

MINISTERIE VAN ONDERWIJS, KUNSTEN EN WETENSCHAPPEN

# ZOOLOGISCHE MEDEDELINGEN

UITGEGEVEN DOOR HET

RIJKSMUSEUM VAN NATUURLIJKE HISTORIE TE LEIDEN

DEEL XXXIII, No. 4

9 Juni 1954

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## THE PELVIC BONES OF *PHYSETER MACROCEPHALUS* L.

by

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Although from 1255 up till now about 47 *Physeter macrocephalus* have been cast upon the coast of the Netherlands, or have come ashore alive, but very few materials have been preserved and we are in the possession of only two specimens, those of 1937, the complete skeletons of which are preserved in the Rijksmuseum van Natuurlijke Historie, Leiden.

Apart from these skeletons the following fragments are preserved:

1. The damaged upper part of the skull and three vertebrae from the animal of Scheveningen, 1617. These fragments are in the possession of the Dutch Protestant Church, Keizerstraat, Scheveningen (Van Deinse, 1918, p. 42, etc., and Plate IV).

2. The left humerus, radius, and ulna, grown together, probably from the same specimen as no. 1. This bone was found, November 1907, in a pond in The Hague, and is now kept at the Gymnasium Erasmianum, Rotterdam (Van Deinse, 1916, p. 521, etc., with 4 figures, and 1918, pp. 38, 39, 47, with 2 figures).

3. One tooth from the sperm whale of Terschelling, 1762, preserved in the West-Terschelling Museum (Van Deinse, 1946, p. 206).

4. Fragment of a lower jaw, found in 1885 in a moat at Leiden, now in the Rijksmuseum van Natuurlijke Historie, Leiden (Van Deinse, 1918, p. 49).

5. The distal part of a humerus, and an ulna with olecranon lacking. Both pieces were found at Sas-van-Gent, Zeeuwsch-Vlaanderen, Zeeland, in April 1948, they are now in the Geological Museum, Leiden (Van Deinse, Nieuwe Rotterdamse Courant, July 24th, 1948).

The above mentioned two skeletons are from male sperm whales (length 18.5 and 16 m), stranded on a sandy flat in the Western Scheldt near Terneuzen on February 24th, 1937. They are separately known as the sperm

whale of Breskens and of Terneuzen, to which respective places they were transported (Van Deinse, 1946, p. 145, etc.).

On July 7th or 8th 1953 a dead and much damaged specimen stranded on the South coast of Texel towards the West of the air base "De Mok". The greatly incomplete skeleton of this 15.5 m long, male animal is preserved in the Museum of Natural History at Den Burg, Texel. The skull (calvarium), the hyoid, all cervical and dorsal vertebrae, the ribs, sternum, and the two scapulae are missing. Only the complete lower jaw with teeth, about 33 lumbar and caudal vertebrae with the chevron bones, the two pectoral fins without phalanges, however, and the pelvic bones are extant.

The right pelvic bone is grown together with a bony rudiment of the femur, while near the left pelvic bone a cartilaginous femur rest was found. These pelvic bones as well as the pelvic bones of the animals of 1937 with the rudiments of the femora will now be described; they differ greatly from the examples of Abel (1907). Although, moreover, the pelvic bones of the three specimens in their general shape present striking differences, there are nevertheless some features which they have in common. The measurements and weights are given in the following table.

	Texel		Breskens		Terneuzen	
	♂, 15.5 m		♂, 18.5 m		♂, 16 m length	
	r.	l.	r.	l.	r.	l.
Pelvic bone						
length, in mm	300	304	320	275	336	343
breadth in the middle, in mm	60	53	83	74	65	70
weight, in g	175 <sup>1)</sup>	170	207	206	290	320
Rudiment of femur						
length, in mm		47 <sup>2)</sup>			68	90
breadth, in mm		32			48	70
weight, in g					22	47

1) inclusive of the weight of the femur.

2) fused to the pelvic bone.

Pelvic bones of *Physeter macrocephalus* L. of 1953, kept at the Museum of Natural History, Den Burg, Texel.

Both pelvic bones are undamaged, the right with a bony femur rudiment fused to its ventral surface (Plate I figs. 1, 2 and 3); the left with a detached knob-shaped cartilaginous femur rudiment.

Right pelvic bone.

Dorsal surface. General shape a narrow straight bone. Over the whole of its length the dorsal surface is convex transversally. On the oral side a

45 mm high arched ridge; caudally sloping to the lateral surface. Some longitudinal grooves of blood vessels. In the middle a medial 30 mm long ridge. Oro-laterally the pelvic bone is somewhat winged, oro-medially too, but less distinctly.

Ventral surface. General shape flat, laterally and caudally somewhat scooped out. Longitudinal grooves of blood vessels. Foramina nutritoria distinct, especially caudally. Close to the caudal end a rudimentary femur is present, its length is 47 mm, its breadth is 32 mm. This rudiment is attached to the pelvic bone by a short, thick, oval stem, 75 mm in circumference. The rudiment (Plate I figs. 2 and 3) is from pear- to club-shaped, thickest at the base and with a rounded point sloping in oro-lateral direction.

The longitudinal axis of the pelvic bone makes an angle of  $60^\circ$  with the axis of the femur rudiment. In the middle of the femur rest, on its caudal side, a deep irregular cavity, which runs almost to the pointed end of the rudiment. The rudiment is to be seen from the ventral, lateral, and medial surfaces of the pelvic bone, but not from the dorsal surface. As far as known this is the only pelvic bone of *Physeter* with a femur rudiment fused to it.

Caudal surface. Obtuse, rough; during the life of the animal it was covered with cartilage (cf. Abel, 1907, p. 173).

Oral surface. The 45 mm high ridge, laterally somewhat compressed, is to be seen.

Lateral surface. The oral third part is sharp edged and winged; the rest of the bone is more rounded and has at the caudal end a rough surface. In the middle of the bone a shallow cavity.

Medial surface (Plate I fig. 3). Orally more sharp-edged than caudally. Just behind the middle of the first half, a 30 mm long ridge. From that point to the caudal end a rough surface.

Left pelvic bone.

Dorsal surface. Resembles the right. Over the whole length the dorsal surface is convex from right to left. Orally a 50 mm high, curved ridge; caudally sloping to the lateral surface. Longitudinal grooves of blood vessels. Oro-laterally somewhat winged, oro-medially scarcely.

Ventral surface (Plate I fig. 1). General shape flat, in the middle somewhat convex. Laterally and caudally somewhat scooped out. Longitudinal grooves of blood vessels. Foramina nutritoria on the caudal end. A detached femur rest of cartilage was found in the surrounding tissue.

Caudal surface. Obtuse, rough, in living state covered with cartilage.

Oral surface. The 50 mm high ridge, laterally somewhat compressed, is to be seen.

Lateral surface. The oral third part is sharp-edged and distinctly winged. The rest of the bone is more rounded. In the middle a shallow cavity.

Medial surface. Orally and in the middle sharp-edged, caudally rounded. No ridge in the middle. At the caudal end a rough surface.

Pelvic bones of *Physeter macrocephalus* L. of 1937, male, 18.5 m, found in the Western Scheldt near Terneuzen, transported to Breskens. Preserved in the Rijksmuseum van Natuurlijke Historie, Leiden. Both pelvic bones are undamaged; without femur rudiments (Plate II figs. 3 and 4).

Right pelvic bone.

Dorsal surface. General shape short, broad, sole-shaped (Plate II fig. 4). Over its whole length the dorsal surface is convex from right to left. Oro-medially a large cavity. An oblique ridge, sloping into this cavity, runs along the entire bone, at the caudal end more to the lateral surface. Quite orally on the medial surface the bone shows a 48 mm long, sharp, bony point which towards its top curves laterally. Next to this point, more laterally, a point of 12 mm length, also curving to the lateral surface. These two points are absent on the pelvic bones of the animals from Texel and Terneuzen, and also in the 7 figures by Abel (1907). Longitudinal grooves of blood vessels. In the middle of the lateral surface a great many small holes. Laterally flattened, and the oral part wing-shaped. Caudal end truncate.

Ventral surface. Flat and distinctly scooped. Longitudinal grooves of blood vessels. Laterally wing-shaped. Just behind the middle somewhat dented. Orally a great number of small holes just behind the longest point.

Caudal surface. Obtuse, rough. In living state covered with cartilage.

Oral surface. Broad, flat, medially thick, laterally very thin. The two projecting points of the anterior margin (see dorsal surface) are to be seen.

Lateral surface. Thin, flat, orally winged with small protruding points. Just behind the middle strongly dented; caudally gradually thickening.

Medial surface. Thick, arched with oral point, behind which a deep hollow. From the middle caudally rounded and thickening. The rough caudal end ventrally somewhat arched.

Left pelvic bone.

Dorsal surface (Plate II fig. 3). Resembles the right, but the long point is missing. Short, broad, flat, laterally winged; transversely convex towards the medial surface. Orally three small points. Laterally broad before the middle; behind the middle suddenly narrowed; caudal half with straight borders. Oblique ridge almost along the entire bone. Oro-medially dented. Longitudinal grooves of blood vessels. On the lateral half many small holes. Caudal end truncate.

Ventral surface. Flat and distinctly scooped. Longitudinal grooves of

blood vessels. The oral side winged, especially laterally. Caudally narrower. Orally three bony points and many small holes, perhaps a damage to the periphery of the bone.

Caudal surface. Subtriangular, obtuse, rough. In living state covered with cartilage.

Oral surface. Medially thick, laterally thin. The three points of the dorsal surface (see there) are to be seen.

Lateral surface. Arched, orally thin, caudally much thicker and surface rougher.

Medial surface. Thick, arched. Behind the oral end a deep hollow. The caudal end is somewhat scooped towards the ventral surface.

Pelvic bones of *Physeter macrocephalus* L. of 1937, male, 16 m, found in the Western Scheldt near Terneuzen, transported to Terneuzen. Preserved in the Rijksmuseum van Natuurlijke Historie, Leiden.

Both pelvic bones are undamaged, each with a detached bony femur rudiment (Plate I figs. 4 and 5; Plate II figs. 1 and 2).

Right pelvic bone.

Dorsal surface (Plate I fig. 5). The oral end of the skate-shaped bone is narrow, compressed from right to left, with a 65 mm high arched ridge. The caudal end is broad and flat. For the larger part of its length the dorsal surface is transversely convex. Laterally a 40 mm long protruding edge; medially, just in front of the middle of the bone, also a sharp edge. Breadth of the caudal end 90 mm. Longitudinal grooves of blood vessels. Especially at the caudal end foramina nutritoria. Caudal end truncate.

Ventral surface (Plate II fig. 2). Flat and especially at the oral end scooped. Front half part is winged on the lateral and medial surfaces. Caudal end broad. Longitudinal grooves of blood vessels. Oral end somewhat damaged.

Caudal surface. Oval, obtuse, rough. In living state covered with cartilage.

Oral surface. The 65 mm high, sideways compressed ridge is seen, which is laterally somewhat damaged.

Lateral surface. Oral point damaged. Orally sharp-edged as far as the 40 mm long protruding edge. Behind this a deep dent with sharp edge, of which the caudal end is rounded.

Medial surface. Arched shape. Orally the 65 mm high ridge; behind it a sharp edge, which is rounded in caudal direction and arched to the ventral side.

Left pelvic bone.

Dorsal surface. The oral end narrow, sideways compressed with a 60 mm high ridge. Caudal end flat and 85 mm broad. Over almost its entire length

the bone is convex from right to left. Longitudinal ramified grooves of blood vessels. At the caudal end foramina nutritoria. Laterally winged in the middle. Medially almost straight. The medial surface of the caudal end slopes somewhat ventrally (Plate I fig. 4).

Ventral surface. Flat and laterally scooped. Laterally winged in the middle. Medially almost straight. Longitudinal grooves of blood vessels. Oral end narrow, caudal end broad (Plate II fig. 1).

Caudal surface. Oval, obtuse, rough. In living state covered with cartilage.

Oral surface. One looks at the 60 mm high, sideways compressed ridge, which is somewhat damaged. At the ventral part of the ridge a small protruding point.

Lateral surface. Strongly curved. At the oral surface, which is winged up to the middle, a sharp edge. From the centre in caudal direction concave.

Medial surface. Curved. At the oral end the 60 mm high ridge; from that point caudally a sharp edge which runs somewhat ventrally to its rounded end.

The two femur rudiments (Plate II figs. 1 and 2).

The left rudiment has about twice the size of the right. For measurements see above.

As the pelvic bone shows no sign of an acetabulum one cannot make out the place of the femur rests nor the direction in which they were situated. But with the help of the right part of the pelvic bone of the animal of Texel, 1953, and the figures and text of Abel (1907) the situation of the femora of the animal of Terneuzen, 1937, is almost to be ascertained.

Abel says (l.c., pp. 174, 175): "Es ist sehr auffallend dass die beiden Femurrudimente den Hüftbeinen dicht anliegen und dass ihre distalen Enden nach vorne gerichtet sind. Sie liegen ganz auf der Unterseite der Hüftbeine und nehmen also eine Lage wie bei *Balaena*, *Megaptera* und *Balaenoptera* ein, nur mit dem Unterschiede, dass die Achse des Femurrudimentes bei *Physeter* zu der Achse des Iliums parallel ist." These last words are in agreement with the left femur of figure 47 of Abel, but not with the right one of figure 46, where both axes make an angle of 150°. The femur of Texel was situated so near to the right pelvic bone that both bones could fuse.

The distal end of the femur rudiments points in oro-lateral direction and the axis of the femur makes an angle of 60° with the axis of the ilium. Just like the femora figured by Abel the femur of Texel lies entirely on the ventral surface of the pelvic bone. Although there are differences between the bones examined by Abel and of Texel, there are also points of resemblance.

So it may be surmised that the femora of Terneuzen were situated near the pelvic bones and at their ventral surface. The distal ends of the femora must have had an almost oral direction.

It is a striking fact that the femur rudiment of Texel is connected with the pelvic bone close to the caudal end of this bone. The centre of the connective point is more than three times as close to the caudal end than to the oral end of the pelvic bone. Figures 44, 45, 46, and 47 of Abel show almost the same thing. The situation of the femora of Terneuzen is now more defined (Plate II figs. 1 and 2). The very rudimental state of the femora indicates that possibly there is a great variety in their situation, so that a quite exact place cannot be given. Besides that we have too few materials for comparison.

The part between the oral point of the pelvic bone and the femur is the ilium, the part between femur and caudal end the ischium. Hence the ilium is much longer than the ischium. The pubis is entirely absent in these three specimens. The ischium is greatly reduced, the greater part of the pelvic bone is the ilium.

All this corresponds with Abel's data, and he observes that the *Mystacoceti* show the same characteristics (l.c., pp. 174, 175). Hence the dividing line between ilium and ischium lies near the femur, another indication of this line does not exist. Neither is there any suture to be seen between ilium and ischium in the other Cetacea (Van Deinste, 1931, p. 203).

Although our three femora are very rudimentary, they show signs of resemblance. The pointed distal part runs in oro-lateral or oral direction; the very broad, big and knotty opposite part points to the pelvic bone. The deep, irregular hollow at the ventral surface in the connected femur of Texel we also find, but much smaller, in the free femora of Terneuzen. At the dorsal surface the free femora are flat, at the ventral surface irregularly convex. The femur of Texel is attached with its dorsal surface to the pelvic bone. The proximal part of the left free femur of Terneuzen shows a big and a small knob, separated by a shallow furrow. These may be an indication of the vague, indistinct rudiments of *caput femoris*, *trochanter major*, and *collum* of the femur of other Mammals and of *Zeuglodon cetoides* Owen, from the Upper Eocene of Alabama, see Remington Kellogg (1936, p. 71, fig. 26). The right detached femur of Terneuzen, smaller than the left, shows the same characteristics, but less distinct. On the connected femur rudiment of Texel these three parts are not to be found as its proximal and dorsal surfaces are attached to the pelvic bone.

All three femora have the pear-shape in common. Remarkable is that the right and left femora of the animal of Terneuzen, which had a length of

16 m, differ so greatly in size, whereas the right connected femur of the *Physeter* of Texel, long 15.5 m, is rather small, and the largest animal, of Breskens, 18.5 m, did not have any femur rudiments at all.

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## EXPLANATION OF THE PLATES

## Plate I

*Physeter macrocephalus* L., male, 15.5 m, Island of Texel, Netherlands, stranded July 7 or 8, 1953.

Fig. 1. Left pelvic bone, ventral view.  $\times \frac{5}{11}$ .

Fig. 2. Right pelvic bone, ventral view, with femur rudiment.  $\times \frac{3}{7}$ .

Fig. 3. Right pelvic bone, medial view, with femur rudiment.  $\times \frac{5}{12}$ .

*Physeter macrocephalus* L., male, 16 m, Terneuzen, Netherlands, stranded February 24, 1937.

Fig. 4. Left pelvic bone, dorsal view. Slightly over  $\frac{1}{3}$ .

Fig. 5. Right pelvic bone, dorsal view. Slightly over  $\frac{1}{3}$ .

Upper side is front of the pelvic bone.

Photographs C. Leyenaar, Rotterdam.

## Plate II

*Physeter macrocephalus* L., male, 16 m, Terneuzen, Netherlands, stranded February 24, 1937.

Fig. 1. Left pelvic bone and left femur rudiment, ventral view.  $\times \frac{1}{4}$ .

Fig. 2. Right pelvic bone and right femur rudiment, ventral view.  $\times \frac{1}{4}$ .

*Physeter macrocephalus* L., male, 18.5 m, Breskens, Netherlands, stranded February 24, 1937.

Fig. 3. Left pelvic bone, dorsal view.  $\times \frac{1}{3}$ .

Fig. 4. Right pelvic bone, dorsal view.  $\times \frac{1}{3}$ .

Upper side is front of the pelvic bone.

Photographs C. Leyenaar, Rotterdam.



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