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FOSSIL AXIAL SKELETAL WALRUS MATERIAL FROM THE NORTH SEA AND THE ESTUARY OF THE SCHELDE, AND A FOSSIL SIRENIAN RIB (MAMMALIA, CARNIVORA; SIRENIA)

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ABSTRACT

Ten fossil odobenid remains, and a fossil sirenian rib, encountered by us in a public and in a private collection since the publication of some earlier papers, are described and discussed. All fossils belong, anatomically, to the axial skeleton. Most specimens can be identified as *Odobenus rosmarus*, but in some cases determination as *O. antverpiensis* (Rutten,1907) may be possible.

INTRODUCTION

As a sequence to our recent description of six fossil cranial odobenid remains in the collection of "Naturalis", the Nationaal Natuurhistorisch Museum at Leiden (Bosscha Erdbrink & van Bree, 1999), we here describe and discuss additional material encountered by us in the same collection, as well as in the private collection of Mr Klaas Post of 8321 EJ Urk, Klifweg 6, an amateur collector. In the first case each fossil is indicated by the symbol St (for "Stamboek"), while in the second instance the symbol KP (followed by its collection number) will be used. Fig. 1 is a sketch map giving the (few) sites whence some of the fossils have been recovered. For attempts at an accurate rendering of colour(s) and hue(s) of each specimen we used the revised Munsell colour charts by Oyama et al.(1967). Measurements have been arranged in four tables. The same procedures as in our earlier publications have been followed, enabling a comparison with data published there. In some cases the measuring practices are identical with those advocated by Desse et al. (1986: 116-120), which were again based on those recommended by Von den Driesch (1976). In those instances a letter D, followed by a number, marks the particular numbered measurement in one of Desse's tables. We are not convinced of the fact that each of the measurements advised by him (for carnivores) does indeed make sense in the case

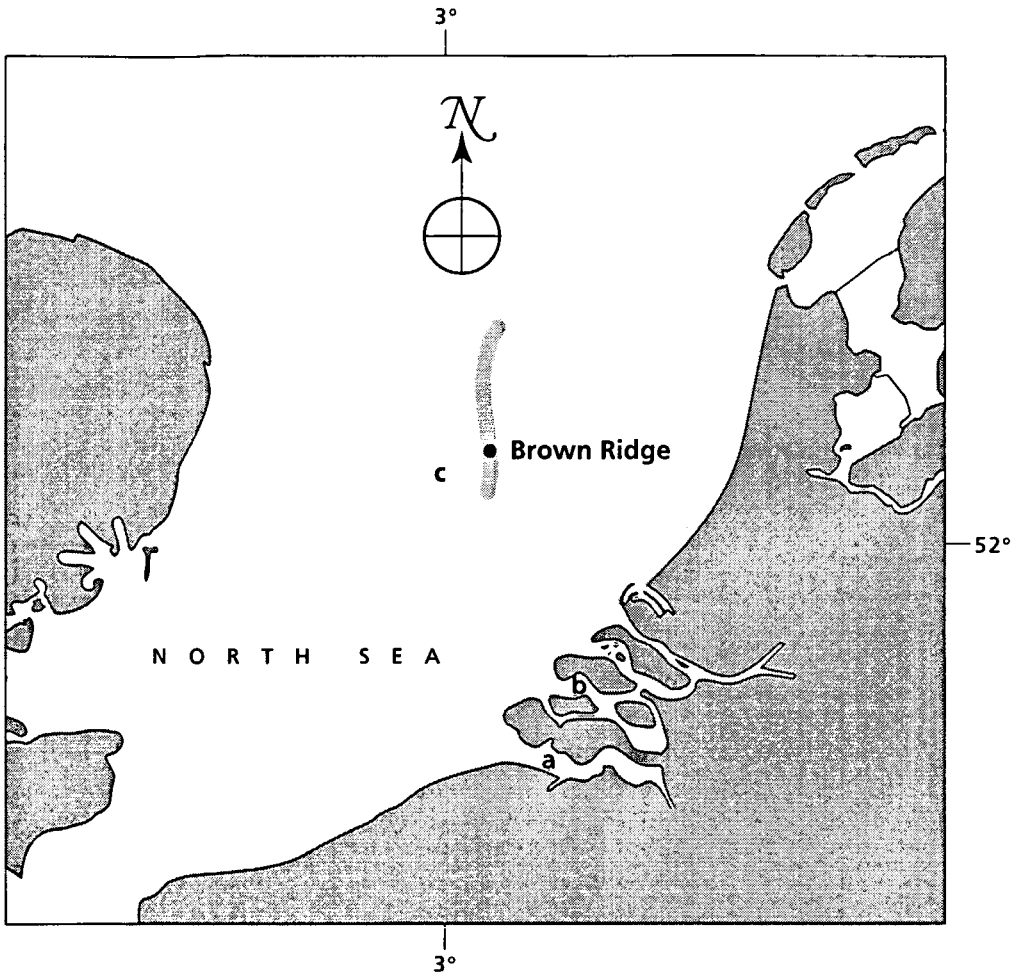

Fig. 1. Sketch map of the southern part of the North Sea and the estuary of the Schelde: a, between Terneuzen and the Braakman (St. 20317); b, opposite the Flaauwerspolder (L 10 and Sacrum); c, near the Brown Ridge.

of the Odobenidae, because there appears to remain too much room for inaccuracy when measuring.

DESCRIPTION

Three atlases in the Leiden collection are numbered, respectively, St. 133227, St. 133476 and St. 137911. They were acquired through the intermediary of the Central Fisheries Laboratory at IJmuiden. In each case the label informs us that the specimen has been trawled up from the North Sea bottom, without giving a more precise location. The date of acquisition of the first fossil is 22nd of March, 1966; that of the second, is 23rd May, 1966; and the third one's is 12th January, 1967. Colour and hue are, respectively: 7.5 YR 4/4 (brown) with patches of 8/4 (light yellow orange); 10 YR 6/6 (bright yellowish brown) with patches of 8/6 (yellow orange); and 7.5 YR 4/6 (brown) with light patches of 7/4 (dull orange) and 8/4 (light yellow orange). A set of seven measurements, in which we follow Desse et al. (1986: 122-123), is given here as Table 1. All specimens (Fig. 2A-F) are eroded and damaged. St. 133476 is the most complete of the three. The lateral extremities of the transverse processes or alae are partly broken off in St. 133227, broken off entirely on the left side in St. 137911, but have only suffered minor damage on the right side of that fossil; most has gone on both sides in St. 133476. Several sharp edges have become somewhat blunted by erosion in this last atlas, which also appears to be the least heavily

Table 1. Measurements of three atlases (in mm), after Desse et al. (1986).

	St.133227	133476	137911
D.1 Max. width over alae	187	224	216 ?
D.2 Max. length	106	114	112
D.3 Max. width, cranial facettes	106	101	99
D.4 Max. width, caudal facette	112	128	124.5
D.5 Max. distance cran.-caud. facettes	93	80	86
D.6 Length of dorsal arc	44.5	41	42
D.7 Height	84	87	89

mineralized one of the three. In St. 137911 the inner surfaces of the neural canal, the ventral side and part of the remaining left ala are covered by Bryozoan colonies, so that this specimen must have lain free on the sea floor for a considerable time.

Next to the atlases comes a single, rather damaged axis (or epistropheus), KP 794A (Fig.3 A-C). On the heavily mineralized fossil a notice is written in white, next to its number, giving a date of collection, 11/93, and ARM 4 (collected by that fishing vessel, from the harbour of Arnemuiden), as well as ZD.NZ (southern part of the North Sea). Colour and hue of the fossil are 5 YR 2/4 (very dark reddish brown), with some lighter areas 5/6 (light reddish brown). The vertebra almost (but not quite) fits to the atlas St. 137911; the other two atlases are somewhat too large in comparison. The remaining part of the axis consists of its centrum with the complete dens. The neural arch has almost completely broken off but for a small part of its base at the right side. The caudal coverings of the two transverse foramina are also gone, partly because of damage to the posterior part of the floor of the neural canal. The anteroposterior ridge along the midline of the ventral face of the centrum has a conspicuous foramen next to it at its right side, some 25 mm from the main caudal facette of the vertebral body. No comparable feature exists at

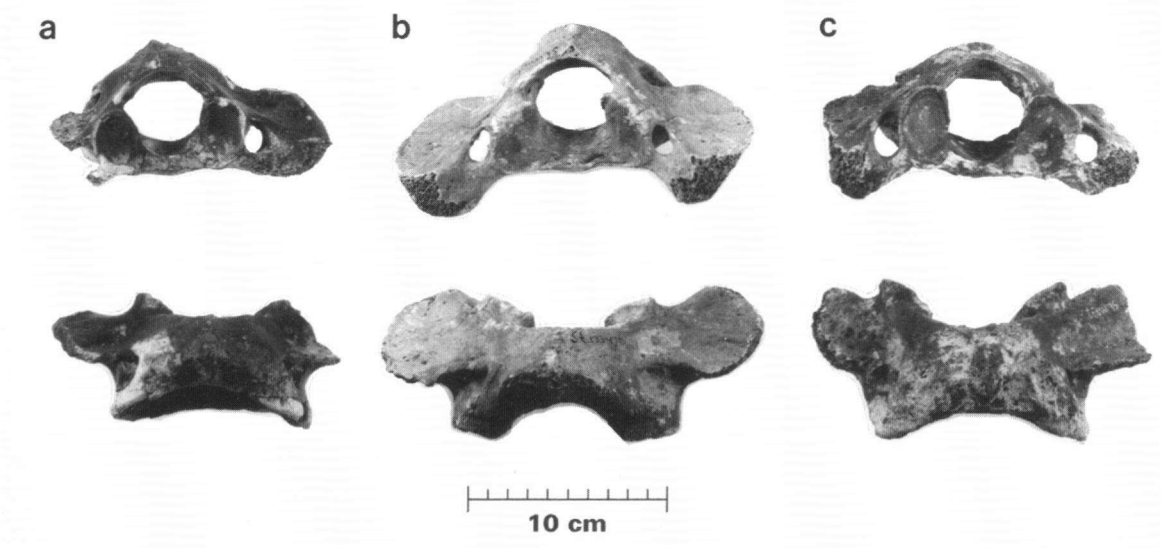

Fig. 2. A, B, C, cranial aspects, and D, E, F, upper aspects of atlas vertebrae (respectively) St. 137911, St. 133476 and St. 133227.

Table 2. Measurements of epistropheus KP 794A (in mm), partly after Desse et al. (1986).

D.1 Entire length of corpus and dens	96
D.3 Max. width over cranial facettes	95
D.6 Min. width of corpus	70
D.7 Max. width over caudal facette	67
Max. length over dens & neural canal	93.5
Horiz. width of dens	30
Length of dens	32
Horiz. width of neural canal, cranial side	34
Horiz. width of neural canal, caudal side	40

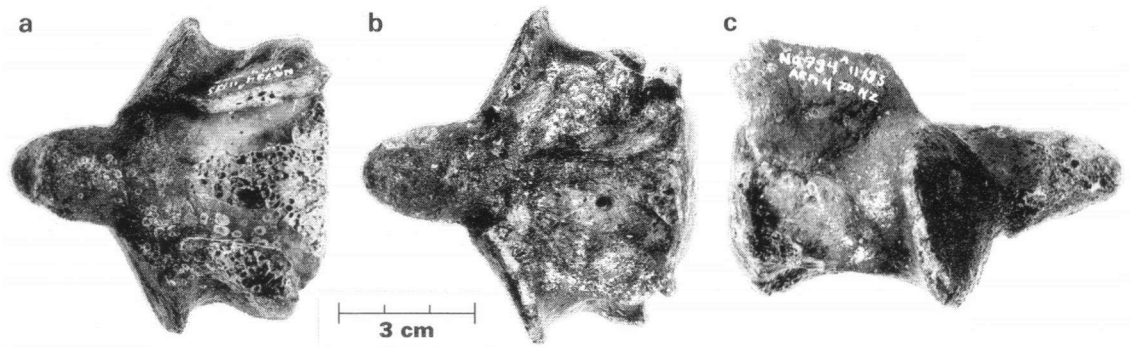

Fig. 3. A, dorsal; B, ventral; C, right side aspects of epistropheus KP 794A.

the left side. Most of the originally sharp edges of the bone are slightly blunted by erosion. Some measurements are given in Table 2; these are partly taken in accordance with those proposed by Desse et al. (1986: 124-125), and partly of our own invention.

A damaged thoracic vertebra in the Post collection bears the number KP 735 and the notice 1993 ZO Noordzee (southeastern North Sea) in white ink on the single remaining anterior zygapophysis, that on the left side. The one at right has broken off, together with its transverse process. The extremity of the left transverse process has also gone. The tip of the neural spine is similarly lost. Erosion has blunted and damaged the edges of the right posterior zygapophysis and the ventral edge of the cranial facette of the vertebral body. Otherwise this fossil is complete. Its colour and hue are 10 YR 2/2 (brownish black), with some minor patches of 4/4 (brown). It is rather heavily mineralized. Position and direction of the neural spine, as comparison with a mounted recent walrus skeleton in the collection of the Zoological Museum Amsterdam has shown, indicate that this thoracic vertebra may be a first or second one (Fig. 4A-B). Some measurements are given in Table 3; we partly follow those proposed by Desse et al. (1986: 126-127), but some are of our own invention.

A very strongly fossilized and much eroded, incomplete thoracic vertebra of an *Odobenus* spec. (Fig. 4G-D) bears the number St. 20317 on its label, which also informs the reader that it has been fished up from the western Schelde between the town of Terneuzen and the Braakman, a curiously named creek in the southern bank of the estuary (Fig. 1). It was brought back to Leiden in August 1935 by Dr. Van der Vlerk from a visit to the Zeeuwsch Genootschap at Middelburg. Colour and hue of this extremely heavy specimen range from 10 YR 4/2 (greyish yellow-brown) to 2/2 (brownish black), while the surfaces of numerous Bryozoan and Balanid encrustations are 10 YR 7/2 (dull yellow

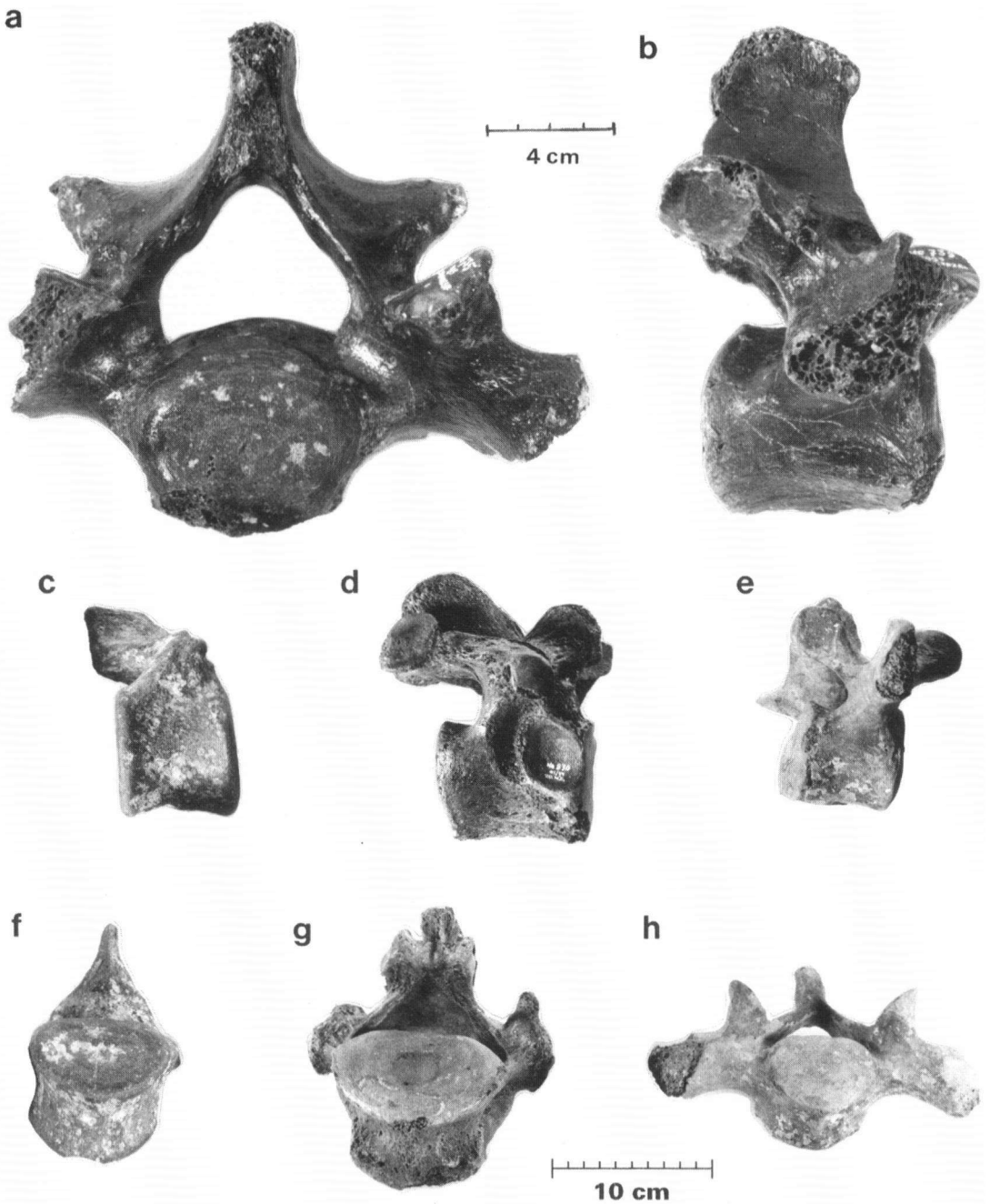

Fig. 4. A, cranial, and B, right side view of 1st or 2nd thoracic vertebra KP 735. C, D, E, right side views, and F, G, H, oblique caudal views of 5th or 6th, and 13th or 14th thoracic, and 10th (?) lumbar vertebrae, respectively St. 20317, KP 830, and unnumbered specimen from opposite the Flaauwerspolder in the Leiden collection.

Table 3. Measurements of vertebrae and a sacrum (in mm), partly after Desse et al. (1986: 126-127).

	KP 735 Th 1/2	St.20317 Th 5/6	KP 830 Th 13/14	St.? L 10
D.1 Physiol. length of centre	64	66.5	80.5	60
D.2 Length a.-p. zygapophyses	96sin	-	124.5s.	92s.
			120.5d.	91d.
D.3 Transv. w. over ant.zygapoph.	-	78	87	113
D.4 Width over post. zygapoph.	120	-	58	102
D.5 W. over transv. processes	-	100	149.5	201
D.6 Max. w., cran. artic., centre	61	81	82	62
D.7 Max. w., caud. artic., centre	71	84	101	69
D.8 Max. height, cran. a., centre	53	65.5	65	56.5
D.9 Max. height, caud. a., centre	53.5	65	63	52.5
D.10 Maximum total height	-	136.5	150	128
Height of neural canal	43.5	33.5	37.5	33
Maximum width of neural canal	52.5	43.5	69.5	51
Basal length of neural canal	43	61	80	45

	St.? Sacrum, Flaauwerspolder
D.1 Maximum ventral length	227
D.2 Physiol.length, cran.-caud.facette	212
D.3 Max. width at cranial alae	170
D.4 Max. width at cranial facette	75
D.5 Max. height of cranial facette	54
Max. width of caudal facette	44
Max. height of caudal facette	40

orange). This rolled and eroded fossil, that has lain free on the bottom for a long time, has rounded edges everywhere and has lost almost its entire zygapophyses and transverse processes. Part of the tip of the neural spine has also gone. The neural canal has, however, remained complete, and so has the vertebral centre. Comparison with recent material has convinced us that it represents the fifth or sixth thoracic vertebra. Its measurements can be found in Table 3.

KP 830 is the number of a superficially damaged large vertebra which, as comparison with recent material has shown (as in the previous case), represents a thirteenth or fourteenth thoracic one. A notice in white ink on the concave surface of the articulation for a rib on the right side contains the information 01/94 (= the date of collection) and ZD.NZ (southern part of the North Sea). As can be seen on Fig. 4C, F, all zygapophyses and transverse processes as well as the neural spine are present, though slightly eroded at their tips so that the materia spongiosa has become visible. The colour and hue are a uniform 7.5 YR 4/3 (brown); measurements are given in Table 3.

An unnumbered specimen in the Leiden collection (Fig. 4E, H), identified on its label as *Odobenus* spec., and as a lumbar vertebra, has been fished up on the sixth of September 1975 by the fishing vessel ZZ 8 (for Zierikzee, skipper Schot) in front of the Flaauwerspolder, on the southern coast of the island of Schouwen (Fig. 1). The flatness of the vertebral centre has convinced us, next to its other features when comparing the fossil with recent material in the Amsterdam Zoological Museum, that this represents the tenth lumbar vertebra. Its measurements can be found in Table 3. Colour and hue are 10 YR 5/4 to 5/3 (dull yellowish brown) with some encrusted patches of 7/3 (dull yellowish orange). Apart from the tips of the transverse processes, which have suffered erosion, the verte-

bra has remained almost complete.

Also not numbered, and belonging in the Leiden collection, we encountered a sacrum (Fig. 5A-B). According to its label it was fished up by the ZZ 8 on the fifteenth of June, 1985, again in front of the Flaauwerspolder. Colour and hue of the fossil are 10 YR 5/3 to 5/6 (dull yellowish brown to yellowish brown). Some measurements, taken according to Desse et al. (1986: 126-127), added to by two of our own invention, can be found in Table 3. From these it will be seen that the specimen is relatively large and heavy, an impression which was confirmed when we compared it with recent material in Amsterdam. It may therefore possibly be a male individual. Appreciable erosion of all protruding parts and processes of this sacrum, together with encrustations, attest to the circumstance that the fossil must have lain free on the bottom for some time. Its morphology does not differ from that of the recent walrus.

A right half fragment of a pelvis in the Leiden collection bears the number St. 400978 (Fig. 5C-D). Its colour and hue are 10 YR 2/3 (brownish black), with some patches and areas of 5/6 (yellowish brown), therefore almost identical in colour to the specimen (also a right half pelvical fragment) described by us in 1986 (Bosscha Erdbrink & van Bree, 1986: 25). The label of this fossil bears the notice that it had been acquired on the twentieth of May, 1988 and that it was trawled up at the Brown Ridge by the fishing vessel GO 50 (from Goedereede). Its determination does not go beyond *Odobenus* spec. The find is almost complete, much more so than the one we described in 1986. Only the dorsal part of the crest of the ilium has broken off comparatively recently, displaying the very roughly textured materia spongiosa, which has the same colour as the rest of the fossil. A minor area of damage occurs along the inside of the ilium at the plane of junction to the now absent sacrum. A relatively large foramen is present about halfway between the acetabular rim and the still present part of the crest of the ilium, on the external side of the bone. Another such foramen can be seen to exist on the outer side of the pubis, halfway along the straight part of this bone away from the acetabulum. This almost circular cup itself is markedly smaller, in all directions, than that in the 1986 specimen. The deepest part of the acetabular fossa opens up, internally, into a very large cavity which is also connected to the acetabular notch. Although present in the 1986 specimen too, this feature is much more pronounced in St. 400978. In Table 4 a number of measurements have been arranged in such a manner that these can be compared with those of the fragment N.Z. 50, described by us in 1986; but a few additional measurements have now been included, for which we follow Desse et al. (1986: 136-137).

It is with hesitation that we include, in this description of Odobenid material, a 223 mm long fragment, St. 20067 (Fig. 5E). According to its label it has been fished up from the western Schelde; it is identified there as part of a silicified rib of a whale, which has been broken in three pieces but glued together again. The typed determination "Whale" has been struck out with pencil and changed into *Alachtherium* (also in pencil). No date of collection is recorded. At one end of the fragment the bone has been cut and polished, but no particular bony structure can be recognized with the naked eye or even with a magnifying lense. No globular vasodentine can be seen, nor are there any visible growth rings. This oval polished plane has axes of 41 and 30 mm. The other end of the fragment ends in a chisel-like, slightly damaged point with a length or 'cutting edge' of 35 mm. The bone shows signs of erosion and transport. Fine striae in a lengthwise direction on both faces also strengthen this observation. The outer, curved face of the rib has a mid-line length of 236 mm, while the mid-line length measured along the inner curved face is 194 mm. Colour and hue of the fragment are a monotonous 10 YR 2/2 (brownish black), which is also the colour of the polished plane at its one extremity. The whitish colour in the photograph has been caused by light reflexion.

IDENTIFICATION AND DISCUSSION

The atlas St. 133476 is only lightly mineralized and therefore probably subfossil, dating back to Holocene, maybe even historical times. There are no reasons to presume that it differs from the recent Atlantic subspecies, *Odobenus rosmarus rosmarus* (Linnaeus, 1758).

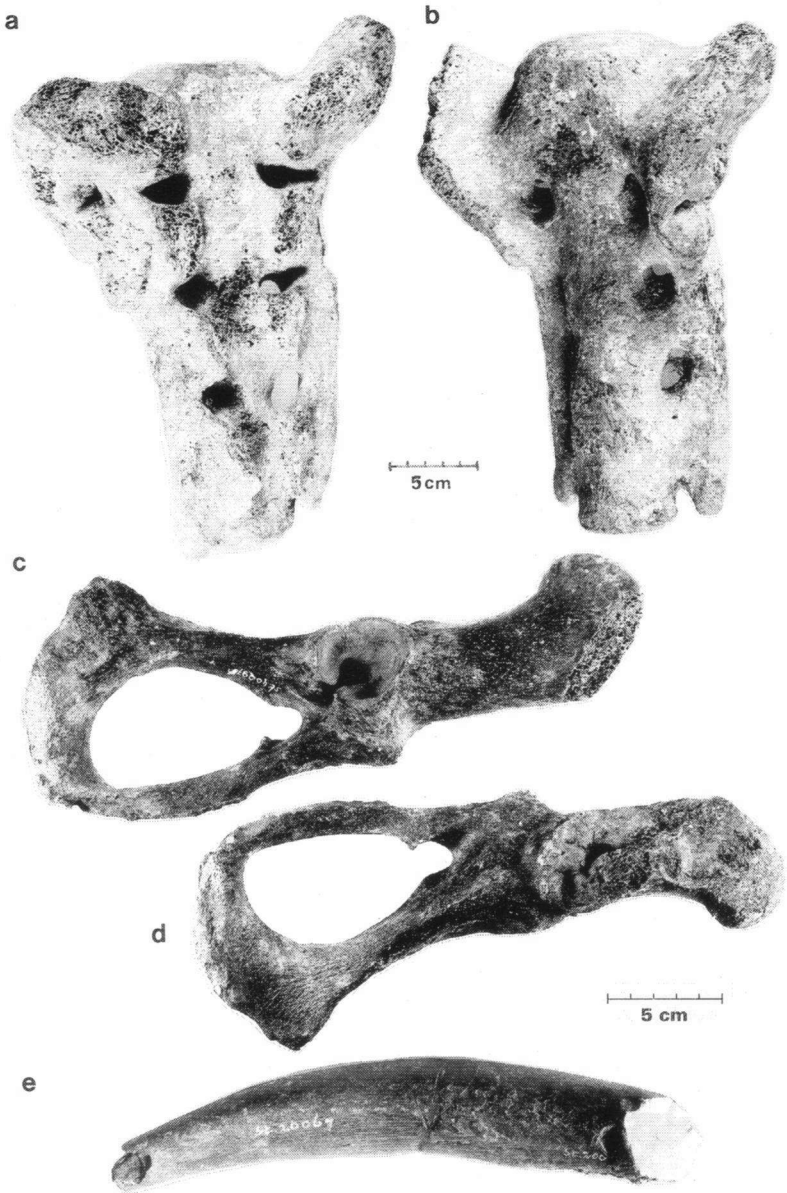

Fig. 5. A, ventral, and B, dorsal aspect of sacrum from opposite the Flaauwerspolder. C, lateral; D, medial aspect of right half pelvis St. 400978. E, fragment of Sirenian rib St. 20067: posterior and slightly oblique aspect.

Table 4. Measurements of right half pelvic fragment St.400978, in mm; partly following Desse et al. (1986).

Diameter of acetabulum in the direction of obturator foramen	65
Diam. of acetabulum at right angle to previous measurement	64
Max. depth of acetabulum	24
Thickness of bone at edge of acetabulum	51
D.1 Max. length of specimen	448
D.4 Length of symphysis	78
D.5 Minimum height of iliac collum	34
D.6 Minimum width of iliac collum	23
D.7 Minimum circumference of iliac collum	103
D.8 Internal length of obturator foramen	157

The other two atlas vertebrae, St. 133227 and St. 137911, and the incomplete axis KP 794A, as well as the incomplete first or second thoracic vertebra KP 735, are all well-fossilized and relatively heavy, but in a morphological sense we do not observe significant differences when they are compared with their recent counterparts. These fossil vertebrae should each be identified as *Odobenus rosmarus* (Linnaeus, 1758), ssp.

The very heavily fossilized fifth or sixth thoracic vertebra St. 20317 from the western Schelde between Terneuzen and the Braakman represents a case which is comparable with the situation discussed in our previous publication, pertaining to the half-mandible St. 118436. Its degree of mineralization and its locality, where older sediments may have been temporarily laid bare by rapidly changing scouring actions of low and high water, make an identification as *Odobenus antverpiensis* seem plausible. But as the morphology of the specimen is atypical, no significant differences of the damaged fossil with a fifth or sixth thoracic vertebra of *O. rosmarus* can be pointed out. In this case the safest procedure appears to be a determination as *Odobenus* species.

The large, perhaps male, thirteenth or fourteenth thoracic vertebra KP 830, the atypical not numbered tenth lumbar vertebra and the also atypical, not numbered sacrum, the last two fossils from opposite the Flaauwerspolder (on the island of Schouwen), in the eastern Schelde, constitute comparable cases with the specimens St. 133227, St. 137911, and KP 735. They should be identified as *Odobenus rosmarus* (Linnaeus, 1758), ssp.

The right half pelvis St. 400978 from the Brown Ridge area, resembling the much less complete specimen N.Z.50 in the Stolzenbach collection described by us in 1986 and identified there as *O. rosmarus* (Linnaeus, 1758), ssp., possesses a relatively large acetabular cup. This might indicate that it is an extraordinary heavy and large male individual. On the other hand, it could point to the supposedly somewhat larger-sized older form *O. antverpiensis* = (?) *O. huxleyi* = *? O. cretsii*. In view of the locality of collection, where it is doubtful whe-ther Plio-Pleistocene deposits attain the surface of the North Sea floor, an identification of the specimen as *Odobenus* cf. *rosmarus* (Linnaeus, 1758), ssp., is the most prudent solution of the problem.

We are aware that costae, and in particular only fragments of the same, are the most difficult parts of vertebrate skeletons to identify. Comparison with correctly determined recent material in a Museum collection constitutes the truest procedure to be followed. Upon our doing so in the case of the costal fragment St. 20067, comparing it with material in the Zoological Museum of Amsterdam University, we found that the degree of curvature and the massivity of the fossil with certainty excluded any of the smaller Cetaceans as well as the Odobenidae. A remarkable likeness, however, exists with the massive costae of Sirenians. Its massivity seems to be the result of local pachyostosis: the Haversian canals in the bone are closed off and fade away, giving rise to a change of the bone into an ivory-like substance, such as described by Abel (1914: 215). It seems that this procedure found its most extreme expression among Sirenians of the Oligocene,

Miocene and Pliocene periods.

One of the last representatives of the Halitheriinae in the Miocene Belgian deposits is *Miosiren*. Another Miocene form, belonging to the Metaxytheriinae, is *Metaxytherium*, while *Felsinotherium* occurred during the Pliocene, according to Thenius (1972: 289). Hooijer (1977) has given a thorough description of Miocene Sirenian skeletal remains from a locality in the eastern Netherlands. In discussing his material, he correctly remarks that pachyostosis (or osteosclerosis) is an incorrect term when the ribs of Sirenians are described; following Spillman (1959), he prefers the word 'ponderosity' for this functional adaptation to submarine life, also encountered in other, unrelated, secondarily marine vertebrates such as seals and whales. In our photograph (Pl. 4, E), giving the (presumedly) posterior aspect of the costal fragment, traces can be seen of weathered growth layers on the anterior and posterior sides of the rib, a kind of layering which Hooijer, citing Simpson, also describes in the Sirenian remains in his publication. Comparing St. 20067 with his material, most likeness exists with the distal part of an eighth, ninth or tenth rib of the left side of *Metaxytherium* cf. *medium* (Desmarest,1822); but in view of the fragmentary nature of the specimen St. 20067 we think it more prudent to identify it as a costal fragment of a Sirenian, gen. et sp. indet.

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