Post-Glacial history of the European seal fauna on the basis of sub-fossil records
Robert Sommer und Norbert Benecke

Introduction

Subfossil bones of six species of true seals (Phocidae) have been recovered during archaeological excavations in Europe: grey seal (Halichoerus grypus), ringed seal (Phoca hispida), harp seal (Phoca groenlandica), harbour seal (Phoca vitulina), bearded seal (Erignathus barbatus) and monk seal (Monachus monachus). All of these species have a recent distribution in different European coastal waters. In the course of climatic changes during the Late Glacial and Holocene, due to the melting ice sheets in northern Europe, new settlement areas developed along the coasts, and also newly-formed water bodies served as habitats for seals. In the past, numerous reports of bones of different European seal species have been published.

Unlike coastal regions on the Atlantic Ocean, the Barrents and the Mediterranean Seas, an extensive inventory of sub-fossil bones from the Late-Glacial and Holocene were discovered in the Baltic area. Based on these records, many attempts have been made to reconstruct the temporal and spatial settlement of the Baltic Sea. These records, however, have been refuted through more recent research (SAARNISTO et al. 1995, BJÖRCK pers. comm., SAARNISTO pers. comm.). With the help of all available sub-fossil records, the present study aims to portray the history of Europe’s seal fauna with special reference to its development in the Baltic Basin.

Geomorphological development of the Baltic Basin in the Late-Glacial and Holocene

For migration purposes, seals are dependent on the presence of appropriately-sized bodies of water. In order to explain and understand the settlement events of individual seal species in the Baltic region, it is necessary to refer to geomorphological and climatic processes. The following is a short review of the important processes in the development of the Baltic Sea.

The Weichselian glaciation reached its peak between 21000 and 18000 BC. Following this, during the Late-Glacial, the glaciers retreated northwards in several stages. The Bølling and Allerød interstadials, left northern Germany, Denmark and a significant part of the Baltic States ice-free at that time (AARIS-SØRENSEN 1992). The retreat of the glaciers from the Onega Basin took place between 12250 and 10750 BC (SAARNISTO & SAA­RNEN 2001), initiating the formation of the Baltic Ice Lake in the Baltic Basin (c. 13600–10300 BC, Fig. 2a), which contained freshwater and was isolated from the ocean. It was after the Allerød interstadial, though, that a connection to seawater took place. Earlier sources (e.g. SAURAMO 1958) report that, in the Late-Glacial, there was still a connection between the Baltic Basin (Baltic Ice Lake) and the White Sea. This viewpoint, however, has been refuted through more recent research (SAARNISTO et al. 1995, BJÖRCK pers. comm., SAARNISTO pers. comm.).

In the Younger Dryas, the last phase of the Late-Glacial (from c. 10300 BC on), the further retreat of the Scandinavian ice sheet caused the formation of a more complex connection between the Baltic Basin and the world’s oceans. As a result, the water level of the Baltic Ice Lake in the Baltic Basin decreased by about 25 m (BJÖRCK 1996). This connection was located in the area of the Vänern Basin in southern Sweden and was characterized by the entry of seawater (Fig. 2a). The Öresund connection no longer existed at that time, but a major land bridge connecting Denmark and southern Sweden was present again (BJÖRCK 1995a). The seawater reached the area of present-day Stockholm through

Fig. 1: Chronozones (Roman numbers) and temporal relationships during the development of the Baltic Sea in the Late Glacial and Holocene.
Fig. 2: Development of the Baltic Sea: a. Baltic Ice Lake; b. Yoldia stage; c. Ancylus stage; d. Litorina stage. Figures by kind permission of Lembi Loügas (Tallinn, Estonia).

the Värnern Basin and Närkesund, respectively. *Yoldia arctica*, a bivalve mollusc, was transported to the southern Swedish Baltic area via deep water currents in the Younger Dryas; this geological stage of the Baltic Sea was therefore named after this species – »Yoldia Stage« (c. 10300–8750 BC; Fig. 2b). In the middle Pre-Boreal,
the connection of the Yoldia Sea with the ocean across the lowland west of Mt. Billingen and the depressed area of central Sweden was cut off by ongoing land uplift, so that an oligotrophic to mesotrophic freshwater lake, the Ancylus Lake, was formed behind the Yoldia Sea. This lake was named after a gastropod, Ancylus fluviatilis, widespread at that time. By 9500 BP (8750 BC) at the latest, the Ancylus Lake was geographically completely isolated from the ocean (BJÖRCK 1995a; Fig. 2c). This period (c. 8750–7000 BC) of the later Baltic Sea lasted until the Boreal climatic epoch (c. 8000–7000 BC) and ended approximately at the beginning of the Atlantic. The area of the western Baltic Sea continued to be land at the time of the Ancylus Lake (Fig. 2c).

Because of Scandinavia’s isostatic uplifting, the Ancylus Lake gradually moved southwards at the beginning of the Atlantic and, in some places, extended as far as today’s coastlines of Germany, Poland and the Baltic States (JAHNKE 1996). Around 7000 BC, the progressive isostatic uplifting of the region initiated the formation of an outlet of the Ancylus Lake into the sea, which was located within the Darss Sill and the straits Fehmarn Belt and the Store Belt. It was approximately from that time that brackish water was detected in the southern part of the Baltic Sea. This lake was named after a gastropod species, from which the characteristic expression »Litorina Sea« is derived. 

Material and methods

Using an extensive database, in which zoological information from both published and unpublished archaeological finds for Europe are registered (BENECKE 1999), all available information about sub-fossil true seal finds from the Late Glacial and Holocene in Europe was collected (Fig. 3). The data were revised, updated and checked.

According to their dating, the data were assigned to chronozones (Tab. 1 and Fig. 1). In most cases, sub-fossil finds were dated by assigning them to an archaeological layer. To facilitate a chronological classification of finds of individual species as exactly as possible, available 14C dates for single bones were used. These were either taken directly from the sources or made available by colleagues. All 14C data are listed in the appendix.

In order to chronologically assign non-14C-dated remains of a species as exactly as possible, each find was temporally placed between the oldest and youngest dating of the remains of other organisms from the excavation site. This was only done, however, when it was clear from the archaeological context that, at the respective excavation, the remains were of only one settlement period. The calibration of 14C data was carried out after Stuiver et al. (1998). Additionally, the PC program OxCal (Oxford University) was used. All assemblages that could not be assigned to chronozones due to unsuitable dating were chronologically arranged by their cultural epoch and included in the investigation. For the cultural epochs, the chronology of Northern Europe was applied.

With the help of a Geographic Information System (GIS), all sub-fossil assemblages from the chronozones and cultural epochs were recorded sequentially on a digital map. The localities, which were simulated temporally and spatially based on GIS, served to gain data on the Late- and Post-Glacial distribution. To accompany the detail in the text, all sub-fossil finds are presented in maps.

Fig. 3: Sites of sub-fossil seal bones from the Late-Glacial and Holocene in northern Europe.
Tab. 1: Number of sites of sub-fossil phocid records in Europe.

<table>
<thead>
<tr>
<th>Chronozone/cultural period</th>
<th>Space of time</th>
<th>H. gryp</th>
<th>P. hispi</th>
<th>P. groen</th>
<th>P. vitu</th>
<th>M. mona</th>
<th>E. barb</th>
</tr>
</thead>
<tbody>
<tr>
<td>I Late Glacial</td>
<td>(15000 BC–9000 BC)</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>II Pre-Boreal/Boreal</td>
<td>(9000 BC–7000 BC)</td>
<td>1</td>
<td>6</td>
<td>1</td>
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<td>III Atlantic</td>
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<td>11</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>IV Atlantic/Sub-Boreal</td>
<td>(5500 BC–3000 BC)</td>
<td>33</td>
<td>11</td>
<td>17</td>
<td>7</td>
<td></td>
<td></td>
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<tr>
<td>V Sub-Boreal</td>
<td>(3000 BC–1000 BC)</td>
<td>44</td>
<td>28</td>
<td>39</td>
<td>12</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>VI Sub-Atlantic</td>
<td>(1000 BC–0)</td>
<td>8</td>
<td>3</td>
<td>3</td>
<td>7</td>
<td></td>
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<tr>
<td>VII Sub-Atlantic</td>
<td>(0–600 AD)</td>
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<td>1</td>
<td>5</td>
<td>1</td>
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<tr>
<td>VIII Sub-Atlantic</td>
<td>(600–1500 AD)</td>
<td>28</td>
<td>4</td>
<td>8</td>
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<td>(9500–4000 BC)</td>
<td>23</td>
<td>13</td>
<td>4</td>
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<tr>
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<td>8</td>
<td>10</td>
<td>6</td>
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<tr>
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<tr>
<td>Iron Age/Roman Times</td>
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<td>2</td>
<td>2</td>
<td>3</td>
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<tr>
<td>Migration Period</td>
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<td>1</td>
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<tr>
<td>Without precise dating</td>
<td></td>
<td>10</td>
<td>6</td>
<td>7</td>
<td>7</td>
<td>2</td>
<td></td>
</tr>
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</table>

Results

Data

Sub-fossil bones of true seals have been found at 297 places and cultural layers in Europe so far. All European localities with sub-fossil seal bones used are listed in the appendix. Available data for individual species are presented in table 1.

Ringed Seal (Phoca hispida)

Except for one record on Spitsbergen from recent times (VAN WIJNGAARDEN-BAKKER & PALS 1981) and four finds at the Varangerfjord in northern Norway from the Sub Boreal and Sub-Atlantic (RENOUF 1989), the ringed seal is documented in Europe exclusively in the Baltic area and the adjoining Kattegat and Skagerrak, in 97 sub-fossil assemblages.

For the Late-Glacial, the presence of P. hispida was recorded by LEPIKSAAR (1964) in the Kattegat. Based on, among others, AMS dates, the ringed seal was also found in the Gulf of Bothnia and on Gotland during the older Holocene (LINDOVIST & POSNERT 1997; UKKONEN 2002). Finds from the middle Holocene (FORSTEN 1972; FORSTEN & ALHONEN 1975; 1977; FORSTEN & BLOMQVIST 1977; EKMAN & IREGREN 1984; JONSSON 1988; TEICHERT 1989; LÖUGAS 1997) can be gathered from Fig. 4. Numerous records from the Mesolithic give supplemental information for characterizing its distribution pattern in the Post-Glacial, such as in the Gulf of Finland (AILIO 1909; FORSTEN 1972; LÖUGAS 1997; s. Fig. 4).

For the younger Holocene (Sub-Atlantic), P. hispida is documented in a few faunal assemblages (LEPIKSAAR 1961; ROSEN LUND 1976; REICHSTEIN 1991; LÖUGAS 1997; 1999) such as the Gulf of Bothnia and Finland as well as in the western Baltic Sea area.

Phoca hispida was the only seal species to enter the Baltic Basin through the Närke Strait during the Yoldia Stage and was able to reproduce there. Immigration of ringed seals from the White Sea during the Late Glacial was not possible, as no connection existed (SAARNISTO et al. 1995). Radiocarbon dates of ringed seal bones along the Finnish coast give a reference for the species in the region of today’s Gulf of Bothnia during the period between 8750 and 7240 BC (UKKONEN 2002). At that time, the Baltic Basin was in the stage of the Ancylus Lake and isolated from the Atlantic (BJÖRCK 1995a). The shores of the Ancylus Lake were situated very far inland, especially in the early Ancylus stage. Therefore, seal remains from the older Holocene and early Atlant-
tic respectively (chronozones II and III) were, in contrast to later times, more often found far in the interior. The vanishing connection between the Gulf of Finland and the Ladoga Lake during and at the end of the Ancylus stage (Saarnisto et al. 1995) led to the enclosure of the population, which came to bear the name Phoca hispida ladogensis. Along with the isolation of the Finnish lake basins from the Baltic Basin, occurring due to land uplifting during the Ancylus period, went the separation of the animals nowadays called Phoca hispida saimensis. While both the Gulf of Bothnia and Finland apparently have been inhabited by *P. hispida* since the Holocene, the species seems to occur only sporadically in the western Baltic region after the Sub-Boreal. It is unclear, though, whether the animals have immigrated from the Arctic population or whether they are members of the Baltic population that have migrated into the western Baltic. Current genetic studies confirm a gene flow into the Baltic Sea (Palo et al. 2001).

Nevertheless, it is possible since their separation that the three subspecies *P. h. bottica* (Baltic Sea), *P. h. saimensis* (Saima Lake) and *P. h. ladogensis* (Ladoga Lake) have been in contact with each other as a result of their wanderlust along rivers.

**Harp Seal (Phoca groenlandica)**

Except for a few records from the southern and northern Norwegian coast, *Phoca groenlandica* is documented in Europe exclusively in the Baltic area and the adjoining Kattegat and Skagerrak from 92 sub-fossil assemblages. Harp seal bones from south-western Sweden (Bohuslän, Västergötland) are dated back to the Allerød and the Dryas III by Lepiksaar (1964) and Freden (1975) on the basis of the geological location of the sites and several $^{14}$C dates. Remains of *P. groenlandica*, which were discovered during excavations of mussel shells near Uddevalla (Bohuslän, south-western Sweden), have been assigned to the Yoldia stage (Lepiksaar 1964). From the Late Atlantic/early Sub-Boreal (chronozone IV), 15 sub-fossil records of *P. groenlandica* are known, which, beside the western Baltic, also come from the Öland Island (Lindqvist & Possnert 1997), the Gulf of Finland (Lougas 1999) and the Gulf of Bothnia (Forsten & Alhonen 1977) (Fig. 5). The most extensive sub-fossil material of harp seal bones in the Holocene can be attributed to the Sub-Boreal (chronozone V) (Fig. 5).

The most frequent records of *P. groenlandica* beside Gotland Island come from the western Baltic region (Lepiksaar 1974; Rosenlund 1976; Aaris-Sørensen 1978; Lindqvist & Possnert 1997; Stora 2001). From the Sub-Boreal the species is also documented in Finland on the Norwegian coast of the Barent Sea (Renouf 1989). Only a few sub-fossil finds are known from the chronozones VI and VII (Salmi 1963; Sellstedt 1966; Renouf 1989; Lougas 1999). In the period of chronozones VIII (600–1500 AD), which roughly corresponds with the Middle Ages, the harp seal is documented on the Swedish, Danish and German coasts (Lepiksaar 1966; Jonsson 1972; Rosenlund 1976; Boessneck & von den Driesch 1979; Reichstein 1991; 1995).

Numerous absolute dates (see appendix) have proved that the harp seal was present in the Vänern Basin, i.e., the passage to the Baltic Ice Lake and Yoldia Sea respectively, during the Allerød and Dryas III. Immigration into the Baltic Basin during that period seems to be very doubtful due to ecological reasons (Lepiksaar 1964; Lindqvist & Possnert 1997) and is clearly rejected, especially with regard to the analysis of available sub-fossil assemblages.

In the past, the history of harp seals in the Baltic Sea has been discussed with three different hypotheses:

1. The relict theory by Ekman (1922) describes the Post-Glacial Baltic harp seals as relicts from the Yoldia stage. This assumption was last expressed by Requate (1962). In accordance with current knowledge, this theory seems very unlikely, however.

2. Forsten & Alhonen (1975) and Lindqvist & Possnert (1997) postulate that harp seals migrated into the Baltic Sea during the Litorina phase and reproduced there.

3. Both Lepiksaar (1964; 1986) and Lougas (1998) consider harp seal invasions from the Barent Sea to be a likely cause for their occurrence in the Sub-Boreal. Major migrations and invasions to regions that lie outside of this area are known and have often been observed (Kapel 1994a). Lepiksaar (1964; 1986) and Lougas (1998) refer to the fact that no seal cubs have so far been detected in the osteological assemblages.
In most recent times, Storå (2001) proved with osteological studies on sub-fossil material of *Phoca groenlandica* from the Sub-Boreal and Neolithic that reproduction of the species did indeed happen in the Baltic. The conspicuously small phenotype of Sub-Boreal harp seals is certainly connected to this fact (Lepiksaar 1964, Lögas 1998).

On the basis of the present ¹⁴C data (see appendix), as well as bone finds from reliably-dated prehistoric settlements, it can be assumed that harp seals migrated into the Baltic Sea in the second half of the Atlantic. It is possible to make a connection between both the immigration and reproduction of *P. groenlandica* in the Baltic Sea and the development of environmental conditions in the Baltic water systems. Along with a high increase in salinity during the Litorina phase (Ehlers 1994), following the Mastogloia phase, marine fish species and thus potential prey such as cod (*Gadus morrhua*) and herring (*Clupea harengus*) arrived in the Baltic Basin (Lögas 1999). Other species also benefited from this development. For example, the harbour porpoise (*Phocoena phocoena*) has occurred in the Baltic Sea since then (Ukkonen 2002).

The small size of *P. groenlandica* in the Sub-Boreal is therefore likely a result of the Baltic's changed climatic and environmental conditions on reproduction. This possibility was pointed out by Lepiksaar (1964). In the Sub-Boreal, the distribution and frequency of *P. groenlandica* in the Baltic Sea apparently reached their maximum in Post-Glacial times (Fig. 5). Compared to those from the Sub-Boreal and Neolithic, the number of finds from the Sub-Atlantic is strikingly low. This fact, however, has also been observed with grey and harbour seals, at least in the period between 1000 BC and 600 AD (chronozones VI and VII). The species' small size can no longer be observed on skeletal remains from the Sub-Atlantic, so it can be assumed that the harp seal population reproducing in the Baltic Sea did not exist any longer. Also, the finds from the Iron Age described by Lepiksaar (1964) appear to be remains of animals that immigrated.

**Harbour Seal (Phoca vitulina)**

Among all true seals in coastal waters of Europe's temperate and boreal zones, the harbour seal is only represented in 59 sub-fossil assemblages. One record from the caverns of Altamira (coast of the Bay of Biscay, Spain) has been dated to the Late Glacial by Altuna (1972). *Phoca vitulina* has been documented since chronozone IV (late Atlantic/Sub-Boreal). From this time sub-fossil bones are known from coastal waters of Norway, Denmark, the Netherlands, Poland and Germany (Rosenlund 1976, Zeiler 1995, Kubasiewicz 1958, Teichert 1989).

In the Sub-Boreal (chronozone V, 3000–1000 BC), the harbour seal is documented on northern Scotland's Orkney Islands (Sutherland 1983) and at the North Cape (Renouf 1989) (Fig. 6), while one record from the Gulf of Riga exists for the Neolithic (Lögas 1999). Further records from the Sub-Atlantic are included in Fig. 6.

The Late Glacial record from northern Spain (Altuna 1972, Altuna & Straus 1976) is separated considerably in time from the remaining sub-fossil material. The bones could originate from mixed layers, as is usually the case in cave sediments, to be a mixture with layers from the Holocene. A final conclusion can only be reached through ¹⁴C dating.

When looking at faunal history, the harbour seal is the most recent immigrant among the seals of northern European coastal waters. Except for the find from northern Scotland, harbour seals have not been detected along the Atlantic coast of the British Isles before the Sub-Atlantic. Even though no ¹⁴C dates are available, the harbour seal is presumed to have been present in northern European coastal waters since at least the Sub-Boreal. The earliest records of *Phoca vitulina* were found in the Baltic Sea, except for one find on the Dutch coast. These relatively recent harbour seal records in the Baltic Sea therefore refer to a dispersal into the western Baltic (Sommer & Benecke 2002).

During the Late-Mesolithic in Europe, members of the Ertebølle culture settled in the region of the south-western Baltic Sea. From some of these settlements harbour seals have been recorded, as these people were also specialized in hunting seals. Finds from the Sub-Boreal have been discovered on the Danish islands, in the Kattegat and the Skagerrak as well as on Gotland.

With the exception of finds from Estonia and Finland, the latter of which (Ukkonen 2002) is doubtful, all further sub-fossil finds from 1000 BC–1500 AD were found in the western Baltic. This find pattern corresponds very well with the recent distribution pattern in the Baltic Sea. As the continuous settlement of the south-western Baltic Sea has been proven, it can be concluded that *Phoca vitulina* has occurred in this area since the Sub-Boreal. Harbour seals could therefore have resided...
there for roughly 6000 years, representing the most recent immigrants of seal species into the Baltic Sea, as also accepted by LEPIKSAAR (1964).

Grey Seal (Halichoerus grypus)

The grey seal has been recorded in 169 sub-fossil assemblages and is by far the most frequently represented Phocidae species in Europe. The earliest records of *H. grypus* from European coastal waters come from northern Spain’s Atlantic coast, dated to the Magdalénien and Azilian (STRAUS et al. 1981; ALTUNA 1986). In Gibraltar, bone remains of the species were recovered from the Palaeolithic and Mousterian (ZEUNER 1953).

Along the North and Baltic Sea coasts, the species is recorded for the first time by two finds on the West-Swedish Skagerrak coast, which date from the Pre-Boreal and Boreal (LEPIKSAAR 1964; FREDEN 1975). From the Atlantic (chronozone III, 7000–5500 BC), only two sites are known, which represent the first confirmation for *H. grypus* in the Baltic Sea (Fig. 7), while the species was recorded in the area of the British Isles (on the west coast of Ireland) for the first time in chronozone IV (WOODMANN 1978). During the same period (5500–3000 BC), it was also found on the south-western Norwegian coast (DEGERBÖL 1951), in the Gulf of Bothnia and Finland (LOUGAS 1997; FORSTEN 1979) as well as in the entire south-western Baltic (Fig. 7). In the Sub-Boreal (chronozone V, 3000–1000 BC), *H. grypus* was first recorded on the Dutch coast (BRINKHUizen 1979, CLASON 1967), on Cornwall’s Scilly Islands (GRAY 1983) as well as at the North Cape (RENOUI 1989).

For the early Sub-Atlantic, records exist from northern Scotland (FINLAY 1996) and the Dutch east coast (VAN GELDER-ÜTTWAY 1988) as well as the western Baltic Sea. All further finds from the Sub-Atlantic (chronozones VII and VIII, 0–1500 AD) come, with only a few exceptions, from the western Baltic Sea (Fig. 8).

Although *H. grypus* is much more frequently represented in sub-fossil faunal assemblages in Europe than all the other Phocidae, it is likely that only fragments of the actual prehistoric distribution in the Holocene exist. The high specialization of the Ertebølle culture alone establishes a representative picture of the seal fauna in coastal regions during the chronozone IV (the Late Mesolithic) (Fig. 7).

*H. grypus* is very rarely documented in northern European coastal waters during the Late Glacial, Older Holocene and early Atlantic. These finds, which have been dated very exactly (LEPIKSAAR 1964; FREDEN 1975), confirm the occurrence of grey seals on the Swedish west coast during the Baltic’s Yoldia and Ancylus periods (Dryas III and Pre-Boreal). In this context, the settling in the Baltic Sea by *H. grypus* needs to be discussed. So far, grey seals have only been documented in the Baltic region from the Atlantic at the earliest, the time of the Litorina stage. LINDOVIST & POSSNERT (1997) describe one *H. grypus* find from Gotland, which they refer to as being from the period between 7300–6600 BC, i. e., the late Ancylus and early Litorina stage of the Baltic Basin.

Because of the temporal and spatial distribution of grey seal finds in relation to the geological development of the Baltic Basin, it seems unlikely that the species lived in the Ancylus Lake. In this case, immigration into the basin would have to have happened at the end of the Yoldia stage at the latest (c. 8750 BC). It is more plausible that the specimen in LINDOVIST & POSNNERT (1997) reached the young Baltic Basin via the Öresund at a very early time. This assumption is also discussed by LINDOVIST & POSNNERT (1997) and UKKONEN (2002). Aside from that, the find site – the Stora Fövar Cave – is also covered with Neolithic layers, so that the early dating of the find should not be overrated.

Contrary to present knowledge, a Post-Glacial isolation of grey seals in the Ancylus Lake has been declared in literature of the past (ANDERSON 1994; DAVIES 1957).
When studying sub-fossil records of *H. grypus* it can be seen that they are restricted, with only a few exceptions, to the western Baltic area. Indeed, a convergence with the Ertebølle culture that specialized on, amongst others, seal hunting, is possible in this region in chronozone IV (5300–3800 BC); however, finds from the Sub-Atlantic also show a western distribution. A further reference for the assumption of a western distribution in the middle and younger Holocene is the fact that numerous ringed and harp seals had been hunted on the coast of the Gulf of Bothnia during this period (Fig. 4 and 5), while the grey seal was hardly ever found. Only in modern times the range of the Baltic *H. grypus* population has moved to the north-eastern Baltic area.

**Bearded Seal (Erignathus barbatus)**

Only a few sub-fossil records of the bearded seal exist in Europe. The seven sub-fossil assemblages that included *Erignathus barbatus* were all recovered in the area of the former Swedish west coast on the Kattegat/Skagerrak (Lepiksaar 1964; Freden 1975). With the help of deposits in the sediment and several 14C dates, these finds are assigned to the Late-Glacial (Freden 1975). The Arctic bearded seal, which is especially found in areas with drift-ice (Kapel 1994b), lived along the margin of the melting Scandinavian ice sheet and ventured to the south-western glacial margin of the Baltic Ice Lake in the Allerod. During the Baltic's Yoldia phase, bearded seals reached the Vänern Basin, documented by the find from Grums with a radiocarbon age of 10105±180 BP (Freden 1975). Since the Yoldia stage, the species has not occurred in the Baltic Basin again.

In the Sub-Boreal and Iron Age, *E. barbatus* has been recorded in the Finland region on the Norwegian coast of the Barents Sea (Renouf 1989). Evidence for its occurrence in modern times is provided by a find from Spitsbergen (van Wingenarden-Bakker & Pals 1981); nowadays, the species can occasionally be found in these coastal regions (Kapel 1994b).

**Mediterranean Monk Seal (Monachus monachus)**

Sub-fossil records of the monk seal in Europe are restricted to the Mediterranean and Black Sea. The species has been recorded from the Spanish south coast in the Late-Glacial (Bate 1928; Zeuner 1953; Boessneck & von den Driesch 1980; Rodrigo Garcia 1994), and cave finds exist from Sardinia in the Atlantic period (Tagliaocozzo 1993). In the Sub-Boreal, *M. monachus* is documented in Sardinia and on the Aegean coast of southern Greece (von den Driesch & Boessneck 1990; Tagliaocozzo 1993).

In the Black Sea region only two sub-fossil assemblages include bones of the monk seal. The first was detected in western coast region (Dobrudsha) and dated to the late Atlantic (Nobis & Ninov 2002). The other was recorded at the mouth of the Bug and assigned to the Roman Times (Calkin 1960). Compared to the present European distribution pattern (Duguy & Marchessaux 1994), no change in range of *Monachus monachus* seems to have taken place since the Late-Glacial. Possible local shifts of distribution within the Mediterranean Sea cannot be shown due to the small range of data available.

**Summary**

In sub-fossil assemblages on the European coasts, six species of Phocidae have been documented so far: grey seal (169 records), ringed seal (97 records), harp seal (92 records), harbour seal (66 records), bearded seal (10 records) and Mediterranean monk seal (12 records). The ringed seal, *Phoca hispida*, was the only species to arrive via the Närkesund in the Baltic Basin during the Late Glacial/Pre-Boreal and to have reproduced there. Ringed seal bones from the Finnish coast confirm the presence of the species in the Gulf of Bothnia during the Ancylus phase from 8750–7240 BC. Therefore, seal remains from the Older Holocene and early Atlantic were more frequently found far away from the coasts towards the interior, compared to later time periods. While the Gulf of Bothnia and Finland have obviously been settled by *P. hispida* since the Holocene, the species seems to have occurred only sporadically in the western Baltic area since the Sub-Atlantic.

Grey seals (*Halichoerus grypus*) are much more frequently represented in the sub-fossil assemblages of Europe than all the other phocids and have been recorded in European coastal waters since the Late Glacial. During the Ancylus phase of the Baltic Sea, grey seals settled along the West-Swedish coast on the Skagerrak. Given the temporal and spatial distribution of grey seal finds in relation to the geological development of the Baltic Basin, it seems unlikely that the species lived in the Ancylus Lake. Contrary to present knowledge, a post-Glacial isolation of grey seals in the Ancylus Lake has been argued in past literature. The range of the Baltic *H. grypus* population has only moved to the north-eastern Baltic area in modern times.

Harp seals spread to the Vänern Basin, i.e., the passage to the Baltic Ice Lake or Yoldia Sea, during the Allerød and Dryas III. Immigration into the Baltic Basin during that period appears very doubtful due to ecological reasons, and is clearly rejected by the analysis of available sub-fossil assemblages. In recent times, it was confirmed for the first time that reproduction of the species had indeed occurred in the Baltic. The conspicuously small phenotype of Sub-Boreal harp seals, which has been described as *Phoca groenlandica neolithica*, is certainly connected to this fact. It is assumed that harp seals migrated into the Baltic Sea during the second half of the Atlantic. There also seems to be a connection between both the immigration and reproduction of *P. groenlandica* in the Baltic Sea and the developing environmental
conditions in the Baltic water body. In the Sub-Boreal, the distribution and frequency of *P. groenlandica* in the Baltic Sea apparently reached their maximum in Post-Glacial times. The reproducing harp seal population vanished in the Sub-Atlantic. The harbour seal (*Phoca vitulina*) is the most recent immigrant among the seals of northern European coastal waters. Harbour seals have spread in northern Scotland, on the Dutch coast and in the Baltic Sea since the Sub-Boreal at the latest. The relatively recent records of the species in the Baltic indicate a settlement of the western Baltic Sea. Harbour seals have occurred in the Baltic Sea for about 6000 years.

The Arctic bearded seal (*Erignathus barbatus*) lived along the margin of the melting Scandinavian ice sheet and ventured to the south-western glacial margin of the Baltic Ice Lake in the Allerød. During the Baltic's Yoldia phase, bearded seals reached the Vänern Basin. The species has not occurred in the Baltic Basin since the Yoldia stage. The Mediterranean monk seal (*Monachus monachus*) has been recorded in the Mediterranean Sea during the Late-Glacial and in the Black Sea during the Roman Times.

**Zusammenfassung**


Kegelrobben (*Halichoerus grypus*) sind im subfossilen Fundgut Europas wesentlich häufiger als alle anderen Phociden repräsentiert und können seit dem Spätglazial im europäischen Küstengebiet nachgewiesen werden. Während der Ancylusphase der Ostsee haben Kegelrobben an der westschwedischen Küste im Gebiet des Skagerrak gelebt.


Die Mönchsrobbe (*Monachus monachus*) kann in Europa im Spätglazial im Mittelmeergebiet und für die Kaiserzeit im Schwarzen Meer nachgewiesen werden.

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**Appendix a: 14C datings of subfossil seal bones.**

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<th>locality</th>
<th>14C dating</th>
<th>Reference</th>
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<td>Västra Frölunda</td>
<td>9410 ± 100 BP</td>
<td>Fredén 1975</td>
</tr>
<tr>
<td>2</td>
<td>Phoca hispida</td>
<td>Kudrulkula</td>
<td>4835 ± 100 BP</td>
<td>Lögas 1997</td>
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<tr>
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<td>Phoca groenlandica</td>
<td>Skottorp</td>
<td>11280 ± 165 BP</td>
<td>Fredén 1975</td>
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<tr>
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<td>Hästefjorden</td>
<td>10875 ± 160 BP</td>
<td>Fredén 1975</td>
</tr>
<tr>
<td>5</td>
<td>Phoca groenlandica</td>
<td>Muhos</td>
<td>5115 ± 75 BP</td>
<td>Ukkonen 2002</td>
</tr>
<tr>
<td>6</td>
<td>Phoca groenlandica</td>
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<tr>
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<tr>
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<td>11</td>
<td>Phoca hispida</td>
<td>Västra Frölunda</td>
<td>9410 ± 100 BP</td>
<td>Fredén 1975</td>
</tr>
</tbody>
</table>

**Appendix b: Localities of subfossil seal-bone finds in Europe.**

