Deglaciation, sea-level change and the Holocene colonization of Norway

HÅKON GLØRSTAD

Museum of Cultural History, University of Oslo, Box 6762, St Olavs plass, NO-0130 Oslo, Norway (e-mail: hakon.glorstad@khm.uio.no)

Abstract: The Norwegian coast facing the Atlantic Ocean was ice free as early as the Allerød oscillation in the late Pleistocene. The landscape was probably habitable for humans. It has, therefore, been assumed by several scholars that this coastline was visited or inhabited from the Late Glacial period onwards. In part, this argumentation is based on the presumed proximity of the Norwegian mainland and Doggerland, which existed between present-day Denmark and Great Britain because of a much lower global sea level. The aim of this paper is to examine the 14C dates available from the oldest Norwegian settlement sites, and to compare them to the Quaternary processes of deglaciation and sea-level change. The hypothesis is advanced that humans did not settle in present-day Norway before a sheltering passage of islands and peninsulas had developed between the Swedish west coast (Bohuslän) and the Oslo area. This happened in the second half of the Preboreal period, at approximately 9.3 cal ka BC, or in the final centuries of the tenth millennium BC.

Supplementary material: 14C dates used in Figures 2, 4 and 9 are available at http://www.geolsoc.org.uk/SUP18779.

It has long been known that large areas of the Norwegian coast facing the Atlantic Ocean were ice free as early as the Allerød oscillation in the late Pleistocene (c. 11.8–10.6 cal ka BC: Sørensen et al. 1987; Jørgensen et al. 1997; Andersen 2000). The vegetation, climate and landscape were probably quite similar to present-day western Greenland (Wishman 1979), and therefore also habitable for humans. For this reason, the literature on the topic is quite positive towards the idea of a phase of human occupation on the western Norwegian coast as early as the Late Glacial period (e.g. Rolfsen 1972; Mikkelsen 1978; Bang-Andersen 1981, 1996; Indrelid 1989; Fuglestvedt 2001, 2007, 2012; Selsing 2012). In part, this argumentation is based on the presumed proximity between the Norwegian mainland and Doggerland, which existed in the area between present-day Denmark and Great Britain because of a much lower global sea level. The aim of this paper is to examine the 14C dates available from the oldest Norwegian settlement sites, and to compare them to the Quaternary processes of deglaciation and sea-level change. The hypothesis being put forward is that humans did not settle in present-day Norway before a sheltering passage of islands and peninsulas had developed between the Swedish west coast (Bohuslän) and the Oslo area.

The oldest evidence for human occupation of Norway

There has been much speculation and discussion about the oldest evidence for human occupation in Norway. A collection of flint pebbles and animal bones from Blomvåg (Fig. 1) outside Bergen has been 14C-dated to the Bølling oscillation in the Late Glacial period (Lie 1990). The combination of terrestrial and marine species, a few fractured or cleaved bones, and pebbles with some crude marks of possible knapping were interpreted as traces of a human campsite (Indrelid 1989; Lie 1990; Johansen & Undås 1992). Critical examination of the flint pebbles and bones has, however, revealed that the Blomvåg find is a natural deposition from the Late Glacial period (Bjerck 1994; Fischer 2012; Eigeland & Solheim 2012).

Also cited as evidence in favour of Late Glacial human occupation in Norway are a few very large tanged points that bear some resemblance to the points used in the Late Glacial Bromme Culture (Rolfsen 1972; Bang-Andersen 1988). Although these points are of human origin, typological and technological examination has proved that they are not Late Glacial but from the Preboreal Fosna Complex, commonly found along the Norwegian coast (Bang-Andersen 1988; Bjerck 1994; Waraas 2001; Fischer 2012). It has, therefore, been very difficult to find any convincing evidence for occupation of the Norwegian coast before the Preboreal period. This has puzzled many archaeologists. It has been claimed that the climate and conditions for living were quite good along the ice-free coast. Arctic trees such as birch (Betula) and, perhaps, also coniferous trees became established in the Allerød period (Mangerud 1970; Wishman 1979; Kullman 2002, 2006; Parducci et al. 2012; Selsing 2012 and references therin). Recently, the presence of
trees in Norway in the Allerød period has been questioned by palaeoecologists (Birks et al. 2005). However, such critical arguments against the existence of habitable conditions for humans have not been taken into consideration in the archaeological literature. Also of significance for human survival in Norway are the marine conditions. It has been claimed that, in the Late Glacial period, the oceanographic conditions contributed to a rich fauna of fish, birds and marine mammals such as seals and whales (e.g. Bjerck 2008a, 2009; Selsing 2012). These would have been very favourable resources for humans, who would otherwise have been dependent on terrestrial ecosystems. Why, then, did people not settle the landscape?

This enigma is all the greater because of the presumed short distance between the Doggerland area and the Norwegian mainland. According to several reconstructions of the global sea level during the Late Glacial period, Doggerland was separated from present-day Norway only by a wide fjord or narrow bay, known today as the Norwegian

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**Fig. 1.** The Scandinavian Peninsula at approximately 10.6 cal ka BC, representing the transition from Allerød to Younger Dryas. Landscape reconstruction by Tore Pässé, Geological Society of Sweden (Pässé & Andersson 2005). Places mentioned in the text are displayed on the map. Rectangle A marks the location of Figure 3 (the Galt site). Rectangle B marks the location of Figures 6 and 7 (the Oslo area).
Trench (e.g. Coles 1998). In cold winters, people could presumably walk on the sea ice from the continent to Norway, or they could travel the distance by boats.

Such a scenario has triggered considerable interest in an early date for the oldest Norwegian settlement sites. According to a long research tradition, the Fosna–Komsa Complex or Culture, is the oldest evidence for regular human occupation in Norway (Bjerck 2008a). Arguments have been advanced for a very early date for a few of these sites, some even thought to date back to the end of the Late Glacial period with its favourable ecology and communication pattern (e.g. Høgestøl & Auestad 1995; Prøsch-Danielsen & Høgestøl 1995; Bang-Andersen 1996, 2003, 2012; Fuglestvedt 2001, 2007; Waraas 2001).

Until the 1990s, the sites were mainly dated by typological means and by shore displacement. Significant parts of the Norwegian coast have been subject to very pronounced land uplift since the Ice Age (Andersen 2000). By determining and dating the rates of regression of shorelines, coastal sites can be relatively dated (e.g. Fredsjø 1953; Cullberg 1972; Mikkelsen 1975; Glørstad 2004; Bjerck 2008a; Bjerck et al. 2008). Although the latter dating technique works well in general terms, the degree of precision is very dependent on the quality and precise dating of the shoreline displacement curve. Most of the curves used for dating Stone Age sites in the 1980s and 1990s were rudimentary. For instance, the statistical time span covered by 14C dates was not properly dealt with. Instead, the curves were usually drawn as a line through the middle value of the 14C date in question. This way of reconstructing the shore regression is probably more than adequate when dealing with geological problems. In archaeology, where relatively short time spans are discussed, problems arise if such curves are taken at face value. A similar problem when using shoreline regression curves is that of determining the distance from the settlement site to the ancient shore at the time when humans used the site. In some types of terrain, the natural morphology of the landscape gives very reliable indications for this distance but, in many cases, this relationship is a matter of conjecture. Hence, dating of the sites will also be subject to the same inaccuracy. During the 2000s and 2010s, geologist and archaeologists have been systematically collaborating on improving the quality and precision of shoreline displacement curves, analysing both archaeological and geological data (e.g. Persson 2003; Bjerck et al. 2008; Sørensen et al. 2012).

In the 1990s, another option for dating the oldest settlement sites became available; accelerator mass spectrometry (AMS)-dating technology enabled the dating of very small fragments of charcoal from archaeological sites (Gowlett & Hedges 1986). Charcoal from Preboreal sites in Norway is, in general, very fragmented, if present at all. Only in contexts exceptionally favourable for preservation, such as bog cover of the site or a very alpine/arctic climate, has the charcoal been preserved. The AMS dating of charcoal from such sites has contributed to a much more precise determination of the initial occupation of Norway. Large-scale development-led excavations (Sandmo 1986; Olsen 1992; Damm et al. 1993; Bang-Andersen 2005; Svendsen 2007; Bjerck et al. 2008) and a few research excavations (Bang-Andersen 1990) have given dates of settlement sites from districts in most parts of the country (Fig. 2). These dates are presented in Figure 2. As seen from the figure, the dates obtained cover the latter part of the Preboreal, approximately 9.3–8.3 cal ka BC. This period very probably presented climatically favourable conditions, not so very different from the present climate (e.g. Nesje & Dahl 1993; Andersen 2000; Bjune et al. 2005; Nesje et al. 2005; Brown et al. 2012). According to the dates obtained, there are so far no indications of Late Glacial or very early Preboreal occupation in Norway. Such a relatively late date for the initial occupation of Norway is also confirmed by shoreline dates of Preboreal sites using new, more precise shore displacement curves (Jaksland 2012; Sørensen et al. 2012).

**New evidence for Late Glacial occupation of Norway?**

Recently, arguments have been presented in favour of an older phase of occupation than indicated by the bulk of AMS ages obtained. The sites in question are from the NE and SW tips of the country, in the Varangerfjord and Boknafjord areas, located in Finnmark and Rogland County, respectively (Fig. 1). In Varangerfjord, charcoal of pine (*Pinus*) from a presumed hearth discovered during a trial excavation of an Early Mesolithic site was dated to 9.9–9.2 cal ka BC (9940 ± 101 years BP; Grydeland 2003). As Sveinung Bang-Andersen (2012) has pointed out, pine forests did not become established before approximately 7 cal ka BC in Finnmark. It is, therefore, very likely that the sample represents driftwood. It is uncertain whether or not the date obtained is relevant to the chronological determination of the settlement site. The sample could be much older than the human activity at this location (cf. Blankholm 2004).

The Galta site (Fig. 1) at Rennesøy in the Boknafjord, north of Stavanger, is presumably the best candidate for Late Glacial or very early Preboreal occupation in Norway (10.4–9.3 cal ka BC; Prøsch-Danielsen & Høgestøl 1995; Fuglestvedt...
The early date is based primarily on the shoreline displacement curve for the island of Rennesøy (Prøsch-Danielsen 1993) (see Figs 3 & 4). The topographical situation indicates that the settlement would originally have been located close to the sea, making shoreline dating relevant.

The construction of the shoreline curve from Rennesøy (Fig. 4) is very thorough work, where different variables are combined into a coherent model. There are, however, some premises underlying this model that must be correct if the curve is to serve as a reliable tool for dating Stone Age sites (Prøsch-Danielsen 1993, p. 63). These premises have not been tested. Small alterations in this framework would trigger adjustments in the sea-level curve. Furthermore, the curve is presented without the uncertainties inherent in all 14C-dated curves. This is in accordance with the standards of the 1990s but, presumably, gives too rigid an impression of the displacement trajectory.

By using some data from this study, directly relevant to the dating of the Galta site, a slightly different conclusion concerning the age of the site can be reached. Only 3 km SW of the Galta site, an isolation level where a pond was separated from the sea because of land uplift has been 14C-dated by two measurements of bog sediments. The isolation point is dated to 9.35–8.6 cal ka BC (Søre Reianes: T-8817A, 9665 ± 135 years BP; and T-8817B, 9605 ± 105 years BP). The threshold creating the basin is situated 14.4 m above present sea level (Prøsch-Danielsen 1993, pp. 84–90). The Galta site is situated 16.5 m above the present sea level. If this position is adjusted according to the isobase lines for this area (Prøsch-Danielsen 1993, p. 65), using the 14C-dated isolation point at 14.4 m as a fixed point, we need to add 1.4 m to the height of the isolation point in order to obtain the height of the sea level at the Galta site at 9.6 ka BP (9.35–8.6 cal ka BC: Fig. 3). This estimate is based on a gradient for 9.6 ka BP of 0.57 m km⁻¹ (cf. Prøsch-Danielsen 1993, pp. 64 and 89). According to this calculation, the sea level was approximately 16 m above the present at the Galta site around 9.35–8.6 cal ka BC. This means that the Galta site, according to the dating of the shorelines, is approximately contemporaneous with the isolation point at 14.4 m, dated to second half of the Preboreal (cf. Prøsch-Danielsen 1993, p. 90). This is within the same time span as the 14C-dated sites in the rest of the country. Dating the Galta site to approximately 9.3 cal ka BC is also in accordance with the youngest suggested typological dating of the site (Høgestøl & Auestad 1995, p. 54). A more refined dating of the site, based on shorelines or typology, seems to be very difficult on the basis of present data.

Lisbeth Prøsch-Danielsen remarked in her analysis of the bog that the isolation of the basin from the sea was a relatively slow process, because salt-water seems to have flowed into the pond on several occasions (Prøsch-Danielsen 1993, p. 90). It is interesting to compare this observation with the evident wave erosion activity at the Galta site. It has been suggested that storm waves or tsunamis resulting from submarine slides could have eroded the site (Bøe et al. 2007).

The Galta site has also been dated by thermoluminescence (TL), optically stimulated luminescence (OSL) and palaeomagnetic dating. The ages obtained are not consistent: one sample (R-903502) has been dated by the first two techniques to approximately 4.5 cal ka BC and by the last technique to 10 cal ka BC. A second sample (R-903501) has been dated by TL and OSL to approximately 9.5 cal ka BC; combining the ages indicated by the two dating techniques. The precision of the dating is, however, poor (Prøsch-Danielsen & Høgestøl 1995) and cannot be given any decisive importance (Høgestøl & Auestad 1995, pp. 50–53) (see Table 1).

Ingrid Fuglestvedt has presented arguments in favour of a strong relationship between the flint knapping technique demonstrated at the Galta site and the tool-making technology of the Ahrensburg Complex on the continent in the Late Glacial (Fuglestvedt 2007). She, therefore, claims that the Galta site should be considered an Early Mesolithic settlement and the tool-making technology of the Ahrensburg Complex on the continent in the Late Glacial. Avoiding the discussion of whether Fosna or Ahrensburg is the correct name for the artefact assemblage of this period, there are good reasons to consider the Fosna Complex as chronologically related to the final Ahrensburg industry. Figure 5 shows the sum of all 14C-datings from the Norwegian Fosna sites, the sum of 14C-datings from some important early Maglemose sites from Denmark (Sørensen & Sternke 2004) and the sum of 14C-datings from the Ahrensburg Complex, as

Fig. 2. The Scandinavian Peninsula at approximately 9.1 cal ka BC. The location of the excavated settlement sites where charcoal has been dated to the Preboreal period is marked. The map is from Pässe & Andersson (2005). The sum of all the dates is present below the map. The calibrations were performed using OxCal 3.10 (Bronk Ramsey 2001). The dates are taken from Sandmo (1986, pp. 117–118), Bang-Andersen (1990, 2005), Olsen (1992, p. 89), Damm et al. (1993), Bjerk (1994), Svendsen (2007) and Bjerck et al. (2008).
discussed by Weber et al. (2011). The summation is done in OxCal 3.10 (Bronk Ramsey 2001). As indicated by the compilation, the Fosna Complex seems to define a transition from the Ahrensburg Complex to the early Mesolithic complexes, such as Maglemose. Consequently, it is not so remarkable or puzzling that the two complexes should also be technologically related (cf. Schmitt 1995, 1999; Bjerck 2008a). But, as demonstrated from the sum of all the dates in Figure 5, this does not necessarily imply that the Galta site needs to be from the very transition between Pleistocene and Holocene. It could also be somewhat younger.

To summarize this discussion, there is reliable evidence in favour of a relatively late date for the initial occupation of Norway, from around 9.3 cal ka BC. The Galta site need not be significantly older than the 14C-dated sites.

Fig. 3. The location of the bog Søre Reianes and the settlement site Galta at Rennesøy in Rogaland. The isolation point for the bog is dated to 9.35–8.6 cal ka BC (T-8817A, 9665 ± 135 years BP; T-8817B, 9605 ± 105 years BP). The isobase lines are indicated. The Younger Dryas baseline (10.4 ka BP, c. 9.6 cal ka BC, 32.5 m above sea level) is used for the construction of the shoreline displacement curve in the area. The isolation points for the different bogs, marked with stars on the map, are adjusted according to this isobase line. The gradient for 9.6 ka BP is 0.57 m km$^{-1}$. Map reworked after Prøsch-Danielsen (1993).
Discussion

Deglaciation history and immigration routes

At the conclusion of this brief examination of Early Mesolithic Norway, the delayed immigration to the country remains enigmatic, if we consider that the coastline had already been habitable and presumably rich in resources for several thousand years. Why did people not arrive? Were potential immigration routes blocked? Three such principal routes to Norway could be hypothesized in the Early Mesolithic: the first is from the Doggerland area (Coles 1998) across the Norwegian Trench to western Norway; the second is via Finland or the Kola Peninsula to Finnmark (Blankholm 2008, pp. 100–101); and the third is from south Scandinavia via the Swedish west coast to the Oslo Fjord area (Waraas 2001; Schmitt et al. 2006; Bjerck 2008a, b, 2009; Bang-Andersen 2012). Other routes seem to have been blocked by the Scandinavian Glacier. The first option has always been quite popular (e.g. Nummedal 1923; Mikkelsen 1978; Welinder 1981; Indrelid 1989; Bjerck 1994, 1995; Bang-Andersen 1996, 2003; Fuglestvedt 2001; Selsing 2012). Its popularity is due much more to the evocative qualities of the model than to any solid evidence for traffic across the Norwegian Trench in the Late Glacial or Preboreal period. All possible artefacts picked up from the seabed on the Norwegian part of the continental shelf (Bjerck 1994; Rokoengen & Johansen 1996) have been rejected as natural or else cannot be decisively connected to this stage of human history in Scandinavia (Bjerck 1994; Eigeland 2012; Fischer 2012). The northern extent of the Doggerland area in the Late Glacial period has not been determined (e.g. Huuse & Lykke-Andersen 2000). Most reconstructions are based on present bathymetry, seismic data and estimated sea levels in the Weichselian period (e.g. Jelgersma 1979; Blystad 1989; Coles 1998; Lambeck et al. 2002; Gyllencreutz et al. 2006). This is, however,

Table 1. Thermoluminescence (TL), optically stimulated luminescence (OSL) and palaeomagnetic dates from the Galta site

| Sample  | TL age (years) | OSL age (years) | Palaeomagnetic age (years) |
|---------|----------------|-----------------|---------------------------|
| R-903501 | 10 500 ± 1000  | 12 500 ± 1000  | –                         |
| R-903502 | 6700 ± 500     | 6600 ± 500     | 12 000                    |

All dates are in calendar years BC. After Prøsch-Danielsen & Høgestøl 1995.
a relatively imprecise method because the exact sea level in the Pleistocene and the morphology of the prehistoric landscape have not been precisely determined. A recent analysis of a sediment core taken from a well situated in the southern part of the Norwegian sector of the North Sea (southern North Sea II) gave unexpected results (Hafeez et al. 2012). This area represents the shallowest part of the Norwegian sector, and evidence of dry land could be expected at least as late as in the Younger Dryas (e.g. Blystad 1989; Coles 1998; Gyllencreutz et al. 2006). It was, however, not possible to demonstrate any evidence for dry land in the sediment core. It appears that a glacial lacustrine environment was replaced by marine conditions as early as 14.45–13.21 cal ka BC (Hafeez et al. 2012, p. 27; see also Andersen & Borns 1994; Clark et al. 2012 for similar models). The inundation of the shelf in this area is quite early, before modern humans settled in Scandinavia. Most probably, this meant that the distance between Doggerland and the Norwegian mainland at the end of the glacial period was at least 160 km. This is a much wider distance of open water to cross than any voyage across the sea documented in the Mesolithic or Neolithic in Scandinavia (Glørstad 2013). The first Scandinavian evidence for such journeys dates back to the final Neolithic, when metals were increasingly being used for tool production (Prescott 2009; Østmo 2011). Hence, it is reasonable to claim that the Skagerrak Sea created an effective barrier between Norway and the continental plains of Doggerland.

The second model is interesting because there has been a growing awareness that significant channels of communication were established between the Scandinavian Peninsula and Eastern Europe and Asia via Siberia and Russia as early as the beginning of the Boreal period (Sørensen et al. 2013). An immigration route from the NE also fits well with the colonization history of several plants and animals in Scandinavia. In the realm of natural history, DNA analysis has revealed two main immigration routes to the Scandinavian Peninsula for several species (e.g. Taberlet et al. 1998; Davidson et al. 2011). These two colonizing waves meet...
approximately in the middle of Sweden and Norway. It is, thus, interesting to note that this area also constitutes a border zone in Stone Age and Bronze Age archaeology (Bakka 1976; Knutsson 2005; Knutsson & Knutsson 2011). This could suggest a NE immigration route in Preboreal times. Theoretically, the Komsa Complex, found in the northern parts of Early Mesolithic Norway, could be of NE origin (Blankholm 2008, pp. 100–101; see also Möller et al. 2013). So far, Early Mesolithic archaeological source material along the coast, from the Oslo Fjord and up to Finnmark, has been interpreted as part of a coastal immigration from south to north (Fuglevedt 2001; Waraas 2001; Bjerck 2008b; Bang-Andersen 2012). The Fosna–Komsa Complex also seems to be closely related. From the early Middle Mesolithic, however, there are several indications for contact and, perhaps, immigration from the NE and into the Scandinavian Peninsula (e.g. Sørensen et al. 2013).

This leaves the third model – that is, an immigration route from the Swedish west coast via the Oslo area – as a likely option. Hence, this model has been advocated by several scholars (Schmitt et al. 2006; Bjerck 2008a; Bang-Andersen 2012). The new AMS dates for the Early Mesolithic sites in Norway add a significant new element to this discussion because the pattern of Holocene deglaciation and land uplift in the Oslo area is relatively well determined and mapped. Consequently, it is now possible to compare the colonization process with the natural history of this area.

Deglaciation and land uplift in the Oslo area: the creation of an entrance to Norway

Most of the Norwegian coast was ice free from the time of the Allerød oscillation (c. 11.8–10.6 cal ka BC: Andersen 2000). The Oslo area was, however,
an exception. Here the glacier extended out into the sea. For certain periods, the ice front was relatively stable and moraines were, therefore, created. These moraines have been $^{14}$C dated and the different moraine segments correlated (Sørensen 1979; Bargel 2005; see also the discussion in Mangerud 2004) (Fig. 6). Six pronounced end moraines have been mapped and dated. The land–sea–ice relationships have been reconstructed on the basis of shore displacement curves and dated moraines (e.g. Sørensen 1979, 1999; Sørensen et al. 2012). Table 2 shows the uncalibrated dates obtained (Sørensen 1979, 1999; Sørensen et al. 2012).

Fig. 7. The ice, land and sea relationship at the Ra moraine stage, the Ås-Ski moraine stage, the Aker moraine stage and the Hauerseter stage of the deglaciation process of the Oslo fjord. The reconstructions are based on shoreline regression curves and dated stages of deglaciation. At the Aker and Hauerseter stages, the deglaciation process of the fjord is finished and a sheltered archipelago created a passage between the present Norwegian coast and Bohuslän in present Sweden (source: Bargel 2005). According to the available $^{14}$C dates from Preboreal settlement sites in Norway, the passage was crossed by humans at the beginning of this stage or a little earlier.
All of the age determinations were made on molluscs and are, therefore, calibrated using a marine calibration curve (Hughen et al. 2004). The calibrations were performed using OxCal 3.10 (Bronk Ramsey 2001) and are presented in the discussion with a 68.2% probability.

As late as around 10.75–9.95 cal ka BC, the glacier covered the whole of the Oslo area and the ice sheet continued along the SE coast of Norway for several hundred kilometres (Ra moraine). The archipelago in Bohuslän – ice free and reachable for humans coming from the south – was, therefore, separated from the ice-free parts of the Norwegian coast by a large area of ice and open water (Sørensen 1979; Bargel 2005). Around 10.1–9.25 cal ka BC, the ice had receded and the land uplift created an exposed archipelago in the Oslo area (Ski moraine). This archipelago developed into a considerably more sheltered environment around 9.3–8.35 cal ka BC (Aker moraine). At this time, a continuous archipelago – with fairly large islands and peninsulas extending beyond the ice front – was created, starting from Bohuslän and running along the whole Norwegian coast (Fig. 7).

This sequence fits very well to the model recently presented by Påsсе & Andersson (2005), covering the whole Scandinavian Peninsula. According to their model, the creation of the passage should be dated to approximately 9.2 cal ka BC (Fig. 8).

Looking at the sum of the calibrated dates for the deglaciation process and the situation of the moraines in the landscape (Figs 6 & 9), it is quite evident that the ice recession must have been very rapid and is estimated to have been as much as 100 m a\(^{-1}\) (Bargel 2005). From approximately 9.3 cal ka BC (i.e. the Aker stadium), the whole Oslo Fjord was ice free and available for coastal navigation in sheltered water. At this stage, the passage between Norway and the continent was opened up, via Bohuslän and the Swedish western coast. The *terminus post quem* for the \(^{14}\)C dates from the

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**Fig. 8.** The estimated relationship between the glacier, sea level and dry land at 9.4 and 9.1 cal ka BC in the Oslo area. Model by Tore Påsсе (Påsсе & Andersson 2005).
Preboreal sites in Norway is around 9.3 cal ka BC. This is more or less the same as the terminus ante quem for the deglaciation of the Oslo area, judging from the sum of the obtained dates (Fig. 10). In my opinion, it is very likely that the deglaciation of the Oslo area and the earliest settlement of Norway are interrelated in such a way that it was the ice barrier in this area that prevented human occupation at an earlier stage.

The historical context of the colonization of Norway in the Preboreal period

Lou Schmitt has, in several papers (Schmitt 1995, 1999; Schmitt et al. 2006, 2009), made very convincing arguments in favour of an older Hensbacka (Fosna) phase in Bohuslän, SE of the Oslo Fjord Glacier. A very rich marine ecosystem created in the archipelago of Bohuslän, due to outward-flowing meltwater from the Uddevalla and Närke straits, could have been an important reason for human occupation in this area. Schmitt argues for a cyclical migration of people between the continental inland and the Swedish coast in the Late Glacial and early Preboreal – a system that could have ended in the late Preboreal with the closing of the straits between the Yoldia Sea (present Baltic Sea) and the ocean, stimulating a more local migration pattern (Schmitt et al. 2006). Both the number and size of sites increase in the Bohuslän area in this period, and it is reasonable to assume that the population was also increasing. Perhaps it was the enhanced use of the western Swedish landscape to

Fig. 9. The calibrated dates of the deglaciation process in the Oslo area. Dates are presented in Table 2. All of the age determinations were made on molluscs and, therefore, they are calibrated with a marine calibration curve (Hughen et al. 2004). The calibrations were performed using OxCal 3.10 (Bronk Ramsey 2001).
provide a sufficient platform of knowledge for exploring the new archipelago in the Oslo area that created a passage to the Norwegian coast? It is reasonable to consider that this coast was an excellent hunting ground because the large marine mammals living there had no experience of man as a predator; and even though mature forest was lacking in the oldest phase of occupation, driftwood must have been easily available (Glørstad 2013) as fuel and as a raw material for the tool industry.

In south Scandinavia, the Late Glacial occupation pattern shows a clear easterly distribution, corresponding to the extent of the most fertile soils (Pedersen 2009). These were also the areas with the densest vegetation and big game, such as elk, aurochs and red deer (Aaby 1993; Fischer Mortensen et al. 2008; Fischer Mortensen 2011). The easterly distribution of the population would have facilitated a communication pattern towards the western coast of Sweden (Bohuslän), pushing migration in this direction and, finally, into Norway. In my opinion, this colonization process reflects an intimate connection between the expansion of settlement and the natural history of sea-level change and deglaciation in the Early Holocene. This indicates that the social systems were adapted to a particular ecology and environment.

With only a very few exceptions, south Scandinavian settlement sites seem to be inland sites for terrestrial hunting (Petersen 2009). The Hensbacka, Fosna and Komsa sites, conversely, are dominated by a clear marine orientation in terms of location. It is still an open question as to whether the latter sites represent an innovation in adaptation and subsistence, as has been boldly concluded by Bjerck (1995, 2009), or a continuation of a common European way of life stretching back into the Palaeolithic (discussion in Cleyet-Merle & Madelaine 1995; Schmitt 1995; Fischer 1996; Kindgren 1996; Bailey & Milner 2002; Fischer & Hansen 2005; Schmitt et al. 2006, 2009; Larsson 2009; Nordqvist 2009; Kettle et al. 2011). The Bohuslän evidence could, perhaps, indicate that the latter possibility is the most likely. If so, this fits well with the Norwegian data discussed here: the colonization of this fringe of Europe was not a leap into unknown subsistence and environments; rather, it seems to have been connected with the spread of a ‘continental’ or Boreal environment, flora and fauna.

**Conclusion**

So far, there is no indisputable evidence for Late Glacial or very early Preboreal human occupation in present Norway, even though the west coast was ice free and habitable. The $^{14}$C dates from the earliest settlement sites point towards an initial occupation of the country in the final centuries of the tenth millennium BC. Of course, new discoveries could alter this picture; still, there is a very clear trend in the dates obtained that points...
Comparing the available 14C dates from the Early Mesolithic assemblages in southern Norway. It seems to have been at least 160 km. This is, as far as we know, a much greater distance of open water than any voyage documented on the open sea in the Mesolithic. Doggerland is, therefore, not a very likely bridgehead for the colonization of the Norwegian coast. The corridor from Finland/Russia was probably accessible for humans but, so far, the technological and typological examination of artefacts from Early Mesolithic north Norwegian settlement sites points to close connections to the Western European (Ahrensburg) tradition. However, a full determination of cultural and technological variations in Russia is so far lacking. Finally, there is solid archaeological evidence for human migration from the eastern parts of south Scandinavia to the western coast of Sweden at the end of the glacial period. The artefact assemblages are closely related to the Early Mesolithic assemblages in Norway, making the connection even stronger. This passage, thus, seems to be a likely bridgehead towards the Norwegian coast. Until approximately 9.3 cal ka BC, this route was blocked by a very large ice barrier covering the present Oslo area. Comparing the available 14C dates from the Early Mesolithic settlement sites in Norway with the 14C-dated process of deglaciation and land uplift in the Oslo area, it seems that a strong correlation between the initial occupation of the country and the pattern of these Quaternary processes can be inferred. A likely conclusion is that human colonization of the Norwegian coast was dependent on the creation of a sheltered passage of islands and peninsulas from the Swedish western coast to the ice-free coasts of southern and western Norway.

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