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## FOSSIL PHOCIDAE IN SOME DUTCH COLLECTIONS (MAMMALIA, CARNIVORA)

P. J. H. VAN BREE & D. P. BOSSCHA ERDBRINK

*Institute of Taxonomic Zoology (Zoölogisch Museum), University of Amsterdam, P.O. Box 20125, 1000 HC  
Amsterdam, the Netherlands*

&

*Prinses Marielaan 27, 3743 JA Baarn, the Netherlands*

### ABSTRACT

Three cranial and seventy postcranial fossils are briefly described and identified as remains of Phocidae. Three of these are ascribed to the Bearded Seal *Erignathus barbatus* (Erxleben, 1777), nineteen to the Grey or Atlantic Seal *Halichoerus grypus* (Fabricius, 1791), and the remainder to the Common or Harbour Seal *Phoca vitulina* (Linnaeus, 1758). Five specimens were collected on the Meuse levels, an artificial plain South of the Hook of Holland formed from sand sucked up at the locality. All other material comes from the North Sea bottom and was found by fishermen trawling for flat-fish.

### INTRODUCTION

In an earlier paper, on fossil remains of Odobenidae, we discussed geographical and stratigraphical particulars of the described specimens at some length (Bosscha Erdbrink & van Bree, 1986). Because the circumstances pertaining to the material on which the present paper is based are largely identical, the reader may be referred to our previous remarks. It appears sufficient to state here that the described fossil remains of Phocidae may date either to sandy Early Holocene and Late Pleistocene sediments, to Early Weichselian clays (the so-called Brown Bank Beds) or to Eemian (Riss-Würm-) interglacial marine sands, or even to earlier Pleistocene deposits. It

is very likely that our material consists of a mixture of bones of different ages. Ignoring whether it could lead to a solution of this puzzle we have attempted to record the colour gradations displayed by most specimens, as we did in the case of the odobenid fossils (for the same reason). For this we used the colour-scale for soils proposed by Oyama *et al.* (1967).

The fossils of Phocidae in the present paper form part of the collections of the Rijksmuseum van Geologie en Mineralogie at Leiden (RMGM) and of several amateur collectors. In alphabetical order these are: Messrs. N. C. Kerkhoff (Nieuwe Damlaan 557, Schiedam); D. J. Mol (De Tuger 141, 's-Heerenberg); Drs. J. Mulder (Merellaan 27, Nieuwleusen); G. J.

van Noort (Thysselaan 2a, Den Burg, Texel); L. and O. Stolzenbach (Regent Smitsstraat 24, St. Michielsgestel); and the Reverend C. F. H. van Tuyll van Serooskerken (Molenweg 36, Oostkapelle).

To distinguish between the individual specimens in the descriptions and tables we used the numbers accorded to each in the collections of the RMGM, Mr Kerkhoff, Mr Mol and the Reverend Van Tuyll van Serooskerken. The Kerkhoff fossils bear the combination of the letters R and M, while we indicated the Mol specimens with the code letters DM, and those in the Mulder collection with JM and an additional number. The Stolzenbach fossils were either given the code LSt by us, or the combination NZ, with and without a number, as provided by their owners.

The material consists of three incomplete half mandibles, a third cervical vertebra, six pelvic fragments, thirty-one complete and incomplete humeri, seven radii, three (left) ulnae, nineteen complete and incomplete femora, and three tibial fragments. Extensive and repeated comparisons with recent material in the collections of the Amsterdam (ZMA) and Utrecht (ZMU) Zoological Museums, and with the excellent figures in Gromova (1950), convinced us that three different species are represented among these fossils: *Erignathus barbatus* (Erxleben, 1777), the Bearded Seal (three fossils only, the first time that this species is recorded in Dutch collections); *Halichoerus grypus* (Fabricius, 1791), the Grey or Atlantic Seal (nineteen specimens); and *Phoca vitulina* (Linnaeus, 1758), the Common or Harbour Seal, in all other cases.

Sixteen times an approximate location of collection was recorded among the North Sea finds. Most of these are in the Mol collection, and they were found by the skipper and owner of the fishing vessel GO 27, Mr P. van Es of Stellendam. Other specimens were collected in the general area between Smith's Knoll and the Brown Ridge (fig. 1). Five more specimens (in the Kerkhoff collection) were discovered on the artificially formed Meuse levels, South and Southwest of the Hook of Holland, in sand sucked up from different depths and at a

number of localities in the immediate neighbourhood. Extensive research into the composition of all faunal remains found on the Meuse levels has shown (van Kolfshoten and Vervoort-Kerkhoff, 1986; Kerkhoff, 1986) that at least three separate faunae can be distinguished here. One dates back to Early Holocene times, another is of Weichselian (= Würmian) age, and a third is almost certainly Bavelian (uppermost Early Pleistocene, following the Menapian stage and immediately prior to the Cromerian complex). In a broad sense this conclusion has been borne out by the data (for instance those of a micro-mammalian nature) obtained by Mr L. Hordijk from a well-boring carried out by him in the Zuurland polder just South of Brielle, quite near the Meuse levels (fig. 1). Judging from their degree of fossilization and colour the phocid remains in the Kerkhoff collection should most probably be ranged among the Early Holocene and Weichselian finds.

The few known localities lie in the southern part of the North Sea basin. When not especially mentioned, the fossil in question was identified by us as a Common Seal. Localities and data of collection are (fig. 1):

52°N/2°40'E (DM 1012, a humerus dext.; DM 1014, a radius sin.; DM 1015, a femur sin. of a Grey Seal; DM 1016, a humerus dext. of a Grey Seal; all collected in November 1982);

52°N/2°20'E (DM 937, a humerus dext. collected in March or April 1982);

52°10'N/2°60'E (DM 1020, a fragment of a pelvis dext.; collected in early May 1983);

52°45'N/3°20'E (Van Noort Br.B.11.9, a fragment of a pelvis dext.; collected by G. Dros of the vessel Tx 43 on February 9, 1985).

Between 52°40'-52°N/2°40'-50'E (JM 5, a radius sin., collected early in 1983);

15 miles E of Smith's Knoll lightship (DM 929, a radius dext., collected in Dec. 1981; DM 930, a humerus dext., no date; DM 1009, an ulna sin., coll. Oct. 1981; DM 1010, humerus dext., same date) and

Southwest of the Brown Ridge (DM, no number, a radius dext., coll. Nov. 1984; DM, no number, a femur dext., same date; DM, no

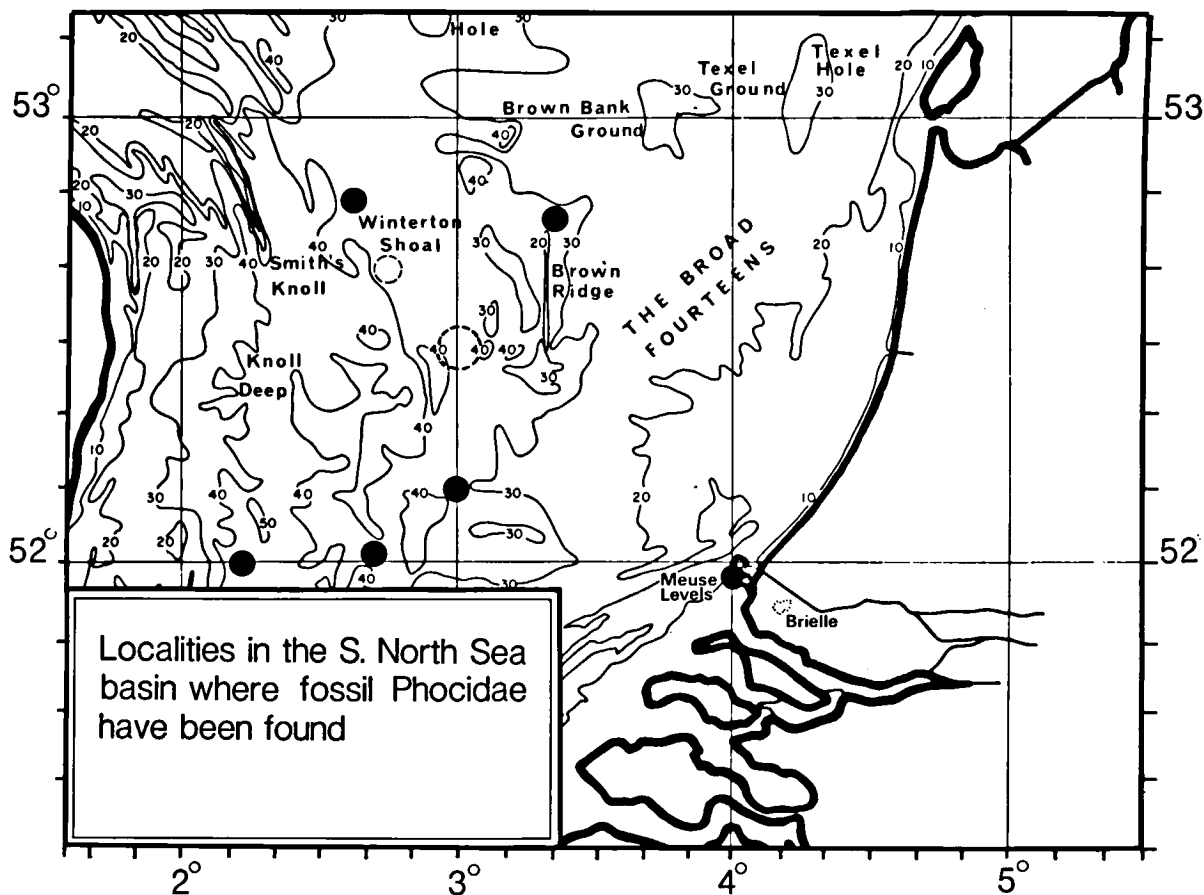


Fig. 1. The southern North Sea basin with six localities (black dots) and two general areas (open circles with dotted margins) where the described fossils were found. Depths in metres.

numbers, a left and a right humerus, same date).

Still more vague is the mention of "Brown Ridge area" and collecting date of November 1986 for DM 1091, a radius dext., and DM 1092, a humerus sin. The Stolzenbach specimens have all been collected around Smith's Knoll lightship or between there and the Brown Ridge. In one case, N.Z., no number, a femur dext., it was recorded that 1985 was the year of collection.

Right humeri are the specimens DM 931, DM 932, JM 9, JM 10, JM 11, JM 20 and N.Z. 21, while JM 7, JM 8, N.Z. 35 and N.Z. 44 are right humeri of Grey Seals; left humeri are JM 6, JM 18, JM 19, N.Z. 4, N.Z. 6, N.Z. 7, N.Z. 10, N.Z. 13, N.Z. 16 and N.Z. 29, while N.Z. 5 is a left humerus of a Grey Seal

and L.St., no number, is a left humerus of a Bearded Seal.

Right femora are JM 13, JM 14, JM 16, JM 17, N.Z. 8, N.Z. 14, N.Z. 31; and JM is a right femur of a Grey Seal, as is N.Z. 3; left femora are JM 21, JM 22, N.Z. 11, N.Z. 15 and L.St., no number. Left femora of Grey Seals are JM 12 and RM 2003.

As the other specimens described below are arranged in small series each, their number and other particulars are given in the descriptions.

## DESCRIPTION

In the collection of the Rijksmuseum van Geologie en Mineralogie at Leiden we were shown a left half mandible with the number St.

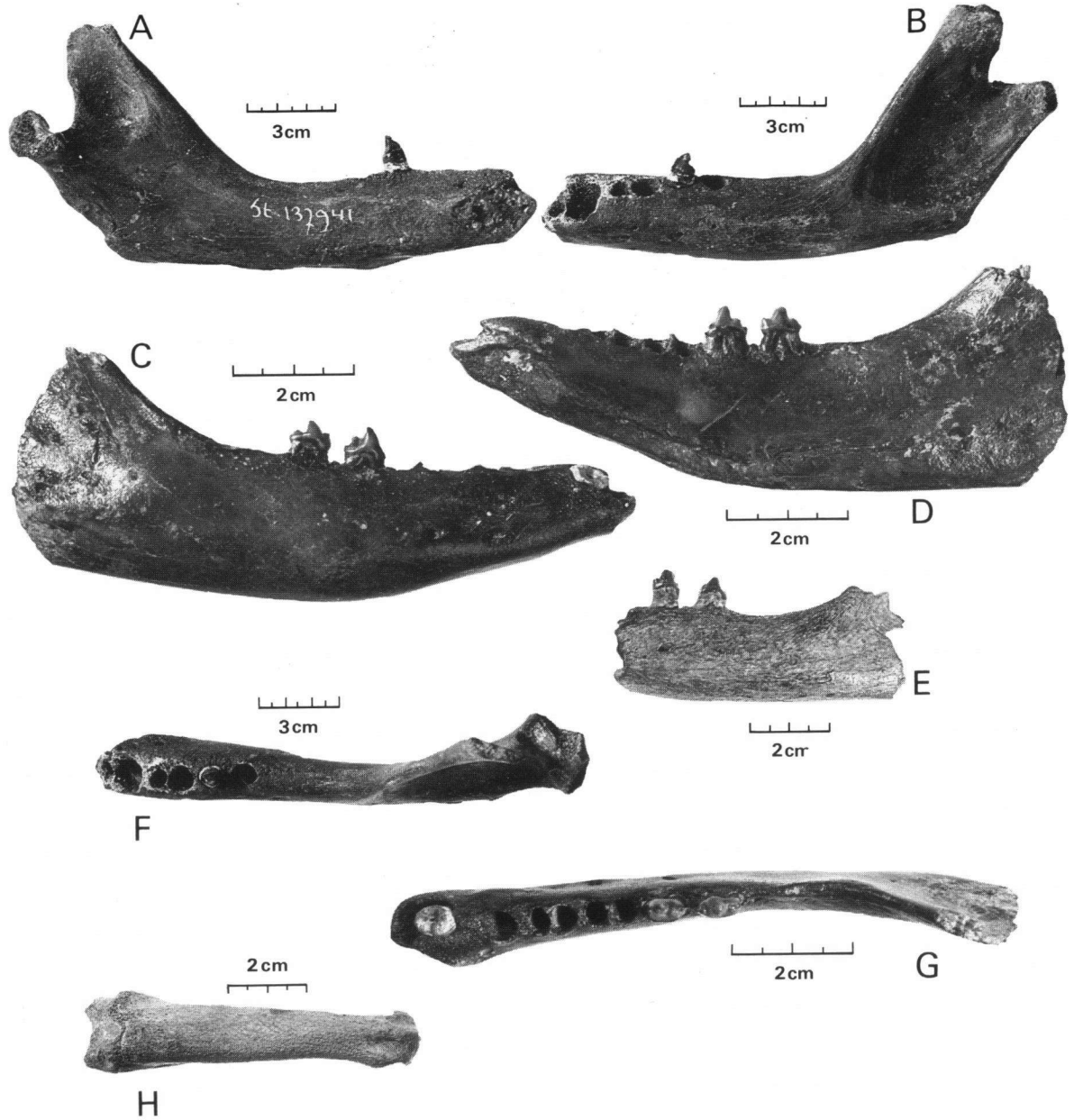


Plate I. A, lingual, B, oblique vestibular, and F, occlusal aspects of abnormal left mandibular ramus (without  $M_1$ ) of *H. grypus*, RMGM St. 137941. C, vestibular, D, lingual, and G, occlusal aspects of fragment of right mandibular ramus of *Ph. vitulina*, Coll. Stolzenbach, N.Z. (n.n.). E, vestibular aspect of fragment of left horizontal mandibular ramus of *Ph. vitulina* RM 2002, Coll. Kerkhoff (Meuse levels). H, left metatarsale V of *H. grypus* seen from above. RM 2006, Coll. Kerkhoff (Meuse levels).

137941 (Pl. I: A, B, F). According to its label it was tentatively determined as cf. *Monachus monachus* (Hermann). It was acquired through the Central Fisheries Laboratory at IJmuiden

on the 12th of January 1967 and reputedly collected at or near the Brown Ridge in the North Sea.

Its colour varies from 10 YR 4/3 (dull

yellowish brown) to 4/4 and 3/4 (brown and dark-brown). The enamel of the only tooth still present, the P<sub>3</sub>, displays the colour 10 YR 4/1 (brownish grey).

This half mandible is complete save for slight damage to the tips of the coronoid and condylar processes and to the edges of the alveoli for the canine and the incisors. In front the mandible has broken at the symphyseal plane. Two alveoli for incisors stand obliquely in front of the alveolus for the canine. In a distal direction two single premolar alveoli are encountered, after which the mentioned P<sub>3</sub> follows. This is a single-rooted unicuspid premolar surrounded by a basal cingulum around its entire crown (developed strongest at the lingual edge) and with a sagittal crista over the tooth from front to back. There are no accessory cuspids. The size of the mandible and this dental morphology are sufficient indications for us to ascribe the specimen to the Grey Seal, *Halichoerus grypus* (Fabricius, 1791). Behind the P<sub>3</sub> one finds a single alveolus, presumably of the P<sub>4</sub>. Evidently some unknown anomaly forms the reason for the complete absence of any trace of M<sub>1</sub>. On the vestibular (external) side of the mandible five mental foramina of equal (pinhead-) size are found. Four of these are arranged along a horizontal line while the fifth one stands obliquely above the most anterior one in the line of four. The third foramen from behind is situated 16.5 mm below the P<sub>3</sub>. Yet another foramen is present quite in front and low-down on the mandible. It certainly occupies a too low position to be explained as the alveolus of an incisor. Straight below the tip of the coronoid process and along the horizontal projection of the upper rim of the horizontal ramus one finds a relatively small foramen mandibulae. Three small foramina are present along a more or less sagittal line, behind each other and quite near the symphyseal plane. Measurements of the mandible and of the alveoli (and the P<sub>3</sub>) are given in table I.

The Stolzenbach collection contains a partial (102 mm long) left half mandible with the code-indication N.Z., collected in 1985 in the Brown Ridge area. Only two teeth are left, the P<sub>4</sub> and

the M<sub>1</sub>. The plane of fracture in front runs through the symphysis, while at the back it passes almost vertically through the jaw from a point at the beginning of the ascending ramus (Pl. 1: C, D, G). There is a single alveolus for P<sub>1</sub> and two double ones for P<sub>2</sub> and P<sub>3</sub>. The P<sub>4</sub> and M<sub>1</sub> also possess double roots. They display the typical form of *Phoca vitulina* (Linnaeus, 1758) in consisting of a primary central cuspid each, inclined slightly backwards at the tip, and preceded and followed by secondary cuspids all standing along a mesiodistal axis. A basal cingulum runs around each tooth and is developed most prominently at the lingual side. Five foramina mentalia are situated in a single line about halfway (10 to 11 mm) down externally from the upper edge to the lower border of the jaw. Each is not bigger than a pin's head, 1 mm across. The most posterior one stands below P<sub>4</sub> and the most forward one can be found below the alveoli for the incisors. These last alveoli are almost impossible to distinguish separately, as they tend to form a single relatively large fossa together with the canine alveolus. A stump of the canine is still present; it has broken off flush with the jaw's edge. The specimen's colour is 5 YR 3/6 to 3/4 (dark reddish-brown). Measurements can be found in table I.

The third mandibular fragment is one of the left side (Pl. 1, E). It has been inscribed as number RM 2002 in the Kerkhoff collection; it was collected from the Meuse levels. Its colour varies from 7.5 YR 6/6 (orange) to 2/2 (brownish-black). The maximum length of the fragment is 78 mm. At the back the sharp plane of fracture, although more irregular than that of the N.Z. specimen, runs vertically at almost the same place, i.e. at the beginning of the vertical ramus. In front the similarly vertical plane of fracture passes through the posterior alveolus of P<sub>3</sub>. Only two teeth are present in the fragment: P<sub>4</sub> and M<sub>1</sub>, each with a double root and morphologically comparable to the just described corresponding element in N.Z. This fact, and its size, form our reasons for ascribing the find to *Phoca vitulina* (Linnaeus, 1758). A single mental foramen is present straight below P<sub>4</sub> at

Table I. Mandibular and dental measurements in mm.

	St. 137941 <i>H. grypus</i>	N.Z., n.n.	RM 2002
Max. length of mandib. ramus	183	—	—
Height of vertic. ramus	>91	—	—
Vertic. height of symphysis (nat. posit.)	26	11.5	—
Horiz. distance of same	32.5	17	—
Mandib. angle (measured on inside)	127°	133°	133°
Horiz. width of condylar process	± 30	—	—
Dimensions of for. mandibulae (hor. X vert.)	4 × 3.5	—	—
Dimensions of each (subequal) for. mentale	2.5 × 2.5	1 × 1	1 × 1
Dimensions of foramen below incisor (h. X vt.)	3 × 4	1 × 1	—
Height of horiz. ramus at P <sub>3</sub>	34	21.5	22
Height of horiz. ramus at P <sub>1</sub>	28	14.5	—
Height of horiz. ramus at M <sub>1</sub>	?30	24.5	25
C <sub>inf</sub> mes.-dist.	13.3	7.4	—
C <sub>inf</sub> vestib.-lingual	12.2	5.2	—
P <sub>1</sub> mes.-dist.	6.6	5.5	—
P <sub>1</sub> vestib.-ling.	6.8	5.0	—
P <sub>2</sub> mes.-dist.	10.1	9.0	—
P <sub>2</sub> vestib.-ling.	9.3	6.0	—
P <sub>3</sub> mes.-dist.	8.8	7.8	—
P <sub>3</sub> vestib.-ling.	6.0	4.8	5.2
P <sub>4</sub> mes.-dist.	9.9	7.0	7.5
P <sub>4</sub> vestib.-ling.	8.0	3.7	5.2
M <sub>1</sub> mes.-dist.	—	6.9	7.5
M <sub>1</sub> vestib.-ling.	—	3.5	5.0
Colour gradation	1GYR3/4-4/4	5YR3/4-3/6	7.5YR2/2-6/6

a distance of 11.2 mm from the edge of the jaw. It has a diameter of only 1 mm. Measurements can be found in table I.

In our material the axial skeleton is represented only by a single vertebra. It forms part of the Stolzenbach collection, in which it is inscribed as N.Z. 33 while it was collected between 1983 and 1984 near Smith's Knoll. Its colour ranges from 7.5 YR 2/1 (black) to 2/3 (very dark brown). Comparison with recent skeletal material in the Zoological Museum of Utrecht University showed beyond doubt that this is a third cervical vertebra of *Phoca vitulina* (Linnaeus, 1758). It is nearly complete (Pl. II: A, B) but for some insignificant damage to the extreme tip of the right anterior zygopophysis. Some measurements of the specimen are given in table II.

Six pelvic fragments, four of which are figured here (Pl. II: C, G) form the material of the

Table II. Third cervical vertebra. Measurements in mm.

	N.Z. 33
Max. width over alae, transversely	78.5
Max. length of corpus, ventrally	33
Max. height of corpus in centre	22
Max. width of corpus, posteriorly	27.5
Max. width of corpus, anteriorly	26
Vertical height of neural canal	14
Transverse width of neural canal	19

pelvic girdle of phocids at our disposition. Some of their measurements are given in table III.

One of these specimens, RM 2001 in the Kerkhoff collection, has a colour which can be defined as 10 YR 4/2 to 6/2 (Greyish yellow-brown). It was found on the Meuse levels and, in our view, has to be ascribed to the Grey Seal, *Halichoerus grypus* (Fabricius, 1791); comparison with recent material in the Zoological Museum of Amsterdam University made this clear. It is

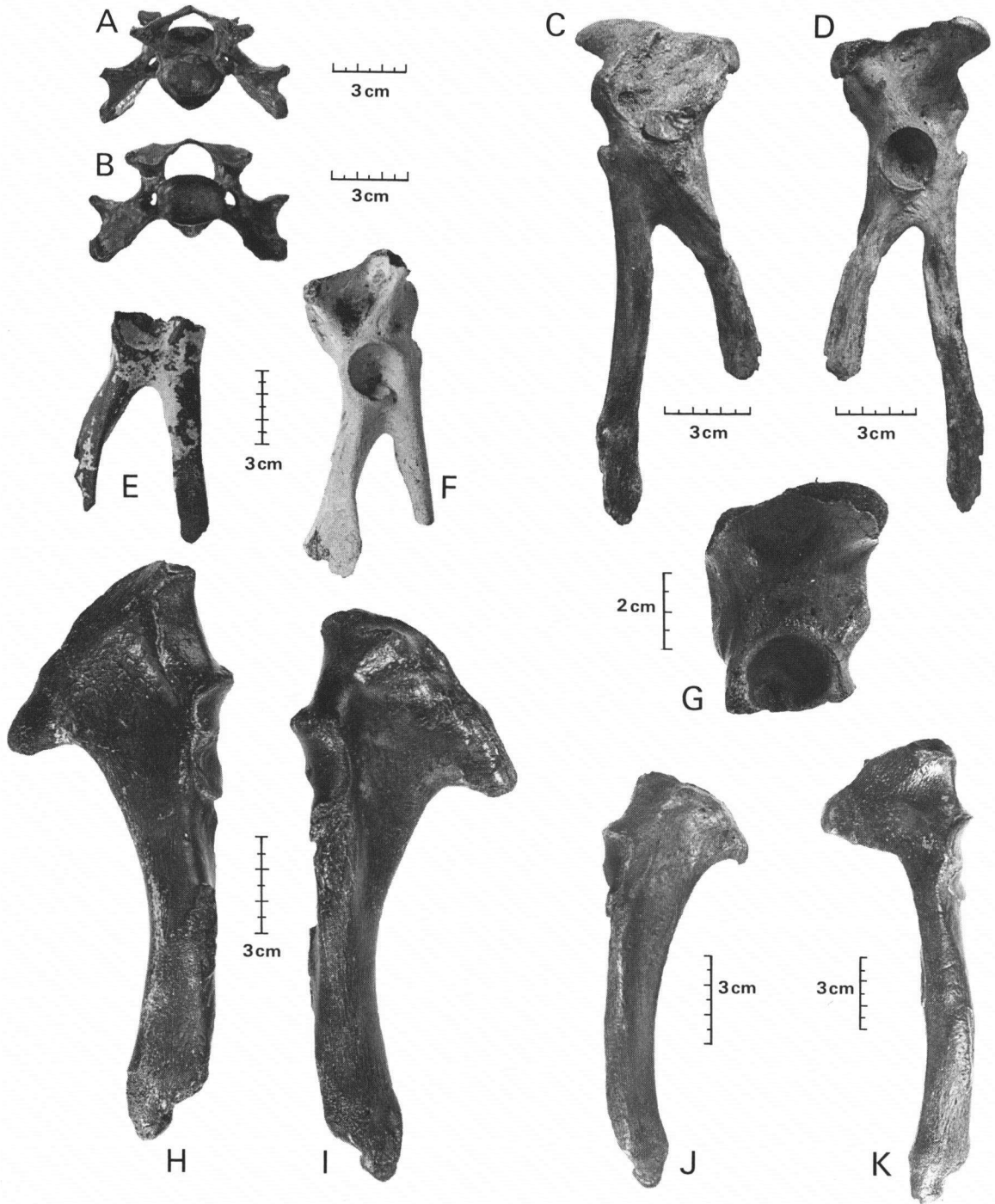


Plate II. A, caudal, B, cranial aspects of third cervical vertebra of *Ph. vitulina*, Coll. Stolzenbach, N.Z. 33. C, internal, D, external aspects of incomplete right pelvis of *Ph. vitulina*, Coll. Stolzenbach N.Z. (n.n.). E, external aspect of small right pelvic fragment of *H. grypus*. Coll. Stolzenbach N.Z. 26. F, external aspect of right pelvic fragment Br.B.II of *Ph. vitulina*, Coll. Van Noort. G, external aspect of small right pelvic fragment RM 2001 of *H. grypus*, Coll. Kerkhoff (Meuse levels). H, internal (medial) and I, external (distal) aspects of left ulna N.Z. (n.n.), Coll. Stolzenbach, of *H. grypus*. J, external (distal) aspect of DM 1009, left ulna of *Ph. vitulina*. K, internal (medial) aspect of left ulna of *E. barbatus*, N.Z. 54 (Coll. Stolzenbach).

Table III. Pelvic fragments. Measurements in mm.

	RM 2001 <i>H. grypus</i>	DM 1020	Br.B.II.9	LSt.	N.Z. 26	N.Z. n.n.
Max. width of acetabulum in direction of obturator for.	—	25	24.5	27	± 30	23
Max. width of acetabulum at right angles to the above	23.5	21.5	23	25.5	28	21.5
Max. depth of acetabulum	9	13	13.5	12	13	13
Max. thickness over edge of acetabulum	22	21	23.5	18	20.5	21
Max. length of still present fragment	± 61	181	139	115	101	181
Colour gradation	10YR4/2-6/2	5YR5/4	10YR6/4		10YR2/1-3/1	10YR5/3

only a small fragment, mainly of the right ilium and its contribution to the acetabulum, as the figure (Pl. II: G) demonstrates. It nonetheless displays the typical ruggedness of most bones of this seal species. Also from a Grey Seal (probably a female) is specimen NZ of the Stolzenbach collection (Pl. II: E). It was collected in 1985 and its colour is 10 YR 5/3 (dull yellowish-brown).

The four other pelvic fragments, none of which is complete, have most probably to be determined as fossils of the Common Seal *Phoca vitulina* (Linnaeus, 1758), again resulting from our comparisons with recent material in the ZMA and ZMU collections. Surprisingly, all fragments are of the right side also. One belongs in the Mol collection (DM 1020); it was collected in May 1983, as stated above. Its colour is 5 YR 5/4 (dull reddish-brown). A number of Bryozoan colonies are attached to its surface, so that it must have lain free of covering sediment for some time. Its acetabulum is complete. Around this, limited areas of ilium, ischium and pubis are present.

Another specimen, in the Van Noort collection, bears the number Br.B.II.9, as mentioned above. The colour of this fossil is 10 YR 6/4 (dull yellow-orange). It is slightly larger than DM 1020 but consists essentially of the same parts of the right pelvis.

The remaining two specimens, LSt (not numbered), and N.Z. 26 form part of the Stolzenbach collection. They were collected

between Smith's Knoll and the Brown Ridge, near the first locality; N.Z. 26 is coloured 10 YR 2/1-3/1 (black to brownish-black) and is overgrown by Bryozoan colonies.

The humerus is the commonest bone among our fossil material. It is represented thirty-one times. This may be due to the fact that it is a strong, relatively short and heavy bone with a shape resembling a dumbbell or, roughly, an hour-glass with a thick waist. It is therefore probably not so apt to break as are many other appendicular bones of the phocid skeleton. These frequently display a flat form, no doubt an adaptation to the rowing mode of propulsion of the members of this family. When isolated, a humerus probably rolls over and over around its long axis if it is moved along the bottom of the sea. Even the thinnest part of its shape (the "waist"), just below the deltoid crista, is still robust.

Twenty-four humeri (twelve right and twelve left) should be ascribed to *Phoca vitulina* (Linnaeus, 1758), while six more (five right and a single left one) have to be seen as bones of *Halichoerus grypus* (Fabricius, 1791). A single specimen (Pl. III: I) was recognized by us as a left humerus of a Bearded Seal, *Erignathus barbatus* (Erxleben, 1777), mainly because of its large size, its resemblance to the borrowed humerus of a recent Bearded Seal and its close morphological affinity to the figures of phocid humeri in Gromova (1950). Table 4 provides a



number of (eight) measurements taken from almost each of the thirty-one specimens (lack of data being caused by incomplete or too heavily damaged bones). The extensive material precludes a description of each specimen. Accordingly the colour(s) displayed by each fossil are included in table IV.

Because it is the first time that a Bearded Seal fossil from the North Sea is recorded, that particular humerus is described more fully here. The left humerus (Pl. III; I) belongs in the Stolzenbach collection. It is not numbered and it is stated to have been collected just East of Smith's Knoll lightship. Damage to the upper side of the deltoid ridge and to the medial epicondylar ridge can be observed. The spongiosa thus made visible has the same, very dark brown to brownish colour (7.5 YR 2/3-3/2) also displayed by the exterior of the bone. Otherwise the fossil, which has very large dimensions (table IV) is complete. An entepicondylar foramen is well-developed and Bryozoan colonies are present on the outside of the bone in several places, attesting to the fact that the specimen has lain free on the seabottom for some time. The caput is large, well-rounded to oval in form. It lies in one plane with the greater and the lesser tubercle. The ulnar notch is rather shallow. A nutritional foramen is present in the diaphysis at 22 mm above the entepicondylar foramen. There is a pronounced supinator ridge above the lateral epicondyle (in Grey Seal humeri this ridge appears to be almost absent). The extent of the recent scar at or near the deltoid ridge shows that the development of that feature in a distal direction is also more pronounced than in the Grey Seal, at least as far as we were able to observe. Taken as a whole, the relative morphology of this bone, compared to those of Grey and Common Seals, is much more slender with less robust cristae and other bony formations, while its distal transverse dimensions, also relatively, exceed those of the two other mentioned species.

It will be seen (Pl. III) that the normal situation in seals includes the presence of an entepicondylar foramen. Remarkably enough our *vitulina*-material contains three cases in

which such a foramen is completely absent: DM 937, DM 1010 and JM 9 (Pl. III, G), while a fourth fossil, JM 20, possesses an incomplete entepicondylar foramen, still open in a medial direction. The six *H. grypus*-humeri each show the foramen clearly. Although possible, we do not know of cases, also in recent material, in which the entepicondylar foramen is absent in this species.

Apart from the larger size (see table IV, maximum length), some additional features may perhaps be mentioned here by which, in our view, it may be possible to distinguish between humeri of *Ph. vitulina* and *H. grypus*.

Firstly, we have been struck by the observation that the tip of the tuberositas minor is positioned markedly higher above the horizontal plane tangential to the caput humeri in *H. grypus* than in *Ph. vitulina*. In this latter species the two features either lie in a single level, or the minor tubercle rises only insignificantly above the horizontal plane through the top of the humeral head.

Secondly we have gained the impression that the deltoid ridge and tubercle are developed relatively stronger in *Ph. vitulina* than in *H. grypus*. The intertubercular sulcus (between caput and t. minor), when observed from in front, is relatively narrower in *H. grypus* than in *Ph. vitulina*.

Thirdly, the lateral supracondylar ridge ends abruptly upwards against the diaphysis, forming an obtuse angular eminence there, in *Ph. vitulina*; in *H. grypus* the ridge fades gradually into the diaphysis.

Fourthly, the base (or distal extremity) of the deltoid tubercle rises up from the diaphysis in a far more gradual manner in *H. grypus* than in *Ph. vitulina*; in the latter species the tubercle juts out abruptly in a flag-like manner.

Finally, when viewed from above (on to the proximal extremity), the circumference of the humeral head itself has a perfectly circular outline in *Ph. vitulina*. In *H. grypus* the caput humeri is less globular, more elongated and at the same time flattened, so that its form seen from above is more an oval or an ellipsoid.

Table IV. Humeri. Measurements in mm.

	DM, no number Nov. '84 sin.	DM, no number Nov. '84 dext.	DM 930 dext.	DM 931 dext.	DM 932 dext.	DM 937 dext.	DM 1010 dext.	DM 1012 dext.	DM 1092 sin.
Maximum length	121	112	>113	114	114	115	>98	123	119
Prox. transv. width	52	50	—	43	45.5	48	—	51	49
Dist. transv. width	43.5	39	36.5	41	38	40.5	39.5	41.5	40
Dist. sagitt. width	26	24.5	22	22.5	24.5	24	27	25	26
Min. sag. width diaph. cent.	18	18	15	17	17	17.5	19	17	17.5
Min. tr. width diaph. centre	21	21.5	18.5	18	21	18.5	18.5	18.5	21.5
Min. circumfer. diaphysis	74	72	62	67	76	70	69	72	70
Max. sag. w. over delt. ridge	40	—	37.5	38	39.5	40.5	>39.5	>40	38.5
Colour gradation	7.5YR4/4 -4/6	10YR4/3 -3/2	7.5YR5/6 -5/8	10YR2/2 -2/3	10YR5/3 -3/3	10YR5/3 -5/6	10YR1.7/1	10YR3/4 -4/2	10YR4/6 -2/2

JM 6	JM 9	JM 10	JM 11	JM 18	JM 19	JM 20	N.Z. 4	N.Z. 6	N.Z. 7	N.Z. 10
sin.	dext.	dext.	dext.	sin.	sin.	dext.	sin.	sin.	sin.	sin.
129	122	116	111	129	>114	115	118	>90	114	>126
49.5	48	45	45.5	49.5	57.5	47	48	—	47	—
46	42	40	38.5	44.5	—	43	44	40	40	>51
27	27.5	22	23	20.5	—	24.5	28	25	25	>23
19.5	17	16.5	16	18.5	19.5	21.5	17	16	17	22
23	20.5	18.5	17	23.5	24.5	22.5	22	21.5	20.5	24.5
77	73	68	70	70	79	75	75	72	80	92
41.5	40	>38	35	41	—	43	39	—	>40	>40
5YR4/3 -6/2	10YR3/2 -4/3	10YR3/4 -5/3	10YR4/3 -4/6	10YR4/3 -3/3	10YR5/3 -3/3	10YR3/1 -3/4	10YR3/1	10YR2/3 -3/4	7.5YR2/3 -3/3	7.5YR3/3 -3/4

N.Z. 13	N.Z. 16	N.Z. 21	N.Z. 29	DM 1016	JM 7	JM 8	N.Z. 35	N.Z. 44	N.Z. 5	L.St. no number
sin.	sin.	dext.	sin.	dext.	dext.	dext.	dext.	dext.	sin.	sin.
133.5	112	>95	114	154	135	147	150	158	>113	165
54	44	—	45	56.5	58	60	56	>55	—	54
46	39.5	41	38.5	53	>48	51	53.5	54	>51	60
24.5	23.5	25	23	31	24	>22	25	25	>26	31
18	16.5	19	18	25	20	20.5	20.5	22	22	24
22	19.5	22	20.5	22	23	23	25	27	27	30
79	71	76	70	89	79	81	92	93	94	88
41	38	>41	41	46	>40	>46	44	50	>49	>38
10YR3/3 -3/4	7.5YR2/3 -3/3	10YR4/3 -5/3	10YR2/2 -2/3	10YR4/6 -5/8	10YR4/3	10YR3/3 -4/3	7.5YR3/4 -5/8	7.5YR 1.7/1-2/3	5YR2/4 -3/6-4/8	7.5YR2/3 -3/2

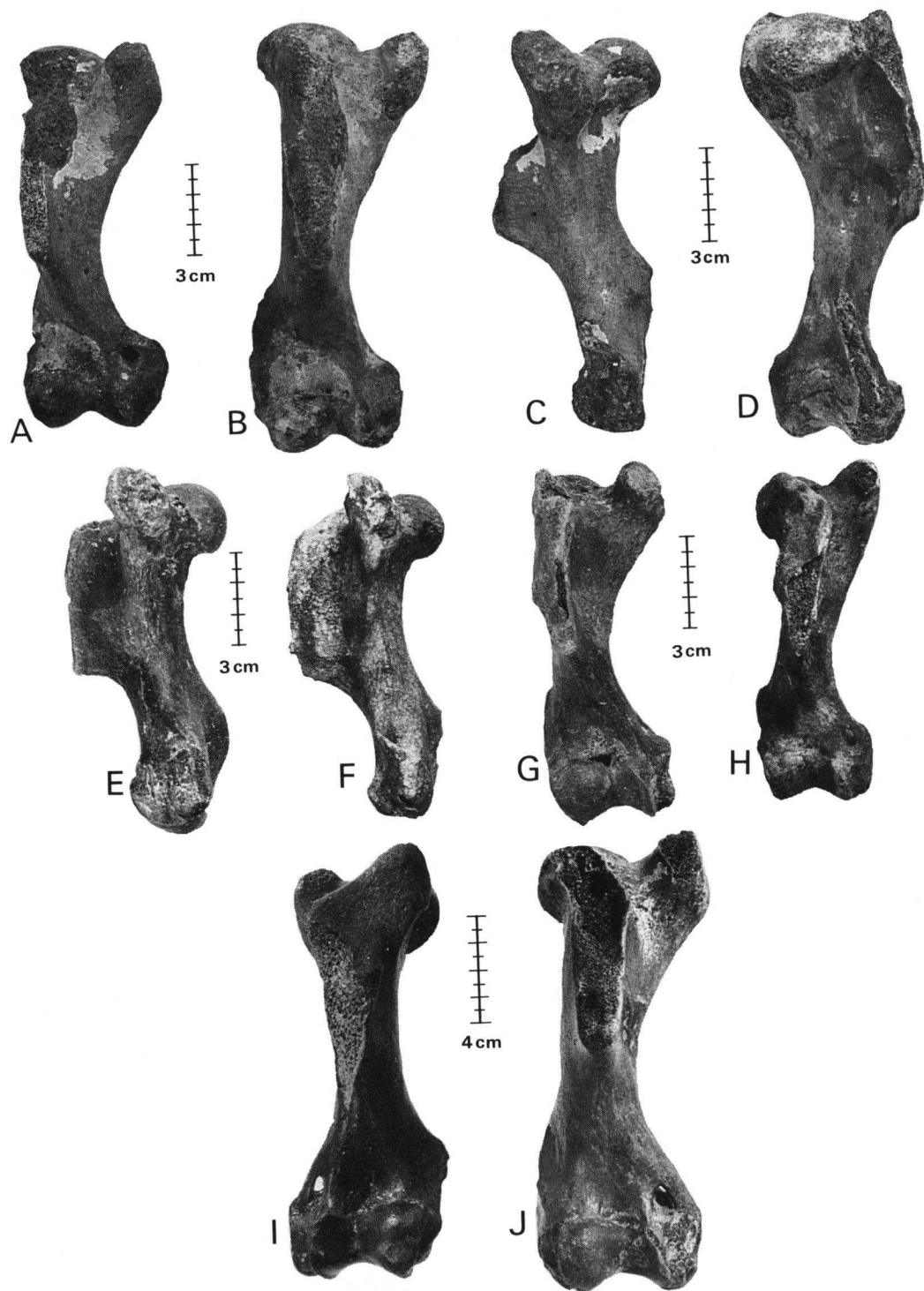


Plate III. Phocid humeri. A, B, frontal aspects of, respectively, JM 7 and JM 8 (*H. grypus*, hum. dext.); C, inner side, and D, external side views of JM 7 and JM 8. E, F, inner side views of, respectively, JM 9 and JM 10 (*Ph. vitulina*, hum. dext.); G, H, frontal aspects of JM 9 and JM 10. I, frontal aspect of LSt, left humerus of *E. barbatus* (Coll. Stolzenbach). J, frontal aspect of DM 1016, right humerus of *H. grypus*.

Our fossil material contains three ulnae; each, coincidentally, of the left side, and of a separate species as far as we have been able to ascertain. Measurements are given in table V, while the specimens are figured in Pl. II (H-K). The smallest specimen is DM 1009. Because of its size and its close resemblance to recent ulnae of that species, we ascribe it to *Phoca vitulina* (Linnaeus, 1758). Its olecranon is relatively sturdy and robustly built. The posterior, flat edge of this feature fades very gradually into the diaphysis of the bone, forming a graceful curve until it reaches the upper posterior edge of the olecranon. The diaphysis is broad and wide in its lateral aspect, while the styloid process at the distal extremity occupies a fairly large central position. The fossil's colour is 10 YR 5/8-4/6 (yellowish brown to brown).

The second specimen, indicated as N.Z. (not numbered) is an almost exact copy of a recent left ulna in a male Grey Seal skeleton collected at Flamborough Head, England, and now in the ZMA collection (no. 15.986). Comparison with ulnae of recent female *H. grypus* demonstrated to us that there exists a marked sexual variability in that the male bones are much heavier and larger, and more robustly built. There can, therefore, hardly be any doubt that the fossil must have belonged to a male individual. In contrast to the *vitulina* ulna it is furthermore possible to remark that the posterior olecranon edge forms a rather abrupt angle (at the level of the trochlear notch) in its course toward the posterior side of the diaphysis. The diaphysis itself is less broad, in a relative and antero-posterior sense, than that of the ulna of *Ph. vitulina*. The styloid process, at the distal end, takes up relatively less space than in *vitulina*. It is also situated more posteriorly. The area of contact with the radius, or interosseous border, displays marked bony excrescences, as does an area just below the radial notch. This indicates the existence of a fairly strong ossification of (part of) the antibrachial interosseous membrane. Such is hardly the case in *vitulina*, where only the region directly below the radial notch is roughened. This radial notch is, moreover, much deeper

and more distinctly developed in *H. grypus*. The colour of the N.Z. fossil varies from 7.5 YR 2/1 (black) to 10 Y 4/1 (grey). It was collected near Smith's Knoll.

The third fossil, N.Z. 54, is ascribed by us to the Bearded Seal, *Erignathus barbatus* (Erxleben, 1777) mainly because it closely resembles the figure of an ulna of that species in Gromova (1950), and because of its size which easily exceeds (table V) that of the male Grey Seal. It is, however, relatively more slender in build and its model rather resembles that of *Phoca vitulina* without the robustly formed ridges found in that species. Part of the upper edge of the olecranon has recently been damaged and is missing. The diaphysis is relatively longer and more gracefully modelled than in the species *vitulina* or *grypus*. Although much of it has broken away in our specimen, it can still be seen that the posterior edge of the olecranon gradually curves into the diaphysis, as in *vitulina*. The position of the styloid process also resembles that encountered in the Common Seal. The trochlear notch is very much larger (relatively) than in the other two seal species, while the radial notch is markedly smaller and less distinct, forming a continuous convex surface with that of the trochlear notch. Traces of ossification of the interosseous membrane are only sparsely present near the distal extremity of the bone. The colour of the materia compacta and the materia spongiosa of this fossil, the second specimen of a fossil Bearded Seal to be recorded from the North Sea, is a uniform 75 YR 2/2 (brownish black). It was collected between Smith's Knoll lightship and the Brown Ridge.

Our material contains seven (three left and four right) radii and fragments of radii. Six of these, JM 5 (sin.), RM 3156 (sin.), DM 1014 (sin.), DM 929 (dext.), DM 1091 (dext.) and DM n.n. (Nov. '84, dext.) closely resemble the flat, oar-like radius of recent *Phoca vitulina* and should accordingly be ascribed to that species. The seventh (Pl. IV, G), RM 2004, is a proximal fragment of a right radius of larger dimensions and more robust in construction. This is clearly visible in spite of the circumstance that

Table V. Ulnae. Measurements in mm.

	DM 1009 <i>Ph. vit. sin.</i>	N.Z., n.n. <i>H. grypus sin.</i>	N.Z. 54 <i>E. barbatus sin.</i>
Maximum length (olecranon-caput)	141	184	198
Length along caudal (flat) side	122	133	185
Min. circumfer. below proc. coron.	55	69	59
Mediodist. width of olecranon	19.5	28.5	22
Ant.-post. width of olecranon	45.5	81.5	63.5
Colour gradation	10YR5/8-4/6	7.5YR2/1	7.5YR2/2

the caput has been considerably eroded and weathered, thereby diminishing in size. Comparison with recent ZMA material did not leave us in any doubt that it belongs to a *Halichoerus grypus*. Measurements, together with the colour gradations of the fossils, are given in table VI, while aspects of six specimens are figured in Pl. IV, A-H.

The concave upper surface of the caput radii forms an uninterrupted ovaloid plane in the radius of the Common Seal. This same feature, also ovaloid or even lozenge-shaped in circumference in the corresponding bone of the

Grey Seal, contains an elongated fovea near its deepest point. Yet another difference lies in the form of the radial tuberosity. Apart from being much larger and, also relatively, more robust in *H. grypus*, it is very clearly divided into two subequal bony rough areas separated by a broad vertical fossa or sulcus in the latter species. At its deepest part a number of elongated foramina can be observed in this fossa. In *Ph. vitulina* nothing of the kind exists and there the radial tuberosity, although indistinctly divided into two areas also, does not contain a marked vertical sulcus in its centre.

Table VI. Radii. Measurements in mm.

	JM 5 sin.	DM 929 dext.	DM 1014 sin.	DM 1091 dext.	DM n.n. Nov. '84 dext.	RM 2004 <i>H. grypus</i> dext.	RM 3156 sin.
Length along ulnar (= straight) side	104	98	108	114	111	—	—
Length along hypotenusa of triangle	—	—	111	116	111	—	—
Breadth at base of triangle	—	—	37	41.5	39	—	—
Circumference of caput	67	70	66	69	74	66	60.5
Transv. diam. of flat upp. side of caput	23.5	24	21	24	23.5	22.5	20
Sagitt. diameter of same	19	20	20.5	21	20.5	21.5	17.5
Minim. circumference of diaphysis	47	52	44	51	50	56	49
Transv. diam. of flat plane of diaphysis	11.5	12	11	11.5	12.5	14	12
Sagitt. diam. of flat plane of diaphysis	15	17	13	15	14.5	20.3	16.5
Diameter at right angles over distal articulation	—	17.5	17.5	20.5	17	—	—
Colour gradation	10YR5/3 -6/4	10YR3/3 -4/3	10YR4/3 -5/2	10YR4/4 -7/4	10YR2/1 -3/4	7.5YR2/2 -6/6	7.5YR6/2

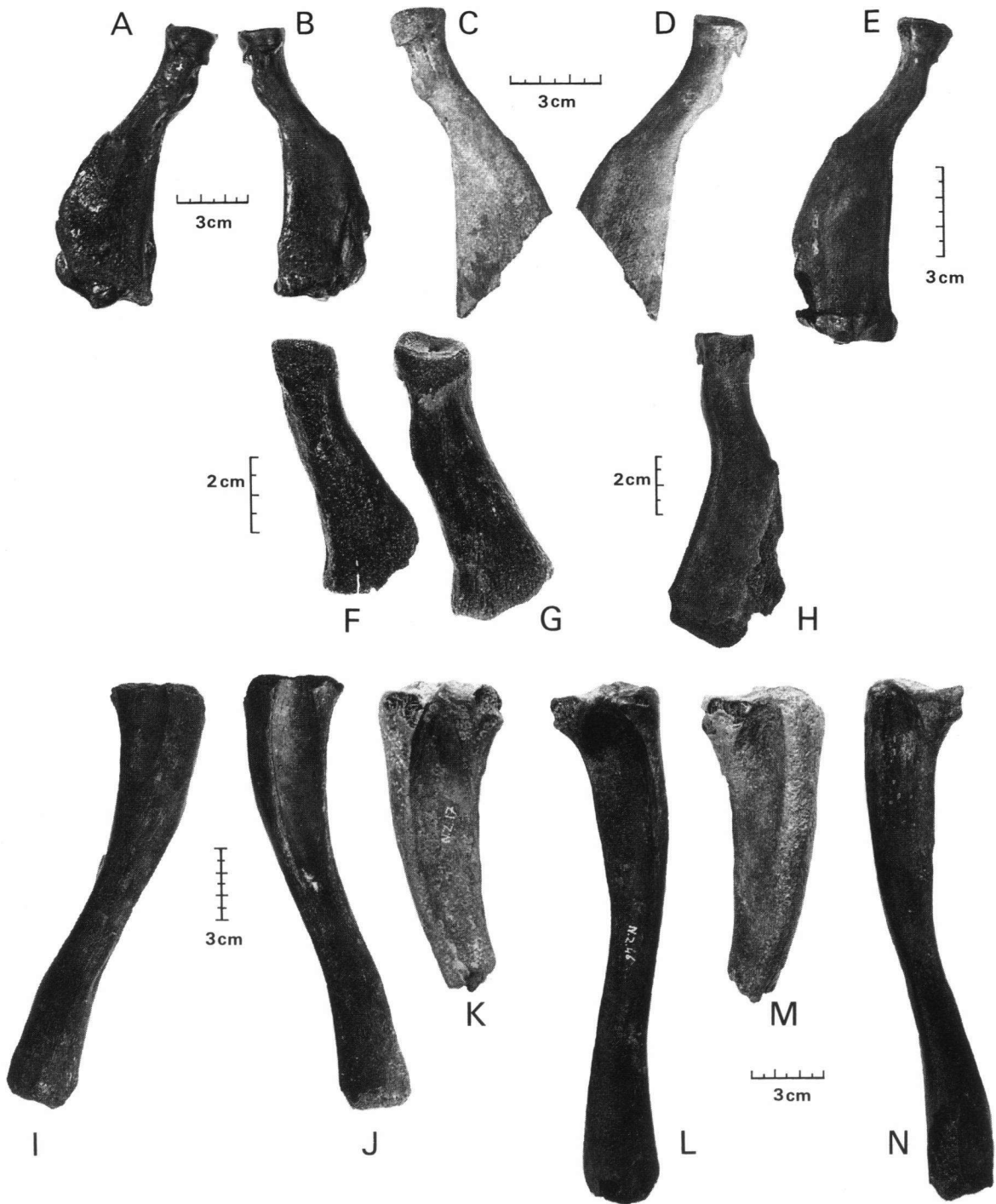


Plate IV. Phocid radii (A-H) and tibiae (I-N). A, medial (internal) and B, distal (external) aspects of incomplete right radius DM (n.n.) of *Ph. vitulina*. C, medial (internal) and D, distal (external) aspects of fragment of left radius JM 5 of *Ph. vitulina*. E, distal (external) aspect of nearly complete left radius DM 1014 of *Ph. vitulina*. F, posterior aspect of (rolled) proximal fragment of left radius RM 3156 (Coll. Kerkhoff, Meuse levels) of *Ph. vitulina*. G, oblique distal (external) aspect of rolled right radius RM 2004 (Coll. Kerkhoff, Meuse levels) of *H. grypus*. Note fovea in centre of caput. H, medial (internal) aspect of fragment of right radius DM 929 of *Ph. vitulina*. I, distal (external) and J, medial (internal) aspects of incomplete right tibia of *H. grypus*, Coll. Van Tuyll van Serooskerken. K, medial (internal) and M, distal (external) aspects of proximal part of right tibia N.Z. 17 (*H. grypus*). L, medial (internal) and N, distal (external) aspects of incomplete left tibia N.Z. 46 (*H. grypus*).

Among the phocid fossils a total of eighteen femora and femoral fragments were counted. Four of these are ascribed here to *Halichoerus grypus*, one to *Erignathus barbatus*, and the remaining dozen-and-one to *Phoca vitulina*.

This determination is based upon:

- a. comparison of absolute sizes;
- b. morphological comparison with recent ZMA and ZMU material and with bones borrowed

from the Institute of Marine Research, Bergen (Norway);

c. morphological comparison with figures in Gromova (1950).

Table VII provides a set of (maximal) eleven measurements taken from almost every specimen, while the colour gradation of each fossil has also been recorded. A selection from the material has been figured in Pl. V.

Table VII. Femora. Measurements in mm.

	DM, no number Nov. '84 dext.	JM 13 dext.	JM 14 dext.	JM 16 dext.	JM 17 dext.	JM 21 sin.	JM 22 sin.	N.Z., no number '85 dext.
Maximum length	100	105	>106	106	107	104	101	101
Length fr. condylar plane	88	94	97.5	101	96.5	89.5	90.5	90.5
Prox. sagitt. width	48.5	51.5	>47	>53.5	>49	50	55	52
Dist. sagitt. width	55	52	59.5	55	52.5	54	54.5	51
Transv. width over troch. major	19	20.5	22	20.5	21.5	16	19	20.5
Transv. width over condylus lateralis	27.5	29.5	29	>27.5	30	29	28	27
Min. sagitt. width of diaphysis	28	29	31.5	29.5	29.5	27.5	28.5	30.5
Min. transv. width of diaphysis	13.5	16	17	18	17.5	13.5	15.5	14.5
Min. circumf. of diaphyseal centre	70	76	82.5	78	78	69	75	75
Sagitt. diam. of caput	19	18.5	22	>19	18.5	20	20	20.5
Transv. diam. of caput	18.5	17.5	20	20	19	20.5	19	21
Colour gradation	10YR2/2 -2/3	10YR3/3 -3/4	10YR4/4 -5/4	10YR5/3	7.5YR3/3 -3/4	10YR2/2 -3/4	10YR3/4 1.7/1	10YR3/3 -4/3

N.Z. 8 dext.	N.Z. 11 sin.	N.Z. 14 dext.	N.Z. 15 sin.	N.Z. 31 dext.	L.St. no number sin.	DM 1015 sin.	JM 12 sin.	JM 15 dext.	RM 2003 sin.	N.Z. 3 dext.
98	97	96	90.5	97	98	>109	113	111	—	123
89	85	87	83	87	87	>101	101	103	—	108
51	49	48.5	46.5	52.5	49	62.5	57	54.5	—	58
53	51	49.5	>49	52	55	>52	54	54.5	53	56
22	20.5	20	19	19	21	21	19	19	—	22
28	30	27.5	26	28	28.5	32.5	27.5	28.5	>29	31
29.5	27	26.5	29	27	28	32.5	29.5	28	—	28.5
14	14	14.5	14	15.5	14.5	17.5	17.5	15.5	±17	16
67	70	69	73	74	75	85	78	73	—	75
19	>19	19	>17	19	20	>20	22.5	21.5	—	21.5
19.5	17.5	18	18	18	19	21	21.5	21.5	—	22
10YR2/3 -3/4	5YR2/3 -3/3	5YR2/2 -2/3	5YR3/1 -3/6	5YR3/4 -5/6	—	5YR4/8 -5/3	10YR4/3 -4/6	2.5YR3/2 -4/2	10GY3/1 -6/1	7.5YR3/1 -4/1

When the absolute size of the bone in each of the three species is not considered, a number of morphological differences can be observed. Placing the femur upright and resting it on its two epicondyles, one sees that the tip of the greater trochanter lies higher above the horizontal plane touching the femoral head in *H. grypus* than in *Ph. vitulina*. The situation in *E. barbatus* resembles that in *Ph. vitulina*. Along the sharp lateral edge of the diaphysis of this oar-like bone one very frequently encounters a bony flange starting at the lateral epicondyle and extending to about a third of the height of the diaphysis. This flange or excrescence (perhaps the base of the musculus plantaris?) which might be termed the *excrescentia lateralis*, usually fades away in an upward direction against the lateral diaphyseal edge in a gradual manner in *H. grypus*, while it does so abruptly in *Ph. vitulina* and in *E. barbatus*. In *Ph. vitulina* the lateral epicondyle projects furthest backwards. The medial and lateral epicondyles are relatively stronger developed in *Ph. vitulina* than in *H. grypus*, while in *E. barbatus* an intermediate situation is displayed. Seen in its 'anterior' aspect (i.e., in seals, in a transverse direction when the normal position is taken into account), the femur of *H. grypus* strikes one as having a lower-down 'waist' or relative narrowest point of the diaphysis, than that of *Ph. vitulina*. The highest situated 'waist' is found in the very much elongated femur of *E. barbatus* (Pl. V: C, F).

Immediately above the patellar area one frequently, but not always, observes a shallow single (in *Ph. vitulina*, *H. grypus* and *E. barbatus*) or a double (in *Ph. vitulina* and *H. grypus*) oval indentation or impression of the lowest part of the diaphysis. The development of a trochanteric fossa and of an intertrochanteric crest (between the greater and lesser trochanters) appears to be very variable. We suspect that it is a matter of individual variation, as, in *Ph. vitulina* alone, one may encounter deep and sharply limited trochanteric fossae as well as shallow and indistinct ones. In *H. grypus* and in *E. barbatus* the two features, so far as we could tell, are

clearly developed but perhaps also variable (Pl. V: C, G, H, I, K, L). Additional morphological differences, mentioned in Ray & Spiess (1981), are discussed here further on. A distal part of a femur of *H. grypus* was found by Mr. Kerkhoff on the Meuse levels (Pl. V: L).

Three specimens in our material represent (incomplete) tibiae (Pl. IV, I-N). The first of these, a right tibia, belongs in the Van Tuyll van Serooskerken collection; it was obtained by barter from Mr Mol, and as most North Sea material in that last collection it was recovered by Mr P. van Es, owner and skipper of the vessel GO 27, at Stellendam, in March 1981 near the Brown Ridge. The specimen's colour is a dark slate-like grey with some brown in it, on its outside as well as in its spongiosa (visible at the proximal plane of fracture). The two epiphyses are absent and it can be surmised that the individual was not fully adult because the bone does not show signs of synostosis. As usual in seals, the tibial tuberosity is hardly developed and its position can be determined mainly because there are some longitudinal rugosities (i.e. in a proximodistal direction) just above its surmised location. Comparison with recent ZMA material has shown us that a considerable degree of sexual variation exists and that the fossil specimen must be female. The relatively moderate tuberosities of the intercondylar eminences, together with the morphology and depth of the indentations at the proximal end of the diaphysis, mainly on the medial side, form certain indications for a determination of each of the three fossil tibiae as bones of *Halichoerus grypus* (Fabricius, 1791). In *Ph. vitulina* the tibia, rather unexpectedly, is not very much shorter but, as remarked just now, there exist morphological differences. The tibiae have in common that the deeply concave upper parts of the medial diaphyseal surfaces gradually flatten out in a distal direction while there is always the typical nutrient foramen (open in an upward, proximal, direction) at about one-third of the length of the diaphysis from above. The two other fossils are N.Z. 17 (approximately the proximal half of a right tibia) and N.Z. 46 (a



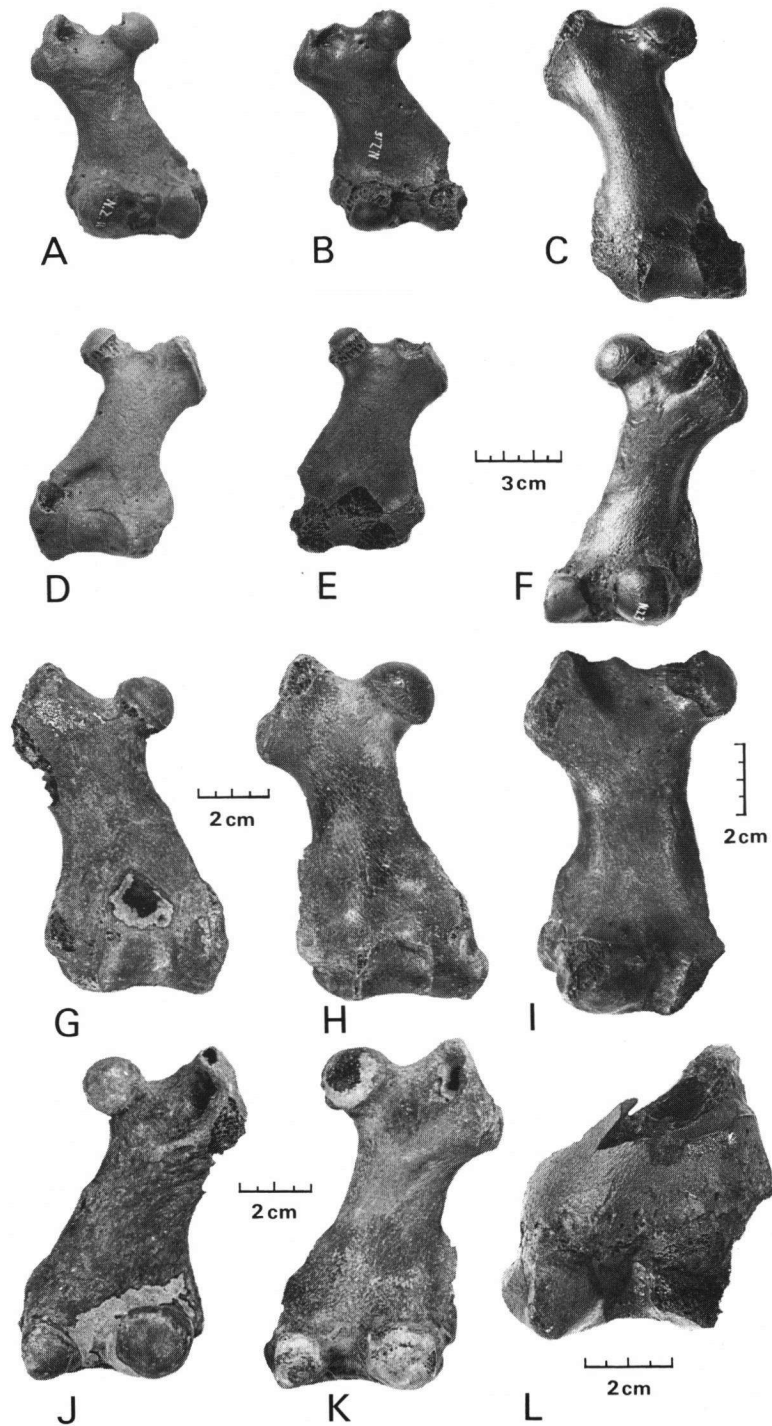


Plate V. Complete and incomplete phocid femora. A, posterior (internal) and D, anterior (external) aspects of N.Z. 11 (*Ph. vitulina*, fem. sin.). B, posterior (internal) and E, anterior (external) aspects of N.Z. 15 (*Ph. vitulina*, sin.). C, anterior (external) and F, posterior (internal) aspects of N.Z. 3 (*E. barbatus*, dext.). G, anterior (external) and J, posterior (internal) aspects of JM 17 (*Ph. vitulina*, dext.). H, anterior (external) and K, posterior (internal) aspects of JM 15 (*H. grypus*, dext.). I, posterior (internal) aspect of DM 1015 (*H. grypus*, sin.). L, posterior (internal) aspect of RM 2003 (*H. grypus*, sin.); distal fragment, Meuse levels.

Table VIII. Tibiae. Measurements in mm.

	<i>H. grypus</i> dext., V.T.v.S., ex D. Mol	N.Z. 17 dext.	N.Z. 46 sin.
Maximum length	>197	>131	>214
Sagitt. width, prox. end	45	51	46
Transv. width, ibid.	24	36	30.5
Sagitt. (a.-p.) width, centre of diaphysis	22.5	24	21
Transv. width, ibid.	15	17	14.5
Circumference, ibid.	63	71	57
Sagitt. (a.-p.) width, dist. end	31	—	>31.5
Transv. width, ibid.	23.5	—	±22.5
Colour gradation	—	7.5YR5/6-8/4	7.5YR3/4

left tibia without its distal epiphysis) from the Stolzenbach collection, collected between Smith's Knoll and the Brown Ridge. These two specimens should also be ascribed to female individuals, probably adult ones. Some measurements are given in table VIII, together with colour gradations for N.Z. 17 and N.Z. 46.

Finally, there is a single metatarsal bone, which we encountered in the Kerkhoff collection in which it is inscribed as number RM 2006 (Pl. I: H). Initially we thought (as did Mr Kerkhoff) that the bone might be of a Cave Lion, but its somewhat aberrant form prompted us later to compare metapodials of recent lions with those of recent seals. We soon concluded that the fossil in question, having an almost round (slightly higher than wide) transverse section and a large number of very fine foramina in the compacta, mainly at each extremity, could only belong to a seal. In felid carnivores the diaphysis of all metapodials is always somewhat flattened on the upper (dorsal) side, causing a flat ovaloid transverse section, while the compacta remains dense, also at the extremities of the bone, when there is no question of a pathological situation such as osteoporosis. Thorough comparison with recent material in the ZMA and ZMU collections (especially with the ZMU, Mammalia, no's 543, an adult, and 535, a juvenile specimen of *Ph. vitulina*) convinced us that the size of the bone suffices for a determination as *Halichoerus grypus* (Fabricius, 1791). The bone itself is a

metatarsale V, the longest toe in the phocid foot. Its colour is 10 GY 6/1 (greenish grey), which is the lightest gradation also encountered in the already mentioned RM 2003, the distal part of a femur sinister from the same locality (the Meuse levels) and also determined as *H. grypus*. The two bones may, in fact, well belong to the same individual! Measurements are given in table IX.

Table IX. Fifth metatarsal. Measurements in mm.

	RM 2006
Maximum length	86.5
Proxim. transv. width	20
Prox. dorsovolar width	27.5
Distal transv. width	15
Distal dorsovolar width	14
Transv. width, diaph. centre	12.5
Dorsovolar width, ibidem	15.5

## DISCUSSION

A review of the colour variations displayed by the seventy-three fossils, a procedure which we also attempted in our description of some walrus fossils (op. cit., p. 31), results in the rather unexpected fact that 35 specimens of *Phoca vitulina* and 6 of *Halichoerus grypus* share the hue 10 YR (in different values and chromata). This hue, brown with a yellowish base, is also the commonest encountered (7 specimens) among the walrus fossils. The more orange-brown hue 7.5 YR was recorded by us

for 8 specimens of *Ph. vitulina*, 6 of *H. grypus*, and also for each of the 3 *Erignathus barbatus* fossils. The still more reddish-brown hue 5 YR occurred in 7 specimens of *Ph. vitulina* and in 2 of *H. grypus*. In a single case, a *H. grypus* femur (JM 15), the dark reddish-brown hue 2.5 YR (with values from 3 to 4 and a continuous chroma, 2) was encountered while two fossils of *H. grypus* from the Meuse levels, as has already been stated, display the rather aberrant hue 10 GY (greenish grey, either dark, 3/1, or normal, 6/1). A single Meuse levels (*Ph. vitulina*) specimen, the radial fragment RM 3156, has a greyish olive colour, 7.5 Y 6/2. In 3 cases no colour was recorded by us.

If it is thought permissible to speculate a little, as we did in our cited paper on fossil walrus remains, we may perhaps again suppose that a conformity of hues indicates an identical (if not common) matrix from which the collected fossils have come. In the case of the hue 10 YR this might (but not necessarily has to) be either the comparatively thin cover of Holocene marine sands, or the complex of sandy Eemian marine deposits (Zagwijn's, 1983, zones E3 up to and including E6) already suspected by us as another possible level with remains of marine mammals. It does not appear very likely that such mammals would have existed along an Early Weichselian freshwater lake which was possibly closed off in the North by a continuous barrier of glacial ice down to what is, at present, the North Sea floor. Neither would such fossils occur in Early Holocene (e.g. Preboreal) continental deposits at a considerable distance from the Early Holocene East-West northern coastline through the North Sea basin.

The close of the interglacial Eemian time would also be a very likely or possible time-space (Zagwijn's zones E5, when sea level reached its peak height, and perhaps the earliest part of E6 with already colder temperatures) during which to expect remains of marine mammals to have been buried in coastal deposits such as the sands from which the present-day Meuse levels have now been artificially formed. In a later time span, including the earliest part of the Holocene, the

coastline was quite distant from the localities where the marine mammalian fossils of the Meuse levels are found. The edge of the sea came sufficiently close again to allow remains of marine mammals to accumulate in the area of the Meuse levels anew only after the close of the Early Holocene. Van Kolfschoten & Vervoort-Kerkhoff (1986, p. 60) consequently situate finds of *Ph. vitulina* and *H. grypus* in their third (Holocene) fauna of the Meuse levels together with fossils of the Common Porpoise *Phocoena phocoena* (Linnaeus, 1758) and of the Bottlenosed Dolphin *Tursiops truncatus* (Montague, 1821). However, in addition to these we encountered fossil remains of the Narwhal, *Monodon monoceros* Linnaeus, 1758, and of the Common Dolphin, *Delphinus delphis* Linnaeus, 1758, in Mr Kerkhoff's collection. The Narwhal remains display the colour hue 7.5 YR, while all the other fossils show several values of the hue 10 YR. We are tempted by this to suggest that fossil marine mammalian remains found on the Meuse levels may come from Holocene (post-Preboreal), as well as from final Eemian deposits, thereby agreeing with the supposed times of occurrence of the fossils from the North Sea bottom sediments. The Narwhal may perhaps be seen as an indicator of low temperatures; at the same time this animal is not so apt to enter and ascend large rivers as the mentioned dolphins and porpoises. There is something to be said for the supposition that the *Monodon* fossils from the Meuse levels could therefore originate from deposits of final Eemian age. Quite coincidentally the three *E. barbatus* fossils in our North Sea material also display the 7.5 YR colour hue. The Bearded Seal also seems to prefer cold waters, as is remarked by Ray & Spiess (1981, p. 426), although stray specimens may occasionally visit more southerly localities such as the four along the northern and western coast of the Iberian peninsula named in Ray *et al.* (1982). The species is "not a notorious vagrant or migrant" (Ray & Spiess, *op. cit.*). A (late) Eemian age for our North Sea specimens may thus be well feasible. Two of the three known occurrences of fossils of the species in North America (Ray et

al., op. cit., pp. 2-3) are somewhat younger (equivalent to the European final Weichselian). So are (Younger Dryas; and even Preboreal, Yoldia sea deposits) the seven fossil and sub-fossil finds of *E. barbatus* recorded by Lepiksaar (1964) from southern Sweden. A find from Ellesmere Island, Canada, is thought to be "Post-tertiary" (Ray et al., op. cit.), and some fossils found at Overstrand, Norfolk, England, reputedly date to Forest Bed times, which would mean that these are the earliest known Bearded Seal remains (Newton, 1889, 1891). Lepiksaar (op. cit., p. 260) again stresses the circumstance that this large seal is not very apt to migrate but prefers areas with unbroken ice and ice floes. It may therefore (but not necessarily is, see further on) be an indicator of climatological circumstances in the same way as the Narwhal, and final Eemian therefore does not appear as an unlikely guess with regard to the age of the three *E. barbatus* remains described by us in the present paper.

In the case of the fossil remains of *Phoca vitulina* and *Halichoerus grypus* it will be clear that this age may just as well be Holocene (younger than Preboreal) as Eemian, or even older, quite as in the case of the remains of *Odobenus rosmarus*. The two seal species can certainly not be regarded as typical climatological indicators. In recent times they occur regularly, even in reproductive colonies, along the British and French coasts, as is remarked by Van Bree & Chanudet (1965), even as far South as in the Bay of Biscay. During Late Pleistocene times this was not much different, as follows from the data cited by Robineau (1984) in a paper on the well-known "bâton de commandement" discovered in 1885 in the Upper Magdalenian of the cave of Montgaudier (Charente, France), on which engravings of a male and a female *H. grypus* are easily recognizable.

Man's unrelenting activity in the northern hemisphere in chasing and destroying seals, either as a source of fat and meat and because of the fur, or because they are supposed to be harmful for his fishing industries, has doubtlessly been the principal cause of the

decrease in numbers and the retreat in a northerly direction, not only of the species *Ph. vitulina* and *H. grypus*, but of seals in general. As a result they are popularly (but wrongly) thought of as "Arctic" animals. Data given by Forstén & Alhonen (1975) on the hunting of Grey Seal in recent times in the Baltic (op. cit., p. 146) show that "...individuals killed since the paying of bounty was imposed at the beginning of this century at times numbered thousands per year in Finland alone", and "The gregariousness of the grey seal has made mass slaughter of young pups as well as of adults feasible". We are aware that this hypothesis, i.e. that most, or many, seal species are not typically arctic animals but have been driven away by their human predators to those regions, stands directly opposed to our earlier supposition that the Bearded Seal might be seen as a climatological indicator. Each way of thinking has arguments in its favour, as we think that we have pointed out.

Ray & Spiess (op. cit., p. 426) have recorded some observations made when they distinguished femora and tibiae of Grey Seals from those of Bearded Seals. According to them the femoral neck is less constricted in *E. barbatus* than in *H. grypus*, while the trochanter major is also less produced proximolaterad, the "notch" between caput and greater trochanter is shallower, as is the trochanteric fossa (which is also more proximal in position), and the medial epicondylar crest is weaker (not so strongly produced cranial and not proximally extended in a prominent process), the intercondyloid fossa also being broader. It follows from our own observations that we can agree with many of these arguments, except for the remarks on the trochanteric fossa, which we think to be individually variable. Presence or absence of a prominent process at the end of the medial epicondylar crest is, in our view, possibly a variable feature also, although it will no doubt occur far more frequently in the robustly built femur of *H. grypus*.

The remarks made by the two cited authors on the features encountered in tibiae of *E. bar-*

*batus* and *H. grypus*, as far as these pertain to this bone in the Grey Seal, agree well with what we observed in the limited material at our disposition.

We have perhaps been lucky in encountering so many humeri among our fossils, as this bone seems to be more clearly diagnostic than, for instance, the femur in establishing the specific identity of a seal. At first sight absolute size forms an important indicator, as follows from the two figures 2 and 3. In each case the maximum length is compared with a measurement indicating the degree of robusticity of the bone, be it a femur or a humerus: the transversal width over the trochanter major in the case of the femur, and the minimum sagittal width of the diaphysis in the case of the humerus. A remarkable feature in each case is the presence of two clusters among the *Phoca vitulina* fossils. These correspond with a group of smaller, presumably female, and another of larger, perhaps male individuals. The *Halichoerus grypus* material consists of a too limited number of specimens to attempt the same procedure, but it is highly probably that here also the male and female specimens will appear in separate clusters if there is a sufficient number of individuals. A decided sexual dimorphism exists within the species, where the heavier males are in the habit of collecting a harem which they defend against other males. As *Erignathus barbatus* seems to be a more solitary living seal, it may not be possible there to distinguish the sex from isolated bones in the same way.

We have already mentioned the circumstance that an entepicondylar foramen is not always present in the *Ph. vitulina* humeri. This foramen lies at the distal and, anatomically, inner side of the humerus and is immediately recognizable as a distinct perforation through which pass the ulnar nerve and the collateral arteria and vena. The formation of this tunnel-like foramen is probably due to a proximad extension of the muscular attachments of the superficial forearm flexors towards the medial epicondyle of the humerus. Such an enlargement starts with expansion of the appropriate

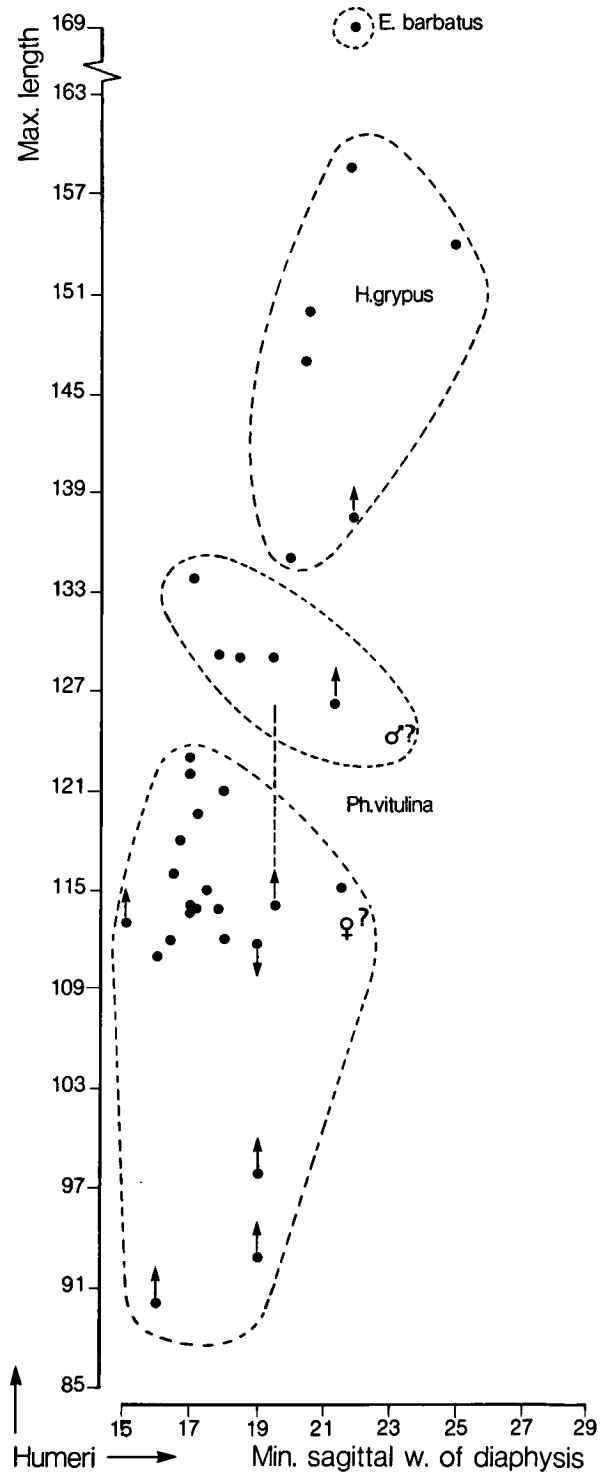


Fig. 2. Relation between maximum length and minimum width of diaphysis of phocid humeri. Arrows denote a probable greater (or lesser) max. length owing to incompleteness of a fossil. Possible sexual (size-) dimorphism of *Phoca vitulina* is indicated.

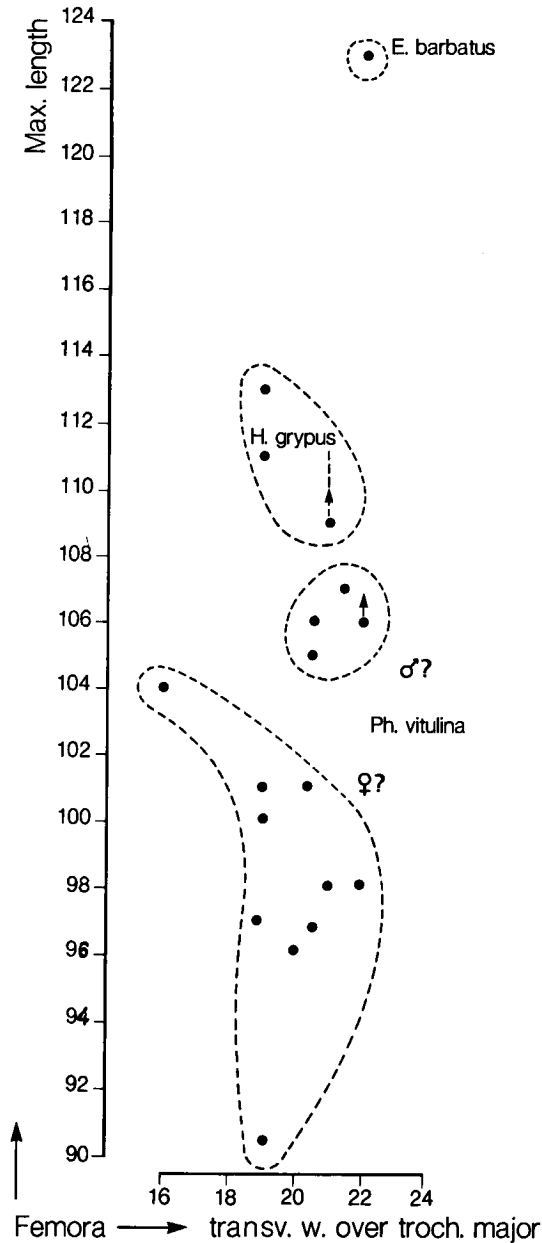


Fig. 3. Relation between maximum length and transverse width over the greater trochanter in phocid femora. Arrows denote a probable greater max. length owing to incompleteness of a fossil. Possible sexual (size-) dimorphism of *Phoca vitulina* is indicated.

tendons at the muscular extremities. Ossification may always occur in a tendon, and it does so in this case, causing the formation of a bony bridge on the inner distal side of the humeral diaphysis: thus the tunnel-like form of the

entepicondylar foramen is explained. The feature, which occurs as a (professionally induced?) rarity in *Homo*, is seen as a diagnostic phenomenon in all Felidae and almost all Mustelidae. It may well be linked to the habitual way in which these carnivores strike, and knock down, their prey immediately before killing it by a neck-bite or by strangulation. Tremendous and sudden power has to be exerted by the lower arm muscles for this purpose. In the case of the Phocidae we are not quite aware whether it is a regular habit here as well, or whether the exertion of swimming (using the flippers) is the principal causative. Anyhow the bony bridge does not appear to be formed so completely, so that it might be supposed that the responsible muscular exertions are of a slightly lesser strength.

Quite another approach to explain the occurrence of the entepicondylar foramen among Phocidae as well as Mustelidae consists of linking the two families by assuming the presence of a common ancestor. Thereby the anatomical feature is thought to be almost entirely influenced by genetical factors. When it is supposed that the Odobenidae (in which the humerus does not possess an entepicondylar foramen) and the Ursidae (also usually without this feature) share a common ancestor also, this leads to the frequently encountered diphyletical arrangement of the Phocoidea and of the Odobenidae, incorporated with the Otariidae into the Otarioidae, as two marine mammalian carnivore superfamilies that are only distantly related to each other. In the classical concept, on the other hand, the two are combined as the Pinnipedia. It seems an accepted fact that the Early Tertiary superfamily Arctoidea forms the common source, but whether the Pinnipedia represent a monophyletic or a diphyletic grouping based upon this source still remains an undecided problem as has convincingly been argued by Thenius (1972, pp. 224-231, fig. 89). Our experience tends to let us lend somewhat more weight to the extreme plasticity demonstrated by the development and growth of most bones as a reaction to their use and to changes thereof, than to genetic forces, with-

out, of course, denying the enormous importance of those influences. At the moment it appears sufficient that the problem is once more recorded and brought to the attention of the reader. We hope that additional evidence may show in the near future, how phocid evolution has really progressed.

It remains a mystery why we have not been able to find even single fossil remains of the Ringed Seal, *Phoca (Pusa) hispida* (Schreber, 1775), the Harp Seal, *Phoca (Pagophilus) groenlandica* (Erxleben, 1777) (nomenclature of both species after Burns & Fay, 1970) or the Hooded Seal, *Cystophora cristata* (Erxleben, 1777), among the dredged-up fossils from the North Sea. We remain confident that they will soon be encountered and recognized.

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#### RESUMÉ

Soixante-treize fossiles de Phocidés sont décrits du fond de la mer du Nord et d'un terrain côtier artificiel, le 'Maasvlakte', en aval du port de Rotterdam (construit de sables Pléistocènes et Holocènes, prelevés sur place). Ils sont attribués aux espèces *Erignathus barbatus* (Erxleben, 1777), le phoque barbu, *Halichoerus grypus* (Fabricius, 1791), le phoque gris, et *Phoca vitulina* (Linnaeus, 1758), le phoque veau-marin. Quelques observations sont faites sur des différences anatomiques entre des os isolés, ainsi que sur la distribution des trois espèces et sur les indications paleo-climatologiques qui en résultent.

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Institute of Taxonomic Zoology (Zoölogisch Museum), University of Amsterdam,  
P.O. Box 20125, 1000 HC Amsterdam, The Netherlands.