bustylus* *germanicus* (Russell, 1964) is remarkable as it is the most complete jaw of an adapisoriculid mammal (Figure 3). The mammals of Maret allowed to propose a correlation with the Walbeck fauna in Germany (De Bast et al., 2013).

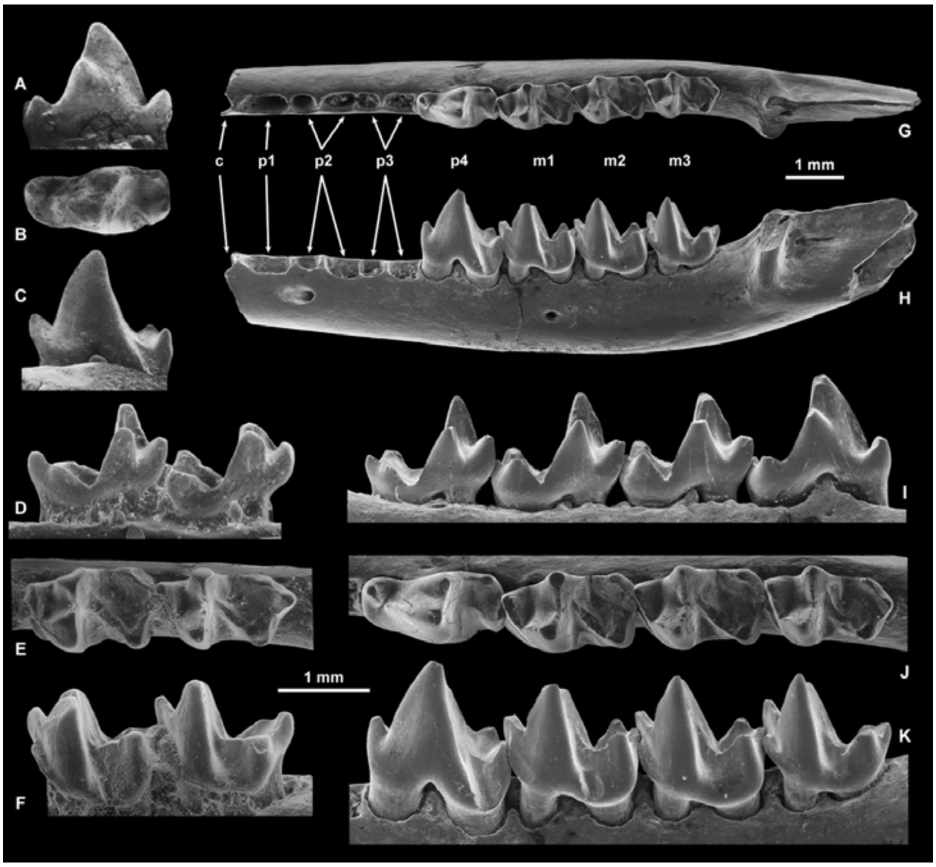

Figure 3. Comparison of the lower dentitions of the adapisoriculid mammal Bustylus germanicus from the Orp Sand Member (Selandian) in Maret, and from Walbeck (Germany). A-C. p4 (MLU Wa/383), from Walbeck. D-F. Associated m2-m3 (MLU Wa/358, holotype) from Walbeck. G-K. Dentary (IRSNB M2017) from Maret. Views are lingual (A, D and I), occlusal (B, E, G and J) and labial (C, F, H and K). From De Bast et al., 2013.

The Orp Sand Member is overlain by the Gelinden Marl Member (Figure 4). Both are subdivisions of the Heers Formation, the lithostratigraphic equivalent of the Heersian Stage, a regional chronostratigraphic unit, defined in Belgium (Dumont, 1851), which internationally is considered to be obsolete and replaced by its correlative, the Selandian. The correlation between the Orp Sand Member and the lower part of the Selandian was based on lithological grounds and micropaleontological evidence. Both units, the Orp Sand Member and the Gelinden Marl Member, contain similar calcareous nannofossil associations, marked by high degrees of Cretaceous reworking and attributable to zonal interval NP4-NP5 (Thomsen & Heilmann-Clausen, 1985; Steurbaut, 1998; Hooyberghs et al., 2001; Clemmensen & Thomsen, 2005). Both units also contain similar dinoflagellate cyst associations (Schumacher-Lambry, 1978; Vlerick, 1988) characterized by the co-occurrence of *Palaeoperidinium pyrophorum* and *Glaphyrocysta pastielsi*, typical markers of North Sea dinoflagellate Zone 2 and Zone 3 of Heilmann-Clausen (1985). The absence in the Orp Sands of *Thalassiphora delicata* and *Alisocysta margarita* (Vlerick, 1988), and the presence of *Isabelidinium*? *viborgense* (middle part of Orp Sand at 209 m depth in Eisden borehole), is more consistent with the middle part of Zone 2, corresponding to the upper part of the Kerteminde Marls in Denmark (see De Bast et al., 2013). The Orp Sands are therefore referred to the early to middle Selandian.

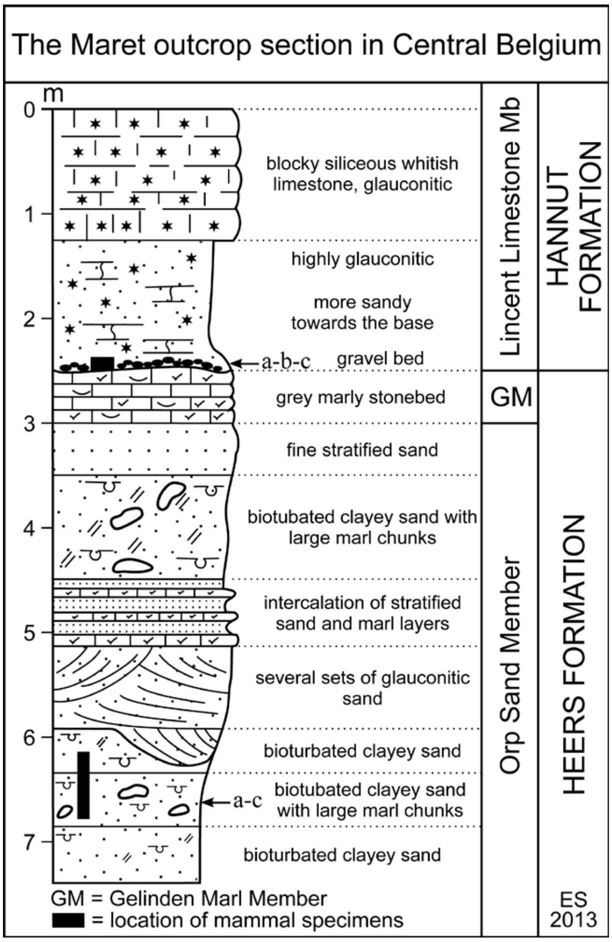

Figure 4. Lithology and lithostratigraphic interpretation of the Maret outcrop (logged on the southern side of the rail track on June 16th 1992), with location of the vertebrate finds: a. Herman, 1973 and Herman & Sigé, 1975; b. Quinet et al., 1971; c. De Bast et al, 2013.

At Maret, the Orp Sands, of which only the upper 4 m are exposed, consist of a heterogeneous complex of essentially sandy sediments, with intermittent influxes of whitish marl material, sometimes forming thin beds, but mostly restricted to centimetric to ecametric large irregular marl lumps (Figure 4). The high carbonate content of these marls is due to the presence of reworked Cretaceous coccoliths. Sedimentation took place in a shallow marine context, with temporary estuarine influences, at the edge of the continent, with exposed chalk strata (cliffs? Bless & Fernández-Narvaiza, 1996; Dreesen et al., 1998). This is evidenced by the presence of bioturbated and horizontally stratified sands and thin marl beds, pointing to rather calm sedimentation conditions, and the reworked marl lumps, the concentrations of glauconite and the channeling, reflecting high energy input.

Vertebrates remains at Maret were also encountered in the basal gravel of the Lincent Limestone Member (*Tuffeau de Lincent* in French). This siliceous limestone to calcareous sandstone unit, overlying a thin basal gravel, represents the lower Member of the Hannut Formation. In agreement with its attribution to the lower part of nannofossil zone NP8, it belongs to the lower middle Thanetian. The basal gravel layer in Maret has yielded a rich elasmobranch fauna that is mainly reworked from the Orp sand Member.

Figure 5. Outcrop section at Maret with the marls of Gelinden sandwiched between the middle Paleocene Heers Formation and the late Paleocene Hannut Formation.

In between the Orp Sand Member and the Lincent Member occurs a whitish crumbly marly chalk, the Gelinden Marl Member, the thickness of which is reduced to less than 1 m at Maret (Figure 5). However, in Gelinden this marl can reach up to 5 meters thick and is rich in fossil leaves and other botanical remains (Figure 6). The age estimate of the Gelinden Marl Member is mid to late Selandian on the basis of the calcareous nannofossil (upper NP4-NP5) and dinoflagellate associations (Zone 3 of Heilmann-Clausen (1985), recorded in the upper part of the Ǽbelø Formation and base of the Holmehus Formation in Denmark (Sheldon et al., 2012).

Figure 6. Leaf imprint of Quercus loozi Saporta and Marion, 1877 from the middle Paleocene (Selandian) Heers Formation of Gelinden.

On the path to Orp-le-Grand

When we are out of the *Ravel* path (bicycle path at the place of the previous railway), have a look to the Vermeulen Farm where the base of the building is made by Maastrichtian silex and the upper part is made by the Paleocene Lincent limestone. Historically, the *tuffeau de Lincent* was used as a building stone at least from the Roman time to 1950's. It was progressively replaced by the brick.

St Martin & St Adèle church is remarkable for its stone composition and is registered on the list of the national historical monuments (Figure 7). This Romanesque church of the XI-XII century is of particular aspect stone of calcrete and silex. Do not hesitate to look for fossils!!! There are nice belemnites and bivalves on some walls (Figure 8).

Figure 7. St Martin & St Adèle church.

Figure 8. Belemnites in a chalk stone.

Stop 02: Dormaal (Earliest Eocene)

The famous fossil locality of Dormaal (Orsmael in old literature), a hamlet of the township of Zoutleeuw (Flemish Brabant) has been discovered on June 7th 1883 along a sunken path (Figure 9) by the geologist Aimé Rutot (Figure 10). The discovered fossils have been first given to Louis Dollo who went to Reims to show them to Victor Lemoine. At that time V. Lemoine was studying another famous vertebrate fauna, the one of Cernay-Berru. Dollo and Lemoine considered that the Dormaal fossils were of the same age as those from the Reims area. They compared them and communicated their results to Rutot (Rutot & Van Den Broeck, 1884). Later, especially with the monograph of Teilhard de Chardin (1927), the mammals were considered as early Eocene in age. The fauna yielded the oldest European modern mammals such as the carnivora *Dormaalocyon latouri* (see Solé et al., 2014), the artiodactyl *Diacodexis gigasei*, (Smith et al, 1996), the primate *Teilhardina belgica* (Figure 11; see Smith et al., 2006), and several species of hyaenodonts (Smith & Smith, 2001), and rodents. The mammal fauna is correlated with the reference level MP7 (BiochroM'97, 1997).

Figure 9. The sunken path of Dormaal along which the fluvial deposits of the earliest Eocene Tienen Formation are exposed (MP7) in 2005.

Figure 10. Aimé Rutot, geologist at the Royal Belgian Institute of Natural Sciences, was a specialist of Cenozoic deposits.

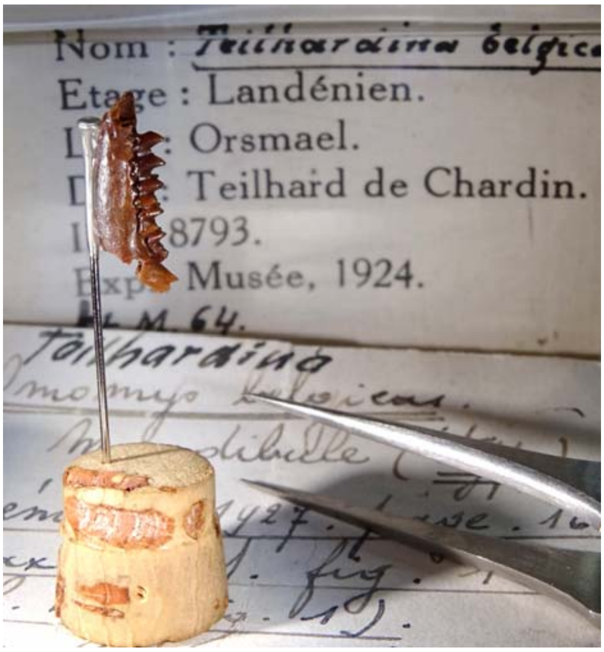

Figure 11. Lectotype dentary of primate Teilhardina belgica (Teilhard de Chardin, 1927) from the earliest Eocene of Dormaal.

Numerous excavations have been done in Dormaal since 1883. One of the last and largest excavations was done by one of us (RS) who collected 24 tons of the fossiliferous layers (Figure 12), which provided thousands of specimens, including 7,000 jugal teeth of mammals. All the type and figured specimens from this collection are deposited in the RBINS.

Figure 12. Excavation of Richard Smith at Dormaal, 1990.

The Dormaal Sands are a series of fluviatile subrounded-pebble beds, cross-stratified lignitic sands, clayey sands and thin grey clay layers, which are restricted to eastern Belgium (Figure 13). They are recorded in west Haspengouw, within a 10 to 15 km wide band between the villages of Tienen and Sint-Truiden and extending to Eghezée, 25 km southwards. The Dormaal Member outcrops in the higher parts of the interfluvial areas, beneath a generally 3 to 5 m thick Quaternary loam cover. Locally, it is overlain disconformably by clayey fine sand of the St.-Huibrechts-Hern Formation (formerly designated as Lower Tongrian), by the Brussel Formation or by clays of the Ieper Group (in the Molenbeek valley, west of Tienen). It usually rests on glauconitic sand of the Grandglise Sand Member (upper NP8), or, between Orp and Hannut, on the Lincent Limestone Member, both belonging to the Hannut Formation (see Steurbaut, 1998 for an overview of late Paleocene stratigraphy in Belgium).

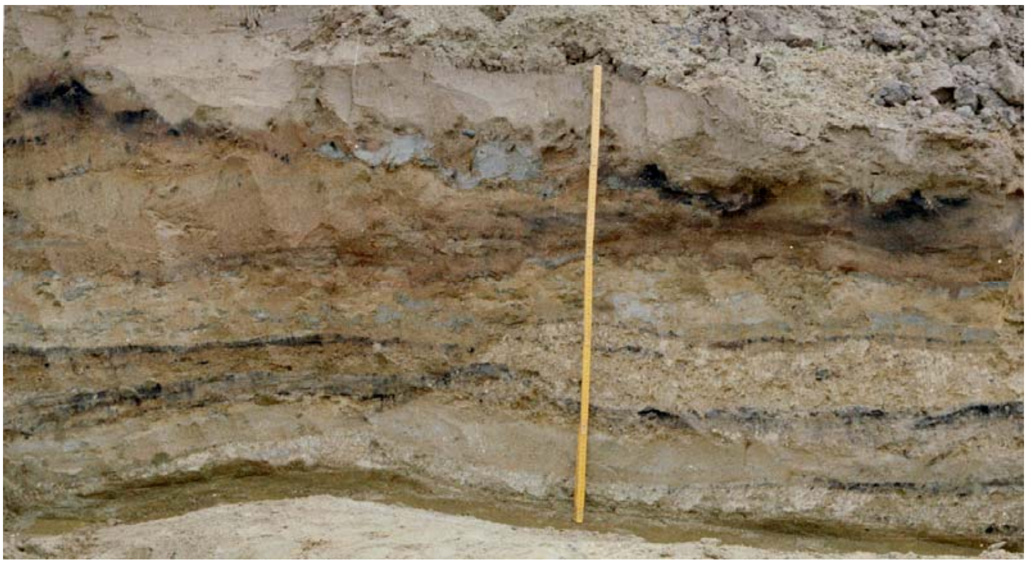

Figure 13. The fluvial deposits of the Tienen Formation at Dormaal, 1990 reached a maximum thickness of 80 cm.

Stop 03: Hoogbutsel-Boutersem (Early Oligocene)

The fossil site of the hamlet of Hoogbutsel, belonging to the township of Boutersem (Flemish Brabant), was discovered by Maxime Glibert and Jean de Heinzelin de Braucourt in June 1951 (Figure 14; Glibert & Heinzelin, 1952). It was originally an abandoned sand pit.

Figure 14. Beginning of the excavations of Glibert and Heinzelin in 1951.

In 1999, one of us (RS) discovered a new locality at 3 km south-west of Hoogbutsel along the highway E40, temporarily exposed during the High Speed Train (TGV) railway construction (Figure 15). Therefore, this site was called Boutersem-TGV.

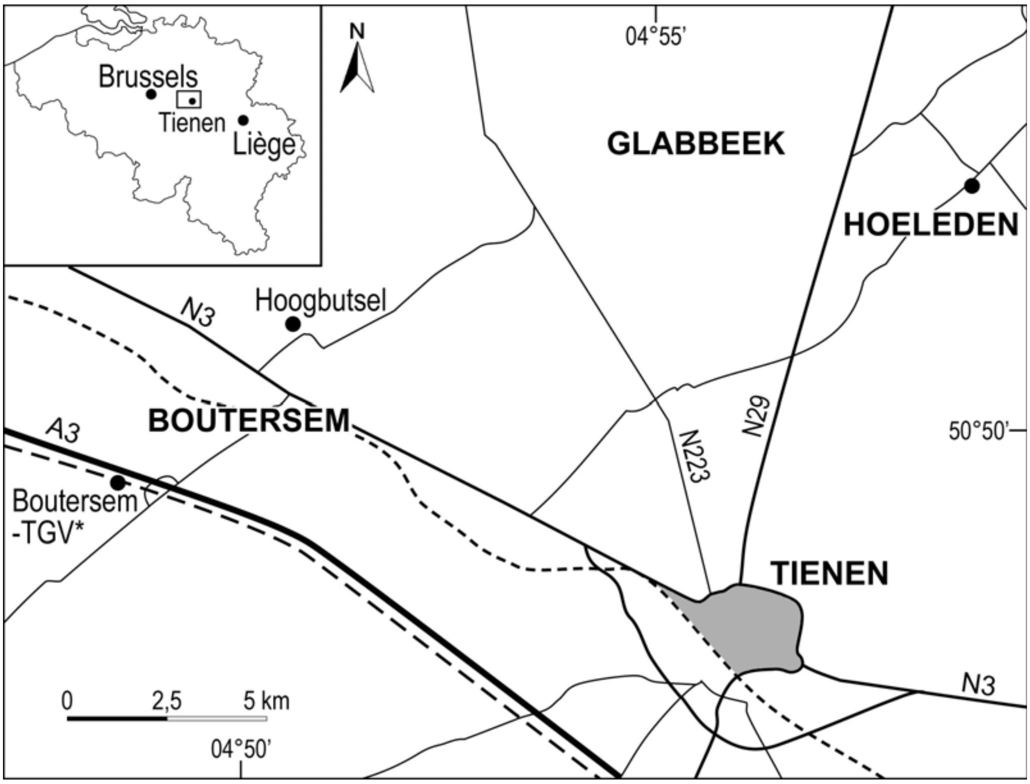

Figure 15. Map showing the geographic locations of the Belgian localities of Hoogbutsel, Hoeleden, and Boutersem-TGV that yielded the early Oligocene vertebrate fauna.

The fossil bed occurred at the base of a fluvio-lacustrine complex, the Boutersem Member that overlies the latest Eocene marine Neerrepen Sands of green color (Figure 16). The Boutersem Member that consists of shell-beds, clayey sands, and shelly sands belongs to the Borgloon Formation that is included in the Tongeren Group (Wouters & Vandenberghe, 1994; Mayr & Smith, 2001). The Boutersem sands contain molluscs (Marquet et al., 2008) and also yielded a rich fauna of vertebrates represented by amphibians (Folie et al., 2010), lizards (Augé & Smith, 2009), birds (Mayr & Smith, 2001), and mammals (Smith, 2003). The latter are notably remarkable by providing the oldest *Myotis* bat (Figure 17; Gunnell et al., 2017), the carnivore-like insectivore *Butselia biveri* (Smith & Smith, 2012), and numerous nyctitheriid insectivores (Smith, 2004, 2006) and glirid rodents (Vianey-Liaud, 1994). The mammal fauna is correlated with the reference level MP21 (BiochroM'97, 1997) defined on the fauna of Soumailles (Aquitaine, France). All the fossils are recorded from the oldest continental levels of the early Oligocene near the «Grande Coupure» (Stehlin, 1909).

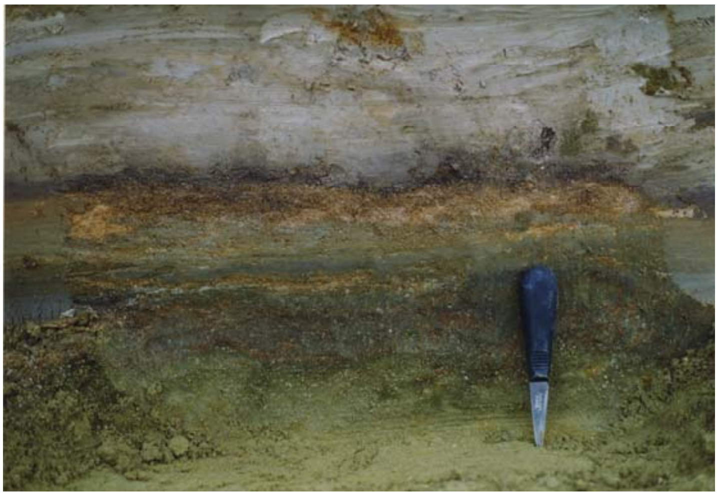

Figure 16. Outcrop section at Boutersem-TGV in the early Oligocene Boutersem Sand Member of the Borgloon Formation (MP21).

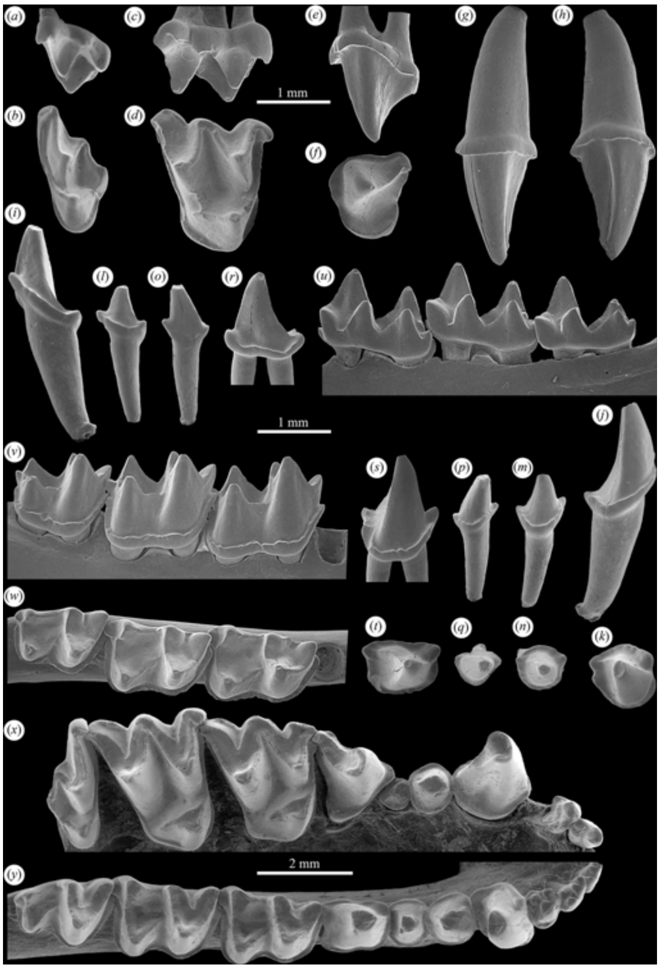

Figure 17. Dentition of early Oligocene myotine Myotis belgicus Gunnell et al. (2017) from Boutersem, Belgium. (a-b) left M3, IRSNB M2180 in labial and occlusal views; (c-d) right M1, IRSNB M 2179 in labial and occlusal views; (e-f) left P4, IRSNB M 2178 in labial and occlusal views; (g-h) left C1, IRSNB M 2177 in labial and lingual views; (i-k) right c1, IRSNB M 2176 in lingual, labial and occlusal views; (l-n) right p2, IRSNB M 2175 in lingual, labial and occlusal views; (o-q) left p3, IRSNB M 2174 in lingual, labial and occlusal views; (r-t) right p4, IRSNB M 2173 in lingual, labial and occlusal views; (u-w) right dentary m1-3, IRSNB M2172 (Holotype) in lingual, labial, and occlusal views. Extant myotine Myotis myotis (x-y) right maxillary with I1-M3 and right dentary with i1-m3, IRSNB 98-067-0003 in occlusal views.

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