A large seal's humerus from the Late Miocene of Liessel (Noord-Brabant), the Netherlands

Noud Peters[1*], Leonard Dewaele[2,3,4] & Stephen Louwye[5]

[1] *Museum Klok en Peel, Ostaderstraat 23, 5721 WC Asten, The Netherlands, amm.peters@kpnmail.nl*
[2] *Department of Biology, Antwerp University, Campus Drie Eiken, Building D, Universiteitsplein 1, 2610 Antwerp, Belgium*
[3] *Royal Belgian Institute of Natural Sciences, Rue Vautier 29, 1000 Brussels, Belgium*
[4] *Department of Geology, Liège University, Quartier Agora, Allé du Six Août 14, 4000 Liège, Belgium*
[5] *Department of Geology, Ghent University, S8, Krijgslaan 281, 9000 Ghent, Belgium*
[*] *Corresponding author*

Received 14 November 2024, revised version accepted 26 February 2025

Between many fossils of marine mammals that are kept in the collection of Museum Klok en Peel in Asten (The Netherlands), seals (Phocidae) from Liessel are well represented. Although many pieces are fragmentary due to the sand extraction process, some of them still show characteristics enabling a closer ranking in the phocid family. One of those not yet investigated fossils, a distal part of a well-preserved relatively large humerus, was studied more in detail, the results are presented here. The fossil exhibits a close resemblance to a humerus of *Frisiphoca aberrata* (Van Beneden, 1877), a seal species known from the Miocene of Belgium. It is the first record from The Netherlands.

Key words: Late Miocene, Phocidae, humerus, Noord-Brabant, The Netherlands

Introduction

In the past decades a variety of fossil remains have been recovered from a sandpit near the village of Liessel in Noord-Brabant, The Netherlands. Quarrying activities during many years were carried out by the firm Hoogdonk BV – now closed – by dredging, later by suction-dredging to supply the factory with sand for the production of sand-lime bricks. Through the nature of the extraction process, the fossils in the sediments from different depths were mixed up in the excavation process and by consequence unfortunately were always ex situ finds. In the course of time many plant remains such as fruits and seeds were collected, together with skeletal parts of land mammals. Most fossils originated from glauconitic sands with a clearly marine origin. Among others numerous moulds of bivalves and gastropods, and shark teeth, fish jaws, and skeletal elements of whales and seals were found and many of them were stored in the collection of museum Klok en Peel in nearby Asten. Many of these Hoogdonk fossils have been studied in more detail and an overview of the finds over the years up to 2008 was presented in a book for a broader public (Peters, 2009).
Meanwhile the Asten collection still hosts fossil specimens deserving closer examination. One of the finds from the past is a large seal humerus, that although the bone is not complete shows enough characteristic details to justify renewed attention. Here we report on the results of our investigation of this humerus Li 381.

Locality – Sandpit Hoogdonk in Liessel

Seismic activities in the southeastern part of The Netherlands have left a pattern of southeast - northwest oriented geological faults. The main fault (Peel Boundary Fault) separates the Roerdalslenk (Ruhr Valley Graben) from the Peelhorst. Sandpit Hoogdonk in Liessel is situated a few hundred metres north of the Peel boundary fault on the horst (Fig. 1).
In 2001, borehole B52C1978 was drilled directly adjacent to the sand pit at RD-coordinates: (X) 185.627 and (Y) 382.024 (51.4265°N, 5.8276°E), bringing to surface numerous sediment samples from the interval 0-44.5 m. The results of the lithostratigraphical and palynological interpretations, summarised in TNO-report 2007-U-R0860/A (Munsterman, 2007) provide a useful framework for the study of fossils from this sandpit.

Stratigraphy and age

A few grams of sediment from the medullary cavity of Li 381 have been subjected to a palynological analysis of dinoflagellate cysts for relative dating. The sediment underwent standard palynological preparation for the removal of carbonates and silicates with hydrogen chloride (HCl) and hydrogen fluoride (HF), respectively.
Following microscopic investigation, the organic residue held a poorly preserved and low diversity assemblage of

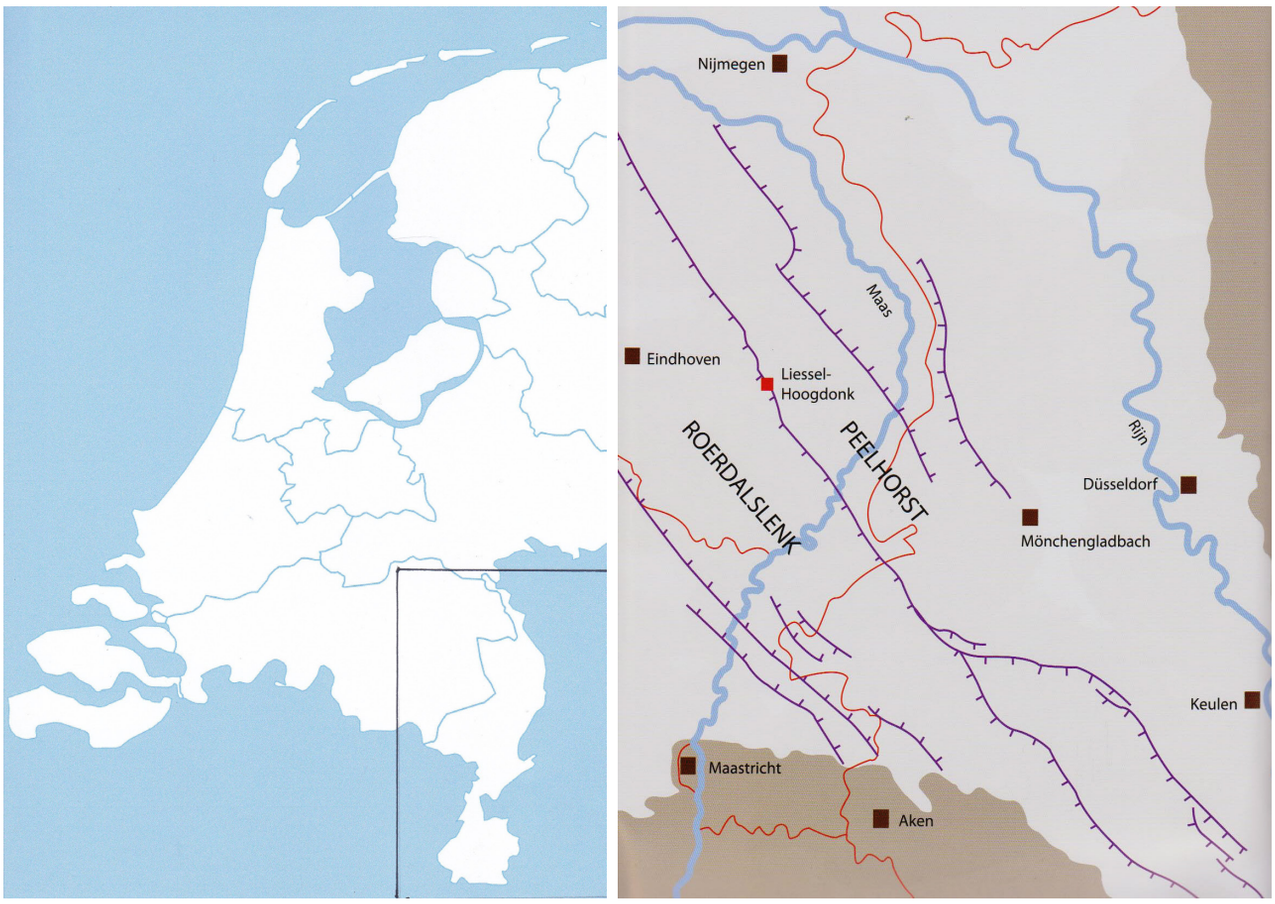

Fig. 1. Liessel in the southeast of the Netherlands (after Van der Toorn, 1976).

organic-walled dinoflagellate cysts. Relative biostratigraphic dating is possible based on three dinoflagellate cyst species; the other species have long stratigraphic ranges, rendering them not useful for relative dating.
Bitectatodinium? *arborichiarum* Louwye 1999 has its earliest occurrence in the late Langhian and is a rare species throughout the Middle Miocene (Louwye & Laga, 2008). The species appears more frequently in sediments of Tortonian age (Louwye, 1999). *Bitectatodinium*? *eirikianum* Head, Norris & Mudie 1989 has its earliest occurrence at 13.01 Ma (early Serravallian; Schreck, 2012), and latest occurrence at 2.62 Ma (late Piazencian; De Schepper & Head, 2008). *Bitectatodinium serratum* Head, Norris & Mudie 1989 was common during the Late Miocene. Hence, despite the poor dinocyst association, a Tortonian age can be suggested for the sediment sample. However, this age is the minimum age of specimen Li 385, as sediment could only have filled the medullary cavity an unspecified time after the animal's death.
Despite the fact that this biostratigraphic dating of the sediment does not yield a very precise age window, a Tortonian age for humerus Li 381 fits well in the framework displayed in TNO-report 2007-U-R0860/A (Munsterman, 2007) and is in good accordance with the age determined for several other marine fossils from sandpit Hoogdonk like the small seal *Batavipusa neerlandica* Koretsky & Peters, 2008 and the early fin whale *Archaeobalaenopters liesselensis* Bisconti, Munsterman, Fraaije, Bosselaers & Post, 2020 (Bisconti *et al.,* 2020; Peters *et al.,* 2021). Based on morphometric analyses of phocid seal long bones by Churchill & Uhen (2019) and Rule *et al*. (2024), the validity of *B. neerlandica* as a distinct species, with an isolated humerus as a holotype, may be questioned.

Systematic Palaeontology

Pinnipedia Illiger, 1811
Phocidae Gray, 1821
Monachinae Gray, 1869
Frisiphoca Dewaele, Lambert & Louwye, 2018

Frisiphoca cf. *F. aberrata* (Van Beneden, 1877)

Referred specimen – Li 381, left humerus, Liessel, The Netherlands (Fig. 2).

Description and comparison – Humerus Li 381 was found isolated. It is a partial left humerus, with only the distal part preserved. Comparison of humerus Li 381 with the lectotype humerus of *Frisiphoca aberrata* (IRSNB 1191-M266; IRSNB = Royal Belgian Institute of Natu-

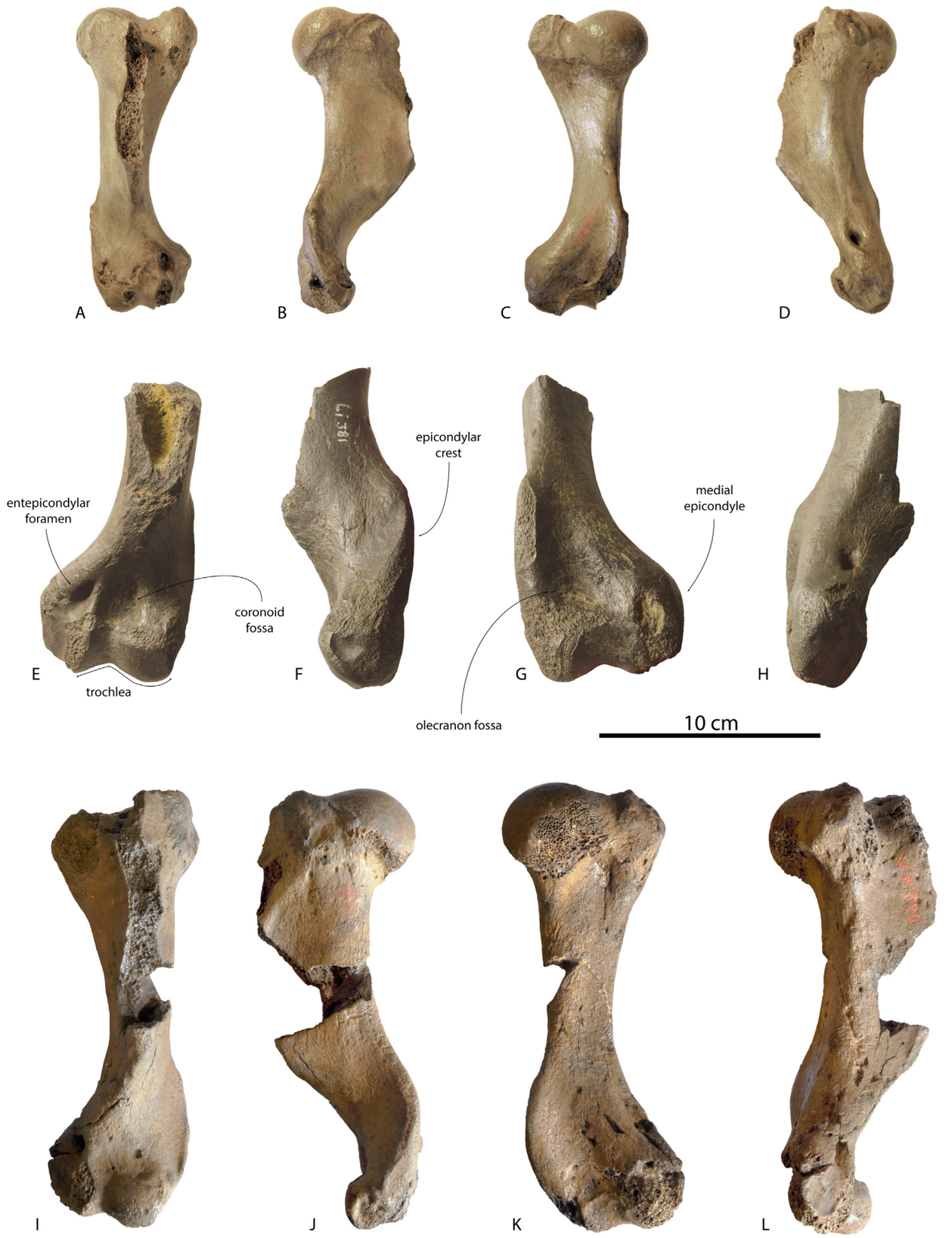

Fig. 2. Comparison of the humeri of *Frisiphoca aberrata* and *Frisiphoca affine* (Van Beneden, 1877), with the referred specimen humerus Li 381 *Frisiphoca* cf. *F. aberrata*. (A-D) lectotype right humerus of *F. aberrata* (IRSNB 1191-M266), (E-H) referred left humerus of *Frisiphoca* cf. *F. aberrata* (Li 381), and (I-L) lectotype left humerus of *F. affine* (IRSNB 1118-M260). Specimens in (A, E, and I) anterior, (B, F, and J) lateral, (C, G, and K) posterior, and (D, H, and L) medial view.

ral Sciences, Brussels, Belgium) is possible due to the overlap, considering that the latter is almost completely preserved, only lacking the anterior portion of the deltopectoral crest and the posterodistal portion of the lateral epicondyle. Humerus Li 381 is noticeably larger than the lectotype humerus of *F. aberrata*, roughly comparable in size to the lectotype humerus of *Frisiphoca affine* (Table 1).

On Li 381, the extreme distal portion of the deltopectoral crest is preserved, *i.e.*, the origin area for *m. pectoralis* gently sloping towards the coronoid fossa. This is a distinctly monachine trait, as opposed to phocine seals, which have a deltopectoral crest that terminates abruptly, distally, at approximately halfway the diaphysis (see, *e.g.*, Dewaele *et al.,* 2018a). However, Li 381 shows an epicondylar foramen on its medial epicondyle. The presence of an entepicondylar foramen is a phocine trait, and among present-day seals indeed is not present in monachines. However, among extinct Monachinae an entepicondylar foramen has been observed in *Frisiphoca* from Belgium, *Homiphoca* Muizon & Hendey, 1980 from South Africa, and *Magophoca* Dewaele & Muizon, 2024 from Peru. The humerus of the latter has also been assumed to share similarities with *Frisiphoca* (Hendey & Repenning, 1972; Muizon & Hendey, 1980; Dewaele *et al.*, 2018b; and Dewaele & Muizon, 2024).

The supinator crest on the lateral epicondyle is not pronounced and rather reduced, as is the condition in other Monachinae, including *F. aberrata*, but unlike *F. affine*, in which this crest flares out and strongly projects posteriorly, as in Phocinae. In addition, like the condition in *F. aberrata*, the supinator crest of Li 381 has a rugose lateral margin. This implies powerful manual extensor muscles originating on this crest. The medial epicondyle is broad. Both the coronoid fossa on the anterior surface, and the olecranon fossa on the posterior surface are well-outlined and noticeably deep. The former contrasts with *F. aberrata*, which has a reduced and flattened coronoid fossa.

Stratigraphic age of Li 381 and *Frisiphoca aberrata*

Stratigraphic dating of a sediment sample from specimen Li 381 delivered a (presumably) Tortonian age. Unfortunately, comparing this datum with the age of the type specimen of *Frisiphoca aberrata* remains difficult because the geological age of the latter is poorly constrained. As noted by Dewaele *et al.* (2018b), the stratigraphic context of most fossil phocid taxa described by Pierre-Joseph van Beneden in the nineteenth century remains uncertain due to the historical use of poorly-defined and currently abandoned stratigraphic terms. Van Beneden (1877) provided an "Diestien" age for the type specimen of *F. aberrata*, IRSNB 1191-M266. The stratigraphic term "Diestien" (or Diestian in English) nowadays generally is considered to be equivalent to the Deurne Sand Member of the Diest Formation in the Antwerp province (Laga & Louwye, 2006). This is confirmed by stratigraphic observations by Mourlon (1876) (see: Dewaele *et al.,* 2018b). The Diest Formation is of Tortonian age (*e.g.,* Louwye *et al.*, 1999; Louwye, 2002; Laga & Louwye, 2006; Houthuys *et al.*, 2020).

Discussion and conclusions

In the critical revision of *Monotherium* van Beneden, 1874, an extinct genus of monachine seals, by Dewaele *et al.* (2018b) several species of this genus have been reassigned. In particular, the former *Monotherium aberratum* Van Beneden, 1877, and *Monotherium affinis* Van Beneden, 1877, were included in a new genus *Frisiphoca* Dewaele, Lambert & Louwye, 2018.

The humeri in both species *Frisiphoca aberrata* and *Frisiphoca affine* show characteristics that are partially monachine and partially phocine. In Li 381 the same mixture is seen, but the match with *F. aberrata* is more obvious as can be concluded from the description of the supinator crest on the lateral epicondyle and its rugose

	Frisiphoca aberrata **IRSNB 1191-M266 (lectotype)**	***Frisiphoca* cf. *F. aberrata*** **Li 381**	***Frisiphoca affine*** **IRSNB 1118-M260 (lectotype)**
Total length	142.5	N/A	177.1
Length deltopectoral crest	77.0	N/A	N/A
Height head	33.9	N/A	36.8
Height trochlea	N/A	N/A	22.8
Width head	35.9	N/A	41.5
Width proximal epiphysis	48.3	N/A	60.2
Width distal epiphysis	53.4	63.7	61.8
Distal width trochlea	32.8	31.7e	N/A
Transverse width mid-diaphysis	22.0	28.9	24.8

Table 1. Measurements of the humerus Li 381, identified as *Frisiphoca* cf. *F. aberrata*, compared to the lectotype humeri of *Frisiphoca aberrata* and *Frisiphoca affine*. Abbreviation: "e", estimate; measurements in mm.

lateral margin. Therefore, humerus Li 381 is identified as *Frisiphoca* cf. *F. aberrata*, a Miocene seal that until now was unknown to have lived in The Netherlands.

This specimen is interesting in the light of recent publications questioning the diagnostic value of isolated long bones in phocid seal identification (Churchill & Uhen, 2019; Rule *et al.*, 2024). Churchill & Uhen (2019) provide quantitative data, showing the considerable interspecific morphologic overlap in long bone shape variation among phocids. It is indeed good practice to refrain from naming new taxa based on isolated long bones. However, despite the overlap in long bone morphometry among different phocid seals, some taxa (*i.e.*, *Mirounga* Gray, 1827 in Churchill & Uhen, 2019) yield notable outliers to the morphometric shape ranges of the others. Rule *et al*. (2024) confirmed the conclusions of Churchill & Uhen (2019), and suggested that extinct phocid species with isolated long bones as type specimens should be regarded as *nomina dubia*. In addition, they also highlight the need for more detailed case-by-case attention. Consequently, ideal practice for dealing with the existing fossil record should be to review each taxon individually and in detail. Whereas many humerus type specimens indeed appear to lack diagnostic characteristics because they are too incompletely preserved, often missing a good portion of the deltopectoral crest, or an entire proximal or distal half (*e.g.*, *Callophoca obscura* Van Beneden, 1877), *Gryphoca* Van Beneden, 1877 species, etc.). Species such as *Batavipusa neerlandica* have other characteristics precluding them from being named *nomina dubia*. In the case of *B. neerlandica* the type specimen is a long bone, and the significantly smaller size of the holotype humerus, in combination with the overall stocky shape and square deltopectoral crest, make it vastly distinctive from, for instance, the coeval *Nanophoca vitulinoides* (Van Beneden, 1871).

We are aware that *F. aberrata* does not have the best type material. The conservative approach of Rule *et al.* (2024) to consider *F. aberrata* a *nomen dubium* provides a safe starting point. However, we treat the presence of an entepicondylar foramen, as well as the overall shape of specimen Li 381 as being very similar – hence "*cf.*" – to the type specimen of *F. aberrata*. In our opinion this does not necessarily imply the resurrection of *F. aberrata* as a valid species. In the absence of more complete material that can be attributed to the species *F. aberrata*, the genus *Frisiphoca*, and the fossil seal fauna from the North Sea Basin, a more detailed analysis should wait.

Acknowledgements

Apart from us, the authors, several reviewers have been involved in the realisation of the manuscript, whom we wish to thank for their valuable input. In particular the comments of James Rule, and an anonymous reviewer improved the article significantly.

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