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***Batavipusa* (Carnivora, Phocidae, Phocinae): a new genus from the eastern shore of the North Atlantic Ocean (Miocene seals of the Netherlands, part II)**

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New material of Phocinae from the Netherlands is studied in relation to fossil seals recovered from the Antwerp Basin of Belgium. This sheds new light on the past distribution of true seals along the eastern shores of the Atlantic Ocean. *Batavipusa neerlandica*, new genus and species is described here. The species originated on the coast of Western Europe (Late Miocene, early-middle Tortonian stage, between 8 and 11.5 Ma). During this period sea surface temperatures were moderate.

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Key words: seals, Miocene, Pliocene, Paratethys, North Atlantic, new genus and species.

INTRODUCTION

This study is the second in a series of papers under the general title ‘Miocene Seals of the Netherlands’. In the first paper ‘A new species of *Leptophoca* (Carnivora, Phocidae, Phocinae) from both sides of the North Atlantic Region’ we discussed in detail the geology of the south-eastern part of the province of Noord-Brabant in the Netherlands (Koretsky *et al.* in press). On the basis of new data from Munsterman of the Netherlands Institute of Applied Geoscience TNO (Munsterman 2007), we now can add that the remains of the fossil true seals from the Hoogdonk locality near Liessel have a Late Miocene age, between about 5.5-11.5 Ma. In the Mill-Langenboom locality at a depth of 15-20 meters early-middle Tortonian sedi-

ments also have been found, comparable in age to the deepest layers in Liessel, i.e. about 8-11.5 Ma. (Figs. 1 and 2). Several seal species from the North Atlantic Eastern shore have been described and illustrated by Van Beneden (1877). These closely related phocines, such as *Phoca vitulinoides*, *Phocanella minor* and *Phocanella pumila* were found in the Pliocene of Belgium. As we stated before (Koretsky 2001; Koretsky & Ray 2008) an uncritical look at the published fossils attributed to the genus *Phoca* would lead to an incorrect impression of the fossil history of the genus. A perfect example of the above is *Phoca vitulinoides* VAN BENEDEN (1871). This species, originally based on Middle (?) Pliocene (Scaldisian) fossils from the Antwerp Basin, is a medium-sized phocine apparently



Figure 1 Map of The Netherlands, showing localities Langenboom (municipality of Mill) and Liessel in the province of Noord-Brabant.

related to recent *Phoca vitulina* (see Koretsky & Ray 2008). When we described and selected a lectotype for *P. vitulinoides* (see Koretsky & Ray, 2008) we explained, that although this species is well known to researchers by name, no one seems to have critically re-examined the original material. Usually the concept of *Phoca vitulinoides* seems to be that of a small *Pusa*-like seal, as illustrated by Van Beneden in his Atlas (1877, pl. 15). However, the bones included in the first description of this species (Van Beneden 1871) do not support this concept. Morphologically these bones are similar to *Phoca vitulina*, but in size they are larger than *Erignathus barbatus*, and the illustrations (Van Beneden 1871, pl. 18, figs. 1-5) show an atlas, astragalus and ulna of very large size also. On the basis of the above statement we have come to the conclusion that *Phoca vitulinoides* includes the larger seal of Van Beneden (1871), but not the smaller seal that was later described and illustrated by Van Beneden (1877: 72-74, pl. 15).

The rest of Van Beneden's cotype series of *P. vitulinoides* from the North Atlantic region requires a new name and we hope to continue to work on this project in the future, carefully checking every individual bone from Van



Figure 2 The outcrop in Langenboom (municipality of Mill) is an underwater sandpit called 'de Kuilen'; sand is dredged from a depth up to maximum 20 meters, using a stationary suction dredger; pumped ashore through a floating pressure pipeline and dumped into large sand depots adjacent to the lake. [photo: Rene van Vliet]

Beneden's collection.

Another genus that we have focused on is *Phocanella*, which originally included two species, *P. pumila* VAN BENEDEN, 1877, and *P. minor* VAN BENEDEN, 1877, both from Middle (?) Pliocene deposits of Belgium. Van Beneden (1877) had connected both species with *Pusa hispida*. Simpson (1945) placed them in the Phocinae and Ray (1977: table 1) considered them to be generalized phocines near *Phoca*. Koretsky & Ray (2008) concluded that *Phocanella minor* is a synonym for *Phocanella pumila* and that the species is closely related to *Phoca largha*. In the same paper another species, *Phocanella couffoni* FRIANT, 1947, is interpreted as a nomen nudum. It had been described on the basis of a very poorly preserved femur and mandible as *Palmidophoca chrysar* from France (Ginsburg & Janvier 1999).

SYSTEMATIC PALAEOLOGY

Family Phocidae GRAY, 1825
subfamily Phocinae GILL, 1866

Batavipusa, new genus

Type species

Batavipusa neerlandica, new species

Included species

The genus is monotypic.

Etymology

From *Batavia*, Latin for Holland; *pusa*, Latin for little; *neerlandica*, referring to the Netherlands.

Diagnosis

Short deltoid crest extends to half of humeral length; maximal width of deltoid crest located in its proximal portion; lesser tubercle of humerus located slightly distally to proximal border of deltoid crest, oval in shape and deviated from bone's axis; head compressed cranio-caudally; lateral epicondyle does not reach to the middle of diaphysis or to the distal end of deltoid crest. Proximal end of greater trochanter of femur wider than distal end; trochanteric fossa shallow and opened medioproximally; lesser trochanter small, located below distal border of greater trochanter; head small, situated on relatively wide, short neck; minimum width of diaphysis located in proximal part of the bone; maximum intercondylar distance 16,2 % of bone's length.

Comparison

The genus *Batavipusa* differs from other known seals by:

- overall smaller size (except for *Monachopsis*);
- not dorsally averted deltoid crest of the humerus (except for *Histriophoca*, *Cryptophoca*, *Prophoca*, *Sarmatonectes*, *Monachopsis*);
- lesser tubercle deviated from the bone's axis (except for *Erignathus*, *Histriophoca*, *Monachopsis*, *Phocanella*);
- shallow musculospiral groove (except for *Erignathus*, *Histriophoca*, *Praepusa*, *Sarmatonectes*);
- proximal location of the lesser tubercle compared to the head (except for *Pusa*, *Histriophoca*, *Monachopsis*, *Cryptophoca*).
- presence of lesser trochanter of the femur (except for *Sarmatonectes*) and long, well developed intertrochanteric crest (except for *Phocanella*);

- triangular greater trochanter, that becomes enlarged at its proximal end (except for *Pagophilus*, *Halichoerus*, *Erignathus*, *Histriophoca*, *Leptophoca*);
 - minimal width of diaphysis at proximal end of the bone (except for *Monachopsis*).
- In addition, this genus differs distinctly from other genera as follows:
- from *Pusa* by: longer deltoid crest, relative to the absolute length of the bone; deeper coronoid fossa; also by relatively short and wide neck of the femur.
 - from *Pagophilus* by: proximally wider deltoid crest of the humerus; shorter deltoid crest and lateral epicondyle; lateral epicondyle twice the length of the medial epicondyle; dorsoventrally flattened head. By relatively short and wide neck of the femur; shallow trochanteric fossa; relatively narrow situated condyles.
 - from *Halichoerus* by: deeper coronoid fossa; short lateral epicondyle. By shallow trochanteric fossa of the femur.
 - from *Erignathus* by: enlargement of the deltoid crest in its proximal end; well formed lesser tubercle, separated from the head, lateral epicondyle longer than medial epicondyle. By greater trochanter of the femur much higher than the head; dorso-ventrally flattened head.
 - from *Histriophoca* by: relatively shorter deltoid crest and lateral epicondyle of the humerus; maximal enlargement of deltoid crest in its proximal end; head wider than the trochlea; deeper musculospiral groove and coronoid fossa. By greater trochanter of the femur higher than the head; shallow trochanteric fossa.
 - from *Praepusa* by: shorter deltoid crest and lateral epicondyle. By relatively short and wide neck of the femur; shallow trochanteric fossa.
 - from *Monachopsis* by: smaller lesser tubercle of the humerus; deeper coronoid fossa; shorter and wider deltoid crest and lateral epicondyle; lesser tubercle located distally compared to the head. By deeper trochanteric fossa of the femur; relatively wider neck.

- from *Cryptophoca* by: deeper, higher and wider coronoid fossa of the humerus, reaching the same level as lateral epicondyle; shallow coronoid fossa; shorter deltoid crest and lateral epicondyle. By shallow trochanteric fossa of the femur.
- from *Prophoca* by: relatively shorter deltoid crest compared to the absolute length of the humerus; deeper and higher coronoid fossa, reaching the upper end of the lateral condyle, ending proximally to the medial epicondyle; dorso-ventrally compressed head; relatively shorter lateral epicondyle.
- from *Leptophoca* by: shorter deltoid crest relative to the absolute length of the bone; longer lateral epicondyle; deeper and higher coronoid fossa; deeper olecranon fossa.
- from *Sarmatonectes* by: relatively shorter deltoid crest and lateral epicondyle. By relatively short and wide neck of the femur; shallow trochanteric fossa.
- from *Phocanella* by: relatively longer deltoid crest and lateral epicondyle; narrow medial epicondyle; deltoid crest enlarged in its proximal end. By relatively short and wide neck of the femur; shallow trochanteric fossa and by posterior border of the greater trochanter hanging over the trochanteric fossa.

Discussion

We do not have any doubts about the need to erect a new taxon, *Batavipusa neerlandica*, on such limited material as three femora and one humerus. According to the ecomorphotype hypothesis (see Koretsky 2001) these bones belong to the same group. Thus we can assign them to ecomorphotype V on the basis of the following characters:

- lesser tubercle of the humerus which is oval in shape and equal in length to the head;
- intertubercular groove is narrow;
- maximum width of the deltoid crest is in its proximal part;
- greater trochanter of the femur much higher than the head;
- intertrochanteric crest long and lowered on the diaphysis significantly below the trochanteric fossa.

Table 1. Measurements (mm) of left humerus (Holotype, MAB 3798) of *Batavipusa neerlandica*.

character	mm
absolute length	64.9
length of deltoid crest	36.7
height of head	16.7
height of trochlea	12.0
width of head	18.1
width of deltoid crest	20.0
width of distal epiphysis	21.1
width of proximal epiphysis	23.3
width of trochlea distally	11.6
width of trochlea, frontal view	10.8
transverse width of diaphysis	11.8
thickness of proximal epiphysis	28.2
thickness of medial condyle	13.3
thickness of lateral condyle	12.1
diameter of diaphysis with deltoid crest	22.6

Distribution

Late Miocene (early-middle Tortonian Stage, 8-11.5 Ma) of the Eastern shore of the Atlantic Ocean (Western Europe).

Batavipusa neerlandica, new species

Figures 3-5; Tables 1-3

Holotype

Left humerus MAB 3798 (Fig. 3), stored in Oertijdmuseum de Groene Poort, Boxtel (the Netherlands).

Type locality

Liessel village, Hoogdonk sandpit, situated in the south-eastern part of the province of Noord-Brabant, The Netherlands (Fig. 1).

Referred material

- Left femur MAB 04342, from underwater sandpit 'de Kuilen' in Mill-Langenboom, S.E. Netherlands (Collection Oertijdmuseum de Groene Poort, Boxtel, the Netherlands).
- Left femur 10373 (illustrated by Van Beneden 1877, pl. 15, figs. 20-21);
- Right femur 10365 (illustrated by Van Beneden 1877, pl. 15, figs. 26-27);
- Innominate, without catalogue number but

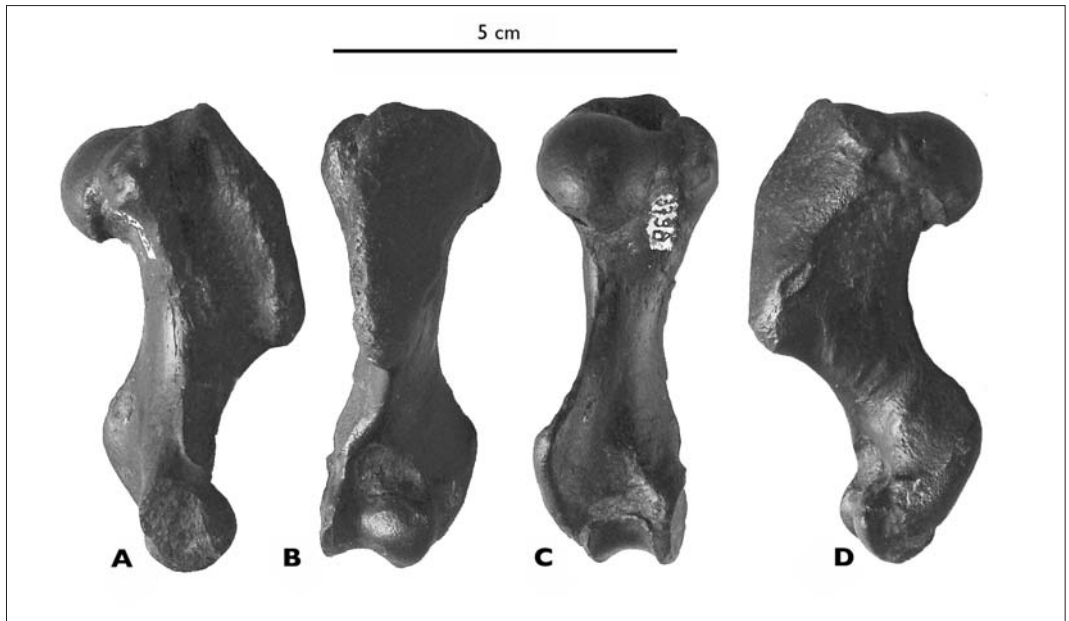


Figure 3. Left humerus of *Batavipusa neerlandica* sp. nov. Holotype MAB 3798 from sandpit Hoogdonk (municipality of Liessel), Noord-Brabant, The Netherlands. **A** medial view, **B** cranial view, **C** caudal view, **D** lateral aspect.

from the same co-type series of Van Beneden (1877). All of them from Middle (?) Pliocene (Scaldisian), 3rd Section Borsbeek, Antwerp Basin, Belgium (Collection IRSNB, Institut Royal des Sciences Naturelles de Belgique, Brussels, Belgium).

Diagnosis

As for the genus.

Description

Humerus (Fig. 3; Table 1) The intertubercular groove is narrow and deep. The deltoid crest is widest proximally, it is short and extends a little less than half the length of the bone. The deltoid tuberosity is located proximally to the middle of the diaphysis. The lesser tubercle is located proximally to the head of the humerus and slightly below the greater tubercle, it deviates from the bone's axis, is oval in shape and well developed. The head is slightly compressed craniocaudally. The musculospiral groove is expressed to some extent. The lateral epicondyle is well developed, but does not reach the distal part of the deltoid

crest below the middle of the diaphysis and extends two times further proximally than the medial epicondyle. The medial epicondyle is flattened, spreading from the lower part of the entepicondylar foramen and terminating at the middle of the coronoid fossa. The coronoid fossa is shallow and forms an oval depression extending proximally to the medial epicondyle, it ends at the same level as the lateral epicondyle. The entepicondylar foramen is big and oval, open, i.e. without a narrow bridge over it. The olecranon fossa is very shallow too.

Femur (Fig. 4; Table 2) The femur of *Batavipusa neerlandica* is smaller in size than the femur of the modern Baikal seal, *Pusa sibirica* but is equal in size to the fossil femur of female *Monachopsis pontica*. The greater trochanter extends proximally higher than the femoral head; its proximal part is wider than its distal part. The trochanteric fossa is shallow and open (not covered laterally by the trochanter), reaching the distal half of the greater trochanter. The substantial intertrochanteric crest is located along the dorsal side of the femur, far below the trochanteric fossa and it

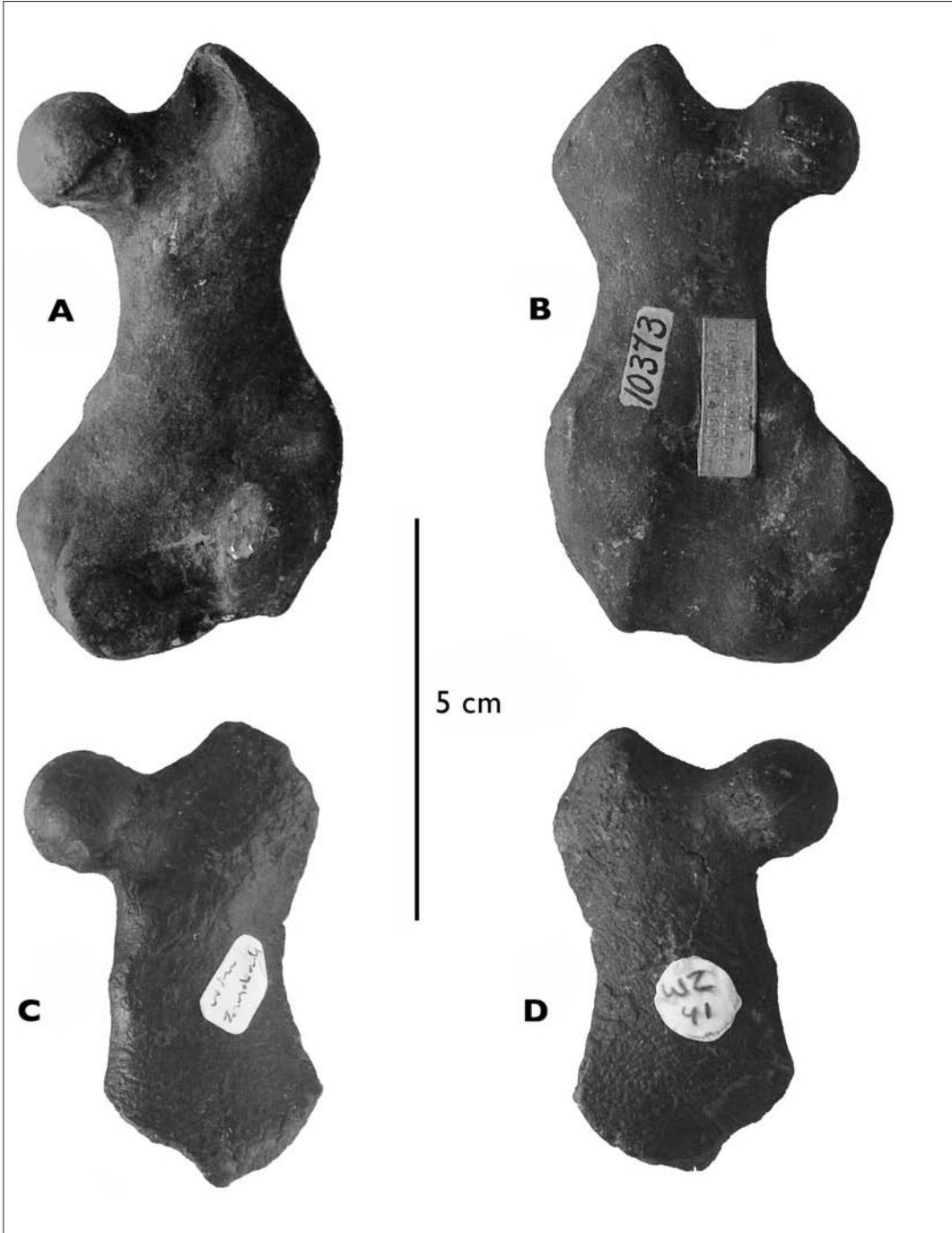


Figure 4. Femora of *Batavipusa neerlandica* sp. nov. **A** and **B**: femur 10373 (illustrated by Van Beneden 1977, pl. 15, figs. 20-21), Antwerp Basin, Belgium; **C** and **D**: femur MAB 04342 from underwater sandpit 'de Kuilen' in Langenboom (municipality of Mill), Noord-Brabant, The Netherlands. (A and C: caudal views, B and D: cranial aspect).

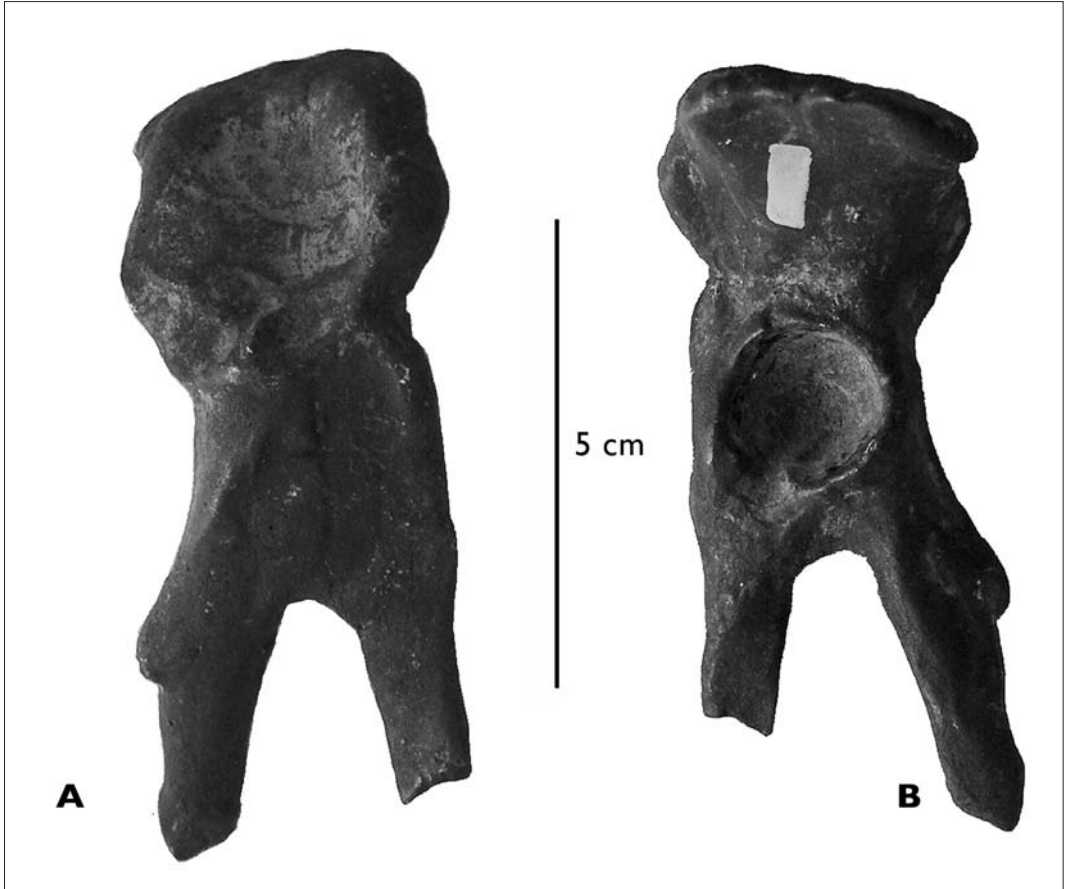


Figure 5 Incomplete innominate, without number, but from the same cotype series of Van Beneden (1877). **A** medial view, **B** lateral view.

does not reach the lesser trochanter. The lesser trochanter is very small and insignificant, located distally from the distal border of the greater trochanter. The femoral head is small in relation to the bone's mass and positioned on a wide short neck. The most narrow part of the diaphysis is located in the proximal half of the bone. The supracondylar fossa located above the lateral condyle is shallow but wide. The supracondylar fossa located above the medial condyle is even more shallow than the lateral one, but its radius is very small. The maximal intercondyloid width is 16,2 % of the bone's length.

Innominate (Fig. 5; Table 3) The iliac crest is only slightly averted as to its exterior surface.

The iliac tuberosity and caudal dorsal iliac spine are not very well developed compared to the size of the bone. The iliopectineal eminence is well expressed and situated at the level of the proximal border of the acetabulum. The greater sciatic notch has a thick well-developed caudal dorsal ischial spine. The shallow fossa for the *gluteus medius* muscle is located on the external surface of the wing. A long shallow fossa for insertion of the *gluteus profundus* muscle is located on the medial aspect of the wing of the ilium at the level of the caudal dorsal iliac spine. Depressions for the *psoas major* and *quadratus lumborum* muscles are not well developed either and they run along the body of the ilium. The acetabulum is deep and circular with a well marked cotyloid notch. The

Table 2 Measurements (mm) of femora of *Batavipusa neerlandica*.

character	n	min-max	mean
absolute length	2	72.5-74.5	73.5
medial length	2	66.0-69.0	67.5
lateral length	2	66.0-69.0	67.5
length of medial condyle	2	11.0-13.5	12.3
length of lateral condyle	2	15.0-18.0	17.0
length of greater trochanter	3	20.0-22.5	21.4
intertrochanter length	3	28.0-34.0	31.4
height of head	3	14.5-15.0	14.8
height of articular area of patella surface	2	15.5-16.5	16.0
width of proximal epiphysis	3	35.0-37.0	36.2
width of distal epiphysis	2	32.0-40.5	38.0
width of condyles	2	29.0-33.0	31.0
width of greater trochanter	2	12.0-14.0	13.0
width of head	3	15.5-16.5	16.0
width of diaphysis	3	20.0-23.0	21.4
anteroposterior thickness of diaphysis	3	9.5-11.0	10.2
thickness of medial condyle	2	17.5-19.5	18.5
thickness of lateral condyle	2	18.0-20.5	19.3
distance between condyles	2	12.8-13.5	13.2
diameter of neck	3	13.5-15.0	14.0

acetabular rim is raised slightly above the plane surface of the bone. The ischium and pubis are broken off. However, we can see that the pubic edge of the obturator foramen is much thinner than the ischial edge.

Geological age and distribution

Late Miocene (Messinian-Tortonian Stages) sandpit Hoogdonk, Liessel, Noord-Brabant, S.E. Netherlands; Late Miocene (early-middle Tortonian stage) and Pliocene (Zanclian-Piacenzian stages) sandpit 'de Kuilen', Mill-Langenboom, Noord-Brabant, S.E. Netherlands; Middle (?) Pliocene (Scaldisian), 3rd Section Borsbeek, Antwerp Basin, Belgium.

Discussion

The discovery of femur MAB 04342 from the south-east of the Netherlands is a lucky coincidence. It is similar to femur IRSNB 10373 (Van Beneden 1877, pl.15, figs. 20-21) from Belgium. This suggests that femur 10373 as well as the femur IRSNB 10365 should be removed from Van Beneden's co-type series of *Phoca vitulinoides* (Van Beneden 1877: p. 74 and Atlas pl. 15, figs. 20-21 and 26-27). Even though the latter femur is rolled, we can conclude from the measurements and detailed morphology that they all belong to one species. These femora (IRSNB 10365 and 10373) must be classified under the new specific and generic name. The same applies to the innominate without number and illustration, which is from the same series in the collection of the IRSNB (Brussels).

Table 3 Measurements (mm) of innominate of *Batavipusa neerlandica*.

from center of acetabulum to iliac crest	= A	39.0
width on the level of ischium	= O	33.0
percentage	= A:O x 100	118.20 %

BIOSTRATIGRAPHY

The holotype of *Batavipusa neerlandica* is the second record of a new Phocine from the coastal shore of Western Europe (The Netherlands). It originates from marine deposits in sandpit Hoogdonk in the village of Liessel that have an Upper Miocene age (Messinian-Tortonian stages between 5.5 and 11.5 Ma).

The only earlier record of a fossil phocine is *Leptophoca amphiatlantica* (Koretsky *et al.* in press) from the Breda formation (15.8-16.4 Ma) in the same sandpit in Liessel. It must be kept in mind that fossils from Liessel as well as those from Mill are all ex-situ finds resulting from dredging activities.

The stratigraphy of the Liessel sandpit was studied some years ago in a hand coring project (Peters *et al.* 2004). Samples remaining from this project were re-examined in 2007 by Munsterman of the Geological Research Institute TNO, who investigated dinoflagellate cysts (Munsterman 2007). In his investigation seven samples (one clay, six greensand) at regular intervals between 9 and 45 meters of depth were analyzed. The clay sample at 9 meter gave a Late Pliocene (Gelasien) age, between 1.8 and 2.6 Ma. This corresponds with the age concluded by one of us (Peters 2004). Munsterman supposed a moderate-warm, coastal-estuarial environment in Liessel during this period. All the deeper greensand samples indicate a Late Miocene age. The samples from between 16 and 27 m indicate: latest Miocene (Messinian) about 5.5-7 Ma, the sample from a depth of 31 m is Late Miocene (late Tortonian, about 7-8 Ma), the sample from 37 and 44.5 m is also Late Miocene (early-middle Tortonian, about 8-11.5 Ma). The data from dinoflagellate cysts at 44.5 m confirmed the age of these deepest layers that was determined during the course of the coring project of 2004. No indications for Pliocene sediments were found.

For the Late Miocene period, dinoflagellate associations indicate moderate SST (sea surface temperatures) in samples from 17, 37 and 44.5 m depth and moderate to (sub) arctic SST in the samples from 22, 27 and 31

m depth. The stratigraphical situation in Mill-Langenboom where femur MAB 04342 was found is somewhat different from Liessel. At a depth of 15-20 m also early-middle Tortonian deposits are found, but layers yielding most fossils here (from about 7-15 m depth) are of Pliocene (Zanclian and Piacenzian) age. At a depth of 15 m a transgressive shell bed is found containing many reworked early Pliocene and Miocene fossils (Wijnker *et al.* 2007).

So, the study of the new material suggests that the phocids from the Antwerp Basin are of the same taxon and could have the same age. It also shows that the temperatures in Late Miocene (Messinian-Tortonian Stage) times were often interchangeable (cooler, mild). At this time the seals became adapted to the cooler climate and later (about 5 Ma) they spread further via the Atlantic Ocean to the Arctic Ocean, as we previously suggested (Koretsky & Barnes 2006).

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