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A Weichselian marine mammal assemblage from the southern North Sea

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A fossil marine mammal assemblage from the southern North Sea is discussed. Carbon data confirm its Mid-Late Weichselian origin and proof that marine transgressions occurred in this area during several intervals of the Mid-Late Weichselian.

Keywords: Weichselian, Cetacea, Pinnipedia

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INTRODUCTION

Remains of extant marine mammal taxa have been recognised during the second half of the 20th century amongst the abundant fossil remains of Late Pleistocene terrestrial mammals dredged from the southern North Sea. These marine mammal fossils were considered to originate from Early Pleistocene, Holsteinian, Late Eemian, Early Weichselian and/or Early Holocene sediments (Erdbrink 1972; Kortebout van der Sluijs 1971; Bosscha Erdbrink & van Bree 1986, 1990b, 1999c; van Bree & Bosscha Erdbrink 1987; Vervoort-Kerkhoff & van Kolfshoten 1988). These assumptions were primarily based on the generally accepted hypothesis that the southern bight of the North Sea was dry land during the entire Mid- to Late Weichselian (Oele 1971; Laban 1995). Late Weichselian marine conditions occurred during the deposition of the Dogger Bank Formation and are postulated for the northern North Sea; however, neither sedimentary nor seismic evidence for Mid or Late Weichselian marine transgressions in the southern North Sea had been produced (Laban 1995).

Based on marine mammal fossils and ¹⁴C results, some authors came to consider the possibility of marine transgressions (Post & Kompanje 1995; Post 1999, 2000). The conflict between traditional geological data and the possibility of marine intervals based on marine mammal fossils caused a careful reconsideration of borehole sediments and resulted in the recognition of a series of short marine transgressions during the Mid- and Late Weichselian (Laban & Rijdsdijk 2002; van den Berg 2003).

This article summarizes fossil data, ¹⁴C results and stratigraphical evidence pertaining to the marine mammal assemblage and its paleoecological environment.

COMPOSITION OF THE WEICHSELIAN NORTH SEA MARINE MAMMAL FAUNA

Kortebout van der Sluijs (1971) was the first author to mention fossils of marine mammals from the southern North Sea when describing the Late Pleistocene *Mammuthus*-fauna assemblage, noting bottlenose dolphin *Tursiops truncatus*, beluga *Delphinapterus leucas*,

walrus *Odobenus rosmarus*, harbour seal *Phoca vitulina* and hooded seal *Cystophora cristata*. Subsequently, Erdbrink (1972) described fossil walrus remains, while Bosscha Erdbrink & van Bree (1986, 1990a,b, 1999a,b,c) and van Bree & Bosscha Erdbrink (1987) discussed fossils of harbour seal, grey seal *Halichoerus grypus*, bearded seal *Erignathus barbatus* and walrus. Vervoort-Kerkhoff & Kolfshoten (1988) described fossils collected at the Maasvlakte, an offshore extension of the Rotterdam harbour created through supplements of North Sea sediments, and listed harbour seal, grey seal, bottlenose dolphin, ringed seal *Pusa hispida*, harbour porpoise *Phocoena phocoena*, common dolphin *Delphinus delphis* and narwhal *Monodon monoceros*. Post & Kompanje (1995) described a large number of beluga fossils, the Late Pleistocene origin of which was established by ^{14}C results. Post (1999, 2000) and Glimmerveen *et al.* (2004) reported that fossils of walrus, bearded seal, grey seal, ringed seal, harp seal *Pagophilus groenlandica*, orca *Orcinus orca* and gray whale *Eschrichtius robustus* are regularly found together with beluga, while providing further ^{14}C dates. Finally, a Late Pleistocene specimen of humpback whale *Megaptera novaeagliae* was reported by Post (1999).

When evaluating the above mentioned taxa within the context of current knowledge, the following observations can be made.

a - A Late Pleistocene marine mammal faunal association of walrus, bearded seal, harp seal, ringed seal, beluga, and grey whale is corroborated by a multitude of ^{14}C results (Table 1).

b - Bottlenose dolphin, harbour porpoise and common dolphin did not occur in this Late Pleistocene fauna, but instead belong to Holocene faunas. ^{14}C dates (Table 1) and Holocene finds from all countries bordering the North Sea confirm their occurrence from the warmer periods of the Early Holocene onwards. These mammals may have entered the North Sea through the English Channel and their presence might therefore be limited to dates subsequent to the inundation of the

English Channel (C. Laban pers. comm.).

c - Postcranial elements of narwhal and beluga are difficult to distinguish and the listing of narwhal by Vervoort-Kerkhoff & van Kolfshoten (1988) appears to be based on fossils of beluga. To date, no fossils of narwhal have been positively identified amongst the North Sea fossils.

d - The identification of humpback whale (Post 1999) was based on a large atlas, damaged by feeding activities of hyena. Since then it became evident that this atlas must be identified to blue whale *Balaenoptera musculus* (M. Hofreiter unpublished data).

e - Hooded seal *Cystophora cristata* was mentioned by Kortenbout van der Sluijs (1971), presumably based on material kept at the National Museum of Natural History (Naturalis) in Leiden, where Kortenbout van der Sluijs was curator of fossil mammals at the time. However, no further details were given and no fossils of hooded seal are present in the collection of Naturalis. Moreover, not a single fossil of hooded seal has been identified amongst the thousands of seal fossils from the North Sea. Therefore conclusive evidence for the Late Pleistocene occurrence of hooded seal is lacking.

f - Reports of harbour seal (van Bree & Bosscha Erdbrink 1987) are based on erroneously identified fossils of harp seal. Based on rib fragments, Hufthammer (2001) reported Pleistocene harbour seal from Norway. However, seal ribs are non-diagnostic at the species level and there is as yet no evidence for the presence of harbour seal in the Pleistocene North Sea.

g - Fossils of orca and grey seal are often found together with fossils of the Pleistocene marine mammal fauna, showing a similar colour and degree of mineralization. Scarce ^{14}C dates of orca and grey seal remains indicate an Early Holocene age (Table 1), which is in line with abundant reports of these species in Holocene faunas around the North Sea (Lepiksaar 1964, Aaris-Sørensen 1988). Further ^{14}C dating may eventually show a Pleistocene occurrence of either or both of

Table 1 ¹⁴C datings on fossil marine mammals from the North Sea.

Species	¹⁴ C no.	Result	Object
Pinnipedia			
<i>Odobenus rosmarus</i>	UtC 3749	47.400+/-1600	Vertebra, No1062, Helgoland
	UtC 3751	50.000+/-2000	Pelvis, No 1090, Brown Bank
	GrA 22178	48.500	Cranium fragment, Eurogeul
	GrN 28548	> 48.000	Femur, dm 76, S. North Sea.
	K 3726	30.880	Cranium fragment, Denmark
	K 3727	24.300	Cranium fragment, Denmark
	K 4473	23.500	Cranium fragment, Denmark
	K?	26.700	Cranium fragment, Denmark
<i>Erignatus barbatus</i>	UtC 7880	46.400+/-1700	Vertebra, No 1494, Borkumrif
	UtC 3747	50.000+/-2000	Pelvis, No 859, Outer Rough
<i>Pagophilus groenlandica</i>	UtC 7883	45.000 +/-1400	Femur, No 2049, Brown Bank
	GrN 28546	45.600 +3400-2400	Humerus, dm 74, S. North Sea
	GrN 28547	> 43.500	Humerus, dm 75, S. North Sea
	GrA 26887	27.510 +/- 180	Sacrum, Cm-dm 78, Eurogeul
<i>Halichoerus grypus</i>	GrN 28551	7180 +/-60	Humerus, dm 79, S. North Sea
Cetacea, odontoceti			
<i>Delphinapterus leucas</i>	KIA 25281	54.010+3940-2630	Axis, MPI, S. North Sea
	GrA 22179	> 47.500	Vertebra, Eurogeul
	GrA 25849	> 45.000	Vertebra, No 2540, Borkumrif
	GrN 28544	> 45.100	Vertebra, dm 69, S. North Sea
	UtC 3752	38.500+/-800	Vertebra, No 1104, Westhinder
	UtC 3753	34.600+/-600	Vertebra, No 1110, Brown Bank
<i>Tursiops truncatus</i>	GrA 25850	7.390 +/- 50	Mandibula, No 3917, Smits Knoll
	GrA 25851	8.135 +/- 45	Mandibula, No 3920, Smits Knoll
	UtC 7885	7.270 +/- 60	Vertebra, No 2683, Brown Bank
<i>Lagenorhynchus albirostris</i>	GrA 25852	3.120 +/- 40	Mandibula, No 3919, Dutch coast
<i>Phocaena phocaena</i>	GrA 26885	3.335 +/- 35	Vertebra, Cm-dm 73, S. North Sea
<i>Orcinus orca</i>	GrA 25820	3.900 +/- 40	Maxilla, No 4133, 53°10' N - 03°19' E
Cetacea, mysticeti			
<i>Eschrichtius robustus</i>	GrA 22182	> 45.200	Vert., No 4032, Cm-dm 45, Eurogeul
	GrN 28549	42800 +4100-2700	Vertebra, dm 77, S. North Sea
	UtC 7884	1.921 +/- 35	Mandibula, No 2682, Witte Bank
	KIA 25282	1645 +/- 25	Mandibula, Rug
		1530 +/- 90	2-nd sample KIA 25282
	land UvA	8330 +/- 85	Cranium, NML 13130, IJmuiden
	land UvA	1730 +/- 50	Cranium, NML 630, IJmuiden
	land UvA	4195 +/- 45	Cranium, NML 20350, Zuiderzee
	land ?	4395 +/- 155	Cranium, Gräsö, Sweden
	land UvW	1329 +/- 195	?, Pentuan, UK
	land UvW	344 +/- 260	Vertebra, Babbacombe Bay, UK
		2024 +/- 110	Cranium, Thames Estuary

UvA = University of Arizona, USA.
 UvW = University of Washington, USA.
 K = University of Copenhagen, Denmark.

UtC = University of Utrecht, Netherlands.
 GrA/N = University of Groningen, Netherlands.
 KIA = Cristian Albrechts University, Kiel, Germany.

these species.

In summary, we may conclude that a marine mammal fauna consisting of beluga, gray whale, walrus, bearded seal, harp seal and ringed seal was present in the southern North Sea during the Late Pleistocene or, more likely, at several colder intervals during the Weichselian. Fossils and data of walrus from Denmark (Møhl 1985, Aaris-Sørensen *et al.* 1990, Table 1) and fossils of walrus and bearded seal from Outer Rough and German Bight locations (Post 1994, Table 1) implicate that this fauna was not only concentrated in the southern North Sea but has been present in other parts of the North Sea (albeit probably less common). Members of this marine faunal assemblage shared the ability to thrive and survive in cold and shallow waters along coastlines and their temporary presence in the North Sea was presumably linked to glacial phenomena during the Weichselian.

MARINE TRANSGRESSIONS WITHIN THE NORTH SEA FROM 50.000-10.000 BP

The North Sea consisted of dry land for most of the Weichselian due to low sea level stands caused by the large glaciated areas of the Northern hemisphere. However, based on the marine mammal fossils, at least three less colder phases, respectively ranging between about 51.000 to 46.000, 43.000 to 40.000 and 36.000 to 28.000 (calibrated) calendar years before present, must have occurred. Further proof for marine conditions between 45.000 to 42.000 BP. is based on datings of mollusc species found in marine intercalations in continental Weichselian deposits at or near the locations where marine mammal bones have been found (Van den Berg 2003).

SPECIES OF THE WEICHSELIAN ASSEMBLAGE

Although all species involved are extant and well-known, some peculiar facts about their Weichselian occurrence are noteworthy.

Walrus

Fossils of walrus from the southern North Sea are common and at least ten complete crania, hundreds of cranial and mandibular fragments and an even larger number of postcranial elements are stored in Dutch museums and private collections. Immature individuals are well-represented, while some material might be of neonates. All fossils belong to Atlantic *Odobenus rosmarus rosmarus* and measurements of tusks and postcranial elements indicate that the Late Pleistocene walrus was equal in size to present-day populations (K. Post unpublished data); the rare occurrence of double-tusked walrus is also noted (Post & van Bree 1996). The rather southern occurrence of walrus in the Atlantic has a parallel in the Pacific (Hoshimi & Akagi 1994). Obviously, glacial factors must have caused this contemporaneous southern occurrence in both ocean basins.

Bearded seal

Bearded seal fossils are rarely encountered among the North Sea material. Less than hundred postcranial remains are known at present and cranial material has as yet not been found. The Late Pleistocene bearded seal probably had a non-gregarious lifestyle similar to extant bearded seal, thus explaining the rarity of fossil remains.

Harp seal

Harp seal is the most common pinniped within this marine faunal association. Eight fairly complete skulls, many cranial fragments and several thousands of postcranial elements have been found from both adult and – to a lesser extent – juvenile individuals. Sizes of 256 fossil humeri and 170 femora are significantly smaller than Recent harp seal (Visser 2004), while skulls show a different dental pattern with no, or only very limited, space between the dental elements (K. Post, unpublished data). Whether these morphological differences with extant harp seal were merely caused by environmental constraints or are of sub specific significance must be resolved by future research.

Ringed seal

Fossils of ringed seal are even more scarce than those of bearded seal and no cranial material is known. This is quite remarkable given the multiple occurrences of Early Holocene ringed seal in Sweden, Denmark and Finland.

Beluga

Together with harp seal, beluga is the most commonly found fossil of the Late Pleistocene North Sea marine mammal association. Thousands of well-preserved postcranial elements (including remains of juveniles) are available for study. Complete crania have not yet been found, but many large cranial fragments are kept in various collections in The Netherlands. Recently some of the material has been used in DNA studies at the Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany, the results of which are forthcoming.

Gray whale

Today, gray whale is confined to the Pacific, but its Holocene occurrence in the North Sea and surrounding areas has been known for quite some time (van Deinsen & Junge 1937; Mead & Mitchell 1984; Bryant 1995). Recent ^{14}C results from North Sea fossils provided further evidence for the Late Pleistocene occurrence of gray whale in the North Sea basin (Table 1). The Weichselian datings of Atlantic gray whale have revived discussions on the Pacific and Atlantic wanderings of the taxon and Weichselian gray whale DNA is presently under study (M. Hofreiter pers. comm.)

Blue whale

Weichselian occurrence is confirmed by a large atlas (with feeding marks of hyena), previously attributed to humpback whale (Post 1999), but now re-identified as belonging to blue whale (M. Hofreiter, unpublished data). The occurrence of this unique fossil of blue whale amongst a multitude of marine mammals with a preference for shallow coastal waters, confirms that open sea must have been near by

and carcasses of larger whales were able to reach the mainland beaches.

CONCLUSION

Although the North Sea area consisted of dry land for most of the Weichselian, research on marine mammal and bivalve fossils proves marine conditions for at least three less colder intervals of the Weichselian. During these marine interfaces a marine mammal assemblage consisting of walrus, bearded seal, harp seal, ringed seal, beluga and gray whale occurred in the shallow coastal waters of the Weichselian North Sea. Occasionally carcasses of large whales were able to reach the seashores.

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