Prehistoric Settlements in the south-western Baltic Sea area and Development of the Regional Stone Age Economy

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Schlagwörter: *Ostsee – Ertebølle-Kultur – Landschaftsentwicklung- Meeresspiegelschwankungen / Küstenverlauf – Kulturentwicklung – Subsistenzwirtschaft – Handel – Radiokarbondatierung*

Keywords: *Baltic Sea – Ertebølle Culture – landscape evolution – sea level changes / shoreline displacement – development of culture – subsistence strategies – commerce – radiocarbon dating*

Mots-clés: *Mer Baltique – culture d'Ertebølle – évolution du paysage – eustasie / évolution côtière – développement culturel – économie de subsistance – commerce – datation par le radiocarbone*

1. Introduction (H. Jöns, C. v. Carnap, F. Lüth)

The general target of the research done between 2002 and 2005 within the framework of the SINCOS research unit funded by the DFG, and from 2006 to 2009 within the DFG project bundle SINCOS II, was to develop a model of the relationships between geosystem, ecosystem, climate and socio-economic system for the southwestern Baltic Sea area from the mid-Holocene Mesolithic and Neolithic period to the Early Medieval period (summarising Lüth / Harff 2007). In the research area the climatically controlled sea level rise and the rebound to the isostatic uplift in central and northern Scandinavia following the last deglaciation caused a continuous transgression, changing the landscape dramatically around the whole Baltic rim, especially during the Littorina Transgression between 6000 and 2000 cal. BC (summarising Jöns 2011). Within the SINCOS research area, between the Oder estuary and the Oldenburg Rift ("Oldenburger Graben"), the intensity of the resulting shore displacement varied greatly regionally; especially the areas of the Bay of Mecklenburg and the coastal waters east of the Darss Sill were affected by this development to a different extent: in the east much less dramatically than in the west (Lampe et al. 2007). Accordingly the ecosphere as well as the anthroposphere in both regions were exposed to differing degrees to the changes in the geosphere and the climate. However, the communities living in both maritime zones had to face a more or less dramatically changing environment and had to adopt their economic and social system to it.

Within the SINCOS research unit the investigation of the socio-economic system for the research areas west and east of the Darss Sill was the main target of the archaeological

and the archaeozoological projects (project 1.6 and 1.7; Jöns et al. 2007; Schmölcke et al. 2007). Further relevant information was gained from palynological, dendrochronological and geological investigations, characterising the overall environmental and climatic conditions in the maritime zone (project 1.4, 1.5 and 1.1, 1.2; Michaelis / Joosten 2007, Haeseler et al. 2007, Rössler et al. 2007, Rössler et al. 2011, Lampe et al. 2007). The archaeozoological and archaeological research was continued within the bundle-projects "Holocene Development of the Vertebrate Fauna and the Related Environmental Change in the South-Western Baltic Area with Special Emphasis on Mecklenburg Bay" and "Prehistoric Settlements and Development of the Regional Economic Area".

The starting position for the archaeological research on these topics was excellent, as a number of previous surveys and excavations had already been done in the different parts of the research areas. A group of Stone Age sites was partly investigated on the shores of the Bay of Mecklenburg as well as on the banks of the Bodden waters around the Island of Rügen from the 1960s, and a couple of submerged Stone Age settlements in the waters in front of eastern Holstein and of Wismar Bay had already been surveyed from the 1990s. They proved at least partly exceptional preservation conditions for artefacts and tools, but also for settlement refuse of organic material and undisturbed accumulation layers, so that new systematic archaeological fieldwork on various sites in both regions, accompanied by nature science dating and analyses of faunal and floristic remains promised an opportunity for gathering various and multifaceted new information. They should provide the foundation for a detailed analysis of the environmental and settlement conditions, as well as the cultural affiliation and identity, and the economic and social strategies of the ancient communities. The data should be utilised to investigate to which extent these communities reacted to their changing environment and in which way the detectable changes of their behaviour were influenced by cultural impact and exchange especially with neighbouring gatherer communities or agrarian societies living in the inland.

As a result, from 2002 to 2005 systematic geo-archaeological surveys – mostly based on geophysical exploration (Tauber 2007) – in both parts of the research area were done with the aim of locating further settlements of the Littorina phase originally positioned on the shore. Given that the settlements that were located had been established on the beach with direct access to the sea, their remains can be used as sea level index points and be of high importance for the reconstruction of the prehistoric shore displacement. On some of these submerged sites, as well as on a few sites on land, small scale excavations were conducted to gain information about their chronological setting as well as about their economic and social strategies (Jöns et al. 2007). For the post-Littorina phase, data from coastal sites dating to the Bronze Age up to the Middle Ages were extracted from publications and the archives of the heritage agencies, so that also for the period additional information about the particular sea level and shore displacement could be added to the SINCOS database. As a result to these investigations, more than 70 originally coastal sites from the whole research area – most of them today positioned on the sea-floor and dating to the period of the Littorina Transgression – were localised and recorded in the SINCOS database.

This was the starting position for the archaeological and archaeozoological projects within the project-bundle SINCOS II, which ran from 2006 until 2009. In the framework of these projects, field-work was concentrated on a couple of well preserved and scientifically exceptionally important sites in Wismar Bay, in the neighbouring coastal waters of eastern Holstein and in the waters around Rügen Island. It was decided not to carry out further surveys to locate new Mesolithic and Neolithic sites outside these areas.

For Wismar Bay the previous investigations had produced sufficient data about the sea-level development and settlement history between ca. 5400 and 4000 cal. BC so that further

archaeological investigations on sites of the period were dispensable. Therefore the fieldwork focused on two phases with a poorer state of research but of high relevance for the SINCOS topics: during the first half of the 6th millennium cal. BC the primary intrusion of the Baltic Sea into Wismar Bay took place (Rössler et al. 2007; cf. Rössler et al. 2011). The communities living there had to face the rapid flooding of their habitat and establish a strategy to deal with the threat. Secondly, the development during the 4th millennium cal. BC had to be considered as a theme of special significance for the research in the Bay of Mecklenburg. In that time – while the intensity of the Littorina Transgression decreased – the communities started to change their economic system and to introduce animal husbandry and farming. So investigation was necessary into the question of whether this modification was to the result of ideological or political factors, or also to changes of the ecosystem.

For the research-region east of the Darss Sill, field work was concentrated on submerged sites in the waters of Rügen Island. This aimed to gather additional information about the cultural development and economic strategies of the older phase of the Littorina Transgression from 6000 to 4500 cal. BC, because well documented investigations of sites of the period were still missing, whereas data about settlement history of the younger phase had already been gained from several sites during previous surveys and excavations.

Furthermore, the compilation of data about shore displacement and sea level changes recorded during archaeological investigations on sites of the last 4,000 years was continued. They were extracted from reports and archives about various surveys, from rescue excavations, but also from the reports of research projects, so that also the economic and social strategies of these communities and societies in the face of the changes of their environment could be respected and investigated within the SINCOS project.

Last but not least all information gained during SINCOS I and SINCOS II from archaeological finds and structures, stratigraphies, samples and cores were to be analysed and discussed in detail to create a foundation for the chronological and cultural, as well as the environmental development in the research areas. Based on this foundation the question in which way the ancient communities reacted to shore displacement and coastal decline – causing serious changes of their natural environment – was discussed and at least partly answered. The multifaceted investigations, their results and the interpretation of the data are presented on the following pages.

2. Archaeological fieldwork 2006–2008 (H. Lübke, S. Hartz)

In order to complement the results of SINCOS I project 1.6 *(tab. 1)*, the archaeological investigations were planned in accordance with the aims of SINCOS II project 4 described above. Again, five months of fieldwork were carried out every year from 2006 until 2008. In the main research area Wismar Bay, excavation of the Late Mesolithic site Jäckelgrund-Orth (Neuburg / Poel 42, Ostsee II), dating to the first half of the 6th millennium cal. BC, and of the Terminal Mesolithic / Early Neolithic site Timmendorf-Nordmole III (Neuburg / Poel 12b, Ostsee II), dating to the 5th and early 4th millennium cal. BC, was continued. In addition, smaller test units were excavated on the Early Neolithic sites Timmendorf-Tonnenhaken-Süd (Neuburg / Poel 15, Ostsee II) and Timmendorf-Tonnenhaken North (Neuburg / Poel 57, Ostsee II), both dating to the first half of the 4th millennium cal. BC. In the second main research area Rügen Island, additional investigations were undertaken at the Late and Terminal Mesolithic sites Breetzer Ort (Bergen 24, Ostsee VI) and Kamminer Ort (Wittow 100, Ostsee VI) in the northern Bodden waters of Rügen Island. Moreover, it was possible to participate in the weekly expeditions of SINCOS II project 1 on board the research vessel

"Professor Albrecht Penck" and in one expedition with the "Littorina". These interdisciplinary geo-archaeological investigations took place in Mecklenburg Bay, Wismar Bay and the Arkona Basin (Tauber 2014).

In addition to the excavation programme of SINCOS II project 4, the investigations at Neustadt LA 156 in eastern Holstein were concluded in 2006 with a final underwater dig. Further excavation campaigns were not to be conducted in that area.

3. The investigated sites and landscapes in the areas of investigation

3.1. Coastal area west of the Darss Sill (Mecklenburg Bay)

3.1.1. West coast of Mecklenburg Bay – eastern Holstein
(S. Hartz, with contributions by D. Heinrich, S. Klooß and U. Schmölcke)

3.1.1.1. Introduction

The research campaign "Archaeological Excavations at Early Agricultural Coastal Sites in the Oldenburg Graben" on the east coast of Schleswig-Holstein was carried out between 1996

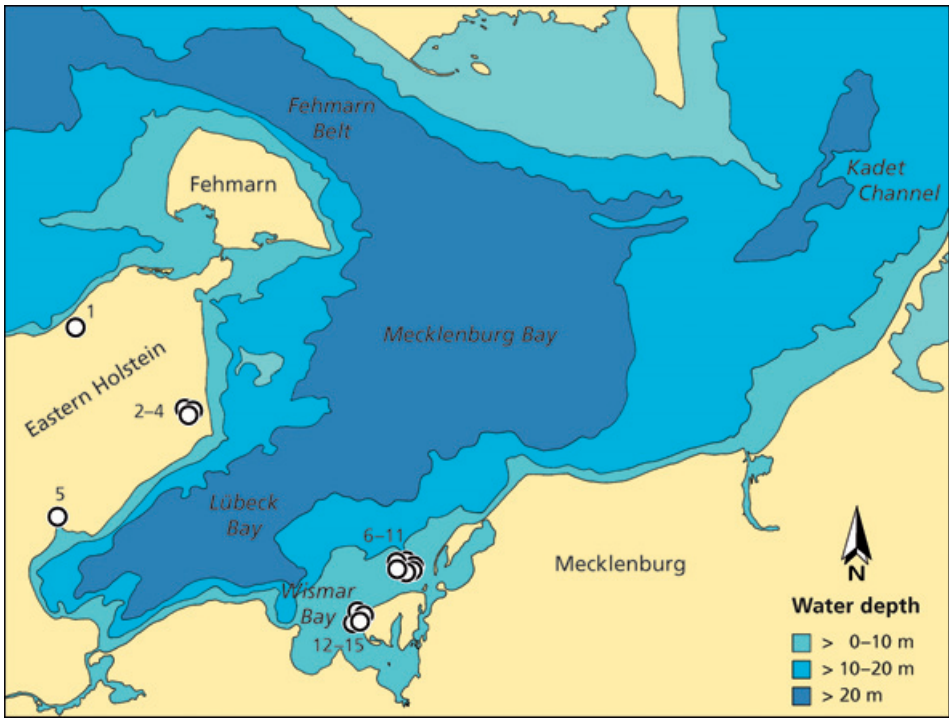


Fig. 1. Bathymetric map of Mecklenburg Bay with Mesolithic and Early Neolithic coastal settlements in Eastern Holstein and in Wismar Bay. 1 Wangels 505; 2 Rosenhof; 3 Rosenfelde; 4 Siggeneben-Süd; 5 Neustadt-LA 156; 6 Jäckelberg-NNW; 7 Jäckelberg-Huk; 8 Jäckelgrund-Furt; 9 Jäckelgrund-Strand; 10 Jäckelgrund-Orth; 11 Jäckelberg-Nord; 12 Timmendorf-Nordmole I; 13 Timmendorf-Nordmole II; 14 Timmendorf-Nordmole III; 15 Timmendorf-Tonnenhaken-Süd. – Scale 1 : 1 000 000 (digital drawing H. Lübke).

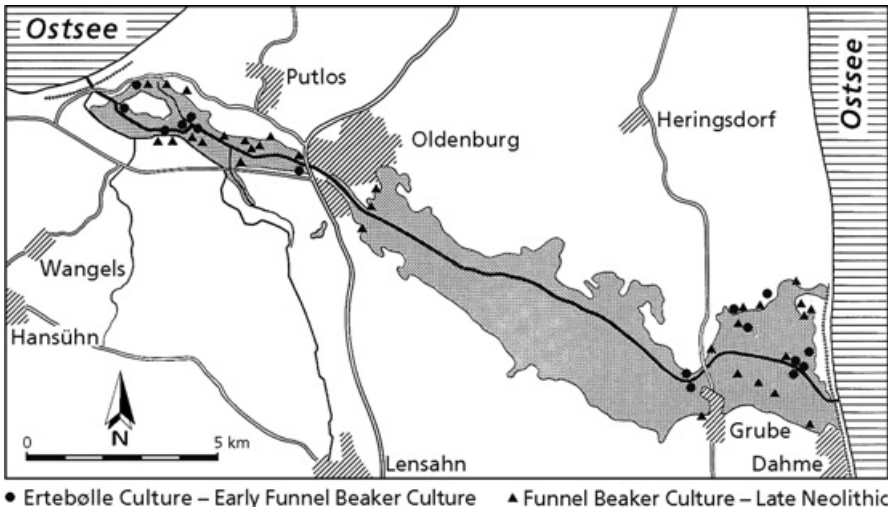


Fig. 2. Distribution of Stone Age sites in the Grube-Wessek wetland ("Oldenburger Graben") area.

and 2006, involving systematic excavations at the sites Wangels LA 505, Grube-Rosenhof LA 58, Grube-Rosenfelde LA 83 and Neustadt LA 156 *(fig. 1)*. In its final phase, it was closely connected with the project 1.6 of the SINCOS I research group and section 4 of the project bundle SINCOS II, so that it will be presented here in greater detail. For example, the animal bones and wooden artefacts from the four sites were analysed by a SINCOS project member (D. Heinrich, U. Schmölcke, S. Klooß), who at the same time worked on finds from Wismar Bay and Rügen Island. Close cooperation also proved helpful with the lithic analysis (conducted by S. Hartz, H. Lübke, S. Mahlstedt) and the pottery (A. Glykou). During this work, the recording systems NoNek (Registration of Northern Central European Neolithic pottery = Erfassung Nordmitteleuropäischer Neolithischer Keramik) and SDS (Systematic digital registration of stone artefacts = systematische und digitale Erfassung von Steinartefakten), which had been initiated at the Department of Pre- and Protohistory at the University of Kiel, were employed to some extent. The aim was to investigate settlement history on the west coast of Mecklenburg Bay as well as the human impact on the environment, and to develop a reliable chronology for this area which was to be based on absolute dating.

For more than 30 years, eastern Holstein – particularly the lowland of the Oldenburg Graben with its adjacent areas – has yielded exceptionally rich Terminal Mesolithic and Early Neolithic finds (Ertebølle and early Funnel Beaker Culture), dating to the period between 5000 and 3500 cal. BC *(fig. 2)*. This region is characterised by excellent conditions for the investigation of settlement sites from the Neolithic transition period. Due to post-glacial transgression, between *c.* 6000 and 3000 cal. BC the lowland formed a lagoon with wide entrances in the east and west, opening out into the Baltic. When the rise of the sea level slowed down, it was closed off by barrier beaches and silted up in a relatively short period of time. Due to this process the remnants of settlements which had been close to the shore were preserved. Traces of such habitation sites – mostly slaughter and food waste of animal origin as well as plant remains, but also tools of different materials – are now covered by marine to brackish deposits up to 4 m thick.

3.1.1.2. Wangels LA 505 (1996–1999)

In 1996 the State Archaeological Department (Archäologisches Landesamt Schleswig Holstein) in Schleswig started a survey in the western section of the Oldenburg Graben when it was made known that this area, which had been artificially drained, was to be partially reflooded. Earlier that year, many organic finds, flint artefacts and pottery fragments had come to light when the main channel was being deepened. The survey showed that one site (Wangels LA 505) was particularly valuable in terms of its archaeological record. It was expected to provide new insights into the very beginning of plant cultivation and animal husbandry, its causes and effects on the environment and its natural preconditions.

The site Wangels LA 505 is situated in the western part of the Oldenburg Graben lowland, south of the village Kleinwessek. The settlement is located on the northern edge of a flat isolated sand hill which, according to geological investigations, is surrounded by thick sediments of organic origin. To the north, the sandy meltwater deposits descend quite abruptly to a depth of 10 m below MSL (mean sea level; Jakobsen 2004).

In order to determine the extent of the artefact cluster, first a densely spaced grid of boreholes was drilled. These investigations showed that since the last sampling, which had taken place in the 1950s, the sediment layers had subsided considerably, more than 1 m, due to artificial drainage measures. The borehole survey was complemented by trial pits and trenches in order to identify the occupation layers. Only when these preliminary works had been completed was the actual excavation started, covering an area of approximately 300 m². The find-bearing layers were observed at depths of up to 1.5 m beneath the surface, between 2.3 and 2.5 below MSL. They consist of grey medium to coarse-grained gravel containing numerous molluscs. The good condition of the organic matter can be attributed to the fact that the finds were discovered at ground water level.

The excavation also demonstrated that, after an initial occupation phase between 4300 and 3700 cal. BC, the site was resettled by Neolithic farmers of the late Funnel Beaker Culture between 2900 and 2700 cal. BC (Hartz 1997/98). In the beginning, the stratigraphic distinction between these two intermeshed occupation horizons presented a major problem and required an intensive study of the individual layers and the conditions under which they had been formed.

The inventory from Wangels encompasses a number of find categories which are typical of waterlogged sites. These are tools made of flint and other stone, sherds from ceramic vessels, implements of organic material such as wood, bone and antler as well as leftovers from meals such as mammal and bird bones, fish remains, molluscs and vegetal remains (Hartz 1997/98; Heinrich 1997/98; Schmölcke 2001).

Among the stone tools, which comprise numerous flake axes, borers, scrapers, flint knives and arrowheads, special mention has to be made of several stone axe heads which were made of non-local material, suggesting contacts with sedentary farming communities south and east of the river Elbe. Similar cultural relationships or interferences are reflected in the pottery, which encompasses an unusually wide variety of forms, including vessels with funnel-shaped tops, shallow and wide bowls, lugged beakers, clay disks, flasks and amphorae. So far, ceramic inventories of a comparable range had only been observed in concurrent cultures of central and eastern Germany that had already adopted an agrarian way of life.

In 2001, an analysis and stratigraphic classification of the ceramics was undertaken by I. M. Grohmann (2010) at the Department of Pre- and Protohistory of Köln University as a master's thesis. Therefore, this find group will not be described in greater detail in this report.

The wooden artefacts from the excavation at Wangels LA 505 are treated by S. Klooß in her dissertation (Klooss 2010). From the Terminal Mesolithic / Early Neolithic settlement period, 201 wooden artefacts were recovered. Among these are leister prongs, paddles, spears, sharpend sticks, leftovers from shafts for antler tools and rounded staffs with crafted ends. The identification of wood types was partly carried out by L. Fischer, Lütjensee.

45 leister prongs were found in the former shallow water area, in some cases in angled or vertical positions, and had been lost during use. The tips of the leisters were pointed, protrudingly shaped and show little sign of use. Two imprints and a small quantity of fibres from the taping were preserved. Mainly pipfruit (Maloideae) and hazel *(Corylus avellana)* were used for the production of leister prongs.

Furthermore, an almost completely preserved heart-shaped paddle with partly preserved shaft made of ash *(Fraxinus excelsior)* was recovered from the Terminal Mesolithic / Early Neolithic find layer. The oar blade had rounded shoulders, a rounded pointed-oval tip and a length-width index of 1.1. This form follows the traditional style of the Ertebølle Culture, while a second paddle, found in the sediment layer of a neighbouring Early Neolithic settlement, has an elongated form with a length-width index of 4.0. This oar blade is lanceolate and shows on one side a reinforcing central rib. It was also made from an ash timber *(Fraxinus excelsior)*.

All in all 23 fragments of spears made of timber were found, with diameters between 1.2 cm and 2.8 cm. Although mainly ash wood was used for spears, there are individual specimens from Wangels and Rosenhof that were made of maple (*Acer* sp.). The tree-rings of the wood used are relatively wide and measure between 1.5 mm and 4.0 mm, which indicates the quality of the wood. A rounded tip is preserved on five specimens. Often fissures occur along the edges of the tree-rings.

Two roundish hazel staffs *(Corylus avellana)* were also identifed, which are flattened and perforated at both ends. These staffs are 2.5 cm to 3.5 cm thick and appoximately 85 cm long. Possibly they were construction elements of fish traps.

On two T-shaped antler axes the remains of the handles were preserved. These shafts were made of simple hazel rods *(Corylus avellana)* on which the bark was partly visible. They were between 1.6 cm and 2.0 cm thick. From the Early Neolithic sediment layer it is worth mentioning a fully preserved shaft for a thin-butted flint axe. It is 67 cm long and was presumably shattered at one end during use, causing the axe to drop off. The shaft was made of a thin, straight oak timber (*Quercus* sp.) (Fischer / Hartz 1998/99, 21).

In the Terminal Mesolithic / Early Neolithic find layer at the former coastal zone three vertical posts and 38 pointed sticks were found that can be interpreted as the remains of a destroyed fishing fence. Mostly these are hazel branches *(Corylus avellana)* between 1.6 cm and 4.0 cm in diameter. The branches were shaped mainly by chopping with an axe, sometimes by ripping off splinters, or a combination of both techniques. Often the processing was limited to two chop marks at opposite sides forming a roof-like point. Only a few pieces of wood without toolmarks were examined, because sampling was not intended at Wangels.

But the most frequently used kinds of wood are hazel *(Corylus avellana)* and oak (*Quercus* sp.). Furthermore, there are partly charred wood pieces from alder *(Alnus glutinosa)*, elm (*Ulmus* sp.), ash *(Fraxinus excelsior)*, maple (*Acer* sp.) and birch (*Betula* sp.).

Charred food remains on pottery fragments could be dated absolutely by means of the AMS-radiocarbon method. Some 30 dates from Wangels indicate that the settlement existed between 4300 and 3800 cal. BC, with an emphasis on the early Funnel Beaker Culture (Hartz 2004). In the pottery assemblage the initial occupation phase is attested by pointed-base vessels and oval lamps. In all probability, this phase can be assigned to the final stage of

the Ertebølle Culture, which up to now could not be dated precisely in Schleswig-Holstein. From *c.* 4100 on, these two vessel forms were superseded by the pottery described above, which can be attributed to the early Funnel Beaker Culture.

In the period just before 4000 cal. BC, the area north of the river Elbe became the scene of dramatic changes: Within a few centuries the hunters and fishermen turned into sedentary farmers who cultivated plants and kept livestock. At the beginning, however, the settlements on the coast were not abandoned, while the subsistence economy was still based on marine resources and wild mammals living in the forest (Hartz / Schmölcke 2013). The number of bones from domesticated animals demonstrates that the introduction of domestic cattle was a gradual process, and in Wangels in particular hunting was still of great economic importance during the late Funnel Beaker Culture (Schmölcke 2001).

The extent and significance of grain cultivation can hardly be assessed due to the difficulties associated with the identification of cereals in the pollen material and the lack of macro-botanical remains. There are, however, a few impressions of emmer grains and glumes in and on vessel walls as well as pollen from accompanying weed. This evidence is complemented by fragments from querns and grinding stones, which show that the cereals were prepared within the settlement.

Wangels has produced substantial evidence for early agricultural activities in Schleswig-Holstein which can be dated to around 4100 cal. BC, thus predating the beginning of the Funnel Beaker Culture in neighbouring Denmark, which is dated to about 3950 cal. BC, by only 150 ^{14}C-years. This considered, it seems most likely that plant cultivation and animal husbandry were introduced to the north simultaneously along the main waterways. This is also confirmed by recent data from settlements of Wismar Bay and Rügen Island.

3.1.1.3. Grube-Rosenhof LA 58 (2001 and 2002)

The site Grube-Rosenhof LA 58 was discovered in 1968 during mechanical digging and partially investigated between 1969 and 1980 by H. Schwabedissen from Köln University. An overall area of *c.* 330 m² could be excavated systematically, some further 300 m² were opened up as trial trenches. Early conventional dates suggested that the settlement was inhabited from 5000 until 3900 cal. BC; in this case it would have represented the mid and late Ertebølle Culture and the earliest phase of the Funnel Beaker Culture. However, in spite of the large excavation area and rich organic finds, a number of questions remained unanswered. First of all, there were only a small proportion of fish bones, although a range of wooden fish catching devices was found at the site. There are also doubts whether the earliest layers already contained pottery or not, which might support the idea of a preceding (pre-ceramic) settlement. Finally, it was unclear at which time the pottery of the Funnel Beaker period, which replaced the pointed-base vessels and oval lamps, was introduced. According to Schwabedissen, this change took place as early as *c.* 4400 cal. BC, but his view was contradicted by Danish research which dated the beginning of the Funnel Beaker Culture to 3950 cal. BC (Fischer 2002). The follow-up investigations (Rosenhof LA 58, area A), which were to answer some of these open questions, were restricted to the refuse area of the settlement on an area of *c.* 60 m². The complete inventory of the recent excavations at Grube-Rosenhof LA 58 has been presented by J. Goldhammer in a monograph (Goldhammer 2008). Therefore, only a short summary of the results will be given here.

These results have led to a reinterpretation of Schwabedissen's findings, as the earliest AMS-^{14}C-dates from the basal find layers do not provide any indication of an occupation prior to 4900/4800 cal. BC (Goldhammer 2008). Thus the early conventional ^{14}C-dates probably have to be assigned to redeposited timber or charcoal reflecting human activity in the

wider environment. Direct sampling of antler axes and charred food residues on ceramic vessels has dated the introduction of pottery and T-shaped axes to around 4600 cal. BC.

The material from area A comprises approximately 320 pottery fragments which belong to thick-walled, coarsely tempered pointed-base vessels with a slight s-profile and U-joins. The bases vary from heavy cone-like to rather flat and rounded shapes. Oval lamps are yet another diagnostic vessel type. They range from large, thick-walled to thin-walled forms and are occasionally decorated with fingernail impressions and stabbing along the rim (Goldhammer 2008).

The number of lithic artefacts totals *c.* 5500 pieces, 2 % of which have been identified as tools (Hartz 2004; Goldhammer 2008). These are dominated by soft-hammered blades with parallel edges, corresponding cores and reduction waste from the preparation of striking platforms. Among the flint tools, axes are the most prominent group. They are represented in almost equal shares by oblong-oval ("flake-axe like") core adzes with a roughly pointed-oval cross section on one hand and by oblong-oval and trapezoidal, flat-trimmed flake axes on the other. The third most common group of lithic artefacts are transverse arrowheads. Obviously their remarkably small number in the former excavations has to be ascribed to a different excavation technique as most pieces were discovered during wet sieving. These projectiles were made from blades and, in terms of size and form, do not form a uniform group, but vary from examples with straight or convex edges to pieces with a markedly flared cutting edge.

The remaining tools consist of blade scrapers with a partially asymmetric front, concave and straight-truncated blades, thick core borers, various edge-retouched pieces and hammerstones. The single occurrence of an angle burin illustrates the relative insignificance of this implement in the Ertebølle Culture of eastern Holstein.

Special mention has to be made of a Danubian shaft-hole axe with a partially preserved handle of a straight branch from pipfruit tree (Maloideae). A sample was AMS-^{14}C-dated to c. 4800 cal. BC and confirms the notion that these early foreign goods, once they had left the settlement area of the younger Bandkeramik, reached the north without much delay (Klassen 2004).

A small group of antler and bone implements completes the tool inventory. T-shaped axes were made from red deer antler. In some of their shaft-holes remains of the hazel axe handles have been preserved. Other finds comprise pressure flakers with distinctive wear marks and a perforated, faceted dag with a continuous line ornament running around. These implements are complemented by a strong chisel made from aurochs bone, slender bone points used as leister prongs and two needle-like awls made from bird bones.

The excellent preservation conditions in the marine to brackish mud sediments also led to the discovery of a number of wooden artefacts. From the excavations of 2001 and 2002 134 wooden artefacts were recovered, among these leister prongs, paddles, fragments of spears, net floats, fragments of a bow and pointed wood. The 25 leister prongs are in a very fragmented state. Nevertheless, on many specimens notches at the barb were made, maybe to fix the bone point in the middle of the eel catching spear (Klooss 2014). Also signs of wear at the tips of the prongs were found. Imprints of a braid taping for the connection to the shaft were detected on three of them. Furthermore, two half-worked examples, one with cut marks and another made from a crotch, were found as well. The majority of the leister prongs from Rosenhof were made of wood of pipfruit (Maloideae) (n = 16). Other specimens were made of hazel wood *(Corylus avellana)* (n = 6) and single prongs consisted of red dogwood *(Cornus sanguinea)*, ash *(Fraxinus excelsior)* and elm (*Ulmus* sp.).

At Rosenhof fragments of four paddles were recovered. They are heavily fragmented, but their shape can be reconstructed. The paddles are manufactured with oar blade and shaft

from a single piece of ash *(Fraxinus excelsior)*. One paddle is nearly round-shaped with a length-width index of 1.25. A further two possibly strongly worn-out paddles have exceptionally wide shapes with a length-width index of below 1. One of them has a visible bulge where the shaft begins. This reinforces the highly stressed parts. The shafts of the paddle are always broken off and their length cannot be reconstructed. The fourth oar blade is elongate-oval and also has a reinforced shaft beginning on the slightly concave upper side. With a length-width index of 2.5, the paddle belongs to the group of elongated paddles (Hartz / Lübke 1999).

There is only one single spear that was made of maple in Rosenhof (*Acer* sp.). All other 26 specimens (as well as the spears from other sites) are usually made of ash *(Fraxinus excelsior)*. Nevertheless the maple spear is made from trunk wood in the same technique as the others. The diameter of the spear fragments is mainly between 1.5 cm and 2.5 cm but the preserved section is rarely longer than 1 m. Only in two cases was a blunted tip preserved. Multiple fragments show signs of splinters, which might have been caused by the technical nature of ash wood.

The fragments of the wicker netting from Rosenhof might be the beginning of a wicker basket, a part of a fish trap. The netting was made of sticks of split guelder rose *(Viburnum opulus)* and of red dogwood *(Cornus sanguinea)*, which were connected by alder (*Alnus* sp.). At Rosenhof the alder material could be identified definitely as part of a thin root.

Three small fragments made of elm (*Ulmus* sp.) could have been part of a bow. They have an oval-shaped, lightly squared cross section. The smallest fragment shows the tip at the end, while the largest fragment shows the beginning of the oval cross-sectioned handle in the middle of the bow. For the construction of the bow a small, slowly growing elm tree (*Ulmus* sp.) of 6–8 cm in diameter was used, which showed around 8 tree-rings on 1 cm width.

A heavily fragmented flat piece of wood of 5.5 × 7.5 cm size with a non-centered, oblique perforation might have been a net float, presumably made of lime (*Tilia* sp.).

At Rosenhof 46 pointed sticks of wood were found, mostly made of hazel branches *(Corylus avellana)* with some specimens of alder (*Alnus* sp.), maple (*Acer* sp.) and ash *(Fraxinus excelsior)*. The largest part measures between 1.5 cm and 4 cm in diameter. The wood was shaped mainly by axe chops, sometimes by ripping off splinters, or a combination of both techniques. Often multifaceted chopping marks are visible, bearing witness to multiple attempts at shaping. Sometimes grooves and traces caused by damaged tool edges were also visible. Only a few pieces of wood without toolmarks were recovered, because sampling was not intended. Accordingly split trunks and branches of ash *(Fraxinus excelsior)* and hazel *(Corylus avellana)* were collected, which were partly charred.

The results of the earlier excavations, the thickness of the cultural layers, which comes up to 0.6 m, and the high frequency of macro-lithic and blade tools suggest that Grube-Rosenhof LA 58 was a so-called base-camp settlement. Evidence that the site was inhabited throughout the year also comes from the bone material which is indicative of both summer and winter activities. As far as the exploitation of marine food resources is concerned, the follow-up excavations demonstrate that subsistence economy was not restricted to sea mammal hunting and eel fishing as suggested by the animal remains, harpoons and wooden leisters from the former excavations. The adaptation of refined excavation techniques has revealed almost 4000 fish remains, the vast majority of which belong to marine species.

The variety of vertebrate species recorded at Rosenhof allows a detailed palaeoecological reconstruction of the landscape *(tab. 2)*. However, in this context only some hints shall be given. The species collection is in parts exceptional, because with pond turtle *(Emys orbicularis)*, Dalmatian Pelican *(Pelecanus crispus)*, and wild horse *(Equus ferus)* three species of

high value as environmental and climate indicators have been recorded. Pond turtle and Dalmatian Pelican suggest extensive reeds and bodies of slow-moving water rich of vegetation with nearby sandy areas as well as warmer climate than today. The 25 bones of Dalmatian pelican (Minimum Number of Individuals = 1) are the first record of this species in northern Germany and emphasise their appearance in southern Scandinavia during the Atlantic period known by some Danish records (Schmölcke / Glykou 2007). Today the nearest nesting colonies are to be found in south-eastern Europe, situated on islands or in thick aquatic vegetation. The wild horse can be used as an indicator species for a more open woodland than in other parts of Central Europe, where it disappeared in the course of the Atlantic period (Sommer et al. 2011). The other terrestrial species recorded at Rosenhof reflect additional environmental aspects such as dense forest in the hinterland and the presence of streaming water.

Ten bones of *Sus scrofa* and seven of *Bos primigenius* belong to small or subadult specimens, and morphologically they cannot be determined to either wild or domesticated individuals. However, analyses of the ancient DNA of some of these *Bos primigenius* remains reveals no evidence for those DNA haplotypes, which are characteristic for domesticated cattle (Scheu et al. 2008). Probably, all bones from Rosenhof with such unclear classification belong to small female specimens of the wild form.

The fish remains comprise 18 species or species groups (Breede 2003). Cod *(Gadus morhua)* bones strongly dominate with a portion of more than 70 %, followed by eel *(Anguilla anguilla)*, flatfish (Pleuronectidae), and cyprinids. This strong predominance of cod demonstrates a specific and purposeful fishery. For this species a total length from 26–47 cm can be estimated, the mean length was about 34 cm. The cod remains are highly fragmented. This is in high contrast to the well preserved bones of flatfish and particularly of bullrout *(Myoxocephalus scorpius)*. Probably the latter ones belong to skeletons as part of a natural thanatocoenosis. It is conspicuous, that 86 % of the burned fish bones belong to eel.

In all, the marine species are much more frequent than freshwater species, and the collective species community indicates similar salinity and sediment conditions as at Rosenfelde LA 83. The species list includes three fish characteristically for the offshore seaweed zone: bullrout, eelpout *(Zoarces viviparus)* and black goby *(Gobius niger)*. Additionally, the fish indicate some information about the seasonal presence of humans, since species such as garfish *(Belone belone)*, shad *(Alosa alosa)*, herring *(Clupea harengus)*, and mackerel *(Scomber scombrus)* migrate only in early summer times in coastal waters.

3.1.1.4. Grube-Rosenfelde LA 83 (2001 and 2003)

The site Grube-Rosenfelde LA 83, which was investigated as part of the research programme in 2001 and 2003, is located on a promontory, 100 m east of Grube-Rosenhof LA 58 (Hartz 2004). It was discovered through a systematic drilling survey and test pits excavated with a machine digger. The sandy top is covered by marine to brackish sediments up to 1.5 m thick and hardly noticeable in the present surface relief.

The complete extent of the settlement site could not be determined, because an expansion of the excavation area to the north proved impossible due to the presence of a closely spaced drainage system. The research area amounts to 130 m², the occupation layers could be traced southward and eastward into the marine sediments accumulated during the silting-up process (shore zone). During the excavation, oval hearths were recorded for the first time, while the waterlogged marine sand provides good conditions for the preservation of organic matter. This makes the site an ideal candidate for the identification of early coastal settlements with evidence of a beginning agriculture.

The finds and stratigraphy of Grube-Rosenfelde LA 83 were analysed by I. Fehr (2011) as part of a master's thesis at the University of Kiel. The find-bearing layer appeared at a depth between 3.5 and 4.5 m below MSL and was found to be only 0.1 to 0.2 m thick. It consists of grey to dark humic sand which gradually turns into mud containing numerous marine to brackish molluscs as it approaches the ancient shoreline. The find layer did not only produce sharp-edged stone artefacts and heat-shattered (cooking) stones but also animal bones, worked and charred wood as well as other botanical remains, though no pottery fragments. A redeposition of finds due to erosion during transgression can obviously be more or less ruled out.

The overall number of flint artefacts amounts to *c.* 5,000 pieces, *c.* 1 % of which have been identified as tools. Among this group, core adzes with a roughly rectangular to rhombic cross section and thick core borers with a triangular to pointed-oval outline deserve special mentioning, while trapezoid flat-trimmed ("Ertebølle") flake axes are missing. Other implements include transverse arrowheads, flake borers and straight and obliquely truncated blades which were made from regular soft-hammered basic forms (Hartz 2004). A large number of blades and cores with negative scars, the diagnostic reduction waste deriving from the preparation of striking platforms as well as small chips point to a local production of basic forms.

While core tools such as adzes and borers predominate, flake axes and ceramic artefacts are absent. Moreover, the settlement remains were found at a depth approximately 1 m below that of the layers at adjacent Rosenhof LA 58, so that Rosenfelde LA 83 was expected to be earlier. Several AMS-^{14}C-samples from charred hazel nutshells and animal bones confirmed this assumption with dates around 4900–4800 cal. BC. The Rosenfelde find layer is thus significantly older than the ceramic Ertebølle layer at Rosenhof LA 58.

From the habitation layer organic artefacts such as leisters, a possible paddle fragment and a fragmented hoop of a fish trap consisting of a *c.* 1 cm thick branch of red dogwood *(Cornus sanguinea)* held together with a cord should be mentioned. Altogether fragments of six leister prongs were recovered, which were made out of hazel wood *(Corylus avellana)*, dogwood *(Cornus sanguinea)* and pipfruit wood (Maloideae). It is not possible to distinguish the wood type of the pipfruit tree any further, so it might for example be of the light-loving species of hawthorn (*Crataegus* sp.), crab apple *(Malus sylvestris)* or rowan *(Sorbus aucuparia)*.

Furthermore, two fragments of spears made of ash trunk wood *(Fraxinus excelsior)* were discovered. A possible paddle has a slightly convex blade with hanging shoulders. Some small fragments of wicker work from a fish trap made from split dogwood *(Cornus sanguinea)*, and alder roots (*Alnus* sp.) were recovered as well.

In addition, eight pointed wooden sticks and seven poles were found that were stuck vertically in the sediments. Poles and pointed sticks were mainly made of hazel rods *(Corylus avellana)*, in some cases of red dogwood *(Cornus sanguinea)*, guelder rose *(Viburnum opulus)* and piptree (Maloideae). The hazel rods were aged between 4–8 years and had a diameter between 2.1 cm and 4.0 cm. Poles and pointed sticks were worked with axes. As no systematic sampling of wood without toolmarks was done, no statistical results can be provided. As on other sites, hazel *(Corylus avellana)*, oak (*Quercus* sp.), elm (*Ulmus* sp.) and red dogwood *(Cornus sanguinea)* are most common.

Rosenfelde LA 83 has provided us with the first excavated inventory of an aceramic Ertebølle phase in the Oldenburg Graben area which, considering the direct and indirect evidence, allows for a functional interpretation. The distinction between a dwelling area where the daily life and work took place and a dumping or shore zone – a division frequently come across at coastal sites – was not observed at Rosenfelde LA 83. An actual refuse area with a

variety of worn and broken tools, animal bone remains and scattered driftwood did not exist there. Apparently, this site had a function completely different from that of other known coastal places of the Ertebølle Culture in Schleswig Holstein (Hartz 2004).

The shallow shore area only produced some isolated though large animal bones, some of them still articulated, charred wood, used leister prongs and comparatively large stepping stones *(tab. 3)*. There were no considerable quantities of fish bones as e. g. in the refuse areas of Neustadt LA 156, Rosenhof LA 58, or Timmendorf-Nordmole I–III. These bones are noteworthy in their fragmentation, since in contrast to the typical situation at Terminal Mesolithic coastal sites they are mostly only shattered in half or are even unfragmented. The species list is relatively short, and most of the bones belong to big game species such as red deer *(Cervus elaphus)*, aurochs *(Bos primigenius)* and wild boar *(Sus scrofa)*. According to morphometrical methods 8.6 % of the 500 identified mammal bones are not clearly allocated to the wild or domesticated forms of *Bos primigenius* and *Sus scrofa* – the bones in question are often strongly weathered and some belong to young or subadult specimens. However, the archaeological and ^{14}C-dating of the site clarify the affiliation of all the remains to the wild form. Including the doubtful bones and teeth, the aurochs accounts for 30.8 % of the mammal bones, this is an extraordinary high value for Ertebølle coastal sites. The minimum number of aurochs represented in the assemblage is six, including four adult females, one adult male and one subadult animal of about two years. Remarkable is the distribution of the remains over the different skeletal elements: vertebrae, but especially elements of low meat quality such as metapodials, tarsals and phalanges are distinctly overrepresented, whereas for instance shoulder blade and humerus – both surrounded by high quality meat – are underrepresented. Obviously, only special parts of aurochs were deposited on the shoreline.

Nearly all fish bones, above all the eel *(Anguilla anguilla)* remains, are coloured white by fire. This could be evidence of people smoking fish at this site. Combined with the extraordinary find situation of the aurochs bone mentioned above, the feature supports the interpretation that humans deposited larger portions of hunted aurochs and red deer as bait for eels in the shallow water near to the shore.

One or more hearths with associated burnt fish bones, the unusual composition and location of the wild animal bones and the uniform tool inventory lead to the conclusion that Rosenfelde LA 83 was a specialised fishing station. The fish bones mainly come from eel and, in combination with leister prongs, broken off bone points and parts of a fish trap, underline the significance of eel-fishing at this site. The fish community as a whole suggests – with its mixture of freshwater- and marine-affiliated species – brackish conditions and muddy to sandy sediments. Additionally, the records of trout *(Salmo trutta)* – and also of otter *(Lutra lutra)* – indicate flowinging water nearby.

The mammal bones are dominated by red deer, aurochs and wild boar. The typical diversity of prey including a distinct marine component that usually occurs at coastal sites of the Ertebølle Culture could not be observed at Rosenfelde.

Thus there is plenty of evidence that this site was not a base-camp settlement but a temporary fishing station where fresh parts of wild game which were of no further use were deposited in the shallow water near the shore in order to lure and catch nocturnal freshwater eel which comes out in the dusk.

3.1.1.5. Neustadt LA 156 (2000–2006)

The submerged site Neustadt LA 156 lies c. 3.5 m below the present water surface at the entrance to the harbour of Neustadt on the edge of Neustadt Bay. It was discovered in 1999 by a military diver and reported to the ALSH (Archaeological State Department of Schles-

wig-Holstein). Analysis of the submarine contours and survey drilling has demonstrated how convenient this location must have been for settlement. The site is situated on the edge of an insular elevation which in the 5th and early 4th millennium cal. BC probably did not lie on the open sea but next to a lagoon sheltered by a barrier beach (Hartz / Glykou 2008).

From February 2000 until 2006, annual diving campaigns took place, each lasting several weeks. By and large 110 m² could be investigated in seven campaigns. Of this area, only 10 m² belong to the occupation area proper. Within that part, the find layer consists of medium to coarse-grained gravel above sterile till in which residual flint artefacts of various sizes, small pottery fragments and a few porous, weathered bones are embedded. In the lower lying area further away from the ancient shore, the find layer merges into a peaty mud/muddy peat with molluscs which provides excellent preservation conditions.

The analysis of the animal bones, bone and antler implements and pottery was conducted by A. Glykou (2011) as part of her dissertation. Therefore these find groups will neither be presented here in detail nor quantified.

The find layers in the marine to brackish refuse area consist of extremely muddy fine sand with proportions of medium and coarse sand which is covered by a 10 to 20 cm thick surface sand layer with stones. From the layers containing a high proportion of organogenic components not only sharp-edged flint artefacts and ceramic finds were retrieved but also plant remains, animal bones, antler pieces, charcoal as well as worked and charred wood. The enormous amount of finds and the thick find layers suggest that Neustadt too was used as a permanent base-camp settlement.

Altogether 40,000 flint artefacts were excavated (excluding chips), 1 % of which have been defined as tools (Hartz 2004). This group is dominated by transverse arrowheads with straight to slightly concave retouched edges. The more or less 600 samples were made from blades and flakes in almost equal shares; some of them have been identified as half-finished products. The second most common group comprises about 250 flake axes. As a rule, these are represented by flat-trimmed trapezoidal forms, but there are also a number of oblong rectangular samples, whereas edge-retouched pieces occur only twice. Unlike the samples from Grube-Rosenhof LA 58, the flake axes from Neustadt are relatively small, which certainly has to be attributed to a poor supply of raw material.

On the third position follows a group of – c. 150 scrapers made from slender, regular blades. Some of these scrapers were produced from comparatively narrow basic forms with parallel edges. Asymmetrical working edges as frequently encountered at Grube-Rosenhof LA 58 and Wangels LA 505 in the Oldenburg Graben area are almost totally missing at Neustadt. The blade implements also comprise concavely truncated tools with and without a stem, short and long borers as well as edge-retouched and denticulated pieces. Burins, however, occur only seldom, just like at other coastal sites of the Ertebølle Culture in Schleswig-Holstein.

Among the core and flake tools, there are borers and a few flake scrapers, but on the whole implements made from flakes form a minority.

The non-flint stone tools comprise hammerstones of quartzite or quartzite sandstone, round-butted axes and two Danubian axes, which underline the special role of eastern Holstein in the distribution of imported amphibolite axes.

Within the ceramic finds, coarsely tempered, thick-walled fragments from pointed-base vessels and remnants of oval lamps are the most prominent group. These are complemented by sherds of a thin-walled undecorated ware which is produced by coils which are placed obliquely to each other.

Among the bone implements, point fragments from leisters, strong awls with the joint left on one end, a slender bone chisel, a spatula-shaped tool with a denticulated end and

several elbow daggers (ulna points) have to be mentioned. T-shaped axes, harpoons, pressure flakers and a small chisel were made from antler.

The wooden tools at Neustadt comprise leister prongs, dugout canoe fragments, paddles, spears, angled shafts for axes, handles for antler axes, the fragment of a bow, arrows, a net float made of bark, textile net remains, several fragments of wicker work fish traps, pointed sticks and poles. From 26 randomly chosen square meters 447 pieces of wood without toolmarks were analysed.

At Neustadt 26 leister prongs were recovered, half of them made of red dogwood *(Cornus sanguinea)* and hazel wood *(Corylus avellana)*. Single fragments of leister prongs are made of ash *(Fraxinus excelsior)*, pipfruit wood (Maloideae) and oak (*Quercus* sp.). On some of the prongs notches are still visible at the barbs. The tips are worn, split, roughend or broken off by use. Two half finished pieces show the manufacturing technique of the leister prongs. From a crotch one branch was removed and then the crotch was split lengthwise in half. The end of the leister shaft and the tip were prepared by a number of recognizable cuts.

The many wooden fragments are from approximately 13 paddles and their shafts. Partly due to being found close togetherand their similar tree-ring sizes, an association could be assumed. All paddles were made out of ash tree trunk wood *(Fraxinus excelsior)*. For seven specimens the shape of the oar blade could be determined more or less. They vary between heart-shaped and short, oval blades, which are typical for the Ertebølle Culture, to elongated slim shapes (one specimen). Only three paddles show signs of a reinforcing rib on the blade.

Four groups of dugout canoe parts could be distinguished by their position in the excavation area. Multiple fragments of dugout canoes show clear traces of toolmarks on the inside. These relatively short, flat-concave chopping marks could be caused by a flint flake axe (Hartz / Kraus 2003/2004). All fragments are made of lime (*Tilia* sp.).

There are 35 fragments of spears in Neustadt, all made of ash tree trunks *(Fraxinus excelsior)*, with a diameter between 17 mm and 22 mm. The close proximity of the ash spears to the paddle fragments suggests that some of the pieces could also be paddle shaft fragments. The longest recovered find of a spear measures 1.87 m. All preserved points narrow slowly and show no signs of any special spear head.

An outstanding find is the handle section of a Holmegaard-type bow and six fragments of arrows. The bow fragment is 23.5 cm long and shows the handle with rectangular rounded cross section, and parts of the bow arms with a D-type cross section. The bow was made out of a slowly grown elm tree (*Ulmus* sp.) of only 6 cm diameter, which shows approximately seven tree-rings per cm. As material for the arrows hazel *(Corylus avellana)*, ash *(Fraxinus excelsior)* and guelder rose *(Viburnum opulus)* were used. One of the arrows was specialised, with a blunted thick arrow head used for the hunting of small animals or birds.

Further outstanding finds were two completely preserved angled shafts to which the flake or core adze had once been tied in an elaborate manner, and a shaft mounting for a round butted axe (Walzenbeil) discovered nearby made out of rock. Two angled mountings were made of hazel *(Corylus avellana)* and a further composed of piptree wood (Maloideae). The tool shaft of one of the angled mountings consists of a 3 to 4 cm thick branch and the mounting area for the actual axe was made out of the flattened trunk part, which originally measured 7 cm in diameter. It has a distinctive neck that overlaps by approximately 3 cm and could provide a firm rest for the mounting of the actual axe. Both other angled shafts are of smaller size. Furthermore, a half finished piece for such a mounting made from a ten year old maple *(Acer campestre)*, and a charred club-like percussion tool made from the crotch of a sloe *(Prunus spinosa)* were found.

Also the remains of handles of four T-shaped antler axes were examined. These were always simple round branches to which were later attached small wooden wedges. Twice

hazel *(Corylus avellana)*, once ash *(Fraxinus excelsior)* and once buckthorn *(Frangula alnus)* were used. The wooden wedges are made of hazel and lime (*Tilia* sp.).

Different sorts of wicker work were found at Neustadt which belong to fish traps. They are constructed using parallel split rods made of red dogwood *(Cornus sanguinea)* and guelder rose *(Viburnum opulus)* and taped with material from alder (*Alnus* sp.). The hoops of fish traps were made of hazel, dogwood and ash twigs, but also from honeysuckle *(Lonicera xylosteum)*. In addition there are two round hazel poles *(Corylus avellana)* that have flattend ends and were perforated. Another round ash pole *(Fraxinus excelsior)* has a circular groove at one end. Similar specimens were found on other sites and belong presumably to fish traps. For an elongated net float made of bark the Ertebølle dating is not definite because the find was recovered from an uncertain location. But multiple braided and twisted strings made of tree bast and the fragments of a net or textiles were found in the deeper areas of the organic silt and prove the extraordinary preservation conditions in the more distant shore zone. The function of a small oak board (*Quercus* sp.) with three perforations, and of one board made of pine wood *(Pinus sylvestris)* with lengthwise perforations is unknown. The same is true for a spoon-like artefact made of ash trunk wood *(Fraxinus excelsior)*.

From Neustadt 60 pointed sticks and four poles are known, which are interpreted as part of a fish weir (Hartz / Kraus 2009). The pointed sticks are often hazel *(Corylus avellana)*, rarely oak (*Quercus* sp.) or ash *(Fraxinus excelsior)*, and in some cases pine *(Pinus sylvestris)*, red dogwood *(Cornus sanguinea)* and privet *(Ligustrum vulgare)* occur. They have a diameter of 2–4 cm; the hazel rods were between 2 and 12 years old. The pointed sticks were intensively worked on by chopping and ripping off chips. Sometimes cutting marks from the tools used were still visible on the wood, so that in some cases it could be observed that the slashes were at an oblique angle.

Among the wood samples without toolmarks, almost a third was hazel *(Corylus avellana)*. Oak *(Quercus* sp.) and ash *(Fraxinus excelsior)* also show high proportions. The appearence of pine wood *(Pinus sylvestris)* with a proportion of 2 % is worth noting, because the tree does not occur on other contemporaneous sites but only at Baabe in south-eastern Rügen Island. The diameters of the hazel rods among the wood without toolmarks are similar to the ones of the pointed hazel rods, and they can also be seen as part of the destroyed fishing fence at the site. Given the uniformity of the rods and the high requirement for hazel wood for the fish weirs, dedicated forest management can be assumed (Klooss 2014). This was also proved in Neustadt with the occurrence of finds of typical hazel shoots with a thick base.

Neustadt differs from the other places in its focus on marine resources. The fish bone assemblage with its approximately 10,000 pieces and the fish species list are clearly dominated by marine species. Moreover, most of the mammal remains also come from marine species such as several kinds of seals, harbour porpoise *(Phocoena phocoena)*, and common dolphin *(Delphinus delphis)*. The large variety of species recorded in Neustadt – altogether more than 60 – and the accurate analyses of the faunal material allows a detailed reconstruction of the surrounding Stone Age landscape and of human hunting behaviour (Glykou 2011).

Apart from that, there are some bones from sheep / goat and domesticated cattle as well as a small number of pieces which cannot be assigned with certainty to domesticates or its corresponding wild form.

The chronological frame is set by more than 20 AMS-^{14}C-dates, which cover the period between 3800 and 4500 cal. BC. Thus the site belongs to the medium to later (ceramic) stage of the Ertebølle Culture *(Timmendorf phase)* and the earliest phase of the Funnel Beaker Culture *(Wangels phase)*. The analysis of a standard pollen profile, which is expected to shed light on the development and age of the marine-brackish sediments, has recently been com-

pleted at the Laboratory for Palaeobotany at Köln University by J. Meurers-Balke and J. A. Kalis (Hartz et al. 2011).

3.1.2. Wismar Bay
(H. Lübke, D. Heinrich, S. Klooß, U. Schmölcke and S. Wolters)

Archaeological investigations of submarine Stone Age settlements in the Wismar Bay area have taken place since 1998 (Lübke 2000; id. 2001; id. 2002a; id. 2003). They were funded by the German Research Foundation (DFG) from 2001 to 2002 as a research project entitled "Ökologie und Ökonomie submariner Fundstellen aus der Zeit der Neolithisierung in der

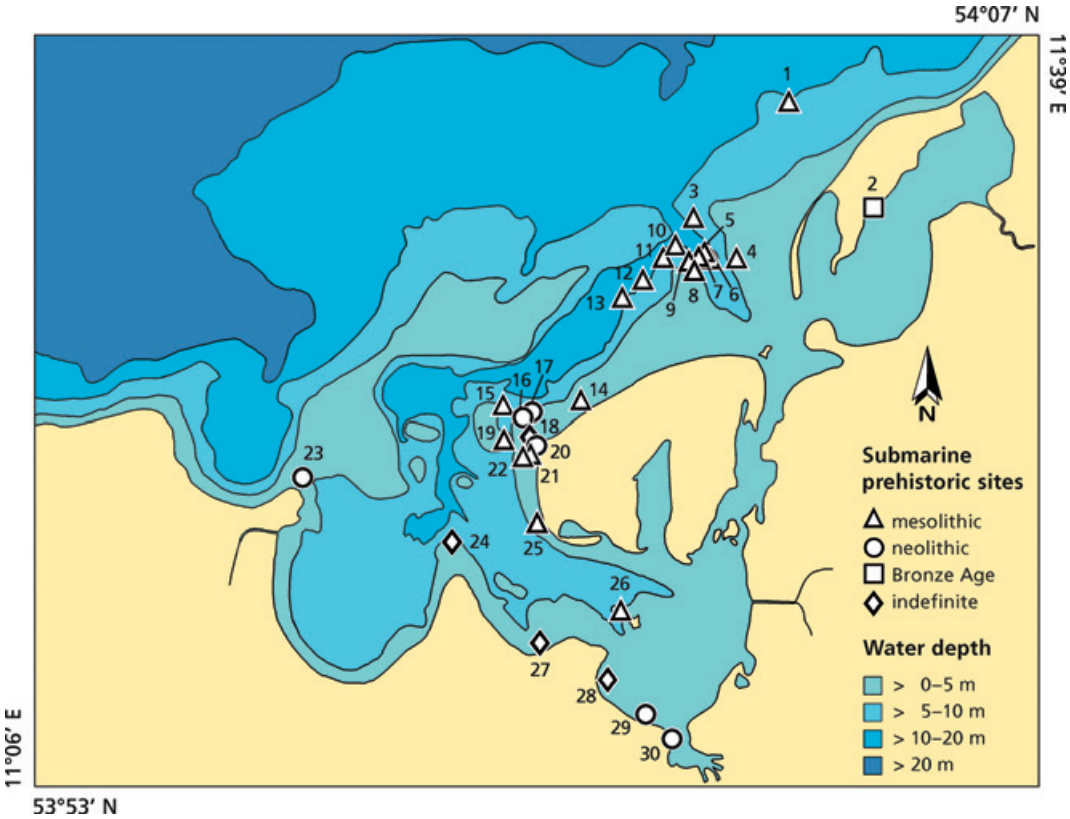


Fig. 3. Wismar Bay, Mecklenburg-Vorpommern. Bathymetric map with submarine Stone Age sites. 1 Rerik-Riff (Poel 53); 2 Rerik-West 43; 3 Großes Tief-Ostufer (Poel 52); 4 Großes Tief-Ost (Poel 58); 5 Jäckelgrund-Strand (Poel 5); 6 Jäckelgrund-Orth (Poel 42); 7 Jäckelgrund-Furt (Poel 40); 8 Jäckelberg-Nord (Poel 16); 9 Jäckelberg-Huk (Poel 45); 10 Jäckelberg-Nordkap (Poel 59); 11 Jäckelberg-NNW (Poel 49); 12 Jäckelberg (Poel 60); 13 Jäckelberg (Poel 61); 14 Schwarzer Busch-West (Poel 18); 15 Flaggtief-Nord (Gägelow 10); 16 Timmendorf-Tonnenhaken Süd (Poel 15); 17 Timmendorf-Tonnenhaken Nord (Poel 57); 18 Timmendorf-Strandwall (Poel 14); 19 Platte-Ost (Gägelow 3); 20 Timmendorf-Nordmole III (Poel 12); 21 Timmendorf-Nordmole I (Poel 12); 22 Timmendorf-Nordmole II (Poel 47); 23 Tarnewitzer Huk (Boltenhagen 5); 24 Hohen Wieschendorfer Huk-Nord (Gägelow 7); 25 Rustwerder-Hals (Poel 46); 26 Walfisch-West (Wismarbucht 7); 27 Zierow MF (Wismarbucht 14); 28 Hobener Bucht (Wismarbucht 9); 29 Wendorf-Steinort (Wismarbucht 8); 30 Wendorf-Yachthafen (Wismarbucht 6). – Scale 1 : 30 000 (digital drawing H. Lübke).

Wismar-Bucht [Ecology and economy of submarine sites in Wismar Bay during the Neolithic transition]". From 2002 to 2005, research was continued within the interdisciplinary DFG research unit SINCOS (Harff et al. 2004; id. 2005; Jöns et al. 2007), and from 2006 to 2008 as part of the DFG project bundle SINCOS II. Until spring 2009, altogether 30 sites with varying preservation conditions were discovered (Lübke 2006). The most important sites are situated in the two microregions Jäckelberg-Nord and Timmendorf West off the Island of Poel *(fig. 3)*.

3.1.2.1. Microregion Jäckelberg

3.1.2.1.1. General remarks

One of the main microregions in Wismar Bay is the north-eastern spit of the so-called Jäckelberg, a moraine ridge located about 1.5 nautical miles off Poel Island. Here, several Stone Age sites were detected at a depth of 6 m to 12 m during surveys with the research vessel "Prof. Albrecht Penck", using geoscientific equipment such as sidescan sonar, a multibeam sediment echosounder, geo-radar, and a remote control underwater video camera (Lübke 2006; Jöns et al. 2007; Tauber 2007; Lübke et al. 2011 and this volume). The sites belong to different phases of the Late Mesolithic and early Terminal Mesolithic between 6500 and 5000 cal. BC – a period which has remained rather obscure in North Germany due to the lack of stratified sites with preserved organic material. From an archaeological point of view, investigation of such sites could provide information on the cultural development in the western Baltic region during the Late Mesolithic, thus answering the question whether the Late Mesolithic population on the German Baltic coast has to be assigned to the Kongemose Culture prevalent in Denmark or to the Mesolithic cultures of the Central European inland characterised by trapeze forms. It should also shed light on the emergence of the Terminal Mesolithic Ertebølle Culture on the southwestern Baltic coast. The accompanying scientific investigations could provide insights into the transformation of the landscape from a glacial valley with lime-oak forests and freshwater lakes to a semi-enclosed fjord with a completely different biodiversity pattern. Another important issue in this context is the question of how the inhabitants responded to this environmental change which also affected their food resources.

3.1.2.1.2. Neuburg / Poel 45, Ostsee II (Jäckelberg-Huk)

The site Jäckelberg-Huk (Ostsee II, Neuburg/Poel 45), discovered in September 2002, is situated on the edge of the Jäckelberg, at a depth of 8.5 m below MSL (mean sea level).

Just like the site Jäckelberg-NNW (Ostsee II, Neuburg / Poel 49; 11 m below MSL) immediately to the west, it is one of the earliest radiocarbon dated submarine settlements known in Wismar Bay. Both sites can be dated to the early Late Mesolithic (*c.* 6400–6000 cal. BC) on the basis of archaeo-typological criteria and ^{14}C-samples (Jöns et al. 2007, 98; Lübke 2009a; Lübke et al. 2011; *tab. 4*).

In 2004 and 2005 the preservation conditions and the stratigraphy of the site were examined. All in all an area of 31 m^2 was uncovered *(fig. 4)* and a 13 m long section recorded *(fig. 5)*. The main cultural layer was detected in the strongly humic upper horizon of the mineral palaeosol, below the peat / mud sediments. Two hearths, uncovered in the deepest part of trench 5 and trench 9 *(fig. 7)*, showed that part of the actual settlement area was indeed covered by the excavation and that the cultural layers had been well preserved by the overlying peat. Even in the deepest test trenches 7 and 8 the ancient shoreline of the settle-

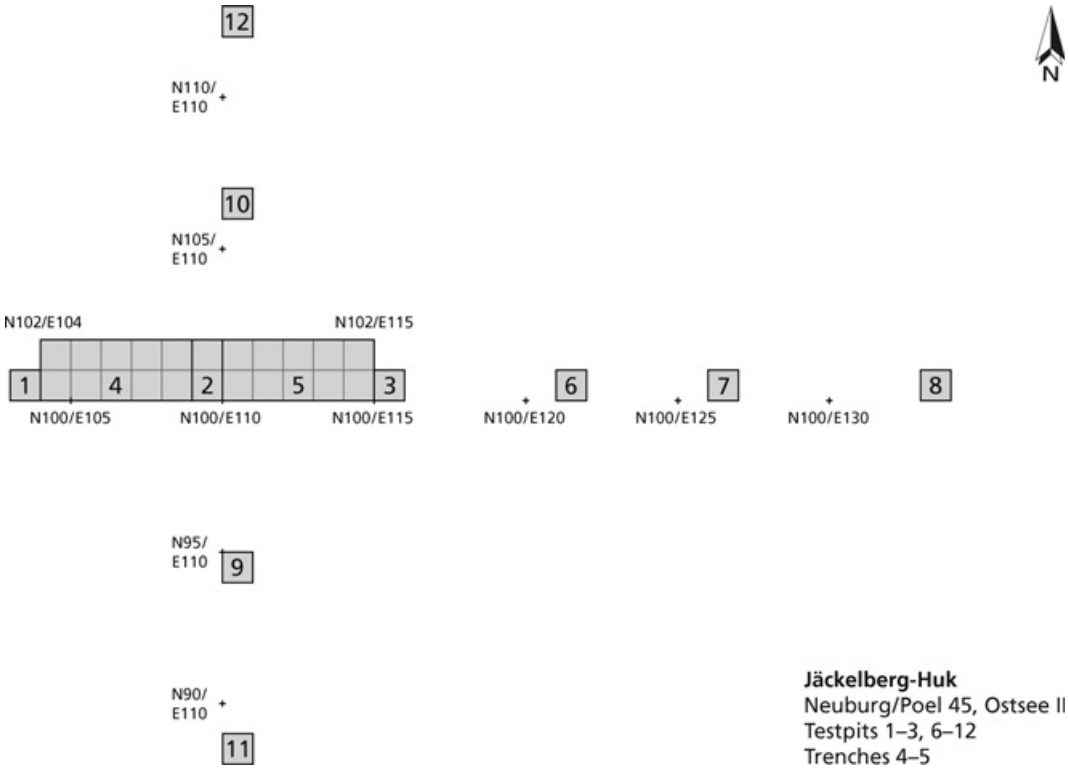


Fig. 4. Jäckelberg-Huk (Ostsee II, Neuburg / Poel 45). Excavation plan. – Scale 1 : 250 (digital drawing H. Lübke).

ment area could not be localised, whereas the main cultural layer was found again in the mineral palaeosol at the base of the trenches *(fig. 6)*. Obviously, the former shoreline has to be sought for at depths more than 10 m below present sea level, thus corresponding to the depth of the slightly older site Jäckelberg-NNW.

The sediments overlying the mineral palaeosol consist of a succession of mud and reed peat layers, indicating varying but steadily rising water levels. Marine molluscs could only be observed in the higher sediment layers of the shoreline.

A sediment profile consisting of two sample boxes was taken from trench 7 *(fig. 6)* to facilitate reconstruction of vegetation and landscape development with the aid of pollen, plant macro fossil, diatom and geochemical analyses *(figs. 8–10)*. Five AMS radiocarbon dates cover most of the sedimentation time and place it between *c.* 6100 and 5600 cal. BC *(tab. 5)*.

The vegetation of the Late Mesolithic site is characterised by a pine-mixed oak forest with pine, oak, elm, lime, ash and hazel (*fig. 8* zone 1), which is typical for the Atlantic period in middle Europe (Lang 1994). High percentages of *Pinus* pollen indicate that larger pine stands have outlasted from Boreal times when *Pinus* had been a major constituent of the landscape. The palynological evidence confirms the records of pine wood below mentioned. Furthermore, the important role of pine in the Atlantic vegetation of Wismar Bay is well illustrated by the diagram Redentin by Endtmann in Lampe et al. (2005) which shows an even higher *Pinus* representation.

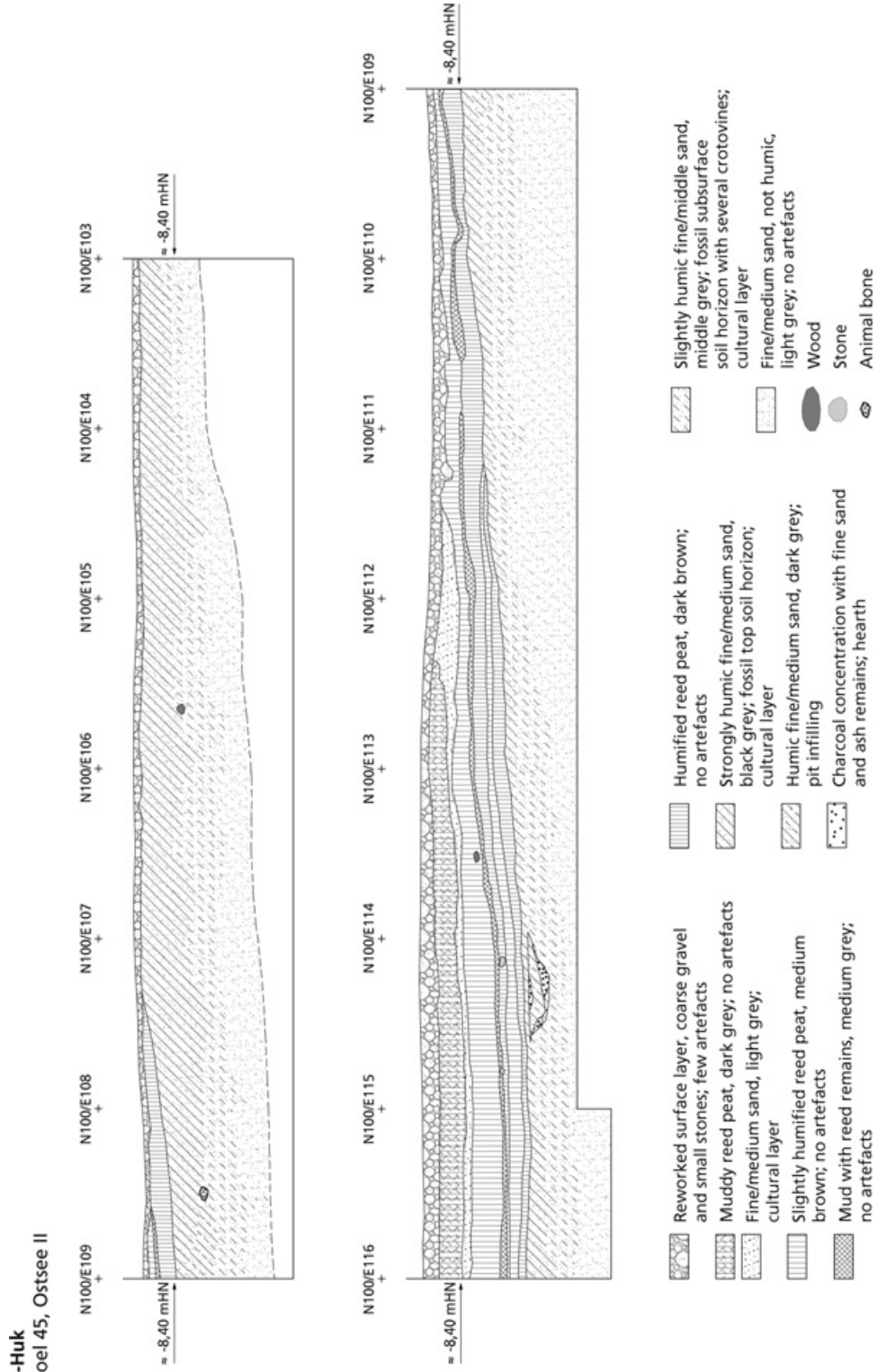


Fig. 5. Jäckelberg-Huk (Ostsee II, Neuburg / Poel 45). Test trench 1–3, trench 4–5. Section E 103–116 / N 100. – Scale 1 : 40 (digital drawing J. Freigang / H. Lübke).

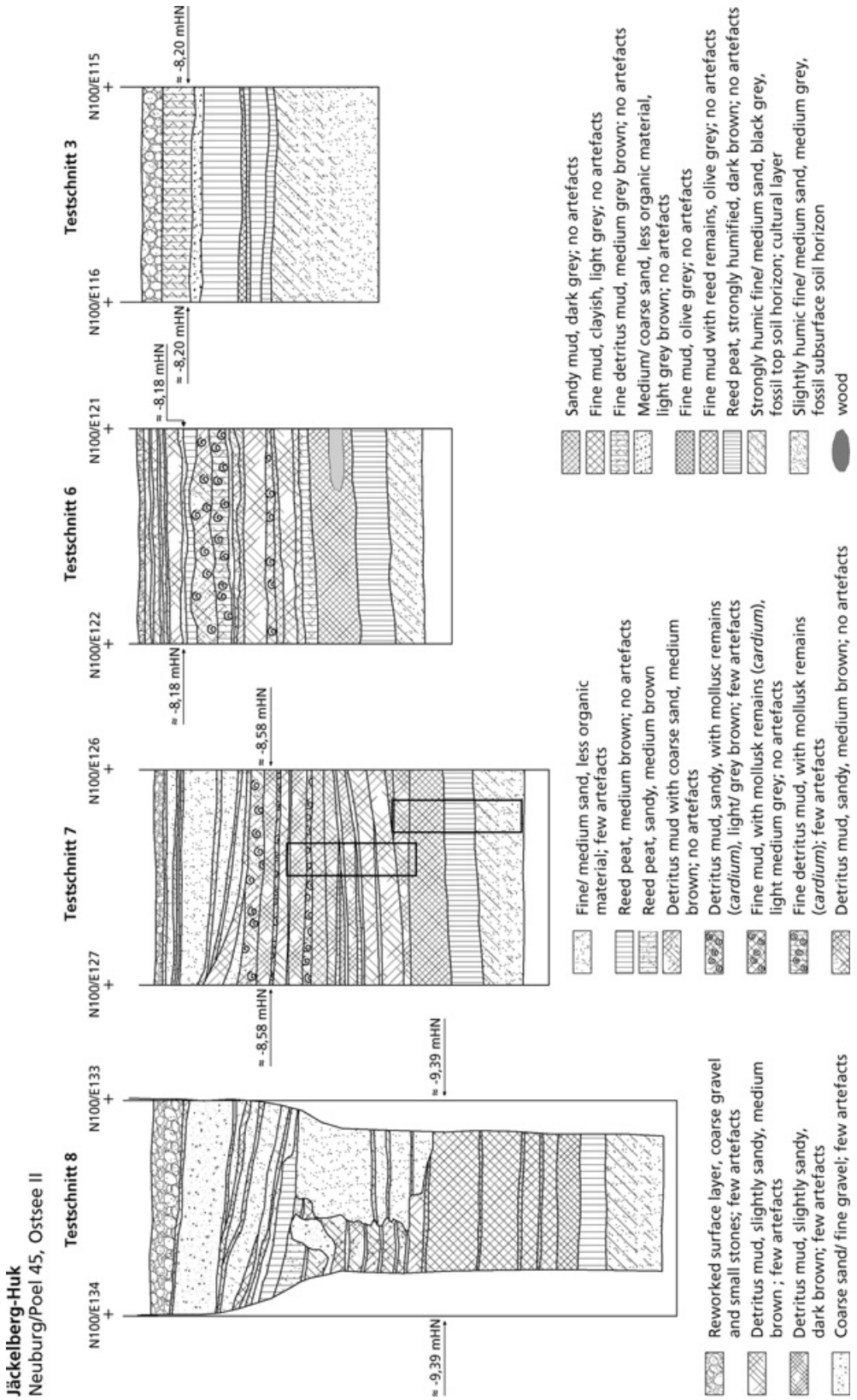


Fig. 6. Jäckelberg-Huk (Ostsee II, Neuburg / Poel 45). Test trench 3, 6–8. Section N 100. – Scale 1 : 30 (digital drawing J. Freigang / H. Lübke).

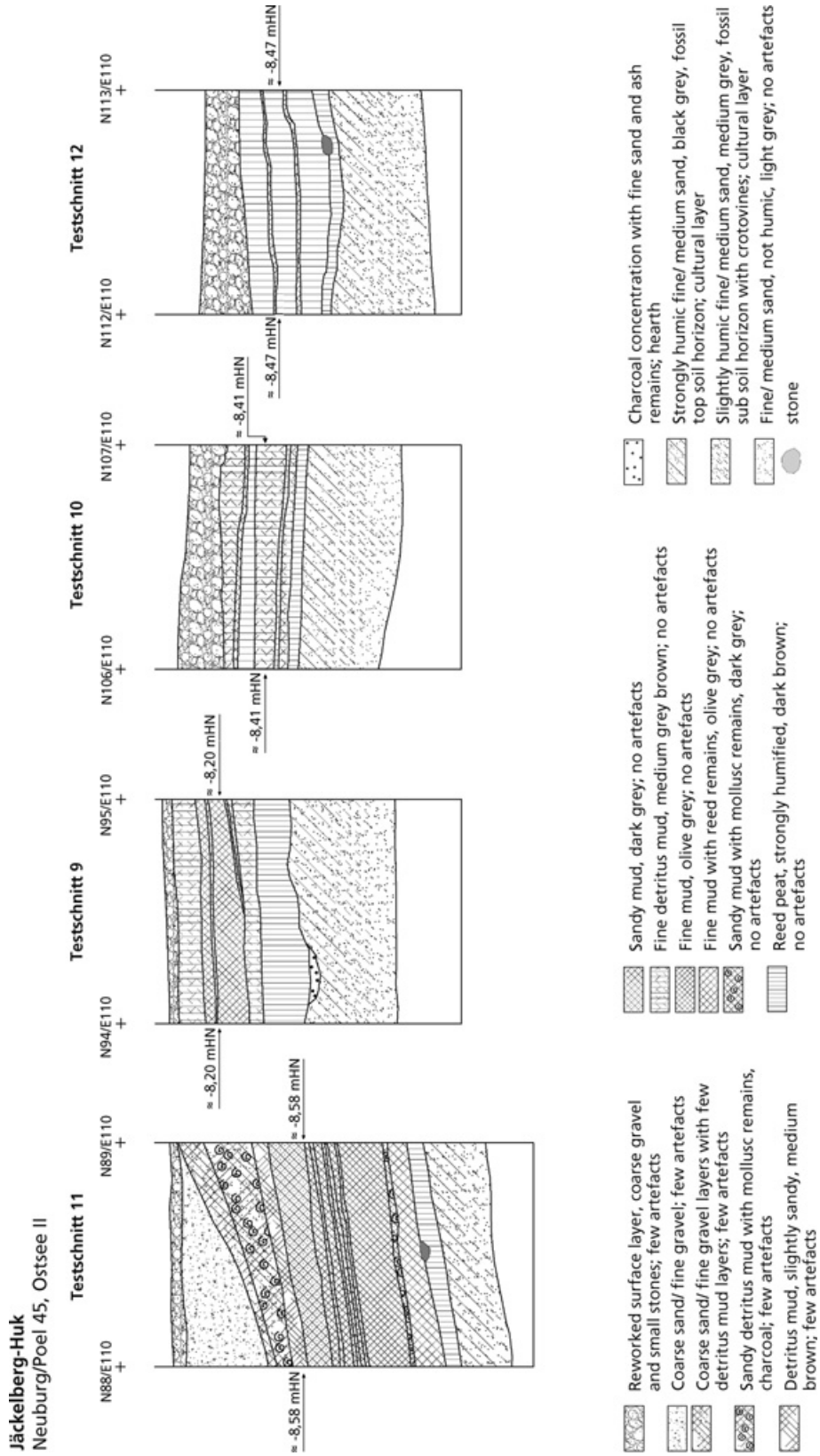


Fig. 7. Jäckelberg-Huk (Ostsee II, Neuburg / Poel 45). Test trench 9–12. Section E 110. – Scale 1 : 30 (digital drawing by J. Freigang / H. Lübke).

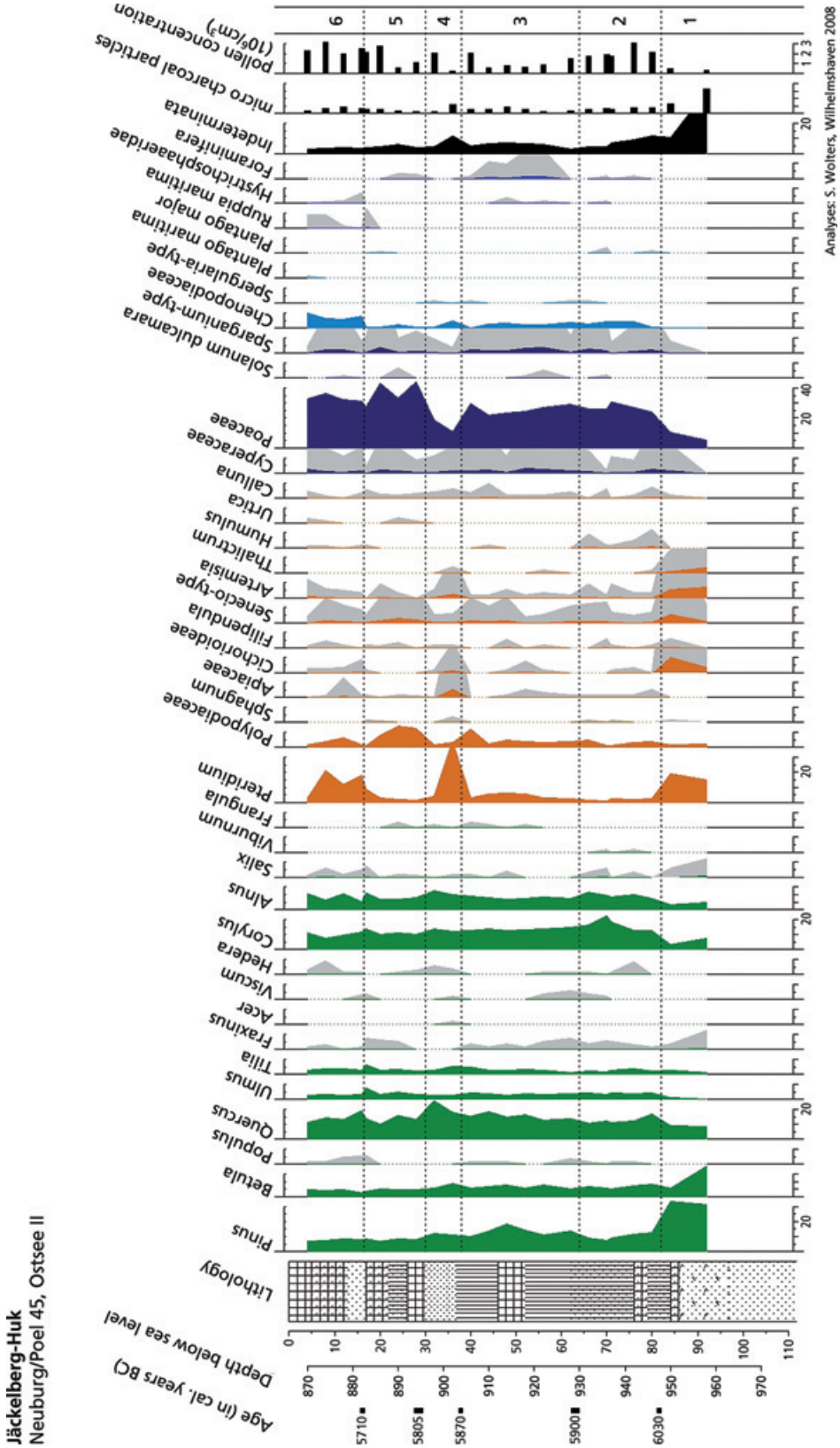


Fig. 8. Jäckelberg-Huk (Ostsee II, Neuburg / Poel 45). Percentage pollen diagram from Jäckelberg-Huk (Poel 45), showing only most important taxa. Pollen sum is based on total terrestrial pollen. Local pollen zones (1–6) and stratigraphy are indicated. The grey shading denotes 10-fold exaggeration for better visualization.

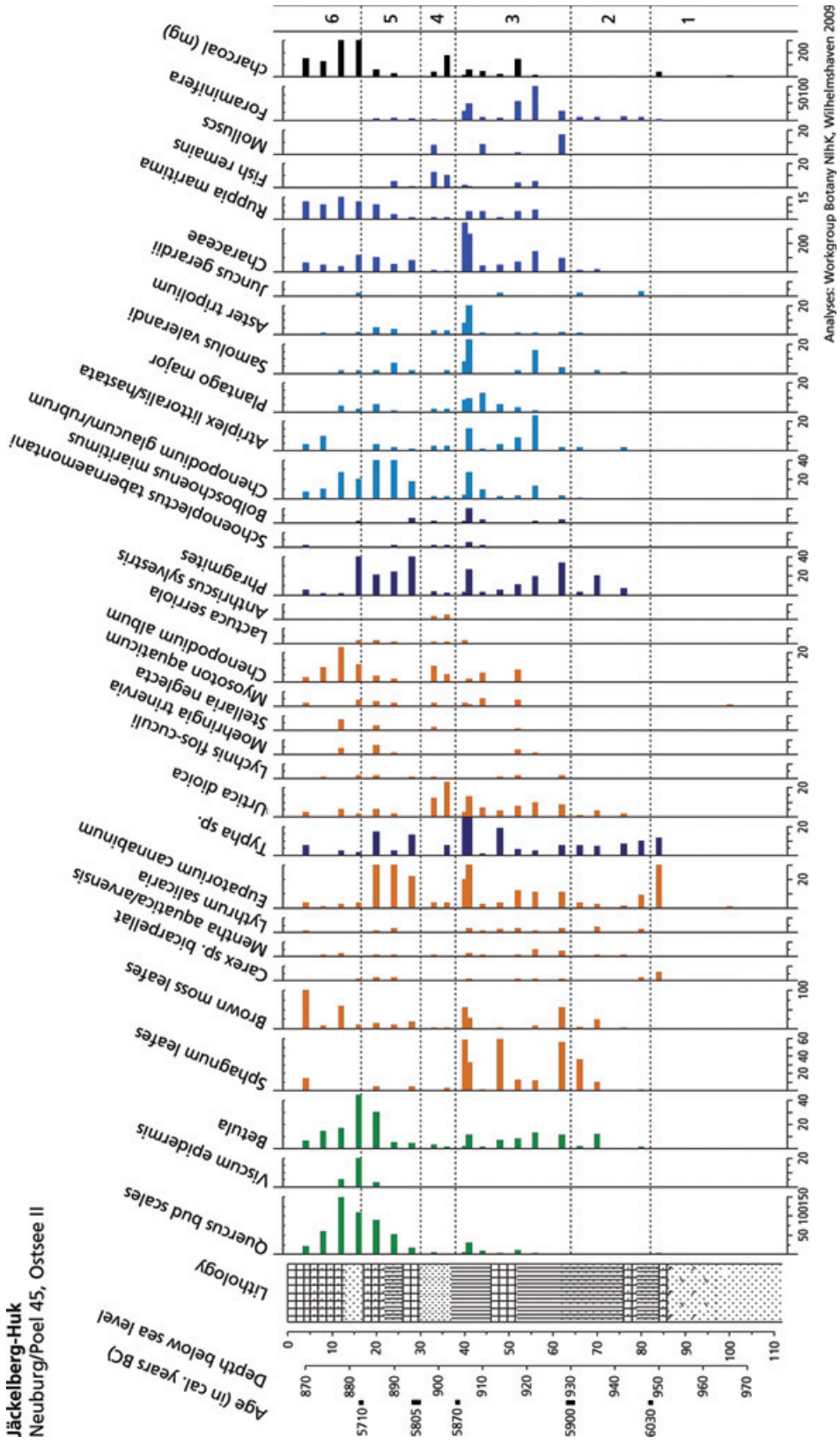


Fig. 9. Jäckelberg-Huk (Ostsee II, Neuburg / Poel 45). Macro fossil diagram from Jäckelberg-Huk (Poel 45), showing only most important taxa. The records are based on total counts. If not indicated otherwise macro remains are seeds or fruits. Stratigraphy is displayed and zonation (1–6) from the pollen diagram is adopted.

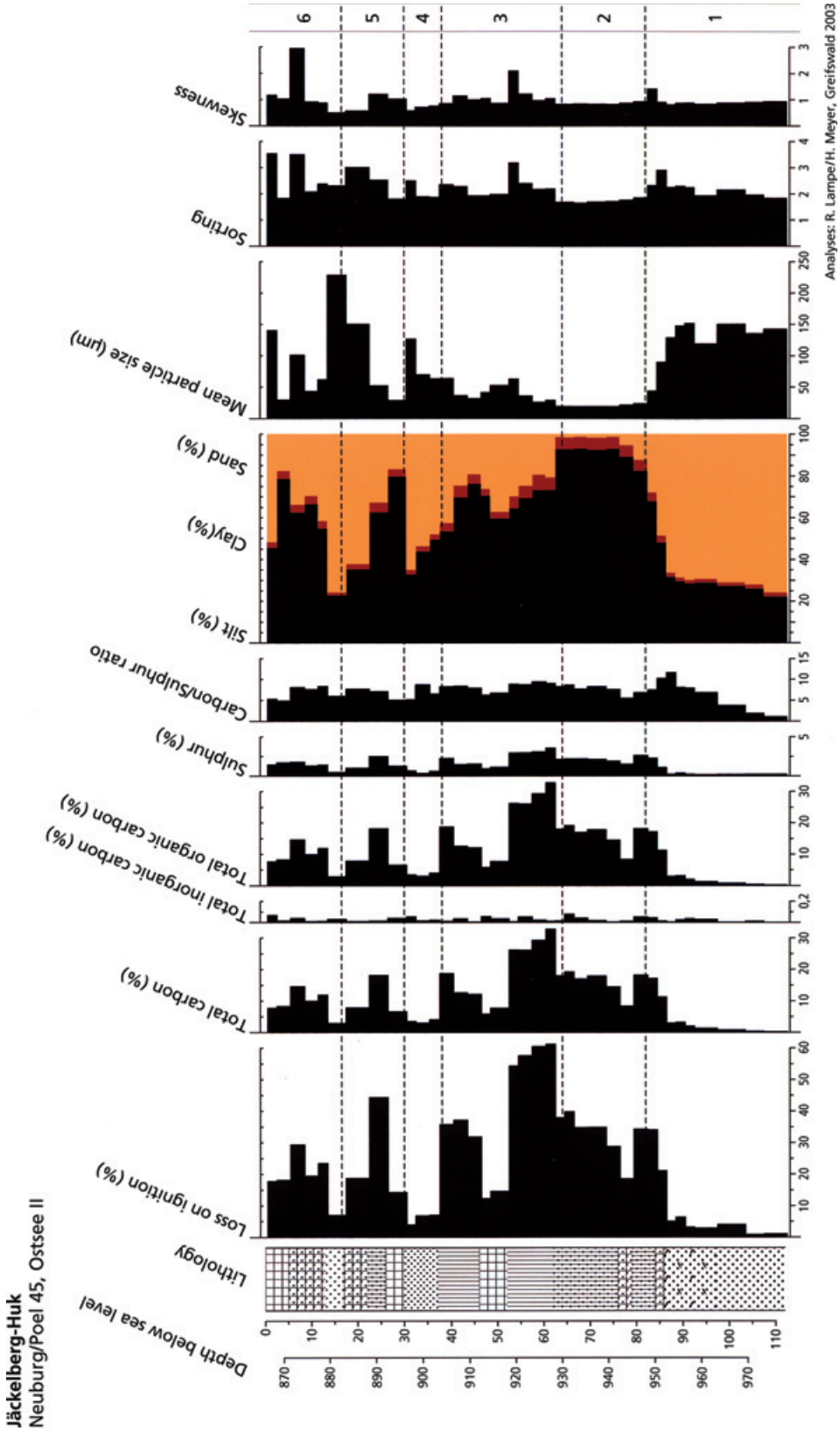


Fig. 10. Jäckelberg-Huk (Ostsee II, Neuburg / Poel 45). Geochemistry diagram from Jäckelberg-Huk (Poel 45). Zonation (1–6) from the pollen diagram is adopted. Geochemical investigations displayed were basis for stratigraphical descriptions used in all diagrams.

The pine-mixed oak forests existed at least during the final phase of the settlement at Jäckelberg-Huk. No evidence can be given for the greater part of the settlement phase, because the lowermost sample analysed derived from the top of the cultural layer, where sufficient pollen preservation enabled vegetation reconstruction for the first time. The humous sands at the base which contain the main cultural layer were virtually void of evaluable botanical remains. Only few palynomorphs were recorded which moreover were heavily corroded. Though pollen preservation improved with rising total organic carbon (TOC) content towards the sand-peat transition *(fig. 10)*, corrosion and possibly selective pollen degradation should still be taken into account for the interpretation of zone 1.

Anthropogenic indicators of the Mesolithic settlement are the apophyte *Artemisia* (wormwood) and *Pteridium* (bracken). While *Artemisia* serves as a typical indicator for disturbed biotopes (Behre 1981), *Pteridium* responds well to forest openings and fire (high micro charcoal values!). Because of the remarkably high values, an active collecting of bracken fronds for the purpose of bedding (Smith 1970) cannot be ruled out.

High percentages of elements of meadowsweet stream bank communities such as macro fossils from *Eupatorium cannabinum* and *Thalictrum flavum (fig. 9)* as well as pollen from *Filipendula*, *Thalictrum* and *Senecio*-type suggest a site location in the vicinity of a small river or stream. However, their conspicuously strong occurrence may also indicate an expansion due to increasing soil moisture as a consequence of the Littorina Transgression.

First distinct evidence of the Littorina Transgression is recognizable from *c.* 6000 cal. BC in zone 2. Increasing soil moisture lead to fen peat formation and caused a change in the woodland composition, promoting the spread of alder *(Alnus)* and water elder *(Viburnum)* including hop *(Humulus)*, a climber in moister woody habitats. Reed communities with common reed *(Phragmites)* and lesser bulrush *(Typha angustifolia)* started to establish. The low percentages of Foraminifera indicate, that first inundations have occurred, but obviously only of minor impact. Macro fossil records of halophilous plants are still rare. However, their regular occurrence (e. g. *Atriplex littoralis / hastata*, *Samolus valerandi*) and the rising curves of Chenopodiaceae and *Plantago major* pollen show that halophilous plant communities developed at that time at Jäckelberg-Huk.

The progressive marine influence becomes fully visible 100 years later in zone 3 with the rapid increase of pollen and macro fossils indicative of salt marsh, drift line and brackish reed vegetation (in addition to the abovementioned taxa now with *Aster tripolium*, *Chenopodium glaucum/rubrum*, *Bolboschoenus maritimus*). The frequencies of *Foraminifera* (both micro and macro fossils) distinctly rise and regular records of cysts of marine dinoflagellates (Hystrichosphaeridae) suggest a considerable inflow of marine water, which also contained pollen and macro fossils from *Ruppia maritima*, a constituent of submarine seagrass meadows in shallow brackish water. The pollen and macro fossil analyses are confirmed by the diatomological investigations, which unfortunately only comprise the uppermost 60 cm of the profile. However, high frequencies of *Diploneis interrupta* all over zone 3 suggest the development of a relatively saline marsh in that time (Witkowski et al. 2014). Noteworthy are the high values of brown moss and *Sphagnum* leaves. They represent material reworked in the course of the surges and are indicative of intertidal conditions (Freund et al. 2004). The high values of TOC obviously are partly attributed to that feature.

The sandy layer of zone 4 is characterised by declining marine indicators and suggests a short regressive phase during the Littorina Transgression with indications of natural desalination. Numerous records of fish remains still point to an aquatic environment, although under less saline conditions. The occurrence of many taxa indicative of anthropogenic influence is striking. In addition to *Pteridium* and *Artemisia*, which were already present in zone 1, further nitrophytes such as *Chenopodium album*, *Urtica dioica* and *Anthriscus sylvestris* were

recorded and suggest an renewed settlement phase. However, that layer was free of archaeological artefacts.

Following the short regressive phase the Littorina Transgression proceded in zones 5 and 6 from *c.* 5800 cal. BC, high Poaceae values in the pollen diagram and plentiful *Phragmites* caryopses document the reestablishment of brackish reed communities which also is the habitat of *Samolus valerandi*. The high quantity of *Chenopodium glaucum / rubrum* seeds mirrors the drift line vegetation and *Aster tripolium* and *Senecio*-type pollen, which are frequently recorded, are representative for the salt marsh vegetation. *Ruppia maritima* (pollen and fruits) increases in the course of zone 5 and reaches highest values in zone 6 when *Phragmites* and *Aster tripolium* already decrease showing that brackish reeds and salt marsh vegetation had been replaced. Thus the last zone 6 represents shallow brackish water conditions with seagrass meadows prevailing while surges caused much erosion on the mainland (brown moss leafes, macro charcoal, *Pteridium*).

The archaeological finds consist of a large number of flint artefacts and several bone implements or pieces of worked wood (Lübke 2009a; Lübke et al. 2011). Among the flint objects, the arrowheads and microliths are especially noteworthy. Apart from trapeze-shaped microliths and oblique transverse arrowheads, rhombic arrowheads and a few very small elongated triangle microliths were found. The blade implements are dominated by numerous burins made from soft-hammered blades. In addition to these, there are a small number of blade scrapers and straight truncated blades. Adzes are represented so far only by a "flake-adze-like" core adze made from a frost-shattered piece of flint as well as several rejuvenation flakes from core adzes with a pointed-oval cross section.

Wooden artefacts occur only in small numbers. Merely one pointed stake and 45 pieces of unworked wood were recovered. Within the latter group, hazel *(Corylus avellana)* and oak (*Quercus* sp.) predominate on both sites. The occurrence of red dogwood *(Cornus sanguinea)*, which was used intensively at Timmendorf-Nordmole II some hundred years later, deserves special mentioning, while the presence of pinewood *(Pinus sylvestris)* indicates that this tree grew in the surrounding area.

The overall inventory is comparable to that of the Danish site of Blak II, the eponymous site of the first phase of the Kongemose Culture, dated to 6400–6000 cal. BC (Sørensen 1996). Apart from 50 trapezoidal and rhombic quadrangles, the find material of that station comprises also four elongated triangles of the same type as at Jäckelberg. Other parallels are the occurrence of specialised micro-blade handle cores and the frequency of blade burins among the blade and flake tools. Three more inventories date to the same period: one from Musholm on Zealand in Denmark (Fischer 1995), one from Ringsjöholm in Scania, Sweden (Sjöström 1997) and one from Seedorf LA 296 in the administrative district of Segeberg (Bokelmann 1999), an inland site in Schleswig-Holstein. At the Seedorf site, which is situated on an elevation in the so-called Heidmoor, a small flint assemblage was retrieved from trench C which is dated to 6102 ± 56 cal. BC by a ^{14}C-sample and which in addition to several long slender triangles also comprises a trapeze microlith. However, except for a core adze fragment and a number of soft-hammered blades with parallel edges, no diagnostic types of flint tools were found. Apart from this small inventory from Seedorf LA 296, Jäckelberg-Huk is the first undisturbed site of this period in northern Germany. Thus, the site is of extraordinary importance with regard to research on the cultural evolution in the southwestern Baltic region, since it has provided us with the first evidence of the Kongemose Culture on the German Baltic coast.

Thus Jäckelberg-Huk is one of the oldest sites in the whole Wismar Bay, and is essential to an understanding of the onset of the Littorina Transgression in the southern Mecklenburg Bay. The sediments show that the dwelling place was obviously located at a small river near

its outlet into a freshwater lake. The recorded fish fauna, strongly dominated by perch *(Perca fluviatilis)*, gives no evidence for fishing in a potential marine or even brackish environment nearby or in some distance of the site: 99.8 % of more than 2000 identified fish remains from Jäckelberg-Huk belong to freshwater or migrating species, the rest, four bones of cod *(Gadus morhua)* from the uppermost excavated layer, with high probability are younger than the phase of occupation. Some more palaeoecological information is provided from the fish species list *(tab. 6)*: it describes a community of freshwater-affiliated but brackish water tolerant species living in vegetation-rich water with muddy bottom. The species in question could have lived both in the proposed lake and in the slow streaming river. The high number of bones from water vole *(Arvicola terrestris)* supports this reconstruction, since it indicates especially moist shores of waters covered by vegetation. The size of the vertebrae of perch show an unselected size spectrum from 14–35 cm total length of the specimens (average 27 cm; n = 176), whereas the pike *(Esox lucius)* were possibly selected by the humans since the smallest were already about 30 cm long, while the largest measured about 70 cm.

The most interesting vertebrate remains from Jäckelberg-Huk are the two records of seals (Phocidae), a molar of a juvenile grey seal *(Halichoerus grypus)* and a fragment of a scapula of an unidentifiable seal. These findings give evidence of the appearance of the transgressing Baltic Sea within some distance of the surroundings of the settlement at about 6000 cal. BC (KIA-26398; but the hard water effect should be taken into consideration). They indicate the first seal hunting in Mecklenburg Bay.

The other recorded mammal species such as red deer *(Cervus elaphus)*, roe deer *(Capreolus capreolus)* and hedgehog *(Erinacaeus europaeus)* are ubiquitous species in wood lands.

3.1.2.1.3. Neuburg / Poel 42, Ostsee II (Jäckelgrund-Orth)

In 2008, excavation work in Wismar Bay concentrated on the site Jäckelgrund-Orth in the outer bay, *c.* 3 km north of Gollwitz on the northern tip of Poel Island *(fig. 3)*. There, located on the northern outskirts of the Jäckelberg, a moraine ridge which stretches from Poel Island in a north-east direction into the bay, lies a small shoal, the so-called Jäckelgrund. Geophysical investigations which were carried out by marine geologists from the Institute of Baltic Sea Research Warnemünde (IOW) on board the research vessel "F/S Pofessor Albrecht Penck" demonstrated that the Jäckelgrund is another moraine ridge, which rises to 6 m below MSL and which is separated from the Jäckelberg by a narrow gully up to 6.5 m deep. Several radiocarbon-dated tree stubs found *in situ* at depths of up to 8 m show that during the 6th millennium cal. BC the Jäckelgrund must have been a small island on the edge of the Großes Tief (literally Great Deep) just off the peninsula of Jäckelberg (Lübke 2004a; Lübke et al. 2011).

On this former island, three sites situated between 7 m and 8 m below the water surface were discovered through underwater survey. The site Jäckelberg-Furt (Neuburg / Poel 40, Ostsee II) is located in the west of the island, at the southern entrance of the gully which separates the Jäckelgrund from the Jäckelberg. The sandy to gravelly surface layer not only contained flakes, indirectly soft-hammered blades with parallel edges, a flake burin and a truncated blade, but also three core adzes with a pointed-oval cross section. Along the margins of the site, the Pleistocene subsurface was found to be overlain by muddy sediments.

The second site, Jäckelgrund-Strand (Neuburg / Poel 5, Ostsee II) on the opposite, north-east edge of the island, is located *c.* 7 m below water surface on an ancient beach ridge beyond which the seafloor of the Great Deep drops to more than 10 m. Except for the rem-

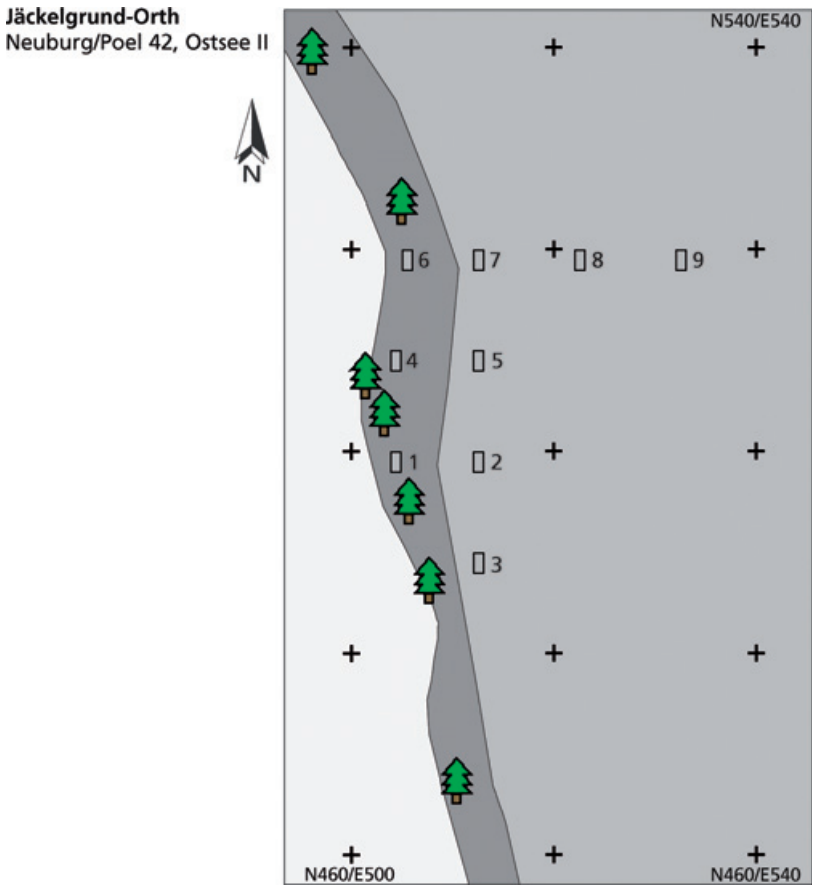


Fig. 11. Jäckelgrund-Orth (Ostsee II, Neuburg / Poel 42). Excavation plan. – Scale 1 : 750(?) (digital drawing H. Lübke).

nants of a tree stub, no organogenic layers or objects have been discovered to date. The find assemblage so far comprises lithic cores, flakes, high-quality blades, a flake borer, a scraper, a blade knife with an oblique truncation, three blade burins, yet another core adze with a pointed-oval cross section and a half-finished core adze.

The best preservation conditions were observed at Jäckelgrund-Orth (Neuburg / Poel 42, Ostsee II), on the south-eastern tip of the island. There, several tree stubs were found in their original position and, apart from sharp-edged flint artefacts, a number of animal bones and antler pieces collected as surface finds *(fig. 11)*. ^{14}C-samples taken from the tree stubs produced dates between 5900 and 5700 cal. BC *(tab. 7)*, suggesting a similar age for the archaeological finds, which have not yet been dated either by stratigraphical or radiocarbon analysis (Lübke et al. 2011).

The aim of the excavation campaign 2008 was to verify the origin of the surface finds at Jäckelgrund-Orth and to investigate the site's stratigraphy. For this purpose, eight test trenches, each covering an area of 2 m^2, were excavated and the sections documented *(fig. 11)*. Complete excavation of trench 9 was hindered by the continually stormy weather in autumn 2008. In the site area, the fossil topsoil, which is merely protected by a thin surface gravel

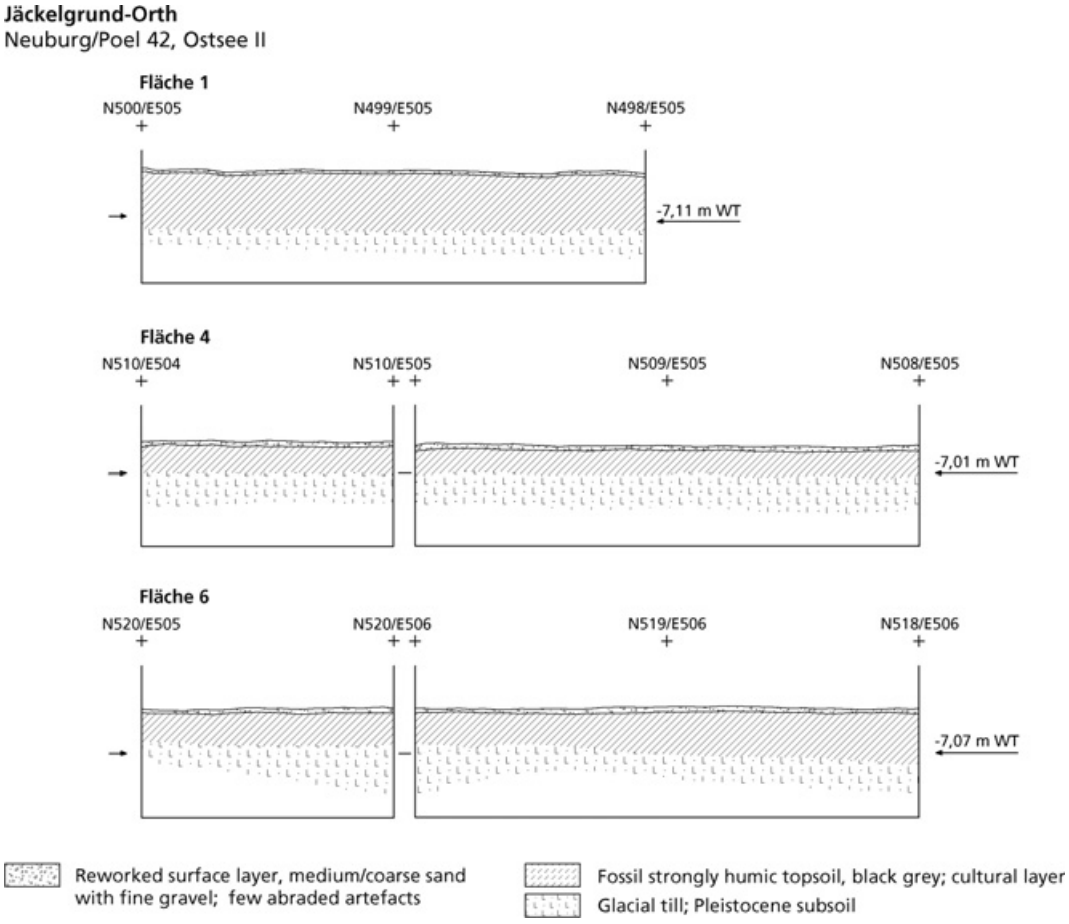


Fig. 12. Jäckelgrund-Orth (Ostsee II, Neuburg / Poel 42). Test trench 1, 4, 6. Sections. – Scale 1 : 30 (digital drawing J. Freigang / H. Lübke).

layer, has been preserved within an up to 5 m wide sector *(fig. 12)*. To the south and east it descends and is overlain by a parcel of peat / mud sediments *(figs. 13–15)*. What is especially worth noticing is the fact that even in the lowermost mud layers, just a few centimetres above the terrestrial ground, numerous shell remains are embedded. Obviously the area was inundated at a time when the sea had already invaded Wismar Bay and started to gradually transform it into a fjord. In the section where the topsoil is almost laid bare, about a dozen tree stubs have been preserved in their original position. In the bordering mud layers, a number of individual oak trunks could be observed, though it remains unclear whether there is any connection with the adjacent tree stubs.

Two find layers containing archaeological objects were revealed in the test trenches. The first find layer was discovered in the fossil topsoil. Especially in and around area 1, several flint artefacts, a few animal bones and some fish vertebrae could be excavated. Burnt flint and fish vertebrae as well as a number of fired clay fragments are evidence for the use of fire. In addition, the remains of two stakes with a diameter of 3–4 cm were unearthed in area 1 and the adjoining square. As the concentration of finds decreases notably in the adjacent test

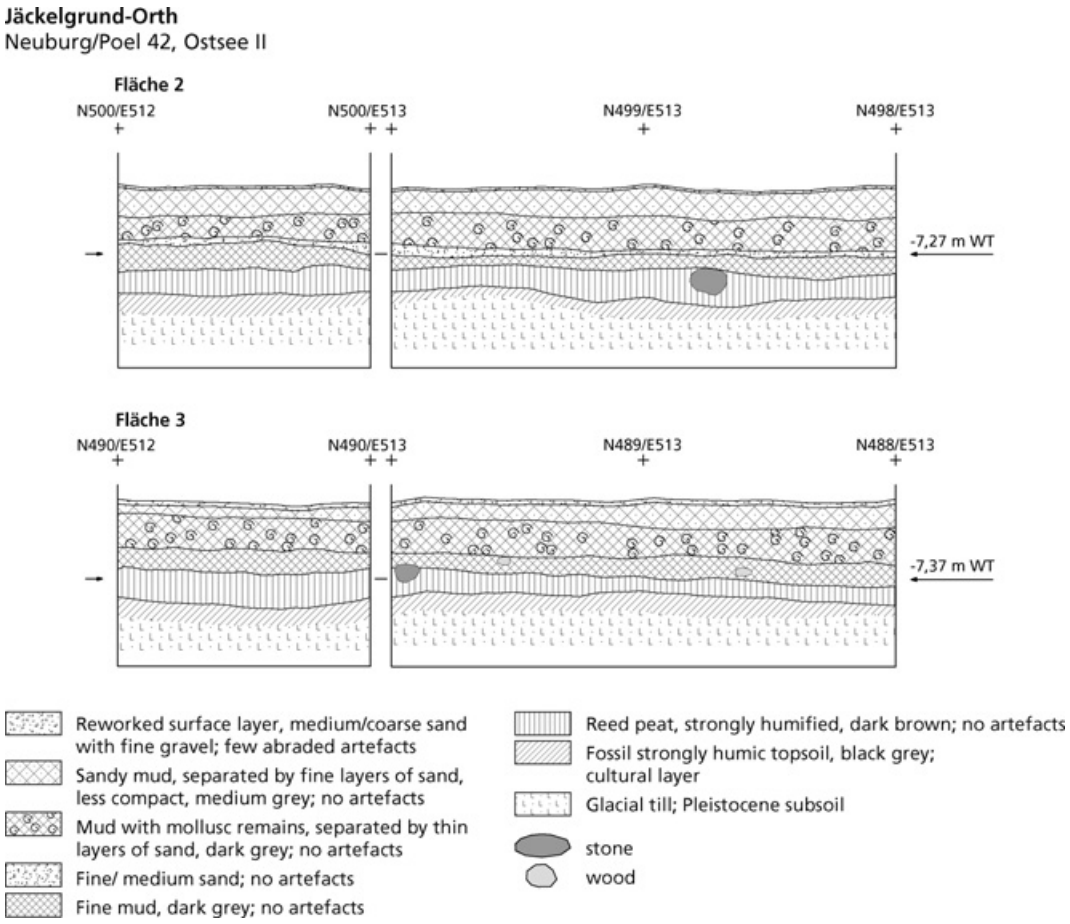


Fig. 13. Jäckelgrund-Orth (Ostsee II, Neuburg / Poel 42). Test trench 2, 3. Sections. – Scale 1 : 30 (digital drawing J. Freigang / H. Lübke).

units, it is to be presumed that the inventory represents the legacy of a minor camp covering only a small area. The precise age of the find layer has yet to be determined by radiocarbon dating of selected find material. However, the dates that have come from the tree stubs in the direct vicinity suggest that the finds have to be attributed to the first centuries of the 6th millennium cal. BC, when the Baltic inundated Wismar Bay.

A second archaeological find layer was recognised in the eastern test trenches in the upper marine mud layers *(fig. 15)*. Apart from a large quantity of charcoal, it was found to contain bones from larger mammals in particular as well as numerous fish remains. In principle, it cannot be excluded that these are residual finds, deposited in a secondary context, which belong to the stratigraphically earlier settlement discovered in the topsoil. However, considering – among other things – the good preservation state of the bone material, it seems more likely that the shore area of a second, younger settlement site has been found.

As the concentration of finds in this layer tends to be higher in the north-eastern test trenches, the original location of the site has to be assumed in the same direction, on the now

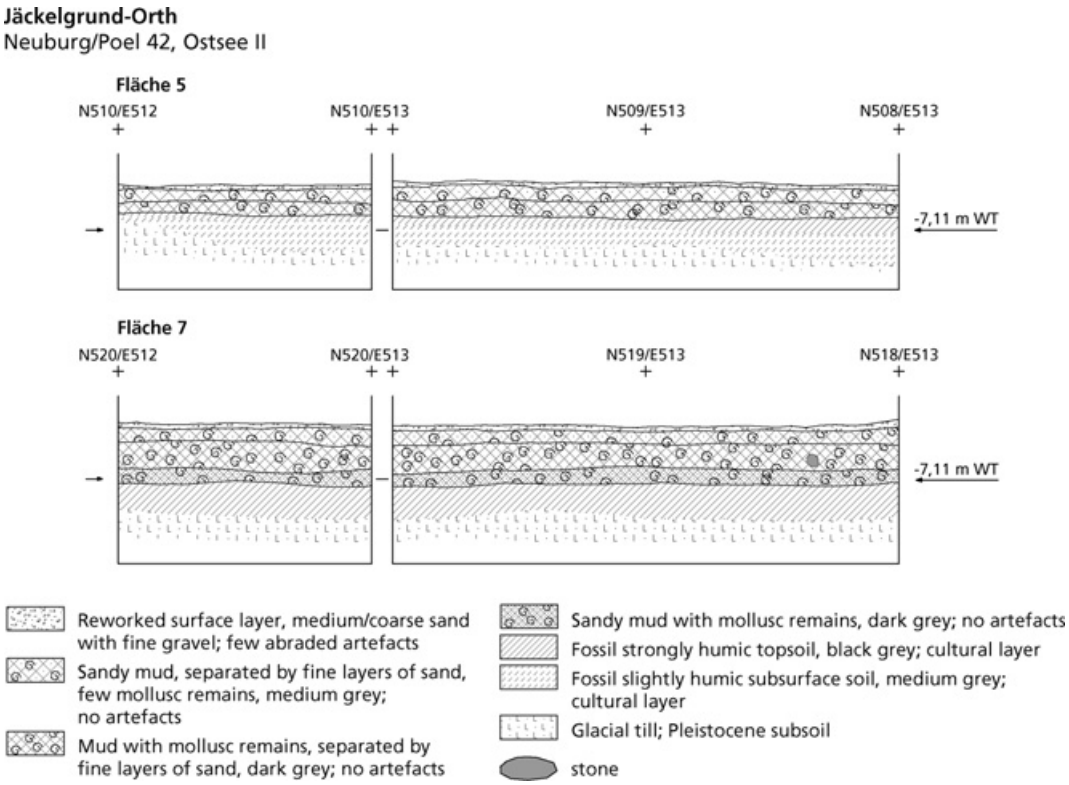


Fig. 14. Jäckelgrund-Orth (Ostsee II, Neuburg / Poel 42). Test trench 5, 7. Sections. – Scale 1 : 30 (digital drawing J. Freigang / H. Lübke).

eroded moraine top. This preliminary hypothesis, however, still has to be confirmed by radiocarbon dating of samples of the find material.

The basic forms of the flint inventory encompass numerous cores, flakes and again soft-hammered macro-blades as well as a couple of micro-blades (Lübke et al. 2011, 31). Although the blade and flake tools still comprise blade burins, these are no longer as prominent as at the earlier site Jäckelberg-Huk. Instead, there are several flake burins on a truncation or break.

Scrapers made from flakes and blades, edge retouch and truncation still occur. Among the heavy-duty tools, core adzes with a pointed-oval cross section predominate. They are complemented by atypical, flat-trimmed flake adzes and a core borer. Unfortunately, projectile points, which would have been crucial for a more detailed comparison with contemporary Danish sites dating to the Villingebæk phase of the Kongemose Culture, are still missing. Likewise, no wooden implements with unambiguous tool marks were recovered. However, in the shore zone a stake which had been driven into the ground was revealed though left *in situ*.

Exceptional finds among the bone and antler implements are a worked boar tusk and an antler punch. Both the fish species community and the frequency of the recorded species prove that the Littorina Transgression had definitely reached the surroundings. Cod *(Gadus morhua)* is the most frequent species, representing about 55 % of the identified bones *(tab. 8)*. Freshwater-affiliated species are in the minority (1.7 %). Thus, the aquatic environ-

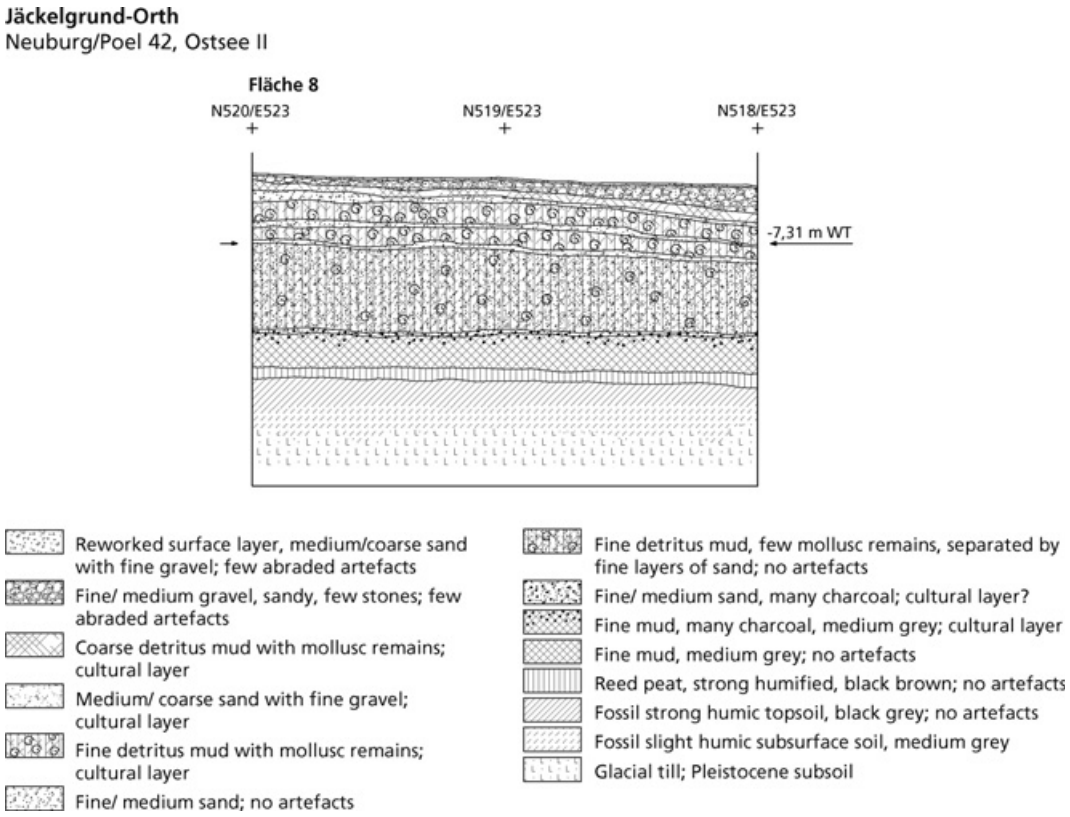


Fig. 15. Jäckelgrund-Orth (Ostsee II, Neuburg / Poel 42). Test trench 8. Section. – Scale 1 : 20 (digital drawing J. Freigang / H. Lübke).

ment in front of the site must have been a marine one, with low freshwater influence at best. In all, the fish species list is relatively small, it includes only ten species.

The favourite prey of the humans beside cod was eel *(Anguilla anguilla)*, and both species together constitute 86 % of the fish remains. This number can be interpreted as an indication for selected fishery.

In spite of the small number of mammal bones, the vertebrate material from Jäckelgrund-Orth provides the characteristic game spectrum known from many Central European Mesolithic sites: red deer *(Cervus elaphus)* and roe deer *(Capreolus capreolus)*, wild boar *(Sus scrofa)* and aurochs *(Bos primigenius)* are worthy of mention. All of these species are typical for the landscape in the Atlantic period with its mixed deciduous forest, and they were the game of most economic interest for the humans as well.

Two fragments of *Sus scrofa* and *Bos primigenius* bones are from comparatively small subadult individuals and could morphometrically not be determined with absolute confidence as wild boar and aurochs. Given that the ^{14}C-datings cover the interval from 6000 to 5700 cal. BC and that the archaeological artefacts confirm this dating of the settlement place, these two bones belong with high probability rather to relatively small, maybe female wild specimens than to domesticated animals. A fragment of a canid mandible is not definitely assigned as wolf or dog.

3.1.2.1.4. Neuburg / Poel 16, Ostsee II (Jäckelberg-Nord)

The site Jäckelberg-Nord (Neuburg / Poel 16, Ostsee II) is situated immediately opposite Jäckelgrund-Furt on the other side of the gully *(fig. 3)*. It was already discovered in 1999 during the first common expedition of marine geologists of the Institut for Baltic Research and archaeologists of the State Archaeological Service (Lübke 2002a; id. 2004). It is located at 6–7 m below water surface on the edge of an organogenic sediment bank which consists of limnic gyttja overlain by marine mud. This change in sediment composition shows that the layers must have been deposited during a transgression phase, when the Baltic Sea began to invade and inundate the large valley which was to form Wismar Bay. Of the Jäckelberg sites, so far Jäckelberg-Nord has been investigated most extensively. This involved the mapping of the sediment bank and the recording of surface finds as well as the excavation of several small test trenches in order to assess the structure and condition of the cultural layers. However, the investigations made clear that only that part of the refuse area has been preserved which had once lain in the shallow water at some distance from the former shoreline and which therefore contains only a few archaeological finds. Most of the actual settlement site with its adjoining shore zone has already been destroyed by erosion.

Nevertheless, the remaining sediment on the sea floor has yielded a large number of flint artefacts. These again comprise numerous blades which were made by indirect soft-hammering, a diagnostic feature of the Late and Terminal Mesolithic. Apart from edge-retouched forms, the blade implements are dominated by pieces with a straight truncation, obliquely truncated knives and blade burins, while flakes were primarily manufactured into borers and in some instances also into burins (Lübke et al. 2011, 32). The archaeo-typological determination of the flint artefacts is based largely on the observation that, in addition to the burnt fragment of a transverse arrowhead, core adzes and flakes from the manufacture of their cutting edges do occur, while there are no indications for the use of flake axes.

A survey of the escarpment of the organogenic sediment bank produced more interesting find material, most notably an axe haft. This consists of the fragmented half of a sleeve with an enlarged head end and a rectangular recess for the handle. It was made of the wood of pipfruit trees (Maloideae), such as hawthorn (*Crataegus* sp.), apple *(Malus sylvestris)* or rowan *(Sorbus aucuparia)*, and can be compared to the rare finds from Vedbæk Boldbaner, Margrethes Næs or Segebro in Scania, Sweden, which are attributed to the Kongemose and early Ertebølle Culture (Brinch Petersen et al. 1977, 157 ff.; Myrhøj / Willemoes 1997, 161, fig. 3). The complete tool would have consisted of two such halves, a wooden handle and the adze head itself (Andersen 1982). Other wooden artefacts include two pointed stakes and 28 pieces of wood without any traces of working.

Eight objects were selected from the find material for radiocarbon dating *(tab. 9)*. The calibrated mean values range over a period of *c.* 450 years, between 5500 and 5100 cal. BC. Basically, the chronological differences correspond to the respective stratigraphical position of the finds. The younger objects, for instance, were recovered from the surface of the organogenic sediment bank, whereas the older ones come from the escarpment and the sections of the trial trenches. Thus, it can be concluded that the settlement site of Jäckelberg-Nord was occupied during a period of *c.* 500 years.

Although animal bones were only retrieved in small numbers, it is possible to reconstruct at least some aspects of the local subsistence economy. The very small fish spectrum of Jäckelberg-Nord is dominated by marine species added by some freshwater-affiliated and migrating fish *(tab. 10)*. The species community documents brackish-marine conditions at this site and a water bottom of mud or sand. The mammal fauna is exclusively terrestrial and

with the presence of the same big game it does not show significant differences compared to the latter site. There is no evidence of an exploitation of sea mammals.

3.1.2.2. Microregion Timmendorf/Poel

3.1.2.2.1. General remarks

The second microregion is situated west of the small fishing village Timmendorf-Strand on western Poel Island *(fig. 3)*. In this area, several sites dating to the 5th and 4th millennium BC were discovered at depths of 2 m to 5 m below water surface *(figs. 16–17)*. Among these, the sites Timmendorf-Nordmole I, II, III and Timmendorf-Tonnenhaken-Süd are of special importance. They date to the period between 5000 and 3500 cal. BC and thus belong to the Terminal Mesolithic Ertebølle and the Early Neolithic Funnel Beaker Culture.

The excellent preservation of organic material especially on the three Nordmole sites enables detailed archaeological and scientific research on settlement structures, the economy and the environment of the last hunter-gatherer societies and the earliest farming communities on the German Baltic coast (Lübke 2006).

3.1.2.2.2. Timmendorf-Nordmole II

The site Timmendorf-Nordmole II (Neuburg / Poel 47, Ostsee II) was discovered in September 2002 (Lübke 2004a; Jöns et al. 2007). It is located immediately north of the present entrance to the harbour of Timmendorf-Strand, *c.* 600–800 m west of the current shoreline, at about 5 m below water surface *(figs. 16–17)*. Embedded in a sandy to gravelly surface sediment, numerous flint artefacts were found lying on top of an abraded till surface which stands out against the sandy sea floor and which must have formed a small peninsula when the site was inhabited. In a southward direction, the till layer descends below an organogenic sediment which contains several tree trunks. Scattered between the trunks, a number of smaller posts which were no thicker than an arm and the remains of a fish-trap basket were discovered.

In order to obtain more evidence, an excavation was conducted in the summer of 2003 as part of the SINCOS I project (Jöns et al. 2007). In a trench measuring 6 × 2 m, the remnants of a fishing fence which had been used to obstruct the outlet of a small stream running in a south-westerly direction were uncovered *(fig. 18)*. The bed of the stream had not been visible prior to excavation, because it was concealed by the level surface layers of the sea floor. When the fence was erected, the gully had apparently already silted up to a large degree and had been filled with organogenic sediment, since the posts were only driven down into these layers. The organogenic sediment was overlain by a sandy to gravelly deposit with an enormous quantity of shell remains and organic residue dating from the time when the fence was in use *(fig. 19)*. It also produced a large number of wooden artefacts, including several leister prongs and additional remnants of the fishing fence. Pottery fragments, however, were not found, so that this cultural layer at Nordmole II has to be assigned to the aceramic phase of the Ertebølle Culture. A series of ^{14}C-dates indicate that the find layer and the fish weir belong to a period between 5100 and 4800 cal. BC *(tab. 11)*. The slightly higher age of some fish vertebrae and animal bones apparently has to be attributed to a marine reservoir effect.

Beneath the marine deposits, which formed the principal find layer, a second find scatter was identified in the limnic sediments of the brook bed and below the reed peat along the bank, which also included a small unpaved fireplace *(fig. 18)*. Due to the lack of finds, it was

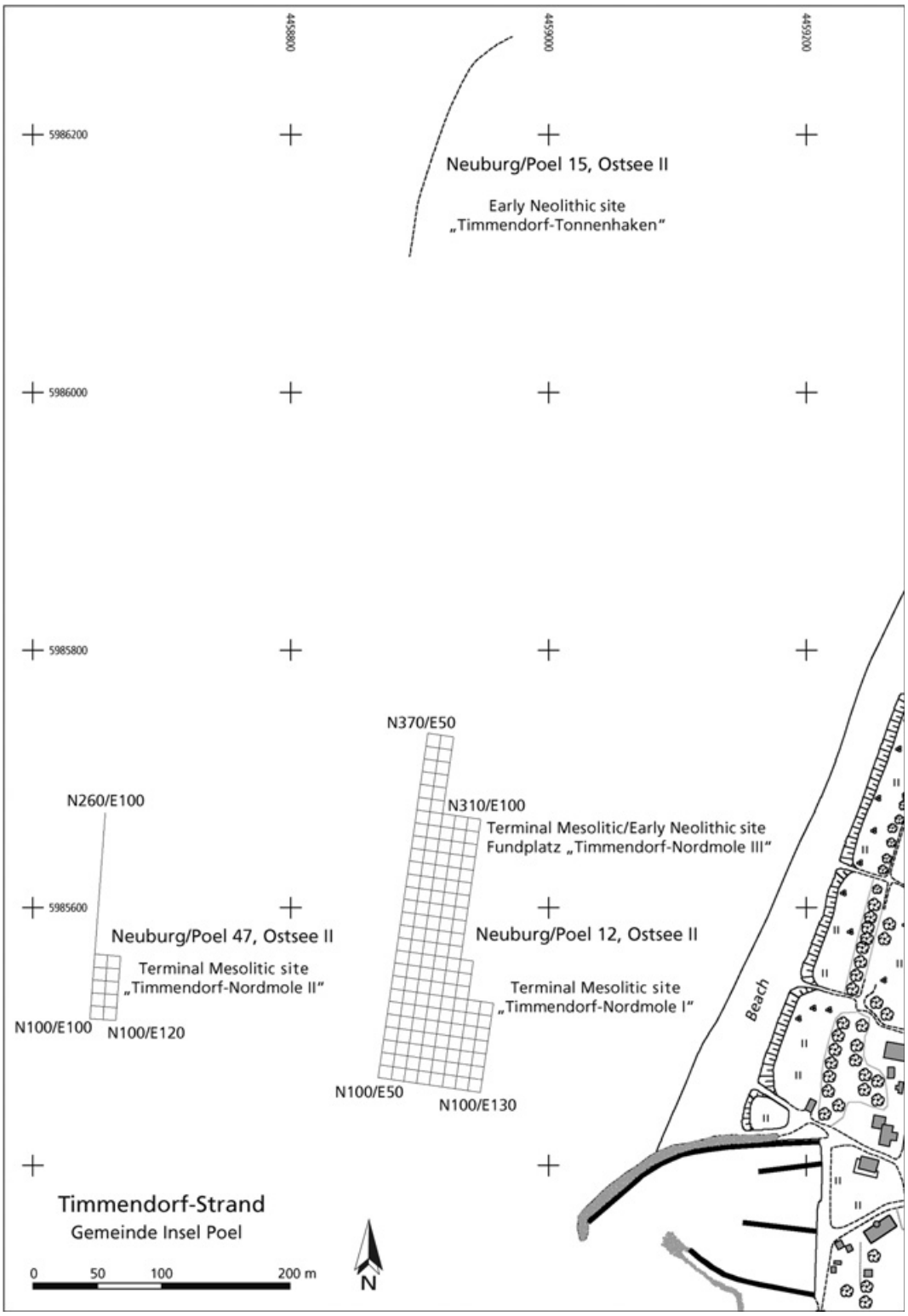


Fig. 16. Timmendorf-Strand, Island Poel. Submarine Stone Age sites. – Scale 1 : 5 000 (digital drawing J. Freigang).

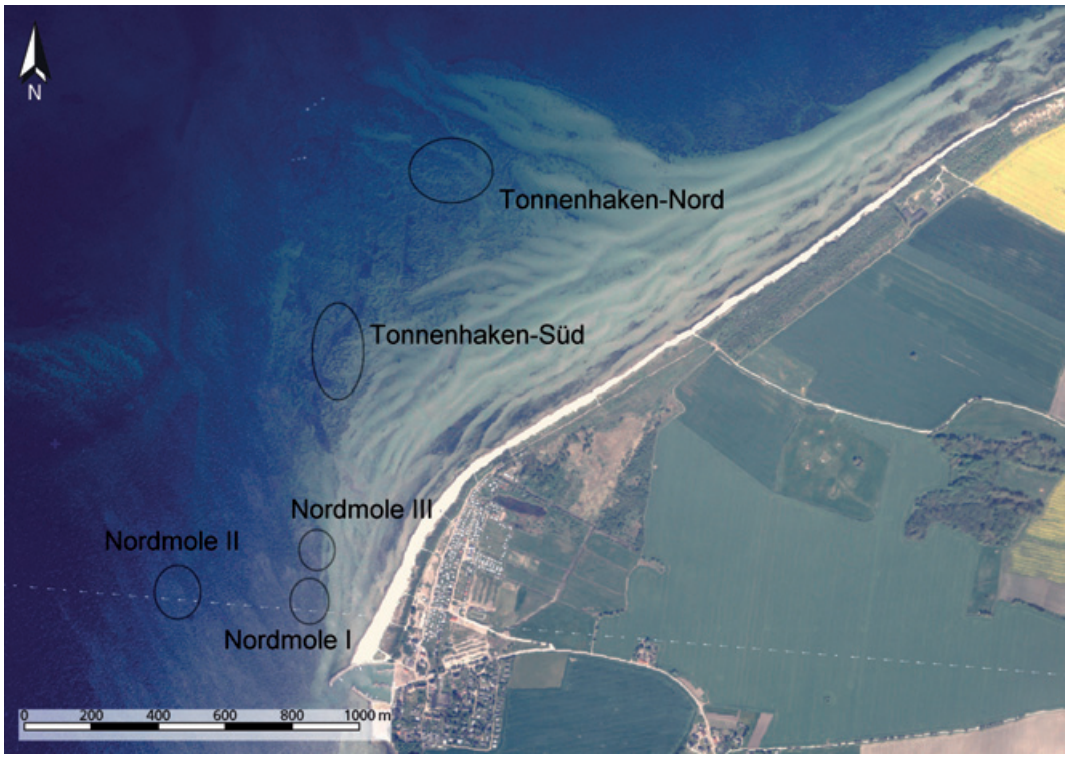


Fig. 17. Timmendorf, Insel Poel. Aerial photo with the position of the Stone Age sites off Timmendorf.

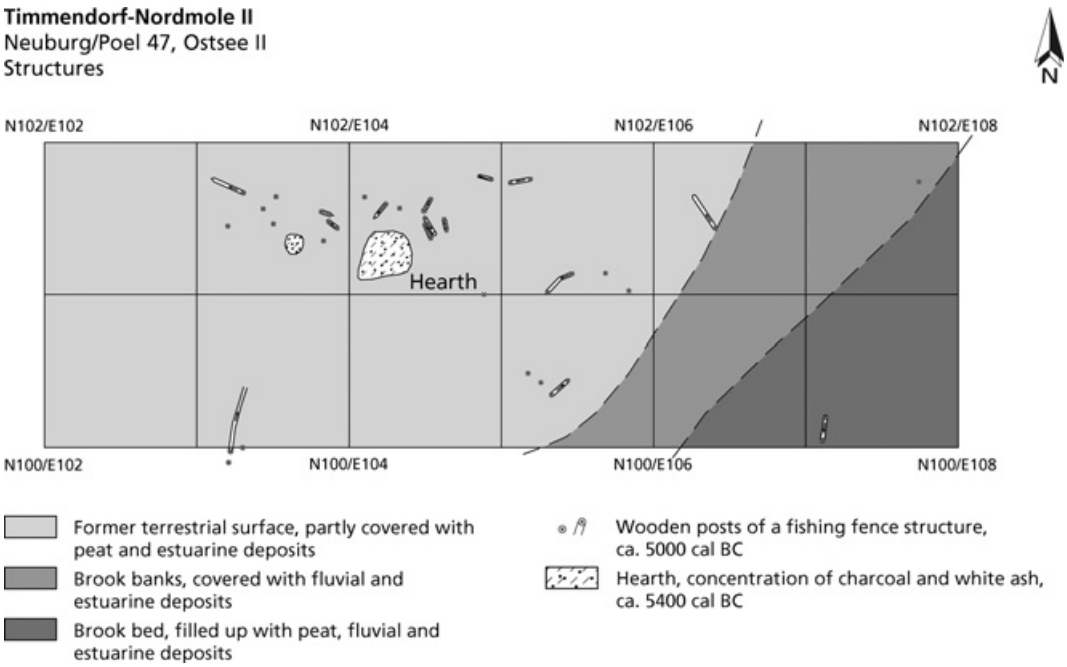


Fig. 18. Timmendorf-Nordmole II (Ostsee II, Neuburg / Poel 47). Excavation plan. – Scale 1 : 50 (digital drawing J. Freigang / H. Lübke).

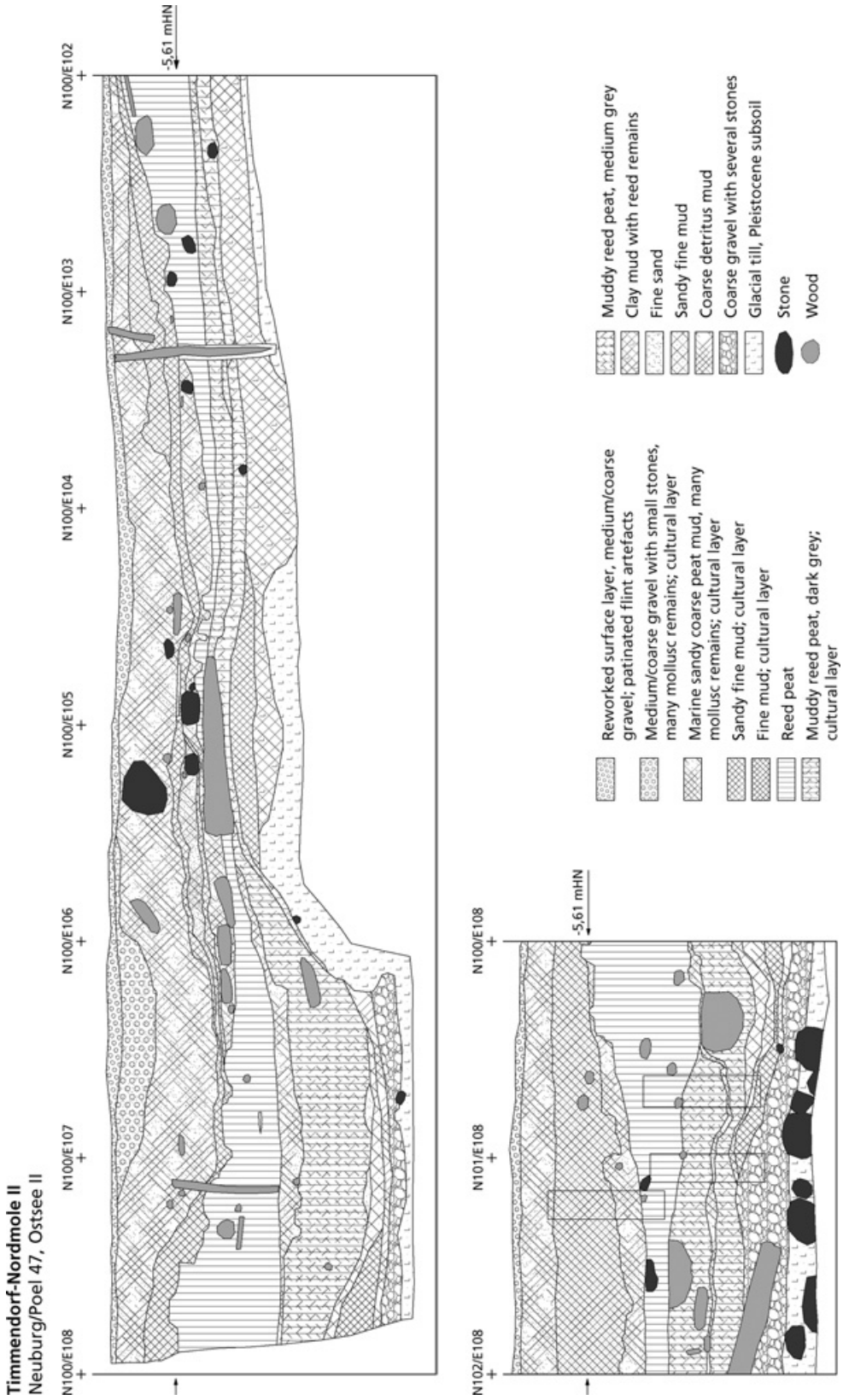


Fig. 19. Timmendorf-Nordmole II (Ostsee II, Neuburg / Poel 47). Trench 1. Section E102 – 108 / N 100. – Scale 1 : 30 (digital drawings J. Freigang / H. Lübke).

impossible to date this phase by means of archaeo-typological analysis, but the ^{14}C-samples point to a date in the Late Mesolithic, between 5900 and 5600 cal. BC.

Pollen, plant macro fossil, diatom and geochemical analyses *(figs. 20–22)* were carried out at a sediment profile taken from trench 1. The master profil consisted of sample boxes 47/1 and 47/3 out of originally three boxes *(fig. 19)* and is dated by five AMS radiocarbon samples *(tab. 12)*.

The vegetation record opens with pine-mixed oak woodland which contained *Pinus*, *Quercus*, *Ulmus*, *Tilia* and *Corylus* (*fig. 20*, zone 1) representing a fairly stable woodland composition in the southern Baltic area during the Atlantic period (Schmölcke et al. 2006). Most striking are the very high values of *Tilia*, which yield in some samples more than 40 % of total terrestrial pollen. Due to the special pollination biology of *Tilia* with low pollen production and insect borne dispersal those 40 % suggest either a generally strong dominance of lime in the mixed oak forests or at least local lime stands (Lang 2003; Wolters 2002). Though *Tilia* is positively selected by pollen corrosion and selective preservation – a feature which is prominent in the basal samples of humous sands with a very low organic content *(fig. 22)* – the composition of the pollen spectra is by and large reliable, because *Tilia* still remains at high percentages when pollen preservation improves in the course of zone 1.

Plant records of meadowsweet stream bank vegetation such as macro fossils from *Eupatorium cannabinum* and pollen from *Filipendula* indicate a site location in the vicinity of a small river or stream. Towards the end of the zone pollen and macro fossil preservation improves as a consequence of moister soil conditions. That is indicated by abundant records of nutlets of *Carex* cf. *paniculata (fig. 21),* a typical element of wet or swampy habitats. A few fish remains and molluscs may even point to an immediate location at the bank of a stream or pond.

The cultural layer of the Late Mesolithic settlement site is found in the humous sands. Anthropogenic indicators are rare and apart from the apophytic *Artemisia* as expression of increased nitrogen input, only *Pteridium* accounts for human activity (Behre 1981). As in Jäckelberg-Huk, percentages are remarkably high and likewise high macro charcoal values document the correlation between burning and the expansion of bracken.

The transition from humous sands to a very sandy highly decomposed peat took place at about 5,650 years BC. Many wood and bark remains suggest that paludification formed a carr peat, but the organic content remained very low (TOC < 8 %). The peat formation was caused by the ground water table rise in the course of the Littorina Transgression.

The woodland composition appears to have been stable apart from occasional clearances (*Corylus* peak). Lime was still the dominant tree though a higher abundance of light requiring taxa such as *Artemisia* and *Filipendula* as well as *Pteridium* and *Corylus* (many anthers) characterise zone 2. Macro charcoal decreased considerably in zone 2, but as micro charcoal is still abundant, a continuation of the Mesolithic settlement at some distance is suggested. Since the initial settlement site became too wet, a move would have been consequent.

The sudden start of records from pollen and macro fossil taxa of marine or perimarine origin at the beginning of zone 3 marks the transgressive contact at 583 cm below sea level (Wolters et al. 2010). There are few indications for earlier inundations. Only the uppermost samples of zone 2 display minor values of Foraminifera or salt marsh taxa *(Suaeda maritima*, *Juncus gerardii)* indicating an approaching coast line. The diatomological investigations show that from the palynologically determined transgressive contact onwards brackish-marine taxa prevail and no diatoms have been recorded below (Witkowski et al. 2014).

Two radiocarbon samples from the uppermost peat and from the lower layers of the transgressive sediments, respectively, date the time of the Littorina Transgression at Timmen-

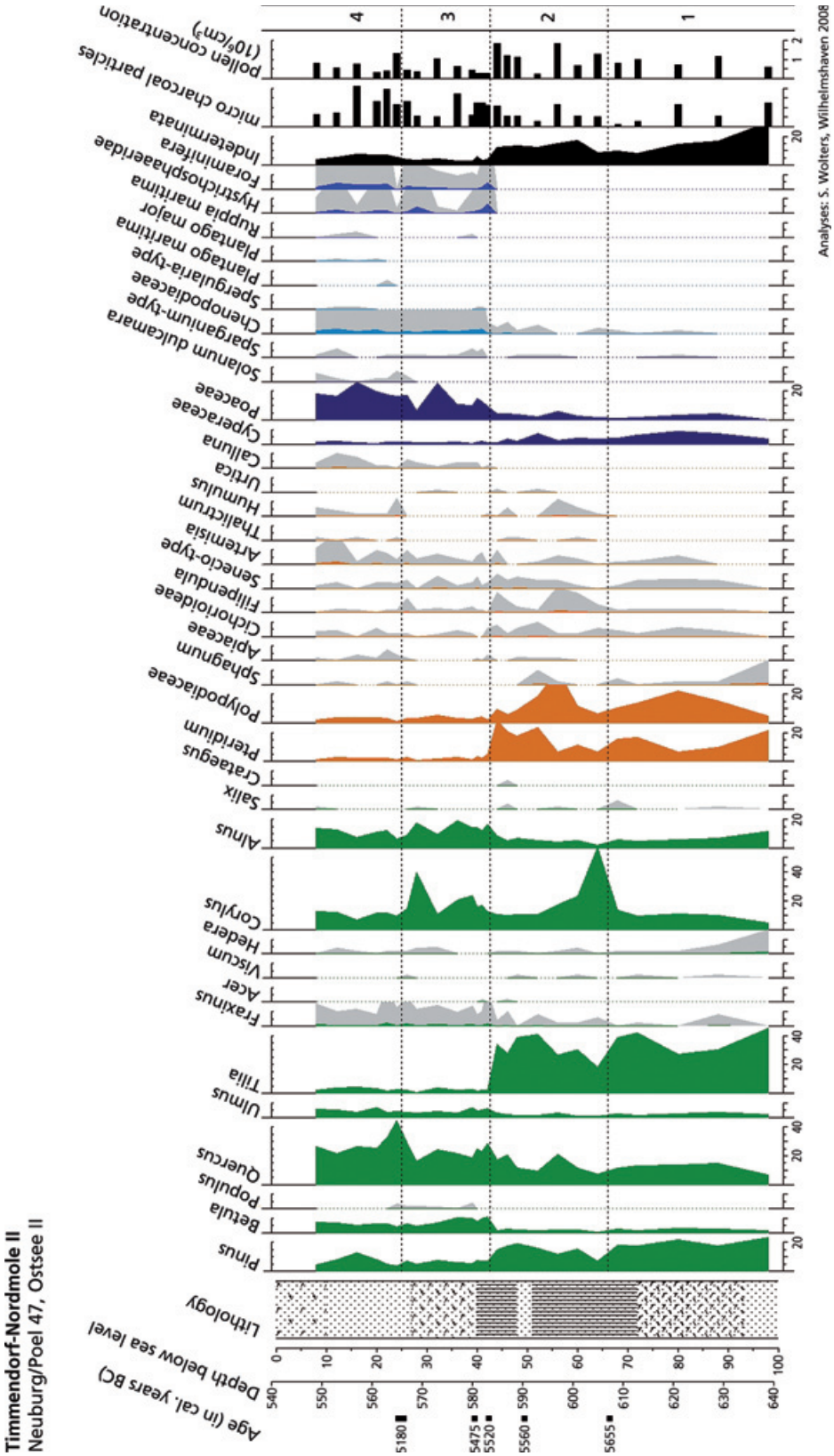


Fig. 20. Timmendorf-Nordmole II (Ostsee II, Neuburg / Poel 47). Percentage pollen diagram from Timmendorf-Nordmole II (Poel 47), showing only most important taxa. Pollen sum is based on total terrestrial pollen. Local pollen zones (1–4) and stratigraphy are indicated. The grey shading denotes 10-fold exaggeration for better visualization.

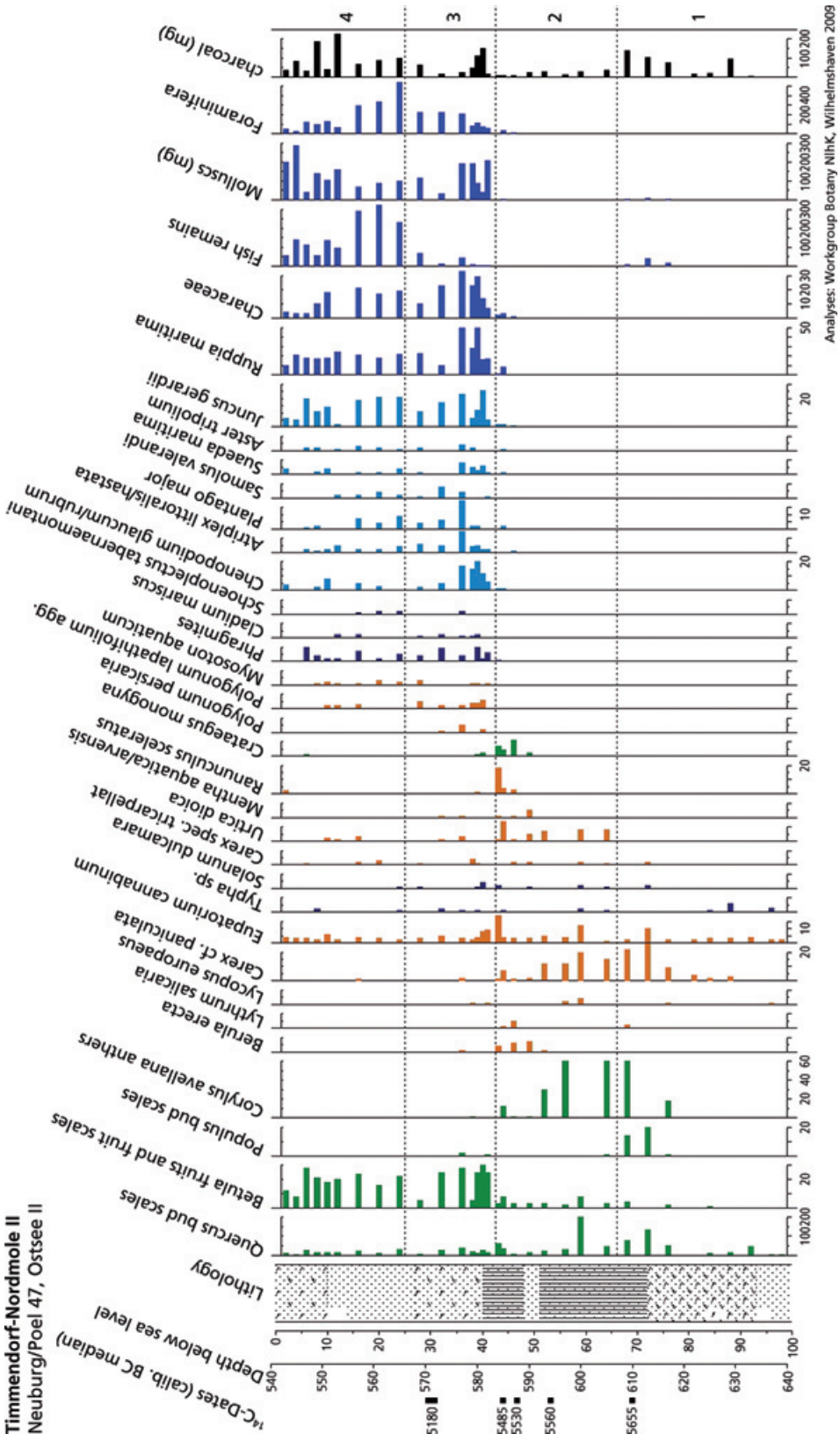


Fig. 21. Timmendorf-Nordmole II (Ostsee II, Neuburg / Poel 47). Macro fossil diagram from Timmendorf-Nordmole II (Poel 47), showing only most important taxa. The records are based on total counts. If not indicated otherwise macro remains are seeds or fruits. Stratigraphy is displayed and zonation (1–4) from the pollen diagram is adopted.

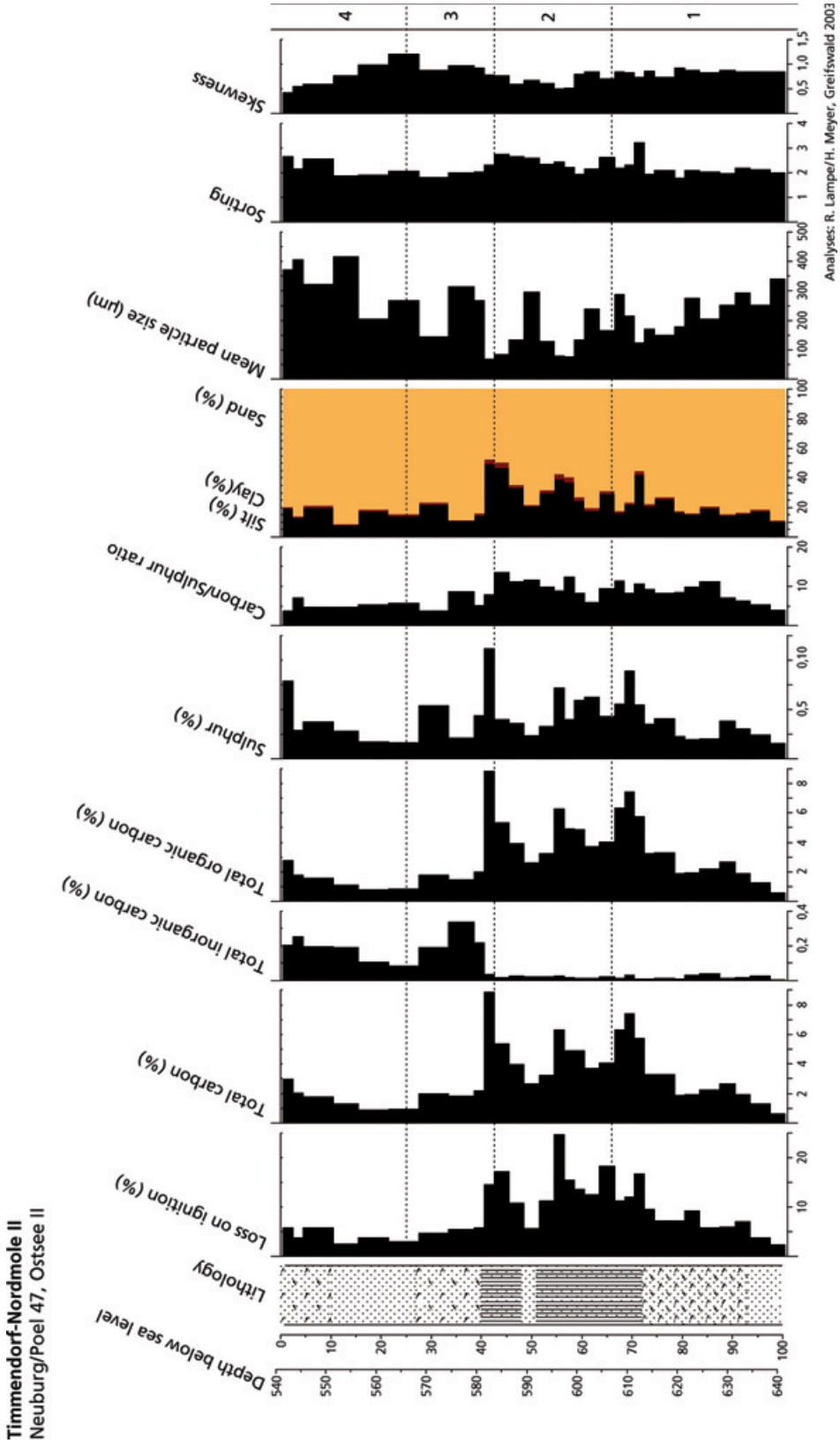


Fig. 22. Timmendorf-Nordmole II (Ostsee II, Neuburg / Poel 47). Geochemistry diagram from Timmendorf-Nordmole II (Poel 47). Zonation (1–4) from the pollen diagram is adopted. Geochemical investigations displayed were basis for stratigraphical descriptions used in all diagrams.

dorf-Nordmole II at about 5500 cal. BC *(tab. 12)*, yielding an older transgression date than suggested by the relative sea level curve from Lampe et al. (2007).

Remarkable is the rapid decline of *Tilia* at the transition of zone 2 / 3 coinciding with the sudden onset of the brackish-marine indicators. These features may indicate peat erosion caused by wave action or surges in the course of the transgression (Waller et al. 2006). However, peat erosion obviously was of minor importance, as the radiocarbon dates from terrestrial and brackish-marine sediments, respectively, are in chronological sequence and only differ by about 50 years. Furthermore, a high pollen concentration and a high abundance of terrestrial macro fossils (e. g. *Quercus* bud scales, *Betula* fruits) point to an inshore sedimentation and exclude substantial peat erosion.

The rapid decline of *Tilia* can therefore only be explained if at Timmendorf-Nordmole II lime was only composed of local dominant stands, and the one reflected in the pollen diagram was inundated in the course of the Littorina Transgression.

Zones 3 and 4 show brackish-marine conditions with a similar vegetation as in Jäckelberg-Huk and comprise indicators from many plant communities both from the supratidal and intertidal zone (Freund et al. 2004). Brackish reed vegetation is represented by *Phragmites* and *Schoenoplectus tabernaemontani* and the drift line habitats by *Chenopodium glaucum/rubrum* and *Atriplex littoralis/hastata*. *Aster tripolium*, *Juncus gerardii* and *Suaeda maritima* are the elements of salt marsh vegetation at different tidal zones and the aquatic facies is represented by seagrass meadows with *Ruppia maritima*.

The main cultural layer of the Ertebølle site is poorly reflected in the pollen and macro fossil diagrams. The settlement phase may only be demonstrated by the high macro charcoal values and somewhat higher percentages of *Artemisia*, having been deposited in the brackish-marine sediments due to erosion processes on the mainland.

Apart from burins and scrapers, the flint inventory is represented by truncated blades in particular (Lübke 2004a). Usually, their distal end is straight or oblique, there are only a few pieces with a concave truncation. The find material also comprises a number of flakes which were laterally retouched, including denticulated pieces. Small borers are complemented by large flake and core borers, and large triangular pointed tools. The majority of the flint adzes are still core adzes, but pieces with an irregular square cross section outnumber pointed-oval forms, which are still a typical feature of the Jäckelberg sites. Flake axes start to occur in minor numbers but they are still much smaller than the core adzes. Among the transverse arrowheads which are usually symmetrical with straight or slightly concave retouched edges, an arrowhead with an oblique cutting edge is especially noteworthy. Most of the blades were still manufactured by indirect soft-hammer percussion and are characterised by unfaceted pointed-oval remnants of the striking platforms, but the proportion of hard-hammered blades already exceeds that at Jäckelberg-Nord.

The numerous wooden artefacts have been analysed with special care. Altogether 1,044 pieces of wood were examined, of which 915 pieces were found to have no tool marks. Nonetheless all wooden pieces from the find layer appear to have been deposited there by human interference. Most of the material (76 %) belongs to the later of the two occupation phases, dating to between 5100 and 4800 cal. BC. The investigation of Timmendorf-Nordmole II originally started with the discovery of the remains of a fish-trap basket. Apart from small pieces of the basketwork, the fragments of two or three hoops were found. The basketwork was made from split branches of red dogwood *(Cornus sanguinea)* and guelder rose *(Viburnum opulus)*, tied together with strips of alder root (*Alnus* sp.). Thin branches of red dogwood were bent into rings which were used to stabilise the basket and keep the mouth of the trap open.

The archaeological evidence at the excavation site and the discovery of 34 vertical and 36 horizontal wooden sticks bearing cut marks, as well as 215 unworked fragments of hazel rods *(Corylus avellana)* point to the existence of a destroyed fishing fence. Scattered remains of fishing fences are a common phenomenon at coastal Stone Age sites. Probably wattle fences between 10 m and 100 m long were built from the shoreline out into the sea, ending in a stationary fish trap (Pedersen 1997). The vertical stakes from Timmendorf-Nordmole II measure between 1 cm and 4 cm across and were chiefly made from hazel, whereas other kinds of wood occur only seldomly. They were worked rather coarsely with flint adzes or produced by tearing off long splinters and bark strips. Three quarters of the horizontal members are of hazel, while one out of four was made of red dogwood, guelder rose or other wood. In most cases they have a diameter of *c.* 1–2 cm. They were worked more carefully than the vertical elements, with adze blows all around, but tearing techniques could also be recognised. Usually the unworked hazel rods also have a diameter of approximately 1–2 cm.

As a rule, the long and straight hazel rods show 2–10 growth rings. Apparently, most of them were harvested at an age of 3, 4 or 5 years. The construction of the large fishing fences required a large amount of raw material, implying the management of hazel coppices. The same can be assumed for red dogwood and guelder rose, which were used for fish-trap baskets.

The fishing gear found at Timmendorf-Nordmole II also includes 15 leister prongs. They were made of red dogwood *(Cornus sanguinea)* and the wood of pipfruit trees (Maloideae), such as hawthorn (*Crataegus* sp.), apple *(Malus sylvestris)* and rowan *(Sorbus aucuparia)*, though one example was produced from hazel *(Corylus avellana)*. Some of the leister prongs can be allocated to type B, which appears to be comparatively early (Klooss 2010).

A particularly interesting find is the end of a narrow bow limb of elm wood (*Ulmus* sp.). The carefully worked limb illustrates the transition from a bow with a D-shaped cross section to a bow with very slightly recurved limbs and an oval cross section. This fragment probably once belonged to a child's bow with a minimum length of 1 m. Although the characteristic handle section has not been preserved, we can assume that the bow has to be assigned to the Mesolithic Holmegaard type.

Another interesting aspect at Timmendorf-Nordmole II is the absence of spear fragments of ash wood *(Fraxinus excelsior)*, which occur at many other sites of the same period. Either the excavated area is too small so that evidence of this find category has remained undetected or the activities connected with these spears were carried out elsewhere.

The two occupation phases at Timmendorf-Nordmole II differ considerably from each other as to the occurrence of poplar (*Populus* sp.), for the layers of the earlier phase were found to contain much more poplar than those of the younger one. Most of this material consists of roundwood without any traces of working or fire and can be interpreted as natural wood.

The animal bones are yet another important find group, especially the fish remains. Among the bone and antler implements, a number of bone points and the fragment of a harpoon made of roe deer antler deserve special mentioning. The recorded fish fauna suggests that the humans used both freshwater and marine environments near the dwelling place *(tab. 13)*. The clear dominance of remains of eel *(Anguilla anguilla)* refers to exploitation preferences of the dwellers, also testified by the numerous finds of leister prongs. Apart from this dominant species and numerous bones from the small-sized species black goby *(Gobius niger)* – they are presumably part of the natural thanatocoenosis or the species was caught for a fish soup – the list includes species living in the sea, for instance flatfish, herring and mackerel (10.0 % of the identified specimens), and species living in lakes or slow streaming rivers, such as pike and perch (6.1 %). This combination suggests that the humans used both freshwater and marine environments near the dwelling place. The marine part of the species

list is characterised by species related at least at times to inshore waters or lagoons with eelgrass.

The presence of some mammal species such as water vole *(Arvicola terrestris)* and beaver *(Castor fiber)*, as well as the skeleton of a water rail *(Rallus aquaticus)*, reflect also a freshwater ecosystem, probably a desalinated bight bordered with a reed zone and a brook.

The direct surroundings of Timmendorf-Nordmole II were fairly open woodland, as documented by the remains of yellow-necked mouse *(Apodemus flavicollis)*, wood mouse *(Apodemus sylvaticus)*, and mole *(Talpa europaea)*. For the hinterland a deciduous forest with its characteristic game species is most probable.

3.1.2.2.3. Timmendorf-Nordmole I

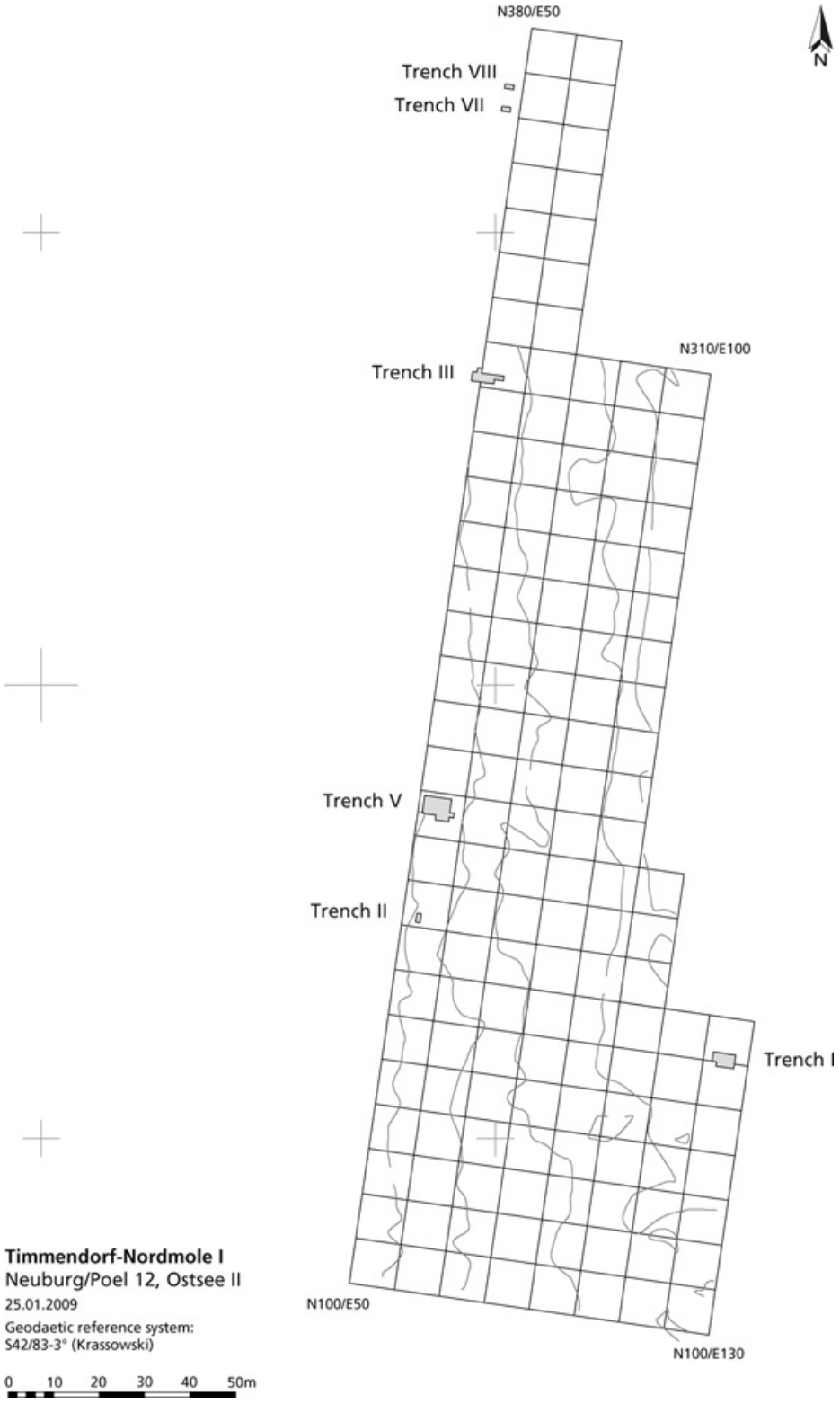
From 2000 until 2002, underwater archaeological research in Wismar Bay focused on the settlement site Timmendorf-Nordmole I (Neuburg / Poel 12, Ostsee II), which can be regarded as the most exhaustively investigated site in this area. It is located 2.5 m to 4 m below the water surface, immediately north of the harbour of Timmendorf-Strand. Contrary to earlier reports (Lübke 2004a; id. 2009; Jöns et al. 2007; Klooss et al. 2009), it extends over a distance of *c.* 100 m (trenches I, II, V), as a find cluster further north (trench III) has to be interpreted as a site (Nordmole III) in its own right (Lübke / Schmölcke 2010; *fig. 23*).

The surveys showed that a large part of the former settlement surface at 2.5 m depth had been destroyed by erosion, since an abraded till layer appeared directly below a 20 cm thick surface layer of gravel containing numerous eroded stone artefacts. Subsurface features, however, were found to be still intact. In the summer of 2001, a pit was found which was 3.5 m long and 1.8 m wide at the top and still 0.9 m deep. The basis had a pear-shaped outline with a narrow entry on one side and an extended utilisation area on the other. Numerous tall logs and poles from a collapsed covering or roof construction had tumbled into the pit (Jöns et al. 2007; Lübke 2009a).

The ^{14}C-dates obtained from the pit filling cover a period of approximately 400 years, though values predating 4200 cal. BC might be the result of various reservoir effects (Hartz / Lübke 2004, 130–131; Lübke 2004a, 101; id. 2009a). The younger dates, between 4200 and 4100 cal. BC, which derive from the poles and cleaved trunks of the roof construction and from the wooden handle of a flint knife most probably indicate the correct age of the pit.

At a greater depth, the margin of the settlement site and the refuse area in the former shore zone have been preserved. In some areas the occupation layer could be traced below a thin sand layer on the bottom of the sea. A trench in the shore zone revealed that the upper part of the stratum consists of gravelly sand with several intermediate thin layers of organic matter *(fig. 24)*. The sandy layers are followed by marine mud which contains reed and wood remains as well as a large number of artefacts. The mud is succeeded by a reed peat layer and finally the glacial till subsoil. The upper sandy layers and the marine mud have been dated to between 4400 and 4100 cal. BC and contain unpatinated flint artefacts, large pottery fragments, bone and antler tools as well as wooden implements (Lübke 2003, 635–638; id. 2004a, 101–105; 2009a, 558–561; Jöns et al. 2007). The wooden artefacts are especially remarkable, comprising numerous leister prongs as well as the shaft of a leister, a broken elm bow, and parts of log boats (Labes 2004; Klooss 2010). Countless pieces of pointed sticks might belong to a fishing fence of which the lower parts of the stakes were found arranged in a line in the excavation area. Along the aligned stakes a row of large stones had been laid with the flat side up so that they could serve as stepping stones in the muddy ground.

Especially the pit in trench I produced several sherds which could be associated with a particular pottery form, i. e. thick-walled vessels with an s-shaped profile. Apart from a


N380/E50
N
Trench VIII
Trench VII
Trench III
N310/E100
Trench V
Trench II
Trench I
N100/E50
N100/E130
Timmendorf-Nordmole I
Neuburg/Poel 12, Ostsee II
25.01.2009
Geodaetic reference system:
S42/83-3° (Krassowski)
0 10 20 30 40 50m

pointed base, rim sherds from different vessels have been identified which in most cases were decorated with fingernail impressions on or with a simple dot motif below the rim. There are also a few fragments from clay lamps. A detailed analysis of the ceramic finds is prepared by A. Glykou who has recorded the pottery from Nordmole I and III in order to compare it with that from the site Neustadt LA 156.

Among the numerous archaeological objects, the flint artefacts and the associated waste material constitute the largest group. They were presented in detail as part of a master's thesis by S. Mahlstedt (2007). Compared to earlier sites, there are a much higher proportion of plain, hard-hammered blades, which account for almost 50 %. However, the majority of the blade tools are made up of regular, long narrow pieces which were produced by indirect soft-hammer percussion. They comprise blade knives with straight or concave truncation, scrapers, burins and edge-retouched samples with coarse or fine denticulation. Flake tools comprise scrapers and various borers. Transverse arrowheads are yet another group. The most frequent type of implement is the flake axe, which is represented by more than 150 samples. An unusual piece is an axe with a specifically trimmed working edge, which normally occurs only on large core adzes. Core adzes, however, are very rare and shaped very irregularly.

A remarkable feature of the find material is the large number of well-preserved wooden artefacts (Klooss 2010). From trench I, 137 wooden artefacts were recovered. 114 of them exhibit no tool marks, but they either belong to the wooden construction or can be interpreted as some kind of refuse. Apart from the blade with a preserved handle and crosswise binding that was recovered from the pit, a half-preserved paddle blade and the well-preserved bow of a dugout canoe are of particular note. A small number of leister prongs and the fragments of an ash spear were also retrieved from trench I. The paddle was split lengthwise, so that the blade can be reconstructed to a short oval of 25 cm length. The weak point at the junction between handle and blade was not reinforced, although paddles tend to break at that point. Blade and handle were worked in one piece from an ash trunk *(Fraxinus excelsior)*. The log boat bow was partly burnt but not collapsed and generally in a good condition. The boat was made from a large lime trunk (*Tilia* sp.) and hollowed out, creating a u-shaped cross section. The sides are 2–3 cm thick and the inside is covered with numerous adze marks. The bow terminates in a point.

Trench I also produced 16 wooden stakes. These were made of hazel *(Corylus avellana)*, red dogwood *(Cornus sanguinea)*, field maple *(Acer campestre)* and oak (*Quercus* sp.). Their diameter varies between 1.2 cm and 4.4 cm; only one oak branch was 8.5 cm thick. The stakes were worked carefully with an axe, producing 2 to 5 cut faces, while the tearing off of long splinters and bark strips occurred only seldom. Such tool marks can be generated by a simple cutting technique (Schlichtherle 1996). About one third of the cut faces had a stepped surface created by multiple axe blows. Some of them exhibited a number of notches, which were caused by the chipped cutting edge of the axe. This feature has also been observed on stakes at other prehistoric sites (Pedersen 1997, 132). Moreover, a *c.* 15 cm thick elm trunk bearing many cut marks from the felling process was found.

From trench V, which was located in the shore zone, 680 wooden artefacts were retrieved. Of these, 455 pieces do not exhibit any traces of working, but 129 finds were identified as leister prongs. 73 % of the prongs are nearly complete or very well preserved. In some

◁ Fig. 23. Timmendorf-Nordmole I, III (Ostsee II, Neuburg / Poel 12). Excavation plan with bathymetry of the investigation area. – Scale 1 : 1.500 (digital drawing J. Freigang / H. Lübke).

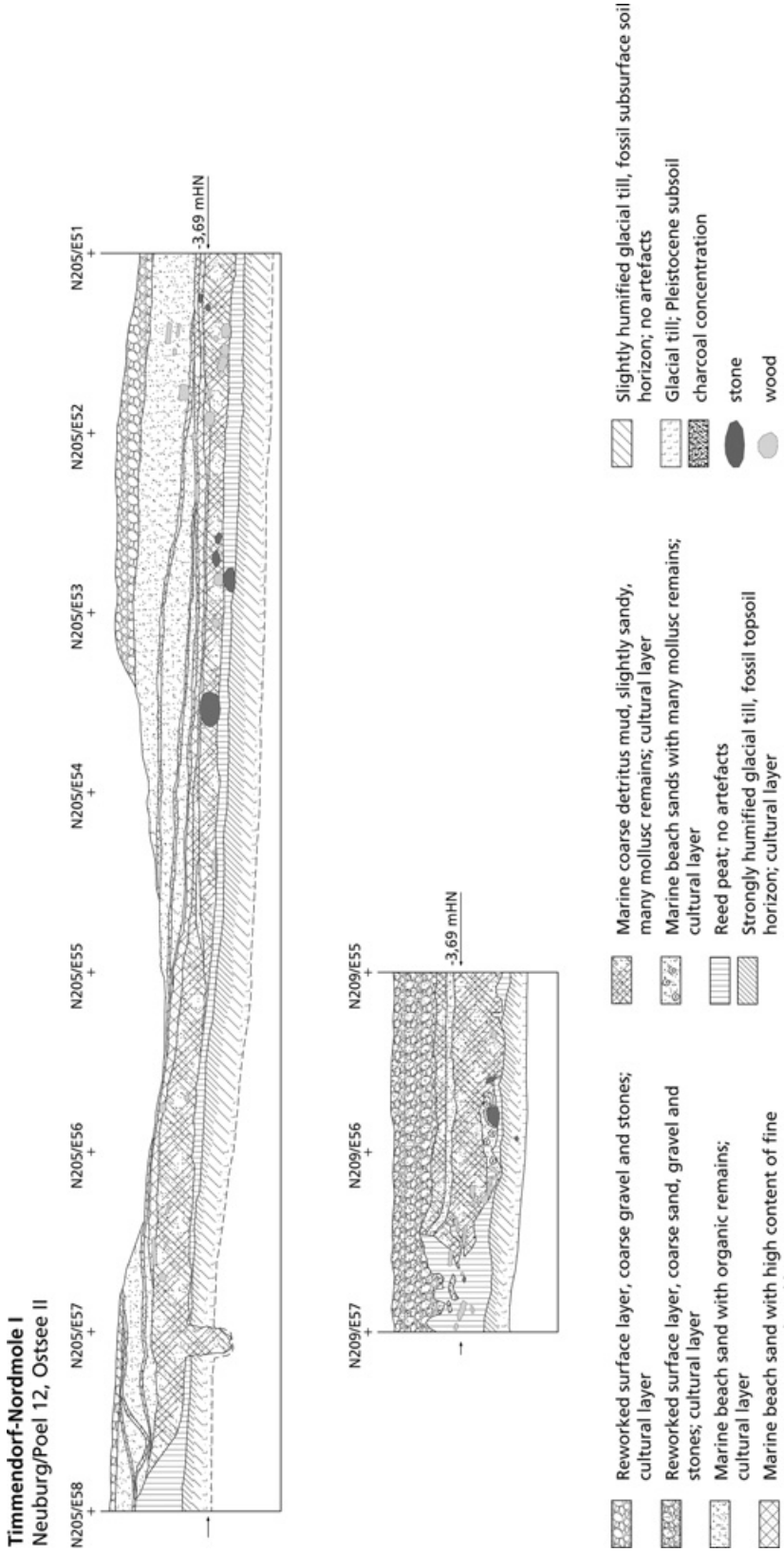


Fig. 24. Timmendorf-Nordmole I (Ostsee II, Neuburg / Poel 12a). Trench 5. Section E 51–58 / N 205; Section E 55–57 / N 209. – Scale 1 : 40 (digital drawing J. Freigang / H. Lübke).

cases even remains of the binding could still be observed. The overall length of the leisters ranges between 19.0 cm and 37.5 cm, while the length of the points of the prongs varies considerably, between 4.0 cm and 18.0 cm. Whereas some points are still long and slender, others are rather short and almost blunt, presumably a result of extensive usage. Use-wear marks like coarse, fibrous tips, splinters and cracks, or even completely broken off points have been observed on 68 % of the leisters. They were either lost during fishing in shallow water or more likely discarded because of such defects. The leister prongs of Timmendorf-Nordmole I were chiefly made of hazel *(Corylus avellana)* and red dogwood *(Cornus sanguinea)*, although samples of pipfruit wood (Maloideae) were also found. In some cases, the wood of guelder rose *(Viburnum opulus)*, oak (*Quercus* sp.), ash *(Fraxinus excelsior)*, elm (*Ulmus* sp.) and maple (*Acer* sp.) was tested as well.

In the shore zone, only a small quantity of ash spear fragments were found and no paddle blades, but numerous fragments from the sides of dugout canoes as well as a broken hunting bow. The largest log boat fragment is 1.20 m long and 16 cm wide and has a bulge-shaped edge which can be interpreted as the gunwale of the vessel. All dugout fragments are made of lime wood. They are only 1 cm thick due to compression, though the original thickness of the sides probably did not exceed 2 cm. Some fragments have a number of aligned holes which show that the side of the boat was repaired or enlarged. Corresponding marks have been found on Mesolithic log boats in Denmark (Andersen 1994).

The hunting bow was made of elm (*Ulmus* sp.) and can be assigned to the Holmegaard type. It broke at a typical point near the handle section, due to overstraining or material fatigue. The limb has a flat oval cross section, with its widest part measuring 4.0 cm at one-third of the length. The handle is *c.* 10 cm long and has an almost round cross section measuring 2.5 × 2.8 cm. The bow can be reconstructed to a length of 1.60 m. The raw material was provided by the stem of a slowly grown elm tree with relatively narrow growth rings of 6–7 rings per cm.

Trench V yielded 63 pointed stakes. Most of them were made of hazel *(Corylus avellana)*, but several seldom-used species like honeysuckle (*Lonicera* sp.) and buckthorn *(Rhamnus cathartica)* could also be identified. Half of the stakes are only 1–1.5 cm thick. In terms of their age, the hazel rods can be divided into two groups. Whereas most samples were 2 to 5 years old when cut, a smaller group is characterised by 10 to 13 growth rings. Two-thirds of the stakes were sharpened to a point with an axe while the other pieces were just worked by tearing off long splinters and bark strips. In both trenches, hazel *(Corylus avellana)* and oak (*Quercus* sp.) have been identified to be the most common species of unworked wood, though there is a remarkably high amount of maple wood (*Acer* sp.) at the site. More than 50 % of the wooden pieces are partly burnt and therefore definitely anthropogenic.

The numerous leister prongs correspond to the large quantity of fish bones retrieved from the sediments. Combined with the other faunal remains, they provide extensive information on the economic resources of this station. Considerable numbers of seal bones are an indication that the hunting of marine mammals already played an important role *(tabs. 14–15)*. This observation complies with the find of a harpoon fragment of red deer antler. Bone artefacts encompass bone points, awls, an ulna dagger and boar-tusk knives. Two red deer antler tines were used as punches in blade production. Another object made of red deer antler is an oblong rectangular pendant with grooved edges. In the last years of the campaign, two T-shaped antler axes were recovered which, according to ^{14}C-analysis, are contemporaneous with the site Nordmole I.

The fish remains from the pit (trench I) were completely dominated by eel *(Anguilla anguilla)* bones, which constitute 75 % of the total sum *(tab. 14)*. Eel fishing therefore appears to have been an important activity. Next to eel, nearly all fish bones which were found in

trench 1 belong to marine fish. As the eel bones indicate, fishing appears to have been taken place during the late summer / early autumn period, in which the eel migration to its breeding areas concentrate the animals in coastal regions. The presence of the seasonal mackerel *(Scomber scombrus)* emphasises this. In all, the fish species community indicate marine conditions in the coastal area in front of the pit, and the remains of grey seal *(Halichoerus grypus)* and harp seal *(Phoca groenlandica)* confirm this result. The record of the latter seal species confirm the findings from the contemporaneous shore line (trench V) and shows the appearance of this Nordic species in Mecklenburg Bay in the middle of the 5th millennium cal. BC.

For three of the mammal bones it is questionable whether they belong to wild or domesticated *Bos primigenius* or *Sus scrofa*. Archaeogenetic experiences with similar findings from the site Rosenhof LA 58 have shown that such remains probably belong to small wild females (Scheu et al. 2008). It is to be assumed that this would be also true for these bones in question.

It is exceptional that in the pit the bird bones are more frequent than the mammal bones. This must be related to the special function of the feature of trench 1. The bird bones represent in the first case several species of ducks, but because of the high degree of fragmentation, only about one third of them could be determined to species level. Among them the common goldeneye *(Bucephala clangula)* – nesting in cavities in trees – and the tufted duck *(Aythya fuligula)* are the most frequent species. Today, both are common breeding birds near southern Scandinavian coastal lagoons, the seashore, and sheltered ponds.

In the shore area (trench V) of Timmendorf-Nordmole I the marine species grey seal *(Halichoerus grypus)*, harp seal *(Phoca groenlandica)* and ringed seal *(Phoca hispida)* contribute substantially to the mammalian assemblage *(tab. 15)*. Remains of seals dominate with a total of 32 %. Accordingly, it may be assumed that hunting of marine mammals and large-sized fish species like gadids was essential at this site. Most likely, the hunting of marine mammals was motivated by the large amounts of subcutaneous fat, the blubber, which is flammable and was probably used in the characteristic oval clay lamps which now appear at coastal sites.

Apart from marine mammals, roe deer *(Capreolus capreolus)* was frequently hunted. This species contributed 29 % of the mammalian bones. Remains of wild boar *(Sus scrofa)* and red deer *(Cervus elaphus)* are much rarer. As aurochs bones are likewise lacking, except for single finds, large game species seem to have avoided the coastal landscape characterised by numerous bays and inlets, while the smaller deer species found suitable conditions.

In the large assemblage of fish bones from trench V, eel *(Anguilla anguilla)* clearly dominates, playing a special role with 47 %. Among the marine species, cod *(Gadus morhua)* and flatfish (Pleuronectidae) are the most abundant of the other 21 identified species or species groups, among which one exotic species, the sea bass *(Dicentrarchus labrax)*, has been recorded. The sea bass is known as an indicator of relatively high water temperatures.

Evidence of seasonality is less clear in the fish bone assemblage from trench V. Typical early summer species in coastal areas, such as herring *(Clupea harengus)*, mackerel *(Scomber scombrus)* and garfish *(Belone belone)*, only add up to 1 % of the total assemblage, the eel should be indeed most frequent in summer and early spring, but will have lived near the settlement during the whole year. Some evidence of seasonality is provided by the avian bones. The most abundant species, the smew *(Mergus albellus)*, uses the Baltic region as a winter refuge, and the goldeneye *(Bucephala clangula)*, the second most abundant species, is equally much more numerous here during the winter months than during the breeding season. As other frequently wintering species, such as whooper swan *(Cygnus cygnus)* and black-throated diver *(Gavia arctica)*, as well as other breeding birds from the Arctic are represented in the assemblage, the material indicates that bird hunting was concentrated during

the winter months. Some highly fragmented findings mostly from subadult specimens can not clearly be determined as wild or domesticated *Bos primigenius* and *Sus scrofa*, respectively. Because of other evidence of Neolithic cultural elements in the surroundings of trench V, it cannot excluded that these findings belong to domesticated specimens.

3.1.2.2.4. Timmendorf-Nordmole III

The settlement site Timmendorf-Nordmole III (Neuburg / Poel 12b, Ostsee II) is located north of the aforementioned Terminal Mesolithic station Timmendorf-Nordmole I (Neuburg / Poel 12a, Ostsee II), which was investigated from 2000 until 2002 *(figs. 16–17)*. Both sites are still listed as one (Neuburg / Poel 12, Ostsee II) in the sites and monuments record, because at the time of their discovery the scatter of surface finds suggested a rather large coastal settlement. However, in the meantime enough evidence has been collected to ascertain that Neuburg / Poel 12, Ostsee II, consists of at least two spatially and chronologically distinct stations. An investigation of the site Nordmole III (*fig. 23*, trench III) was conducted in 2006 and 2007, when a 2 m wide trench covering an overall area of 12 m² was excavated and a 7 m long section *(fig. 25)* documented in the former shore zone, primarily in order to obtain samples for scientific analysis as well as exact stratigraphical information on the contemporaneous sea level.

During the investigations in 2007 further surface finds were located north of trench III but the two test trenches VII and VIII *(fig. 26)* delivered only very few stratified archaeological finds.

One of the essential results of this investigation is the observation that in trench III the cultural remains embedded in the upper alluvial sand and peat layers date as early as between 4000 and 3800 cal. BC and thus belong to the Wangels-Rosenhof group of the Early Neolithic Funnel Beaker Culture, which so far could be traced only in eastern Holstein *(tab. 16)*. Beneath the Early Neolithic cultural layers an almost sterile marine mud was discovered, which was succeeded by another cultural layer containing finds which can be attributed to the Terminal Mesolithic Ertebølle Culture. These finds have been dated to between 4600 and 4500 cal. BC, thus predating the find layers of the final phase of the Ertebølle Culture at Nordmole I, *c.* 100 m further south, which have been dated to between 4500 and 4100 cal. BC (Jöns et al. 2007).

The more or less eroded pottery sherds also comprise some fragments characteristic of the early Funnel Beaker Culture (Glycou 2011). So far, there has been no detailed analysis of the numerous flint artefacts, as this part of the find material will be reserved for a separate thesis on the flint technology of the earliest Funnel Beaker Culture in the Mecklenburg Bay area. However, there seems to be a general tendency of regular blades declining in numbers, even though most blade implements (scrapers, truncated and edge-retouched pieces) were still manufactured from such basic forms. They are complemented by flake scrapers and borers. Especially noteworthy is the fact that the number of flake axes and transverse arrowheads is in reverse proportion to that at Nordmole I. While core adzes only occur in small numbers, the transverse arrowheads now form the most prominent group of implements at Nordmole III.

The find assemblage comprises a large number of wooden artefacts (Klooss 2010). Altogether 408 wooden artefacts were examined. Considering the small scale of the excavation (12 m²), the number of 47 leister prongs appears to be unusually high. Most leister prongs were made of hazel *(Corylus avellana)*, about a quarter of red dogwood *(Cornus sanguinea)*, while the wood from pipfruit trees (Maloideae) was used only seldom. In some cases oak (*Quercus* sp.) and ash wood *(Fraxinus excelsior)* was tested. The proportion of different spe-

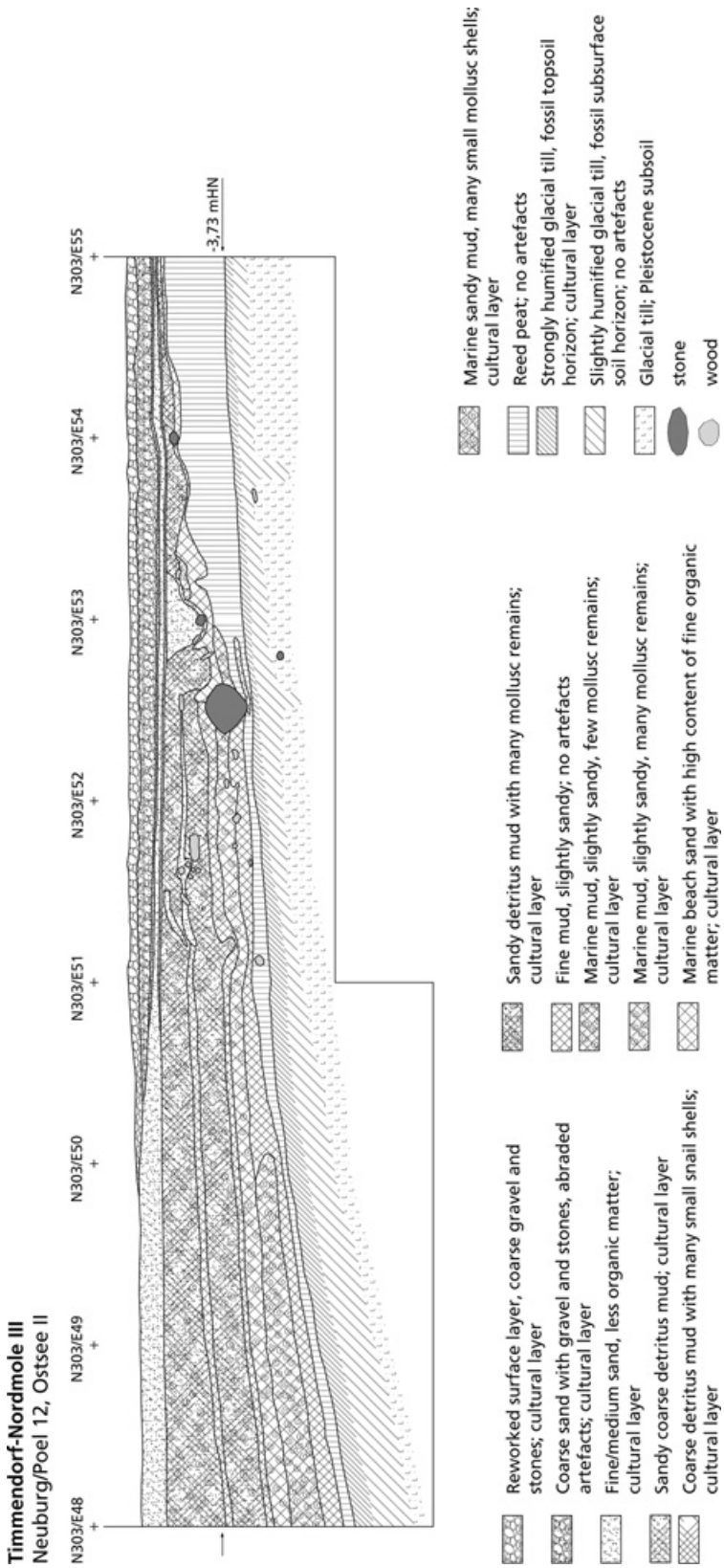


Fig. 25. Timmendorf-Nordmole III (Ostsee II, Neuburg / Poel 12b). Trench 3. Section E 48–55 / N 303. – Scale 1 : 40 (digital drawing J. Freigang / H. Lübke).

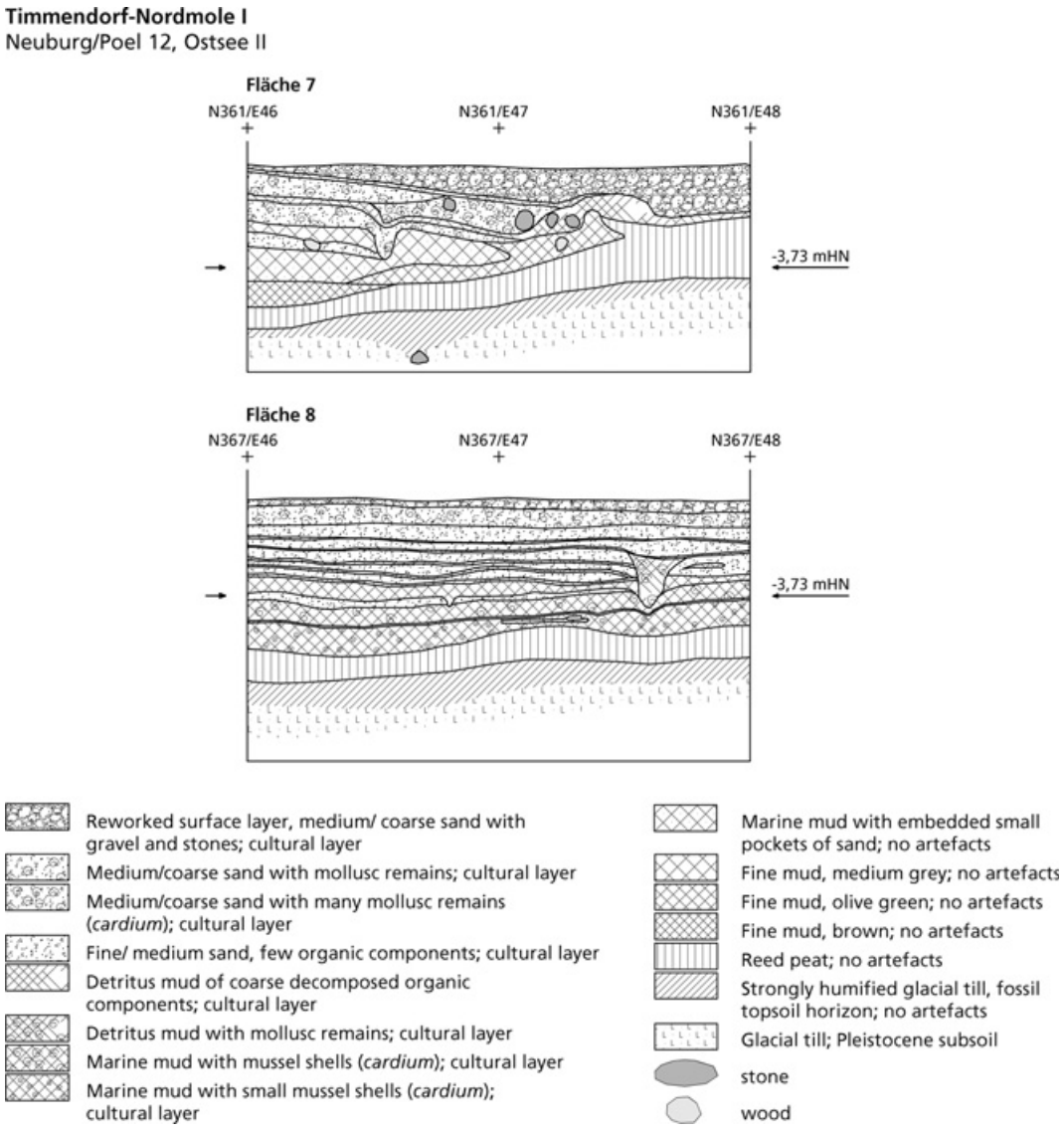


Fig. 26. Timmendorf-Nordmole III (Ostsee II, Neuburg / Poel 12b). Test trenches 7–8. Sections E 46–48 / N 361; E 46–48 / N 361. – Scale 1 : 30 (digital drawing J. Freigang / H. Lübke).

cies is similar to that of the leister prongs of Timmendorf-Nordmole I, but compared with the finds from Timmendorf-Nordmole II, explicitly more hazel and less dogwood was used, possibly a result of over-exploitation of dogwood bushes. Again, there are fragments of dug-outs made of lime trees (*Tilia* sp.). These comprise a 54.5 cm long, 8 cm wide and up to only 0.8 cm thick piece with a row of irregular holes. Inside two holes the remains of bast fibres were still present. In accordance with the log boats of Timmendorf-Nordmole I, this feature can be interpreted as the traces of a repair or an enlargement of the boat's side. Shavings from the working of lime wood (*Tilia* sp.) with an axe were also found, suggesting the existence of a nearby boatyard on the shore.

A 26 cm long piece of ash *(Fraxinus excelsior)* may be regarded as the fragment of the limb of a hunting bow. It is 4.0 to 4.6 cm wide, 1.6 cm thick and has a flat D-shaped cross section. The slightly curved back of the probable bow runs almost parallel to the growth rings of the wood. The interpretation as a bow is not certain as the piece is too small and nothing of the handle section has been preserved. The flat limb is relatively broad, corresponding with the Holmegaard type. Ash wood as a raw material is not the best though a possible choice, but usually elm (*Ulmus* sp.) was the favourite wood for Mesolithic bows. Possibly the fragment of an 8–9 cm thick elm trunk that was split by accident has to be interpreted as discarded raw material for bow building.

Furthermore, a tiny piece of basketwork, probably from a fish-trap basket, was found. It is comparable to other finds, e. g. the remains retrieved at Timmendorf-Nordmole II, and was made of a split guelder rose branch *(Viburnum opulus)* tied with a strip of alder root (*Alnus* sp.).

Some ash spears, a regular find at coastal sites, were also discovered. Close to the surface, a device was found which may be interpreted as the remains of a dip net. It consisted of a straight stave to which a thinner, bent branch was tied with a cord of bast fibres. The purpose of a completely preserved scoop-like implement of hazel *(Corylus avellana)* is also unknown. The artefact is 43 cm long and has a 1.7 cm thick handle broadening to a width of 3.3 cm. The enlarged part has an oval cross section. Another unidentified object is the half of an almost circular board which had been pierced by a vertical stake when still complete. The board has a diameter of presumably 16 cm and is only 0.5 cm thick. It was made from the wood of a maple trunk (*Acer* sp.). Provided that it was pierced by accident after deposition, the object could also be interpreted as a paddle, though the majority of Terminal Mesolithic paddles are made of ash (Mertens 2000).

A hazel stake *(Corylus avellana)* with a perforated end bears similarities to finds from other Terminal Mesolithic and Early Neolithic sites. With all probability, it belongs to the mouth of a fish trap (Andersen 1995 fig. 15; Klooss 2014).

At Timmendorf-Nordmole III, 34 pointed stakes were discovered, most of them 1–2 cm thick hazel rods *(Corylus avellana)*, though some also consisted of red dogwood *(Cornus sanguinea)*. Two-thirds of the stakes were worked with an axe and one third by removing long splinters and bark strips. The distribution of the hazel rods suggests a fishing fence in the environs.

Among the pieces of wood that did not bear any tool marks are also numerous hazel rods *(Corylus avellana)* with diameters between 1.0 cm and 3.5 cm. Hazel and oak (*Quercus* sp.) are the most common species of wood left unworked. Similar to Timmendorf-Nordmole I, there is a remarkably high amount of maple wood (*Acer* sp.). More than 60 % of the wooden pieces are partially burnt and thus definitely anthropogenic.

With the exception of a weathered T-shaped red deer antler axe which obviously can be regarded as a residual find and which, according to radiocarbon analysis, has to be assigned to the occupation phase of the site Nordmole I, no additional antler artefacts were recovered from trench III. The bone implements comprise a number of small plain bone points, probably parts of leisters, and a compact broad bone point made from the long bone of a mammal. Its inner surface is decorated with a simple ornament of incised bundles of lines.

The recorded fish, mammal and bird species from Timmendorf-Nordmole III show that marine resources were still highly important for human subsistence in this late stage of the Stone Age Timmendorf microregion *(tab. 17)*: Seals are the most frequent mammal species group and marine-affiliated species comprise the dominating fraction of the fish remains. Thus, a community of vertebrates was established which is typical in coastal areas of the

Baltic Sea up to present days. Additionally, the community indicates sandy or even stony conditions (Schmölcke / Ritchie 2010).

Probably, the main habitation period of the site appears to fall between November and early spring, since many recorded bird species should have been winter visitors in Mecklenburg Bay breeding in more northern regions *(Mergus albellus, Clangula hyemalis, Aythya marila, Melanitta fusca*, *Melanitta nigra, Cygnus cygnus)*. In all, this bird assemblage reflects a protected bight near the human settlement. Such a marine bight could have been also the habitat of most of the identified fish species. The freshwater-affiliated cyprinids which are tolerant to brackish water, represented by tench *(Tinca tinca)* as well as the Percidae pikeperch *(Sander lucioperca)* and perch *(Perca fluviatilis)*, constitute only 0.7 % of the determined fish remains.

However, the existence of a freshwater habitat is also confirmed by otter *(Lutra lutra)* and water vole *(Arvicola terrestris)*. Furthermore, several game and fur species indicate a closed forest nearby, but the direct environment of the settlement of trench III was more open with shrubs as shown by the records of a variety of smaller species such as harvest mouse *(Micromys minutus)* and common shrew *(Sorex araneus)*.

In the context of cultural history the quite long list of fur species should be mentioned. It includes, besides seal, red fox *(Vulpes vulpes)*, wild cat *(Felis silvestris)*, pine marten *(Martes martes)*, otter *(Lutra lutra)* and squirrel *(Sciurus vulgaris)*. It is indicative that the vast majority of the remains of these species are skeletal elements like phalanges or metapodials – parts of the skeleton which often remain in the fur.

The record of potentially domesticated pigs and cattle at Timmendorf-Nordmole III is something special. However, all the potential pig remains are partly problematical in their classification, and very scattered, and the potential record of cattle is a single molar of a not fully mature specimens. Summarising the bone materials from Timmendorf-Nordmole II, the site could be interpreted as a hunting camp comparable to Hesselø / Sølager (Skaarup 1973, cf. Hartz / Schmölcke 2013, 27). There are considerable economical differences with sites like Rosenhof and Wangels shown in the osteological assemblages, because among the bones from these eastern Holstein sites a larger quantity of domesticates were detected.

3.1.2.2.5. Summarising remarks on the sites Nordmole I–III

Considering the evidence provided by recent research, it can be assumed that the area off Timmendorf-Strand was not – as it had appeared originally – occupied by a large base-camp settlement similar to Neustadt-Marienbad or Rosenhof. Instead, the site Neuburg / Poel 12, Ostsee II, in its present extension, seems to have consisted of several smaller chronologically distinct stations. When the westernmost *(figs. 16–17)*, earliest known station Timmendorf-Nordmole II (Neuburg / Poel 47, Ostsee II), dating between 5600 and 4800 cal. BC, had been given up, a second activity area emerged at Timmendorf-Nordmole III (Neuburg / Poel 12b, Ostsee II) between 4600 and 4500 cal. BC, leaving behind the lower cultural layer unearthed during the excavation in 2007 *(fig. 27)*. In the following 400 years, the main occupation area shifted c. 100–150 m to the south, where the station Timmendorf-Nordmole I (Neuburg / Poel 12a, Ostsee II) was investigated from 2000 until 2002. At the beginning of the Early Neolithic, human activity concentrated again further north, in the area of the station Timmendorf-Nordmole III, generating the main find layer of the site. The investigation of these cultural remains provided the first evidence of the initial phase of the Early Neolithic in this part of the coast.

In 2005, the underwater excavations of the SINCOS project were complemented by a geophysical survey of the sites Timmendorf-Nordmole I and III which was conducted in the

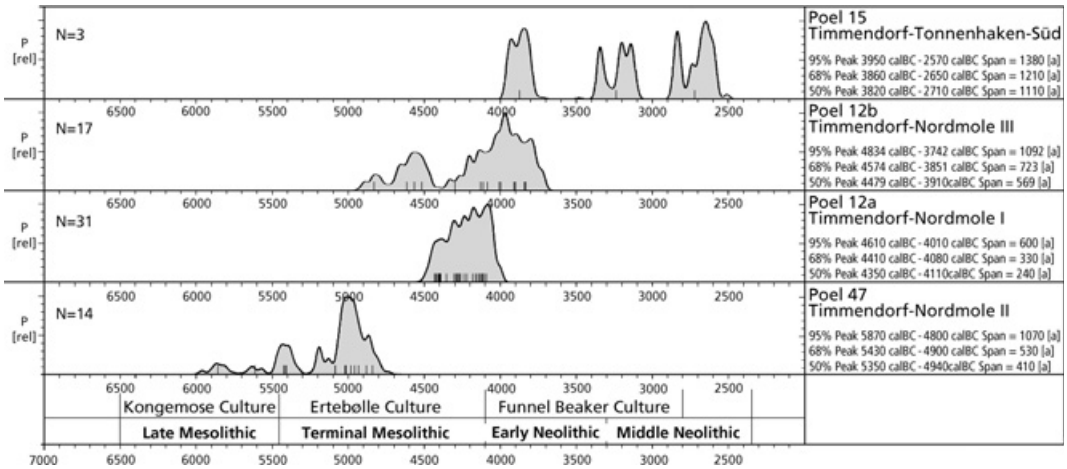


Fig. 27. Group calibration of radiocarbon dates of Mesolithic and Early Neolithic coastal settlements off Timmendorf-Strand, Insel Poel. The calibration was conducted with the programme Calpal of O. Jöris and B. Weninger (cf. www.calpal.de) and the calibration curve Intcal98 (Stuiver et al. 1998) (digital drawing H. Lübke).

frame of the Seamap3D project by the Department of Geosciences of the University of Kiel (Müller et al. 2007). This investigation not only provided important insights into the topography of the landscape before and during the inundation caused by the Littorina Transgression and before the erosion and accumulation processes which have been changing the shape of the coastline up to the present day, but also produced evidence of subsurface structures in the former occupation area. The question whether these are comparable to the sunken construction at Timmendorf-Nordmole I, has not been definitely settled yet as the primary task of the SINCOS project was the investigation of ancient shore zones in order to establish the respective sea level and to obtain samples for scientific analysis that enable a reconstruction of the environmental and economic conditions.

3.1.2.2.6. Timmendorf-Tonnenhaken-Süd

The site Timmendorf-Tonnenhaken-Süd (Neuburg / Poel 15, Ostsee II) was already discovered in 1999, together with the site Timmendorf-Nordmole I, and is situated approximately 1 km further north, at a depth of *c.* 2 m below the water surface *(figs. 16–17)*. The first underwater surveys took place in 2001, as part of the DFG research project "Stone Age in the Wismar Bight area" (Lübke 2002a), but due to the extraordinary evidence unearthed at the adjacent site of Nordmole I, the investigations at Tonnenhaken were suspended for some time.

The finds recovered in 1999 and 2001 not only comprise flint implements such as transverse arrowheads, flake scrapers and strong backed blades but also a number of pottery fragments. There are several rim sherds decorated with a single row of rectangular incisions below the rim, which point to a later phase of the earlier part of the Early Neolithic (FN 1c).

During the survey dives in 2001, only find clusters of a smaller scale were discovered. This was probably caused by the dense seaweed mats that covered the site area in the years

1999–2002. This situation did not change until 2007, when the seaweed in Wismar Bay started to recede for unknown reasons. Due to this process, which has continued until the present day, the outcrops of the peat banks which mark the shoreline of the former lagoon have been exposed, so that the site could be surveyed again comprehensively in the summer of 2008. These investigations showed that the site Tonnenhaken-Süd covered a larger area than previously thought and that especially north of the test pits of 2001 more find layers had been well preserved. The find assemblage recovered form that area also includes a

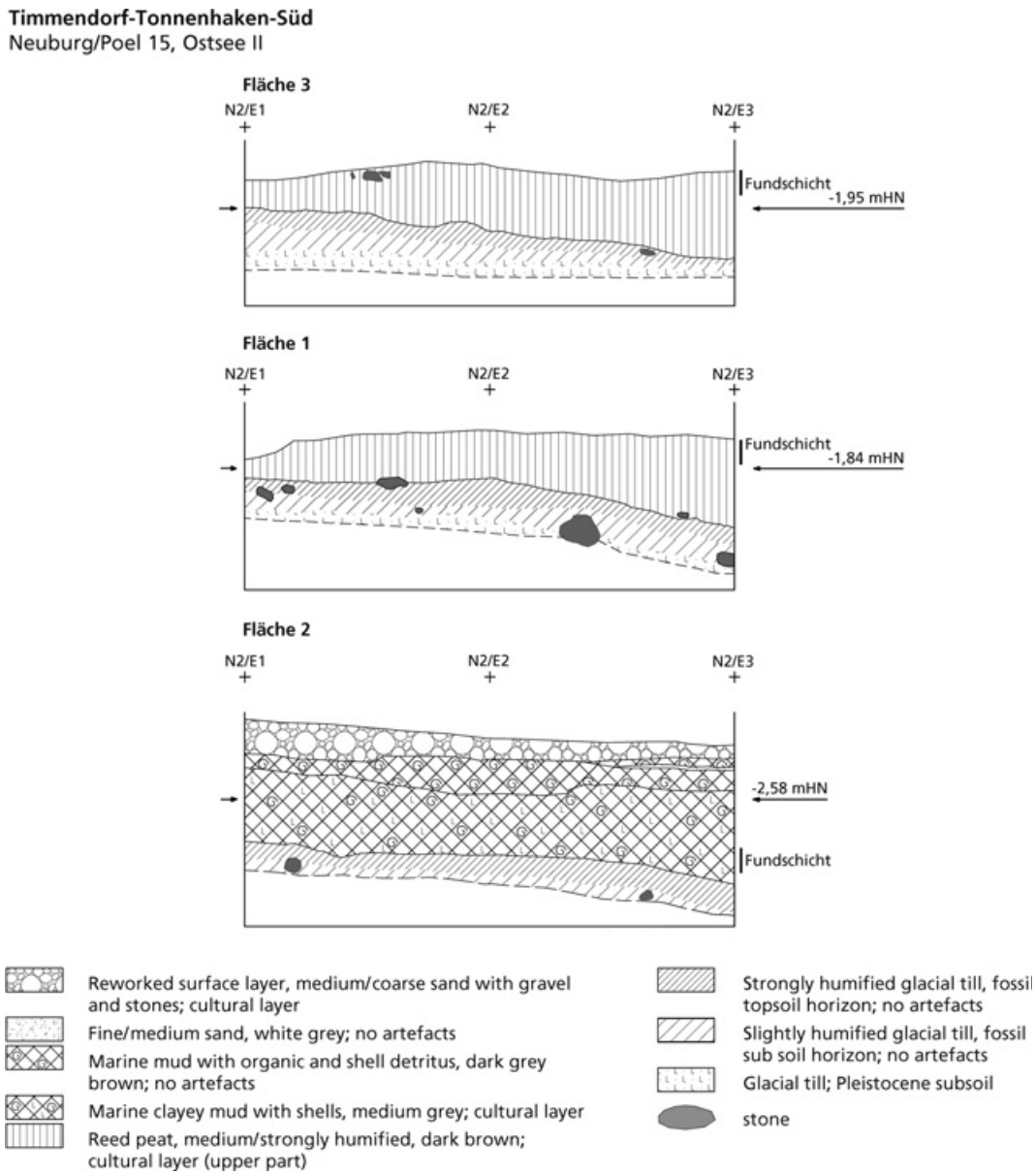


Fig. 28. Timmendorf-Tonnenhaken-Süd (Ostsee II, Neuburg / Poel 15). Test trenches 1–3. Sections. – Scale 1 : 30 (digital drawing J. Freigang / H. Lübke).

ground stone axe the shape of which corresponds to that of the thick-bladed, thin-butted flint axes which are a classical feature of the Early Neolithic Funnel Beaker Culture.

The Early Neolithic finds of Timmendorf-Tonnenhaken-Süd come from a *c.* 15 cm thick cultural layer at the outcrop of a peat bank *(fig. 28)*. The find layer is situated immediately below the surface, in the upper section of a reed-sedge peat overlying the mineral Pleistocene subsoil. Worth noticing is the fact that the Pleistocene subsoil does not drop in a westerly direction, towards the present bay, but to the east, in the direction of the present shoreline, where obviously a lagoon must have stretched during the time of occupation. The cultural layer runs parallel to the Pleistocene subsoil and is increasingly covered by peat and mud strata as it extends into the basin. Apparently, Timmendorf-Tonnenhaken-Süd was not a large settlement site, but a temporary small-scale settlement unit that was not oriented towards the sea but towards a sheltered lagoon.

The outcrop of the peat bank indicates its western shore, whereas the eastern part is still visible as a depression behind the beach ridge and the sand dunes which form the current coastline. The till banks west of the peat bank, which have been abraded to a large degree, are an indication that in Neolithic times this area must have been occupied by a peninsula which probably was connected to the former mainland in the north. In the south, there was a sheltered bay on which the earlier sites Nordmole I and Nordmole III had been situated.

The analysis of the faunal remains indicates that the mammal bones retrieved so far – except for a water vole *(Arvicola terrestris)* – exclusively derive from domesticated animals such as bovines *(tab. 18)*. This is a marked difference from the sites Nordmole I and III. The few fish demonstrate marine to brackish conditions of the waters in front of the settlement.

Although the data base is still insufficient for further interpretation, it may be assumed, considering the present evidence, that during the late Nordic Early Neolithic the economic structure of the Stone Age settlements off Timmendorf changed considerably and that the hunting stations were abandoned in favour of more agriculturally oriented settlements.

In order to confirm the archaeo-typological dating, altogether three accelerator dates were obtained. However, the three samples which were taken from animal bones collected from the surface of the peat bank did not produce consistent results. If the samples have not been contaminated with younger carbon after their deposition, the site must have been frequented several times during the Neolithic period. This hypothesis, however, is not confirmed by the current inventory of finds, which has a uniformly Early Neolithic appearance. In order to settle this question, more research will have to be done.

3.1.3. Coastal area west of Darss Sill – summary

In the main research area Mecklenburg Bay, the earliest settlements investigated within the frame of the SINCOS project date to the second half of the 7th millennium cal. BC and thus to the beginning of the Late Mesolithic in the southwestern Baltic area. These sites have been located exclusively in Wismar Bay, where, due to the special topographical situation particularly north of Poel Island, at a depth between 6 m and 12 m below the water surface, settlement sites dating to the 7th and 6th millennium cal. BC have been preserved. However, so far only the earliest station, Jäckelberg-Huk, dating to 6400–6000 cal. BC, has been the object of comparative studies employing archaeo-typological methods. Although the younger stations, dating from after 6000 cal. BC, such as Jäckelgrund-Orth, also yielded large flint inventories, the projectile points and the bone and antler implements typical for the period and vital for any conclusive analysis are missing. Nevertheless, the extensive samples for scientific studies

which were taken at these sites do permit a reconstruction of the environment and its economic potential in Wismar Bay during the 7th and 6th millennium cal. BC.

Between *c.* 5500 and 4100 cal. BC, the north German Baltic coast was the homeland of the Ertebølle Culture. Sites from this period have been investigated on the coast of Mecklenburg Bay in eastern Holstein, at Rosenfelde, Rosenhof and Neustadt, but also in Wismar Bay, where the stations Jäckelberg-Nord and Nordmole I-III were discovered. The extensive archaeological find material, which not only consists of flint artefacts but also of implements of bone, antler and especially wood, enables a comprehensive study of the material culture and the chronological pattern of the Ertebølle Culture in this area.

From 4100 cal. BC, the Ertebølle Culture was superseded by the Early Neolithic Funnel Beaker Culture. Sites from the period have been traced particularly in eastern Holstein, at Wangels, Neustadt and also Rosenhof, while the station Nordmole III was discovered in Wismar Bay. Whereas the flint inventory did not change considerably compared to that of the late phase of the Ertebølle Culture, there are distinct technological and typological differences regarding not only the pottery, but also the economic basis. Around 3700 cal. BC, typical elements of the Nordic Funnel Beaker Culture appear which did not only affect the ceramic inventory. As an example, flake adzes were now complemented by all-over polished thin-butted flint axes. Considering the present research results, it can be concluded that the settlement pattern adopted as early as 4100 cal. BC was retained until the period around 3600/3500 cal. BC. This hypothesis has been confirmed by evidence from the stations Siggeneben-Süd and Siggeneben in eastern Holstein and the partially investigated station Tonnenhaken-Süd in Wismar Bay.

3.2. Coastal area east of Darss Sill - Rügen Island and the Strelasund coasts (H. Jöns, D. Heinrich, H. Lübke, U. Schmölcke)

3.2.1. Introduction

Research on the transformation of the Late and Terminal Mesolithic to the Neolithic cultures on Rügen Island and the coastal areas of the adjacent mainland could already look back on a long tradition starting in the early 20th century (summarising Lübke et al. 2000, 439 ff.; Terberger 2007, 241) before the SINCOS research project was established in 2002. In particular the composition of dredged and collected find complexes, for example from Drigge and Ralswiek-Ausgustenhof, comprising in some cases large quantities of flint artefacts, but also well preserved tools and weapons made of organic material, attracted the interest of numerous archaeologists *(fig. 29)*. The fact that the material from these sites also comprised a few human skulls and objects of central European provenience was interpreted as evidence of supraregional contacts of the Terminal Mesolithic-people to agrarian societies from the south. Further analyses of this material led to the conclusion that during the 5th millennium cal. BC on the coast of western Pomerania communities that were closely linked to the Ertebølle- / Ellerbek Culture of southern Scandinavia lived on hunting and fishing. But differences in the composition of the material culture, especially the lack of pointed-bottom ceramic vessels, led to the hypothesis that the material culture of the people from Rügen Island and the neighbouring area was not identical with that of their northern and western relatives, who represented the Ertebølle Culture. In fact they were considered to be a regional group of the latter and the culture was named the Lietzow Culture after the site of Lietzow Fährberge, next to the strait between the Großer and Kleiner Jasmunder Bodden. Not far away, near the shore of the Kleiner Jasmunder Bodden, the sites Lietzow-Buddelin and Ralswiek-

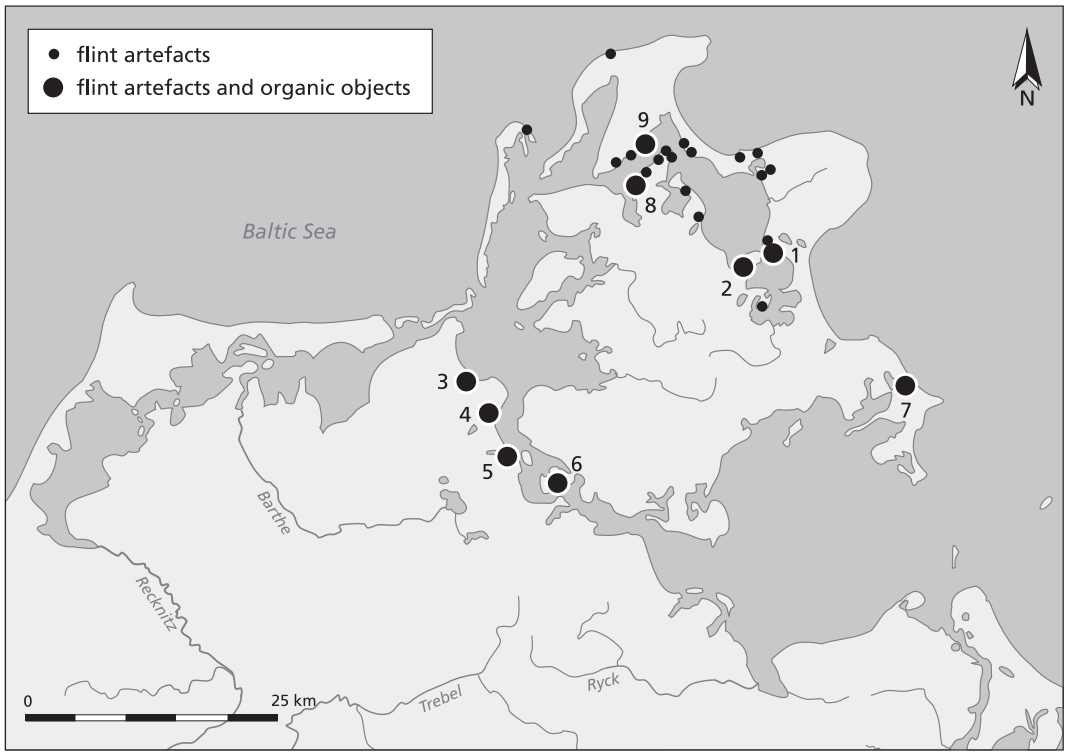


Fig. 29. Terminal Mesolithic and Early Neolithic sites on Rügen Island and along the adjacent Coast of northwestern Pomarania. 1 Lietzow-Buddelin (Lkr. Rügen, Saiser 1); 2 Ralswiek-Augustenhof (Lkr. Rügen, Ralswiek 8), 3 Prohn (Lkr. Nordvorpommern, Prohn 15); 4 Parow-Sportboothafen (Lkr. Nordvorpommern, Parow 4); 5 Stralsund-Mischwasserspeicher (Hansestadt Stralsund, Stralsund 225); 6 Drigge (Lkr. Rügen, Drigge 7002 / Ostsee VI, Putbus-West 29); 7 Baabe (Lkr. Rügen, Baabe 2); 8 Breetzer Ort (Lkr. Rügen, Ostsee VI, Bergen 24); 9 Kamminer Ort (Lkr. Rügen, Ostsee VI, Wittow 100). – Scale 1 : 750 000 (Kartengrundlage: K. Ruppel, RGK [digital drawing] after Jöns 2007 fig. 14 with additions).

Augustenhof had been partly excavated as early as during the 1930s (summarising Gramsch 1978). New sites of the Lietzow Culture from both sides of the Strelasund were detected during further dredging activities from the 1970s, leading to the localisation of new coastal sites of the Lietzow Culture, for example in Parow and Prohn (Lübke et al. 2000).

Although the chronological placement of these sites was not proved by AMS-^{14}C-datings, and their original location in relation to the contemporaneous shoreline was more or less unknown, the materials from these sites were a good foundation for the SINCOS research project; so all of them were individually integrated into the research agenda (summarising Jöns et al. 2007, 94 ff.).

In contrast, submerged sites from the waters east of the Darss Sill dating to the phase of the Littorina Transgression were almost unknown before the SINCOS investigations started. Consequently, underwater surveys aiming to find well preserved remains of inundated settlements were one of the most important activities of the geo-archaeological team within the SINCOS research unit (Jöns et al. 2007, 94 ff.). The geophysical exploration and the diving surveys finally lead to the discovery of numerous, partly well preserved sites. A few of them

delivered organic remains, for example Neuhofer Ort (Ostsee VI, Putbus-West 30), where the remains of a small pit were found in which red deer antler fragments with typical Stone Age working traces were preserved (Jöns et al. 2007, 101). Of special importance were the submerged sites Kamminer Ort (Wittow 100, Ostsee VI) and Breetzer Ort (Bergen 24, Ostsee VI), which were investigated further during SINCOS II.

It has to be considered as a piece of luck that during the working phases of SINCOS and SINCOS II in Stralsund City, as well as in Baabe (Rügen Island), coastal sites of the 6th until 4th millennium were investigated by the state heritage authorities due to construction works. These large scale investigations produced a lot of finds, stratigraphies and samples that could be integrated to the SINCOS-research and are enriching the SINCOS-database.

3.2.2. Drigge

Already in the 1930s a complex consisting of antler and bone finds was dredged up from the Strelasund on the southern coast of Rügen Island near Drigge *(fig. 29,6)*. The material also includes three T-shaped axes and a few fragments of red-deer antlers, indicating the production of this kind of tools. These artefacts led to the assumption that the site belonged to an early phase of the Ertebølle Culture (Terberger 1998). This was confirmed by ^{14}C-datings of two samples to the period around 4950 cal. BC (Terberger 2006, 137).

The composition of the recovered animal bones proves that red deer was the most frequently hunted game. Together with a few bones from wild boar they point to a rather terrestrial diet of the people from Drigge. Nevertheless, the community had also occasional access to marine resources, as can be seen from single bones of seal and whale, although these finds can not be taken as evidence for hunting in the Baltic Sea (Terberger 2006, 138).

The skull belonged to a male person. It has to be considered as one of the most important finds from Drigge and was directly dated to around 5150 cal. BC. Because of the δ^{13}C value of –19.7 ‰, a strong reservoir effect is not expected and a terrestrial diet seems to be most probable, but additional analysis of the nitrogen values is desirable to receive additional information on the diet. As long as these investigations are not completed, and as long as no more ^{14}C-datings of other finds confirm the dating of the site, it must be assumed that the skull is roughly 200 years older than the settlement remains.

The skull shows fractures at the occipital that have been discussed as an indication of cannibalism (summarising Terberger 1998, 28 ff.). After detailed investigations of the skull this theory has to be rejected, but cut marks indicate that scalping had been practiced. These marks confirm that we have to reckon with special treatment of deceased members of the Late Mesolithic communities on Rügen Island. Although the site at Drigge is of high importance for cultural history, it can not provide any verifiable data about the sea level during the time of its colonisation because it was not possible to localise and reinvestigate the site during an underwater survey campaign, nor could the find layer be localised and identified during a drilling programme.

3.2.3. Stralsund-Mischwasserspeicher

During construction works for a large-scale water reservoir in the periphery of the historical city of Stralsund, the remains of a Stone Age site were discovered in 2002 *(fig. 29,5)*. They were covered by more than 5 metres of sediments, filling material and settlement remains of

the Middle Ages and the Modern Age. The investigations showed that the site was originally established on the shore of a bay of the Strelasund, so that the people living here had direct access to the Baltic Sea (summarising Kaute et al. 2004). On the site two subsequent cultural layers could be distinguished, indicating that the favourable conditions at the site presumably existed for more than 1,000 years. In the oldest cultural layer, composed of peat and sand, multifaceted find material could be recovered that cannot be discussed here in detail (see Kaute et al. 2004, 224 ff.). Relevant for the dating and the cultural classification of the site are numerous artefacts, production refuse and a few artefacts that can be considered as typical for the early phase of the Ertebølle Culture. Apart from a few harpoon fragments, core axes with rough pointed-oval cross section, symmetrical arrowheads and one ulna point, one T-shaped antler axe is particularly relavant. It was directly dated by AMS-^{14}C to around 4900 cal. BC. This confirms the general dating of the find layer to the period between 5100 and 4800 cal. BC, which is based on dendrochrological datings of tree trunks that were imbedded below and within the find layer (Kaute et al. 2004, 223 ff.). Within the Ertebølle layer two completely flattened dugout canoes were also found, that were still preserved with lengths of 8 and 9 m. One was made of lime wood (*Tilia* sp.) and the other possibly of a maple trunk (*Acer* sp.) (Klooss 2014). On the bottom of both dugouts discoloured circular patches were preserved, indicating that small hearths existed on board. These vessels have to be considered as some of the best preserved dugout canoes of the terminal Mesolithic period in the southwestern Baltic area. Both vessels were directly dated by AMS-^{14}C- to the period between 4800 and 4700 cal. BC (Lübke 2004c; Klooss / Lübke 2009).

Separated by a layer consisting of sand and peat clay, another cultural layer was discovered consisting of marine fine sand of roughly 50 cm thickness. In this layer numerous wood, ceramic, stone, antler and bone finds were recovered. Some of the ceramic sherds could be reconstructed as typical funnel beaker vessels of the Early Neolithic period (Kaute et al. 2004a, 235 ff.). AMS-^{14}C-datings of charred incrustations from a few sherds to the period between 4000 and 3500 cal. BC confirmed the typological dating to the material. A third dugout canoe, also constructed from lime wood (*Tilia* sp.), was imbedded in this layer. With a preserved length of almost 12 m, it is the longest known vessel of the Funnel Beaker Culture recovered in the southwestern Baltic area. This canoe was also directly dated by AMS-^{14}C. It was constructed around 3800 cal. BC (Lübke 2004c, 260).

Given that the settlement of the Ertebølle community as well as that of the Funnel Beaker people were not eroded into the shallow water zone of the bay, but inundated and buried by sediments during storm tides in situ, the stratigraphic position and the level of both cultural layers may be used as indicators of the corresponding sea level of the Strelasund. If this is true, the sea level around 5000 cal. BC has to be reconstructed at a level of around 2.2 m below the recent sea level (Lübke / Terberger 2004, 244). Judging from the rate of sedimentation on site, it has to be assumed that the sea level rose during the following 1200 years around 50 cm, so that around 3800 cal. BC the sea level must have been between 1.50 and 1.8 m below the recent sea level. These data are within the span of the sea level curve calculated by Lampe et al. (2007, 127 ff.).

3.2.4. Kamminer Ort

The Terminal Mesolithic site of Kamminer Ort, which today is situated at the northeastern end of the Breetzer Bodden (lagoon area) in the transition area to the Breeger Bodden *(figs. 29,9; 30,4)*, was surveyed in spring 2007. After the discovery of this site in 2003, first surveys were made in 2005, where organic material was recovered. Radiocarbon dating fixed

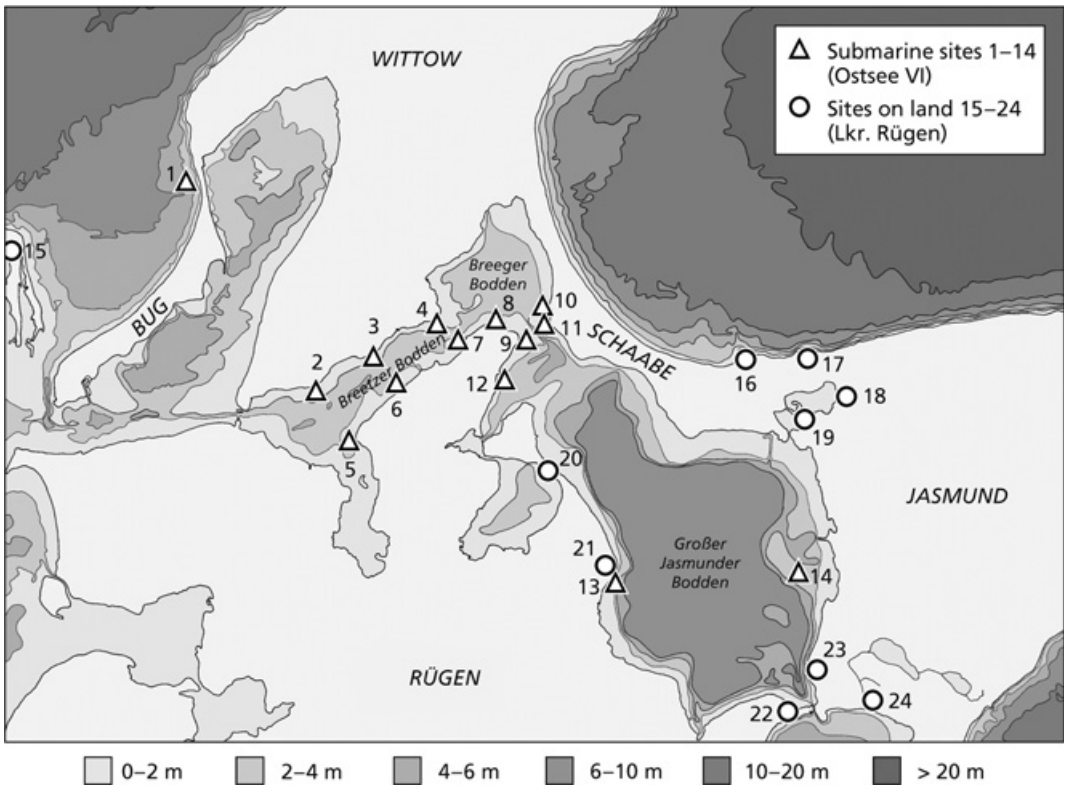


Fig. 30. Late and Terminal Mesolithic settlements on the Northern Island Rügen. 1 Dranske-Süd (Wittow 102), 2 Kontoper Haken (Wittow 99); 3 Woldenitzer Haken (Wittow 10); 4 Kamminer Ort (Wittow 100); 5 Breetzer Ort (Bergen 24); 6 Vieregge-Westhaken (Bergen 23); 7 Fährbusch (Bergen 25); 8 Finkenhaken (Bergen 29); 9 Lebbiner Haken (Bergen 27); 10 Gelmer Ort (Wittow 97); 11 Kleiner Ort (Wittow 103); 12 Lebbin-Südostufer (Bergen 26); 13 Banzelvitz-Süd (Bergen 28); 14 Helmutflach (Wittow 104); 15 Enddorn (Kloster 8); 16 Königshörn (Glowe 5,7); 17 Bakenberg (Ruschvitz 8); 18 Baldereck (Baldereck 6); 19 Grämer Ort (Spycker 5); 20 Röddelin-Berg (Liddow 7); 21 Banzelvitzer Berge (Groß Banzelvitz 3); 22 Augustenhof (Ralswiek 8); 23 Lietzow-Fährberge (Lietzow 1); 24 Lietzow-Buddelin (Saiser 1) (cf. Gramsch 1973; Lübke et al. 2000 and own additions). – Scale 1 : 250 000 (digital drawing J. Freigang / H. Lübke).

a date between 4900 and 4700 cal. BC *(tab. 19)*, so that the site could attributed to an older phase of a Terminal Mesolithic Ertebølle Culture. Small-scale sondage cuts were planned to help to locate the former shoreline and to verify the stratigraphy and preservation.

For this reason a north-south orientated axis more than 50 m long was established, running from today's shallow water area towards the Bodden. Altogether five survey trenches were dug, each covering an area of 2 m² and reaching up to 0.8 m deep. While in trenches 1 and 4, in the shallow water area directly beneath a subrecent layer of sand, gravel and seashell breeze (broken clams), the Pleistocene glacial clay was found *(fig. 31)*, in the three excavation areas situated deeper the transition to the former shore zone could be located.

Already in the immediate vicinity of the shoreline, in trench 2, unpatinated, flint blades that were still sharp and single animal bones could be recovered from a marine gyttja layer *(fig. 32)*.

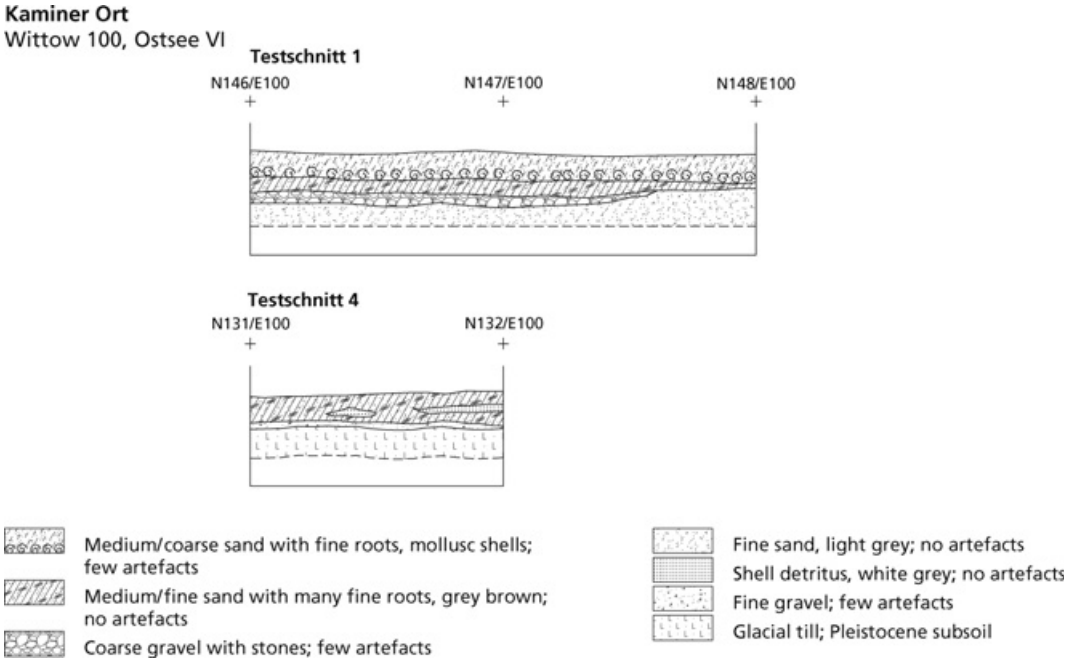


Fig. 31. Kamminer Ort (Ostsee VI, Wittow 100). Test trench 1, 4. Sections. – Scale 1 : 30 (digital drawing J. Freigang / H. Lübke).

In both trenches 5 and 3, beneath the remaining subrecent (modern) covering layers and a layer of sand, alternating deposits of peat and marine gyttja were found. Especially in the gyttja layers further archaeological finds could be observed.

Selected finds were sent for radiocarbon dating to the Leibniz laboratory at the University of Kiel *(tab. 19)*. However, the general amount of finds was small so that it can be assumed that this might have been a site of only small dimensions, or that the survey trenches only uncoverd the edge of the former site. Therefore further extension of this excavation area was waived and efforts were focussed on excavations at Breetzer Ort (Bergen 24, Ostsee VI) instead.

Up to now only very preliminary archaeozoological results are available. Approximately half of the determinable fish bones come from perch *(Perca fluviatilis)*, with a further 20 % of other freshwater affiliated species such as pike *(Esox lucius)* and cyprinids. Marine species are represented by pleuronectids and eelpout *(Zoarces viviparus)*. The animal remains include the characteristical species of Late Mesolithic hunters: wild boar, red and roe deer and marten.

3.2.5. Breetzer Ort

This site was discovered in 2004 (Lübke 2004b; Jöns et al. 2007) and was surveyed in three excavation campaigns in 2004, 2007 and 2008 (Lübke 2009b). The site is located in the area of the mouth of the Neuendorfer Wiek on the southwestern end of the Breetzer Bodden, south of Wittow ferry *(figs. 29,8; 30,5)*. At the time of settlement, a peninsula must have

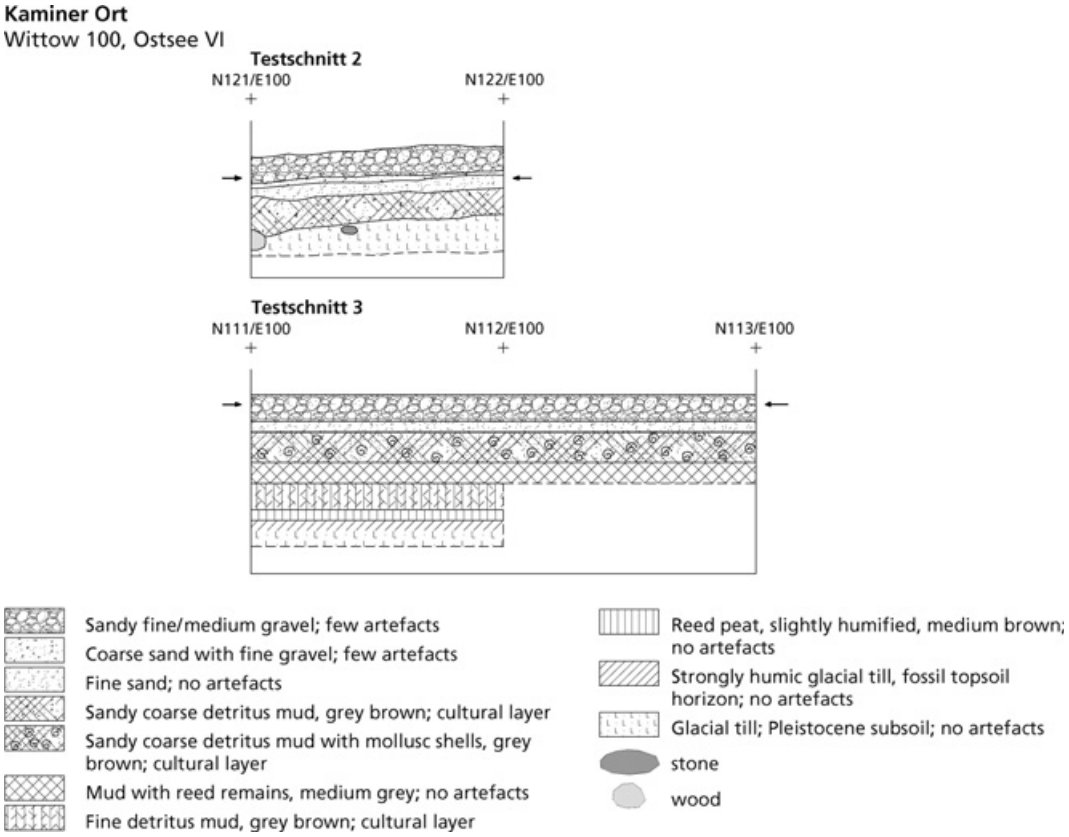


Fig. 32. Kamminer Ort (Ostsee VI, Wittow 100). Test trench 2, 3. Sections. – Scale 1 : 30 (digital drawing J. Freigang / H. Lübke).

separated the Neuendorfer Wiek from the Breetzer Bodden more than is the case today, so that the sheltered south shore of the peninsula offered the ideal position for a settlement site.

In a first survey campaign in 2004 three phases of use could be found and dated in area 1, which was 3 m² in size *(tab. 20)*. At the base of the trench was a Late Mesolithic campfire (*c.* 5600–5500 cal. BC) that was covered by Terminal Mesolithic finds of the Middle Ertebølle Culture (*c.* 4800–4500 cal. BC). The last phase dates to the Final Mesolithic (4200–4100 cal. BC), a date derived from a wooden post belonging to a possible fish weir.

The goal of the campaign between 2007 and 2008 was the extension of excavation area 1 in order to uncover the finds located in 2004, and to recover further finds mainly from the Terminal Mesolithic shore line because there is only inadequate stratified material available from the middle phase of the Ertebølle Culture on the Island of Rügen.

In spite of the early start of the excavation in March 2008, in both years the visibility under water was very bad due to the mild winter which failed to diminish algae growth in the Bodden. Therefore no photographic documentation but only drawings of the excavation could be done. Altogether another 13 m² were excavated so that finally the size of area 1 after completion was 16 m² *(fig. 33)*. It showed that the Late Mesolithic fire place was preserved between two oak trunks, which collapsed around 400 years later with the transgression of

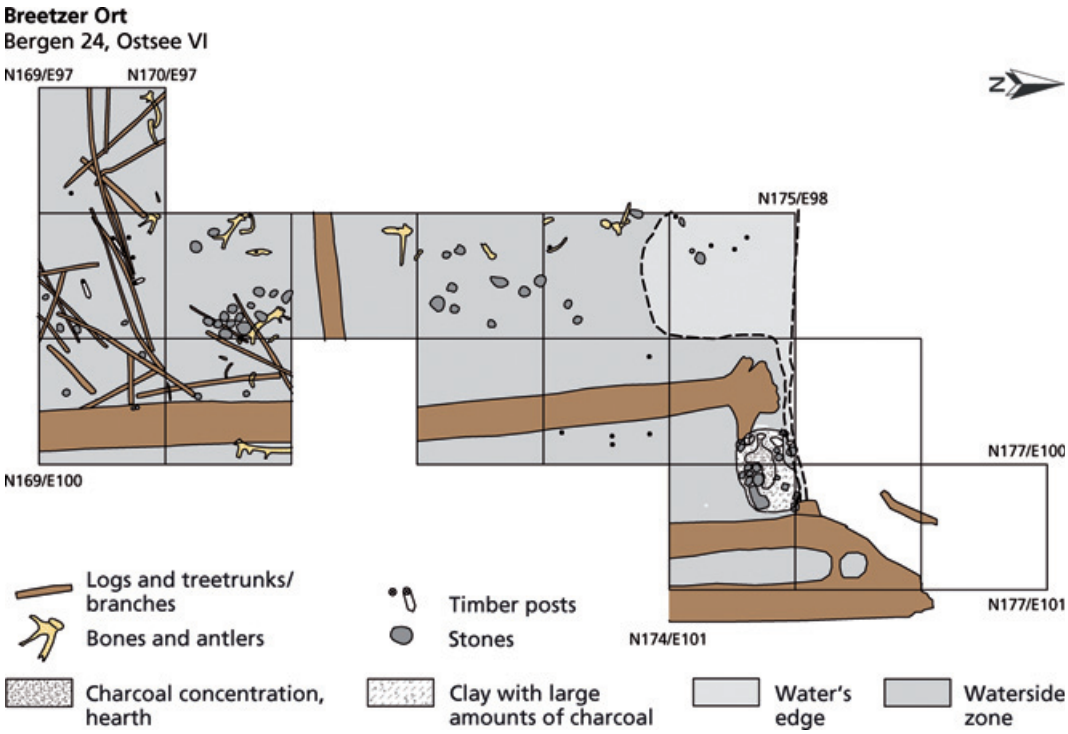


Fig. 33. Breetzer Ort (Ostsee VI, Bergen 24). Excavation plan. – Scale 1 : 60 (digital drawing J. Freigang / H. Lübke).

the sea level onto the shore area and so preserved the campfire from further destruction. Further Late Mesolithic settlement finds could not be observed. Obviously only the embedded fire place was preserved. In the course of the ensuing flooding the entire top soil must have been washed away because the Pleistocene clay followed beneath the marine peat of the Terminal Mesolithic shoreline area *(figs. 34–35)*.

This process happened around 5000 cal. BC; with the transgression the local oak trees died and the trunks finally collapsed and were embedded in sediments.

The reoccupation of the site during the Ertebølle Culture took place according to published ^{14}C dating at around 4800 cal. BC. Settlement refuse became sedimented in the shore zone between the collapsed trees. Besides numerous flint artefacts, various organic tools were recovered. Next to leister prongs and raw material for arrow shafts made of hazel wood *(Corylus avellana)* (Brühl / Klooss in print), tools and refuse products from deer antler manufacturing were encountered on this site for the first time. Worth mentioning are – next to roe deer harpoon, a small antler chisel, a fragmented T-shaped axe and several prefabrication axes – three deer antler mauls from antler burrs. Obviously in area 1 a refuse zone from a nearby manufacturing site was observed, where above all deer antler was processed. Remarkably, no pottery was found, although clay vessels were already known in the western Baltic area. This phenomenon was also observed on the younger sites of the Ertebølle Culture on Rügen Island and might be an evidence for a local Lietzow group.

Quantitatively, the investigated vertebrate remains from Breetzer Ort are heavily dominated by fish bones *(tab. 21)*, which in turn are completely dominated by perch *(Perca flu-*

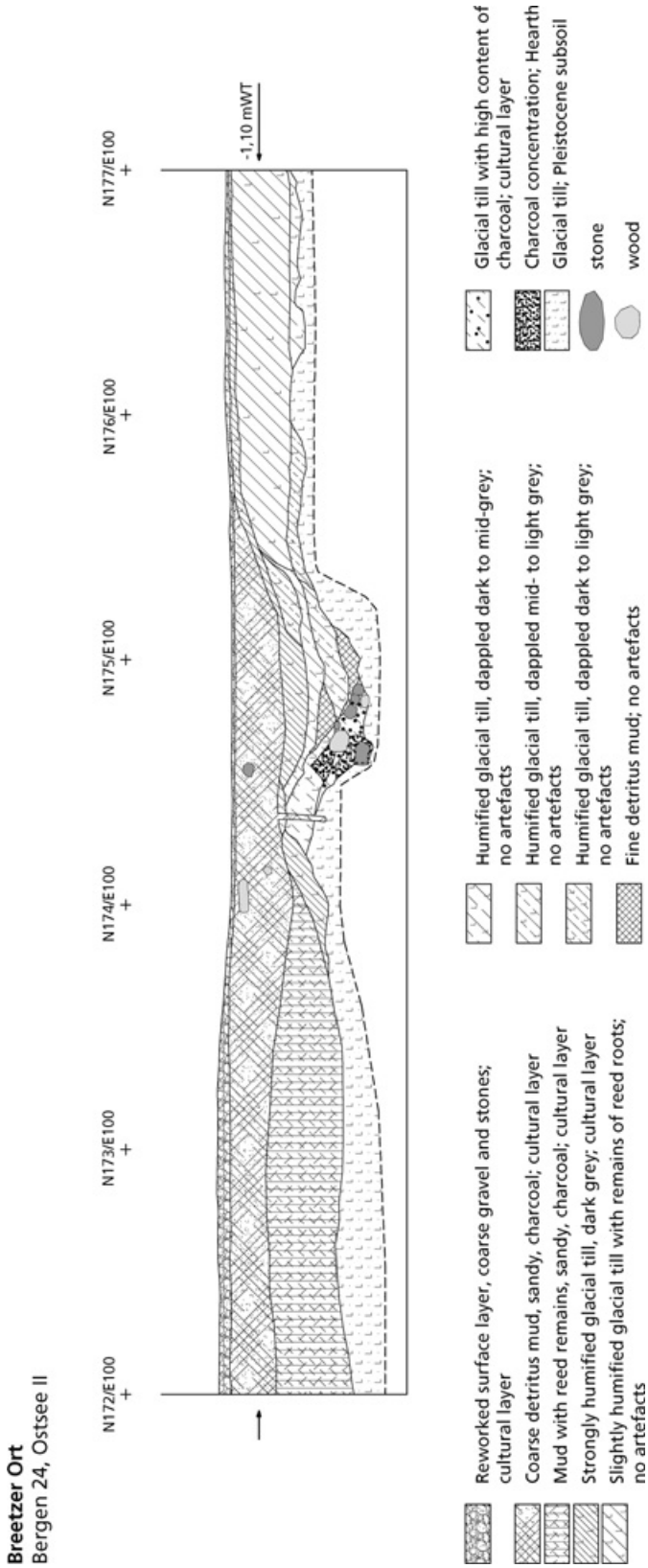


Fig. 34. Breetzer Ort (Ostsee VI, Bergen 24). Trench 1. Section 172–177 / E 100. – Scale 1 : 30 (digital drawing J. Freigang / H. Lübke).

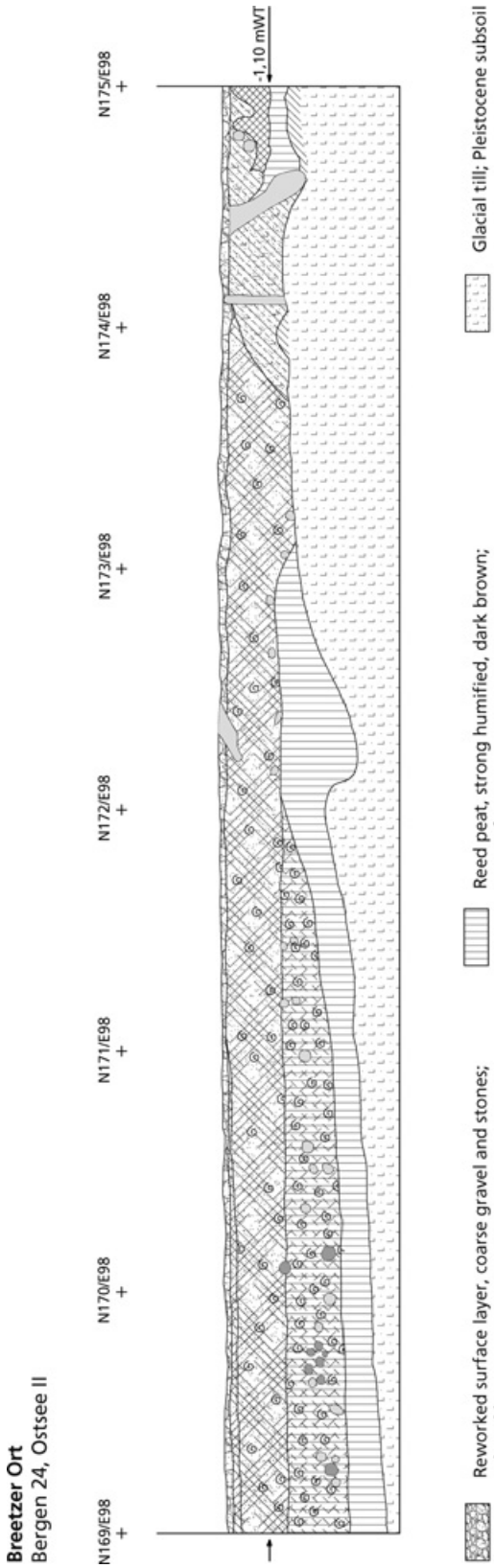


Fig. 35. Breetzer Ort (Ostsee VI, Bergen 24). Trench 1. Section 169–175 / E 98. – Scale 1 : 30 (digital drawing J. Freigang / H. Lübke).

viatilis). The recorded perch specimens had a total length of 15–35 cm (average 25 cm; n = 511). Obviously, there was selection by the inhabitants, who were not interested in fish smaller than about 15 cm in length. Selective fishing is also apparent from the pike vertebrae: they are all derived from large specimens with an average of 57 cm total length (range 28–94 cm; n = 22). All in all, the fish species indicate a freshwater environment with a slight brackish component.

With white-tailed eagle *(Haliaeetus albicilla)* and osprey *(Pandion haliaetus)*, two water affiliated birds of prey species should be mentioned. The mammalian fauna is dominated unselectively by the characteristical game spectrum of roe deer *(Capreolus capreolus)*, wild boar *(Sus scrofa)*, and red deer *(Cervus elaphus)*. Although the seashore must have been nearby, sealing was obviously of minor interest for the community.

3.2.6. Lietzow Buddelin

The site Lietzow Buddelin – located on the banks of the "Kleiner Jasmunder Bodden" *(fig. 29,1)* – is famous in Stone Age research since excavations conducted at the site in the 1930s and 1960s, leading to the establishment of the name Lietzow Culture for the local group of the Ertebølle Culture on Rügen Island (Gramsch 1978). Within the SINCOS research unit, a drilling programme and excavations were again carried out in Lietzow Buddelin aiming to recover new samples for scientific investigation and AMS-^{14}C-dating, as well as to gather further information about the palaeo-topography and the sea level development in the Rügen bodden waters.

Preliminary reports about the excavations at Lietzow Buddelin have been published and can be referred to (summarising Terberger / Seiler 2004; Jöns et al. 2007, 95 ff.). In addition, the recovered material and the stratigraphy was investigated recently as part of a magister thesis (see also Kotula 2014), so that here only a short summary of the most key characteristics of the site shall be given.

The main cultural layer of the site at Lietzow was dated by AMS-^{14}C to the phase between 4450–4100 cal. BC. It belongs to a short period within the younger Ertebølle Culture. The site originally was established close to a lake by a small river, and was separated by a spit from the Kleiner Jasmunder Bodden. Caused by the successive rise of the sea level from 1.60 to 0.50 m below the recent sea level, the lake became connected to the Bodden (Lampe 2004). This changing of the human habitat is also mirrored in the composition of the animal remains, which was analysed in the framework of a diploma thesis (Hegge 2010). The fish bones indicate brackwater surroundings *(tab. 22)*. Perch *(Perca fluviatilis)* is by far the dominant species followed by flatfishes, whereas all other fishes were obviously of minor interest. The mammal bones show a relatively large variety of forest (red deer, aurochs, wild boar, pine marten, wild cat, squirrel), marine (seals, porpoise) and domesticated (cattle, pig, sheep / goat; the latter in the younger layers) species.

Apart from the animal remains, the recovered finds are composed of a considerable amount of flint artefacts, as well as a few organic tools and pottery sherds; but typical pointed bottom pottery could not be identified. Sub-regional contacts of the Lietzow people are indicated by an amphibolite adze (Terberger / Seiler 2004, 174). This tool must have been imported from agrarian communities living in the loess regions of the inland. Finds dating to the Neolithic period of the 4th millennium cal. BC are present, so the site was clearly occupied in 4500–3300 cal. BC.

3.2.7. Ralswiek-Augustenhof

The site Ralswiek-Augustenhof is located in the central part of Rügen Island at the end of a peninsula stretching into the Großer Jasmunder Bodden *(fig. 29,2)*. It is well known in archaeological circles since the 1920s, above all because it has produced not only a large quantity of finds of stone as well as of organic material (Terberger 2007, 246 ff.), but also a small number of extraordinary decorated artefacts of the Late Ertebølle-Culture (summarising Terberger 2006, 140 ff.). In particular a few bone daggers with cross-hatched decoration and a bone plate with a geometric decoration have to be mentioned here, indicating cultural contacts from Rügen Island to the Brzesc Kujawski group, living along the River Vistula (Gramsch 1971; Klassen 2004, 66-68; summarising Terberger 2007, 249). Together with other objects of foreign provenience from Rügen Island and the neighbouring mainland, this artefact confirms the hypothesis of L. Klassen (2004, 100 ff.) of increasing cultural exchange across the Baltic Sea during the end of the 5th millennium cal. BC, finally leading to the acceptance and introduction of the productive economy during the Early Neolithic period.

In addition, the skull of a female individual was found in Ralswiek-Augustenhof; it has been interpreted as evidence of graves on the site. The skull was directly AMS-^{14}C-dated to the period around 4300 cal. BC (Lübke et al. 2000). Because of the δ^{13}C-value of –17.1 ‰, a reservoir-effect has to be considered, so that a date of c. 4150 cal. BC has also been discussed (Terberger 2007, 245). If this is correct, the skull/grave has to be considered as contemporaneous with the settlement remains.

Within the SINCOS research project a few test trenches were dug in 2004 aiming to gather further information about the structure and chronological setting of the site, as well as to recover samples for further scientific investigations. During this fieldwork an undisturbed stratigraphy could be documented, revealing a sequence of layers deposited during the Ertebølle and the Neolithic period. The main layers could be dated with the AMS-^{14}C-method to the period between 4450 and *c.* 4000 cal. BC for the Ertebølle layer, and to around 3570 cal. BC for the Neolithic layer (Terberger 2007, 246).

During the excavations in 2004 a large amount of artefacts could also be recovered. Their composition generally coincides with the material from the previous excavations. A typical Late Ertebølle roe deer harpoon carrying a simple stripe decoration was also found (Terberger 2007, 247 ff. fig. 7,2). It was embedded in the lower layer, so that its stratigraphic position confirms the presumed dating.

The animal remains from the excavation of the 1920s to the 1960s reflect the typical economy of a Late Mesolithic community subsisting from hunting the available game such as wild boar, aurochs, red and roe deer – all well represented in the animal remains from Ralswiek-Augustenhof (Teichert 1989). A few seal bones indicate the additional usage of the sea for hunting. The topographical situation of the site alone leads to the assumption that fishing was an important source of nutrition. However this cannot be confirmed because small bones – as fish bones are – were not systematically salvaged during the excavations in Ralswiek-Augustenhof in the 20th century, and were badly preserved in the layers investigated in the excavation of 2004.

Within the framework of SINCOS, new investigations were also conducted intended to obtain data about the environmental situation and topographical setting of the site during the Littorina Transgression.

As a result of a drilling programme the remains of a silted up basin were located northwest of the site. The Stone Age settlement was originally situated on a sandy hill by a lake that was separated by a beach ridge from the Großer Jasmunder Bodden (Terberger 2007, 243). The lake had no connection to the Baltic Sea. Consequently its water level may have

been different from that of the Baltic Sea, so that the relatively high position of the find layers above the recent sea level can not be considered as being relevant for the reconstruction of the Baltic Sea level.

3.2.8. Baabe

Already in the 1960s numerous flint artefacts were discovered on the shore of Lake Selliner near Baabe in the southeast of Rügen Island *(fig. 29,7)*. But first excavations at that site were not carried out until 2005 when the construction of a dyke that probably would affect and presumably destroy the organic layers of the site was planned. This threat led the responsible heritage agency to organise an excavation of the most jeopardised areas of the site (Klooss/Klooss 2009). The excavations not only resulted in the recovery of a large amount of multifaceted finds of anorganic as well as of organic material from the centuries around the turn of the 5th to the 4th millennium cal. BC, but also enabled the detailed documentation of an undisturbed sequence of stratified sediments some 3 m thick from the period between 4100 and 3800 cal. BC *(fig. 36)*. Thus Baabe has to be considered as one of the most important Stone Age sites of the southwestern Baltic area, one that allows us to get a deep insight into the development of landscape and settlement history of this phase of the Littorina Transgression. Until now, detailed analyses of the excavation and all the recovered finds and samples could not be realised, but a substantial report has recently been published (Hirsch et al. 2007).

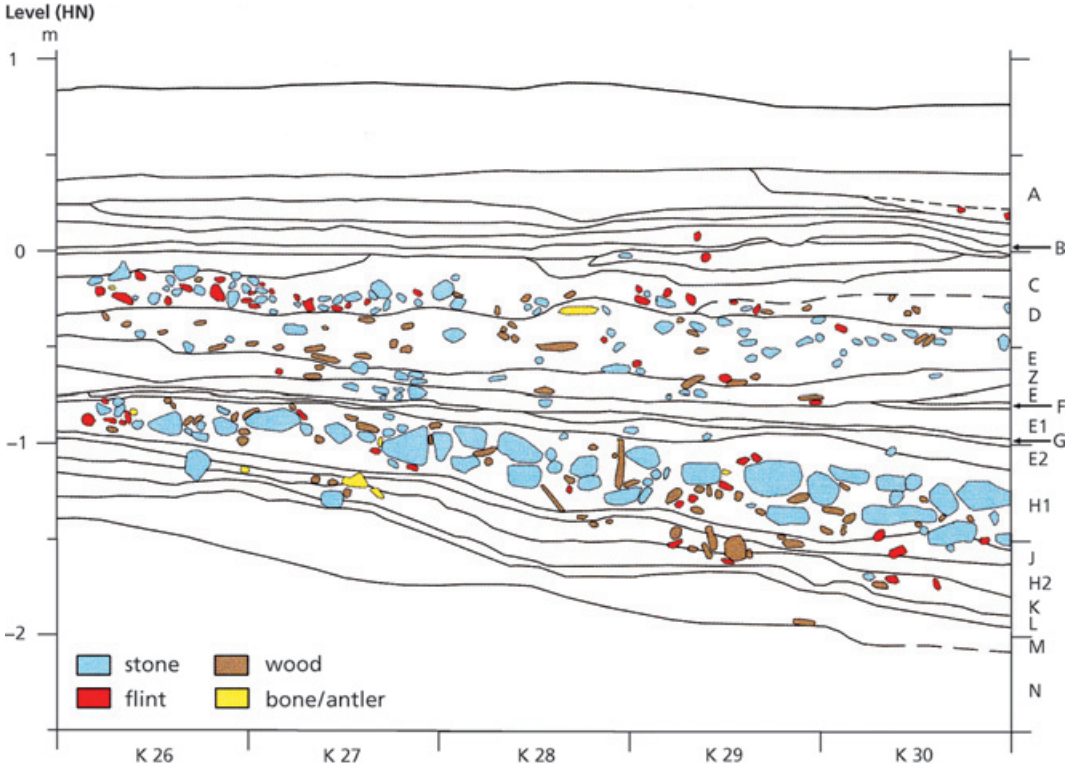


Fig. 36. Mainprofile from the Baabe excavation 2005. – Scale 1 : 40 (Hirsch et al. 2007 fig. 5; digital drawing M. Wagner/H. Jöns).

Analyses of the main profile indicate that the development of the area can be reconstructed in at least six phases. The lowest deposits in the documented stratigraphy were detectable for the period around 4300 cal. BC. At that time the lake was a bay, as from 6500 cal. BC the Littorina Transgression had caused the flooding of the low parts of the boreal landscape. Around 4300 cal. BC the sea level is estimated to have been around 1.5 m below the present state, so that the Lake Selliner basin was a part of the Baltic Sea (Lampe et al. 2007). A few artefacts indicate that people produced silex tools directly on the coast. Phase 2 – dating to the period 4300 to 4200 cal. BC – was characterised by a considerable increase of the sea level that reached around 1 m below the present situation. A small number of silex artefacts and worked fragments of wood and antler can be regarded as evidence of temporary human activities at that time. During phase 3 the site experienced intensive occupation that resulted in the accumulation of a cultural layer 50 cm thick, interspersed with numerous settlement remains such as bones, worked wood, antler etc., and a few antler and silex tools as well. The direct AMS-^{14}C dating of a fragment of a leister prong places this layer to the period between 4200 and 4100 cal. BC. The sea level is estimated to have been slightly above 1 m below the present state at the time. In the profile the beginning of phase 4 is characterised by alternating layers of sand and plant remains, with a few, presumably displaced artefacts, so that it is assumed that there was a period with more or less no human impact and a slight drop in the sea level. This period ended around 4000 cal. BC when a large amount of settlement refuse, but also various tools and parts of fishing equipment were embedded into the layer. The find of three paddles, pieces of leister prongs and of a fish trap underline the economic significance of fishing in this and the next phase. As the fish bone assemblage shows, the most important prey for the fishers were flatfish (49 percent of the identified bones) – a unique result for the sites of the SINCOS project – followed by cod. Again, all other species were of minor interest. This result does not differ significantly between the sediment layers (Hegge 2010), although the sediments show an environmental change: The rise in the sea level slowed down and allowed the building of beach ridges that successively closed the entrance of the bay and transformed it to a lagoon, leading to a change from a brackish to a limnic system, and finally to the shaping of the present Lake Selliner. This development was almost finished during phase 5, as can be seen in the growth of *Phragmites* peat. In this layer numerous silex artefacts, including core axes as well as polished axes, but also worked fragments and tools of antler, bones and wood were found. They indicate that in the period of transformation from the Ertebølle to the Early Funnel Beaker Culture between 4000 and 3800 cal. BC the site was intensively settled. The sea level in this phase is calculated at 0.5 m below the present situation. The series of strata is closed by alternating layers of peat and sand forming the foundation of a beach reach, so it can be assumed that the site was inundated at least seasonably and the settlement was presumably moved.

During the excavations a large quantity of well stratified finds was recovered, representing the whole material culture of the Late Ertebølle / Early Funnel Beaker Cultures. An assortment of the whole spectrum has recently been presented by the excavators (Hirsch et al. 2007, 22 ff.), so in this article only a short comment on the most important and characteristic finds is necessary. Apart from more than 10,000 silex artefacts and 1,200 ceramic fragments, unworked and worked bone and antler fragments, as well as artefacts made of these materials, form the biggest part of the find material. For the cultural designation of the site the composition of the ceramic material is of special interest. It is remarkable that no fragments of vessels with pointed bottoms were represented and that the sherds of lamps were all found in the upper layers in association with funnel beaker fragments. Clearly in Baabe, as well as on other sites of the Late Ertebølle Culture on Rügen Island, ceramics were not common (Hirsch et al. 2007, 30 ff.). Not only is the large quantity of partly well preserved wooden

artefacts such as the paddles and fish-trap fragments already mentioned exceptional, but also the find of more than 100 partly worked amber fragments, nine of which were drilled and could be used as pendants. The amber finds all were recovered in the layers of phase 4 and 5, so that the amber working took place at the beginning of the 4th millennium cal. BC. Together with two semi-finished stone beads, they confirm handicraft activities over and above the production of tools and equipment. Last but not least, two fragments of unperforated stone adzes have to be mentioned; these are common in the Rössen and the Linear Band Ceramic Cultures during the first half of the 5th millennium cal. BC, so that in Baabe they have to be considered as foreign, imported goods. Moreover, the adzes are also evidence of human activities at the site already during the older Phase of the Ertebølle Culture (Hirsch et al. 2007, 27 ff.).

Apart from about 2000 fish remains, the animal bone assemblage consists of 596 mammal and 16 bird bones *(tab. 23)*. Significantly, the first bones of cattle, pig and sheep/good are recorded in the upper layers in association with Funnel Beaker pottery fragments. However, the economic importance of husbandry was still small, because the proportion of remains from domesticated species comprises only 6 percent of the identified mammal bones in the layers mentioned (Hegge 2010, 120). As in the lower layers, the supply was based mainly on red deer hunting (44 percent of the identified bones) and sealing (23 percent; Hegge 2010, 25).

3.2.9. Parow

Construction works for the building of a harbour led in the 1980s to the discovery 2 km north of Stralsund of the Stone Age site "Parow-Sportboothafen". The site was located in a bight of the Strelasund which separates the Island of Rügen from the mainland *(fig. 29,4)*. The composition of the find material recovered– successively collected during the 1980 and 1990s from the remnants of dredging – is characterised by a large number of Terminal Mesolithic and Early Neolithic flint artefacts, e. g. core and flake axes, transverse arrowheads, trapeze microliths, blades including microblades, as well as fragments of polished axes, but also tools made of bone and antler and a few typical Late Ertebølle and Funnel Beaker ceramic fragments (Mertens 1995; Lübke et al. 2000; Terberger / Seiler 2004). But the material also comprised a few fragments of decorated vessels and a stone adze that have to be considered as imports from Neolithic societies from the Loess regions of northern Central Europe. Of special interest is a decorated sherd of the younger Linear Band Pottery that – according to its ornamentation – has been suggested as being produced in the Rhineland around 5000 cal. BC (Mertens / Schirren 2000). Given that this object in fact was found in Parow – which was recently doubted because of the unclear find circumstances (Terberger et al. 2009, 23) – it would indicate not only an occupation Parow already some time during the early phase of the Ertebølle Culture, but also long distance contacts of the Parow people at the time (Klassen 2004, 72; Terberger 2006, 139). However, even if a complete scientific analysis of all dredge finds from this important site is still lacking, the finds published up to now include trapeze microliths and microblades (Mertens 1995; Mertens / Schirren 2000), which are further evidence for older occupation phases on the site.

Already before the SINCOS project a selection of Early Neolithic Funnelbeaker sherds from the material recovered was AMS-^{14}C-dated to the period around 3900 cal. BC. So it has to be assumed, that the Funnel Beaker Culture must have taken the place of the Ertebølle Culture between 4100 and 4000 cal. BC in the area between the Oder estuary and the Darss Sill (Hartz et al. 2000; Lübke et al. 2000). The date from Parow thus confirms that Neo-

lithic pottery was introduced contemporaneously in the area east of the Darss Sill and the coastal area along the Bay of Mecklenburg, in spite of the different tradition of ceramic use during the previous centuries by the groups of the Ertebølle Culture in both regions.

Furthermore, the SINCOS research project initiated in 2003 a drilling programme and a small scale excavation (Terberger / Seiler 2004, 157 ff.; Terberger 2006, 126 ff.; Jöns et al. 2007, 97 ff.). These investigations produced evidence that the site was originally situated on the mouth of a small brook flowing into a quite shallow brackish coastal lake. The stratigraphy documented showed different cultural layers accumulated during the middle phase of the Ertebølle Culture around 4500 cal. BC, and probably at the turn of the 5th to the 4th millennium cal. BC. In this phase the Parow community was part of the Early Funnel Beaker Culture (Terberger / Seiler 2004, 168 ff.). Evidence of the earlier phase of the Ertebølle Culture could not be documented during the investigations, so that the context of the imported objects mentioned above remain unclear (Terberger et al. 2009, 16 ff.). However, because of the small size and the lower find density in the test trenches compared with the large amount of dredge finds, it is highly probable that the main concentration of the site was situated in a deeper position and/or already destroyed by earlier dredging work.

New data about the sea level development could also be attained during the field work. In the main trench remains of the former shore could be excavated, attesting a sea level of 1.5 to 1.8 m below the present situation during the time of occupation around 4000 cal. BC (Terberger / Seiler 2004, 163).

The topographical setting of the site at Parow on the mouth of a former brook flowing into the Strelasund near to the modern town of Strelasund was favourable for the exploitation of the resources of the sea, the brook, the brackish coastal lake, and of the adjacent hinterland (Terberger / Seiler 2004). However, as evidenced by the vertebrate remains, the people from Parow were not primarily orientated to the open Baltic Sea, since the marine component of the fish bone assemblage is relatively low with only about 17 % *(tab. 24)*. The list of marine affiliated species is dominated by flatfish (Pleuronectidae) with cod *(Gadus morhua)* taking second place, accompanied by garfish *(Belone belone)* and herring *(Clupea harengus)*. All these species could have been fished in the coastal lake. The same is true for the recorded freshwater fish, which amount to almost 82 %. Perch *(Perca fluviatilis)* is clearly the main freshwater species with a proportion of 69 % of all fish remains, cyprinids take second place with nearly 7 %, followed by pikeperch *(Sander lucioperca)* and pike *(Esox lucius)*. With three remains of eel *(Anguilla anguilla)* and one of a salmonid (*Salmo* sp.), the role of migrating species was negligible.

The quality of the mammal bones is in accordance with the low marine exploitation of the sea shown by the fish remains: The small mammalian portion in the material consists of terrestrial species, especially game, that is roe deer *(Capreolus capreolus)*, red deer *(Cervus elaphus)*, and wild boar *(Sus scrofa)*, whereas marine mammals are totally lacking. Birds are represented only by some remains of three duck species *(Anatinae)* which were perennial in this region.

3.2.10. Prohn

From 1971 to 1976 large scale drainage works were carried out some 6 km north of Stralsund in order to lay dry the lowland of a small creek that originally flowed into the Prohner Wiek, a bight in the Baltic Sea *(fig. 29,3)*. About 1.5 km from the modern shoreline the excavators brought extensive find material to the surface dating from the Mesolithic to the Middle Ages (summarising Lübke et al. 2000).

The site attracted special attention above all because it contains one of the most extensive and varied – unexcavated – complexes of material of the "Lietzow group". In order to obtain more information about the stratigraphical setting of the late Mesolithic / Early Neolithic find layer, a survey was carried out in 1979. During this investigation Stone Age finds were recorded deriving from a layer consisting of sandy peat covered with thick marine layers, so that the site is assumed to have originally been positioned directly at the mouth of the creek where it flows into the Baltic Sea. The cultural layer was situated 5.5 to 6 m below the current surface, which means about 3 to 4 m below the recent sea level.

The lithic material consists of core axes with a mostly rhombic or rhomboid cross section, and edge-trimmed or flat-flaked flake axes. Furthermore, a large quantity of blades was found showing traces of production using soft as well hard-hammer blade technique. In addition, tools made from the blades are also represented, such as scrapers, truncated blades and different borers. The conditions under which the finds were collected have to be taken into consideration in order to understand the main reasons for the limited number of small artefacts. Thus the fact that transverse arrowheads, which normally are always present in the find material of sites of the Lietzow Culture, are completely missing should not be overestimated from the viewpoint of cultural history.

The find spectrum of Prohn leads to the assumption that the site existed during the middle phase of the Ertebølle Culture (Lübke / Terberger 2004, 249). This is confirmed by the AMS-^{14}C-dating of a bladebone of an aurochs to 4600 cal. BC. In addition, a fragment of a perforated Danubian shaft-hole axe was recovered in Prohn. Probably it must be considered as a prestige object of high status within the Ertebølle Culture (Klassen 2000, 47 ff.). Most of these objects entered the southwestern Baltic in the period between 4300 and 4000 cal. BC, but is also possible that the Prohn axe already came to the Strelasund region in the middle of the 5th millennium.

The organic material recovered consists, among other things, of numerous fragments and pieces of worked antler and bones, indicating that antler and bone tools were produced on site. This is confirmed by the find of two T-shaped axes made of red deer antler, and several points and awls produced from bone.

Discussing the composition of the animal remains, the find conditions again have to be remembered because small bones are clearly underrepresented. So the fact that only a few fish and birds could be identified should not be used as an argument against the assumption that these species might also have played an important role in the nutrition of the Late Mesolithic community at Prohn. Almost all animal remains collected from Prohn result from hunting for land mammals. As on other sites of the period, red deer *(Cervus eleaphus)*, wild boar *(Sus scrofa)*, roe deer *(Capreolus capreolus)* and aurochs *(Bos primigenius)* are represented. In addition a few bones of a badger *(Meles meles)* could be identified (Lehmkuhl 1992). Several bones of seals (Phocidae) and one of a mute swan *(Cygnus olor)* provide evidence of hunting in the coastal waters.

Among the animal remains bones of domestic species could also be identified that probably were embedded in the Neolithic layer, as is evidenced by the AMS-^{14}C-dating of two seal bones to the period from 3550 to 3350 cal. BC (Lübke / Terberger 2004, 249). Also a human calvarium from the Prohn ensemble was dated by AMS-^{14}C to around 3450 cal. BC, so there is also a clearly detectable Neolithic phase in the Prohn material (Lübke et al. 2000 fig. 2). Thus the bones of cattle, horse, pig, sheep and goat in the osteological material from Prohn probably belong to that or an even younger phase, and cannot be considered as evidence for animal husbandry within the Lietzow group.

3.2.11. Summary: coastal area east of Darss Sill

Within the SINCOS research unit and the SINCOS project bundle, new information could also be gathered for the area between the Darss Sill and the Oder estuary from various archaeological sites dating from the period 5500 to 3500 cal. BC. In the first instance these data comprise information about the topographical setting of coastal sites, especially in relation to nearby waters, the relative period of occupation and the economic basis of the communities. Furthermore, information about the structure of settlements and society could also be gathered. The new data are partly based on fieldwork that was done at sites that were already well known, such as Lietzow-Buddelin, Ralswiek-Augustenhof or Parow, or on submerged sites that were first discovered within the framework of the geo-archaeological surveys of SINCOS. Especially the sites Breetzer Ort and Kamminer Ort in the Bodden waters of Rügen Island must to be mentioned in this context. Of great importance are also data from excavations that were carried out in the courser of construction works in Stralsund and Baabe on Rügen Island. They produced a great deal of data and samples which could increase our knowledge about the settlement and environmental history of the research area. But SINCOS also enabled the revaluation of material from already well known "classical" archaeological sites such as Drigge and Prohn, especially by AMS-^{14}C-dating, leading not only to a better understanding of their chronological setting, but also of the diet of the people from these sites.

In summary it can be stated that for the maritime zone east of the Darss Sill SINCOS also formed a new foundation for further discussions and investigations about the development of the environment, society and economy during the transition from Late Mesolithic hunter and fisher communities to Early Neolithic agrarian societies.

4. Coastal sites from the last four millennia (Bronze Age until Modern Times) and sea level development in the research area (H. Jöns)

As it already has been pointed out in the SINCOS I final report (Jöns et al. 2007), the character of the economic significance of the maritime zone of the Baltic rim generally change since the Neolithic period from an area of exploitation by fishing and hunting to a zone of transport and communication. At the latest from that time on rivers, lakes and the sea formed the backbone of the prehistoric and medieval infrastructure. Especially since the beginning of the 1st millennium AD a growing social, economic and military importance of water transport and control of seafaring can be studied at various archaeological sites (Nørgård Jørgensen 2003). Even if the gathering of maritime food was never completely abandoned during the Bronze and Iron Ages, nor during the Middle Ages, this part of the economy played a secondary role in the nutrition of the respective societies and communities. Therefore most of the settlements of these periods were established off the coast in the agriculturally favourable areas. Against the background of this, it is not surprising that archaeological evidence from coastal sites preserved in-situ for the last 4000 years is rare and its state of preservation differs regionally.

During the last 4,000 years the global sea level was characterised by a more or less continuous, but minor rise that periodically was interrupted by phases of decreasing sea level (Kliewe / Schwarzer 2002). Although this generally is also valid for the Baltic Sea, the different coastal landscapes around the Baltic rim experienced considerable changes, mostly caused by further regionally varying substantial isostatic rebound (in summary, Jöns 2011). Especially the Northern Baltic rim was – and still is – highly affected because of the con-

tinuous isostatic land uplift leading to the emergeance of new land and to environmental changes of originally coastal sites from maritime to inland conditions. Consequently the prehistoric and historic coastal landscapes and settlements in northern and central Scandinavia today are located far from the shore, so that science based shore-displacement models can be used to determine their chronology and are an important tool for the reconstruction of the original environment (e. g. Grimm 2006; Berglund 2004; Ling 2004; Risberg et al. 2002).

4.1. Sea level and settlement development at the southern Baltic rim

In comparison to that, the shoreline changes of the last 4,000 years along the southern Baltic shore can be regarded as overall moderate, although regional differences are clearly detectable. The different local conditions are also responsible for the present state of preservation of sites originally located at the coast.

The shore of the eastern part of the southern Baltic on the territories of Lithuania, Latvia and Estonia is characterised by a slight uplift, so that the remains of the abandoned shore-based settlements are today normally preserved on dry land.

A different situation prevailed for the area of research of the SINCOS project bundle in the western part of the southern Baltic area between the estuary of the Oder and the Bay of Mecklenburg. Here there was a slow but continuous relative sinking of the coast, differing in intensity for the areas east and west of the Darss Sill which functioned as a threshold, separating Mecklenburg Bay and the Arkona Basin (Harff / Meyer 2007; Rosentau et al. 2007).

The recent rate of the sea level change differs considerably in both regions: the area between the Darss Sill and the Oder estuary currently experiences a relative sea level rise of

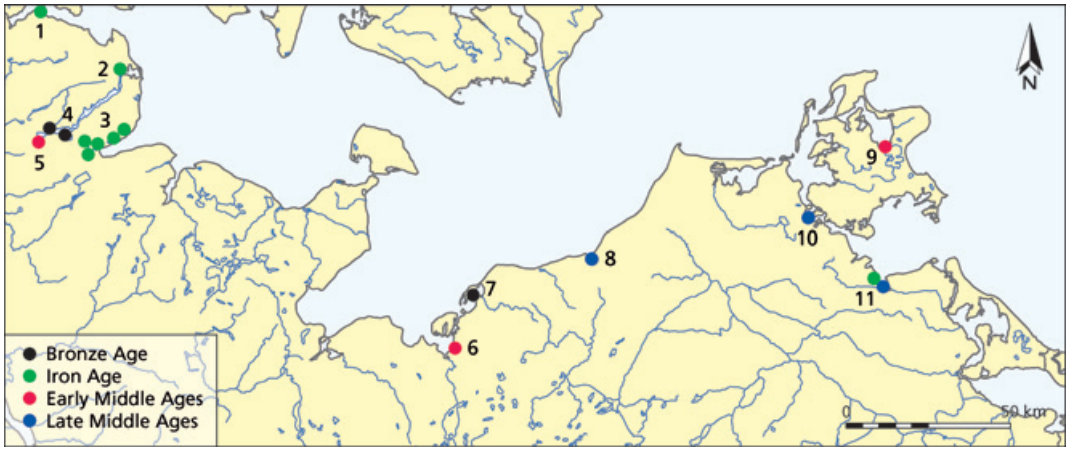


Fig. 37. Map of archaeological sites producing data about the sea level for the last 4000 years. 1 Glücksburg (shell midden); 2 Rabel (shell midden); 3 Bay of Eckernförde / Windebyer Noor (shell middens); 4 Schlei Fjord (tree stumps); 5 Haithabu (settlement / trading centre); 6 Groß Strömkendorf (settlement / trading centre); 7 Rerik-West (fireplaces / hearths); 8 Rostock (Hanseatic League town / waterfront area); 9 Ralswiek (settlement / trading centre); 10 Stralsund (Hanseatic League town / waterfront area); 11 Greifswald (iron age fishing site, Hanseatic League town / waterfront area) (digital drawing H. Jöns).

between 0.6 and 0.8 cm/century, whereas the Bay of Mecklenburg has to face a sea level rising rate of 1.2 to 1.6 cm / century (Dietrich / Liebsch 2000). As the work of the SINCOS progamme could prove, these tendencies were already valid during the Littorina Transgression (Lampe et al. 2007 fig. 4), so that the Stone Age hunter and fisher communities living east and west of the Darss Sill had to react in different ways to the changing sea level.

For the last 4,000 years the sea level curves of the areas east and west of the Darss Sill both show slow rising or stagnant, partly oscillating sea level for the period from 2000 cal. BC to AD 800. During the following centuries the Late Subatlantic Transgression leads to a moderate sea level rise that was interrupted during the Little Ice Age Period from 15th until the 19th Century (Lampe et al. 2007, 125 ff.). Although these overall conclusions are valid for the whole area of investigation, the archaeological record from various sites from the area east and west of the Darss Sill indicates that regionally differentiated consideration is essential *(fig. 37)*.

4.1.1. The research area east of the Darss Sill – Rügen Island and the Greifswalder Bodden

For the area east of the Darss Sill only a few sites from the last 4,000 years can be considered where the investigations of archaeological sites could produce data about the local sea level during the particular period of settlement. Against the background of this situation the finds and features discovered in 2003 in the course of construction works in the harbour basin of Greifswald in West Pomerania are of special importance (Kaute et al. 2005; Kaute / Schindler 2009). The site is positioned in a former bay of the Ryk river that flows after some 5 km into the Greifswalder Bodden and with that to the Baltic Sea. On the site partly well preserved remains dating back to the Stone Age, the Bronze Age and the Roman Iron Age could be documented.

For the discussion of the sea level development of the last four millennia the Bronze and Iron Age phases of the site are especially relevant. Within a layer that was laced with marine molluscs a few sherds of an early Bronze Age vessel were found. The investigation of the sediment of this layer indicates that the vessel was deposited in the muddy shore area of the bay (Silber et al. 2005). The measured salinity proves that the bay at that time was filled with marine water, so that a direct connection to the Baltic Sea must have existed. The position of the vessel about 1.10 m below the modern sea level may be regarded as a hint as to the sea level for the time 1900 cal. BC.

The next documented phase of utilisation of Ryck Bay can be dated to the Roman Iron Age. The most important features of the period discovered here were the remains of several well preserved fishing fences *(fig. 38)*. AMS-^{14}C-dating of several wooden samples proved that the oldest fence was constructed during the 1st/2nd century AD and that it was replaced during the 3rd/4th century by another fence (Kaute et al. 2005, 27 ff.). The investigations of the sediments into which these features were set show that environmental conditions had changed since the Bronze Age and that in the beginning of the 1st millennium AD fresh water was also flowing into the bay, although it was still directly connected to the Greifswalder Bodden. This is confirmed by the mixture of bones from fresh water fish species, probably caught in the fishing fences (Silber et al. 2005). Furthermore, some well preserved parts of the fishing fences indicate that the construction was established in the shallow waters of the bay and that the water level must have been around 1 m lower than today. To sum up, we can state that the results from the site fit well into the sea level curve published by Lampe et al. (2007, 125 ff. fig. 4).

Fig. 38. Greifswald-Museumshafen, fishing fences of the Roman Iron Age (Schindler / Kaute 2009 fig. 3).

For the period of the Late Subatlantic Transgression from the 8th century onwards – for which a moderate sea level rise is postulated by Lampe et al. (2007) – the early Medieval trading centre of Ralswiek on the Island of Rügen is of special significance. The site was investigated and partly excavated from 1972 to 1989 within the framework of a research-project (in summary, Herrmann 2008). The site is located on a barrier beach on the banks of the Großer Jasmunder Bodden and consisted of a trading and market settlement, a sanctuary, a berth area for boats and a nearby cemetery. According to the project-director, J. Herrmann (2008, 126), the people from Ralswiek probably had direct access via several natural channels and the Bodden waters to the waterways along the Baltic Sea coast to the east as well as to the north and south, although the site was established in the centre of the island. The settlement existed from the 8th until the 12th century and was reorganised at least four times.

During that time the inhabitants of Ralswiek had to react to the changing water levels by filling in land to increase the settlement area and to assure better protection against flooding. Based on these observations Herrmann (1998, 117 ff. fig. 108) concluded, that the sea level in Ralswiek rose continually from the 8th until the 12th century, and reached levels from 0.2 (8th century AD) to 0.8 m (12th century AD) above the present sea level.

This interpretation, as well as the reconstruction of the settlement structure and the water level development has recently been criticised by Ruchhöft (2004, 77 ff.). Based on the published plans and profiles he argues that there are some contradictions between the stated water levels, and that the minor differences between the assumed level of the water table and the ground level of the settled areas would have caused periodically inundation.

Furthermore, the author doubts the existence of the berths for boats and argues instead for unfortified boat landing places on the bank of the Bodden. According to the sea level Ruchhöft (2004, 89) concludes that the sea level around AD 800 was markedly lower than the recent sea level, and that it did not reach the recent sea level before the final stage of the settlement in the 12th century. If this argumentation is right, the development of the sea level at Ralswiek would confirm the sea level curve published by Lampe et al. (2007, 125 ff. fig. 4).

4.1.2. The research area west of the Darss Sill – Wismar Bay and Schlei Fjord

Also for the area west of the Darss Sill, there are a number of archaeological sites dating back to the periods between the Bronze Age and the Middle Ages that delivered data about the sea level of the past. According to Lampe et al. (2007, 125 ff. fig. 4A) the isostatic rebound in combination with the sea level rise in this area led for the last 4,000 years to a continuous rise of the relative sea level. The most significant rise is postulated for the period from 300 cal. BC until AD 1200. In this phase a rise of the relative sea level from 1.80 to 0.40 m below recent sea level has been calculated.

A revision of the discussed sea level curve with data from archaeological sites is only possible in exceptional cases, because there are only a few archaeological sites known that produced verifiable information about the sea level of the last 4,000 years. For the Bronze Age, the Pre-Roman and the Roman Iron Age only a couple of inundated and partly eroded sites can be mentioned here, indicating that the sea level must have been considerably lower in the time of their usage than today. As an example for the period before the turn of the eras, several fireplaces and hearths from the Late Bronze Age (900–600 cal. BC) can be mentioned that were recorded at Rerik, southwest of the Wustrow peninsula by the shore of the Salzhaff in Mecklenburg (Jöns et al. 2007, 106). Their position indicates that the sea level must have been at least 1 m lower in the days of their construction than today (Jöns 2011).

Of special interest for the sea level at the beginning of the 1st millennium AD are a few shell middens distributed along the Baltic shore of eastern Jutland and along the Flensburg Fjord that originally were positioned on the beach at the shoreline. Today most of them are affected by erosion (Harck1973, Løkkegaard Poulsen1978). They prove not only the seasonal exploitation of marine resources 2,000 years ago, but also indicate that the sea level northwest of the SINCOS research area was probably only slightly lower than today (Labes 2002/03).

Archaeology-based information about the sea level development during the Late Subatlantic Transgression at the beginning of the early Middle Ages is also available for the Bay of Mecklenburg. On the shore of Wismar Bay near Groß Strömkendorf the remains of a trading centre of the 8th and 9th century were discovered and partly excavated, that is presumably identical with the *emporium reric* mentioned in the Frankish annals (Jöns 1999). The site was founded immediately south-east of Poel Island, in a long stretched-out shallow bay that had been washed out by meltwater in the deglaciation phase *(fig. 39)*. The site's waterfront is of special interest in the discussion of shore displacement in the area of Wismar Bay. Geological and geophysical investigations have proved that in the 8th century the bay was still separated from Wismar Bay by the remains of a ground moraine that formed a natural barrier (Dörfler et al. 1997). The moraine was then cut through by just a small inlet, thus connecting Wismar Bay with the bay to create outstanding conditions for its use as a natural harbour. Due to the rising sea level of the Late Subatlantic Transgression the ground moraine was gradually completely eroded over the last 1,200 years and the shoreline

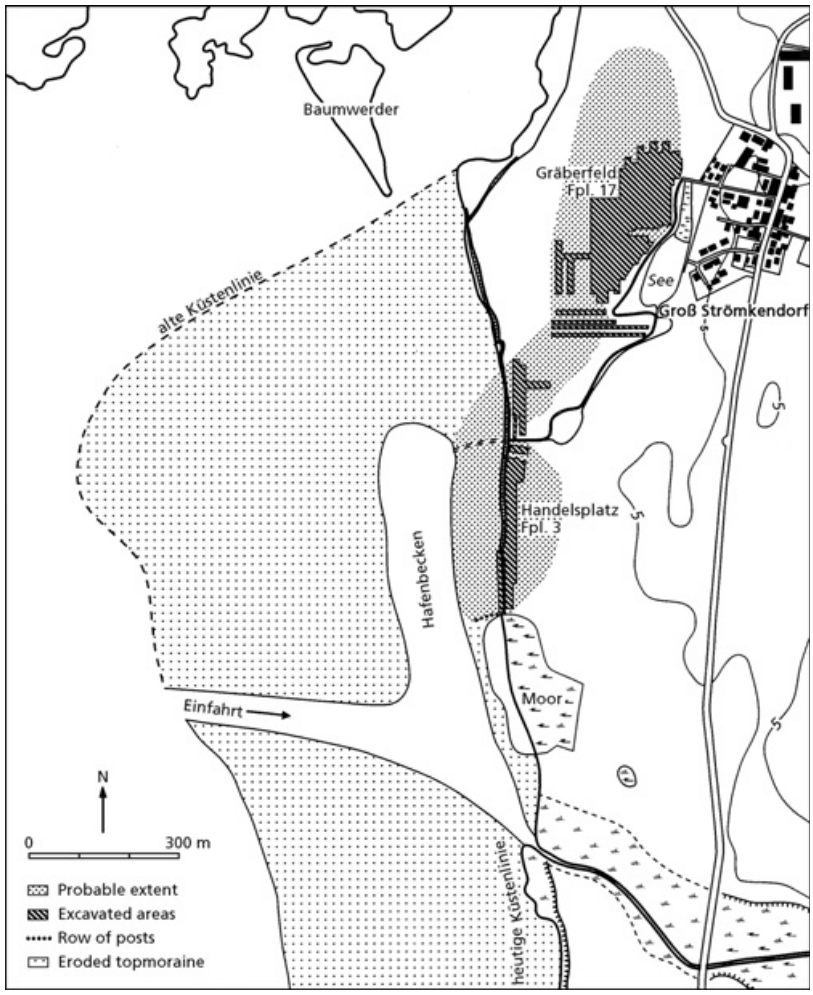


Fig. 39. Plan of the topography of Groß Strömkendorf. – Scale 1 : 15 000 (after Dörfler et al. 1997 fig. 1; digital drawing H. Dieterich, Kiel).

of the harbour bay displaced by about 80 m towards the coast so that the former waterfront area and harbour basin are now completely submerged. Observations made on the site indicate that the sea level in the 8th century AD was 80 to 100 cm lower than the present sea level. It seems possible that the gradual erosion of the ground moraine as a result of the rising sea level finally led to the loss of the harbour's natural protection, which could also be a reason for abandoning the trading centre already at the beginning of the 9th century AD.

The results from the Bay of Mecklenburg are generally confirmed by investigations in the neighbouring Schlei region in Schleswig-Holstein. The Schlei is a narrow, navigable fjord flowing into the Baltic Sea. Since the deglaciation this fjord has always been directly connected to the Baltic Sea, so that the development of the level of the Schlei mirrors that of the Baltic Sea at the fjord's outlet. The Schlei region has been in focus of archaeological research for many decades, because at its head the well known trading centre Haithabu was estab-

lished in the 8th century (Dobat 2003). Haithabu existed from the 8th to the 11th century AD and has to be considered as the most important centre for trade and exchange on the southern Baltic rim. The settlement functioned like a link between the North Sea and Baltic trade routes (for a summary see Carnap-Bornheim / Hilberg 2006).

The history of the Schlei fjord has recently been reconstructed by Labes (2002/03; see also Dörfler et al. 2009) with special regard to the sea level changes from the Bronze Age to modern times. Her research is mainly based on a number of radiocarbon-dated tree stumps and data from several archaeological sites that were originally located on the banks of the fjord. The data prove, that the sea level at the beginning of the Bronze Age was approximately 2 m lower than today, and that it rose during the 2nd millennium cal. BC up to 1 m below the present sea level. For the centuries after the turn of the eras, the author assumes that the sea level had reached almost the present level. A regression to a level 1 m below the present sea level has been reconstructed for the 1st millennium AD, followed by repeated transgression phases during the 2nd millennium AD until the present level was reached. These data were, in general, confirmed by the recently completed evaluation of the excavations in the harbour area of Haithabu (Kalmring 2010). In his conclusion, the author has assumed a sea level in the 10th century AD at 80 cm below the present level.

For the following centuries of the late Middle Ages and early Modern Times, data about the sea level along the southwestern Baltic shore are available from some excavations carried out in the course of construction works in the waterfront areas of the Hanseatic League towns of Rostock, Greifswald and Stralsund (Schäfer / Schäfer 1993; Scharmach / Schäfer 2000; Kulessa 1999). On the one hand, they showed clearly that for the foundation of the ports and particularly for the construction of port reinforcements and piers the natural environment was changed to a great extent, and on the other hand that the water level must have been insignificantly lower than at present. A more precise fixing of the sea level from the last 500 years is methodically hardly possible because the changes of the relative sea level remained within the rate of annual fluctuation and are usually no longer detectable in the archaeological record.

Comparing the short discussion of the data about the sea level changes for the last 4,000 years west of the Darss Sill to the sea level curve published by Lampe et al. (2007) for that region, it can be stated that in fact the general tendencies described are confirmed, but that a detailed inclusion of the available archaeological data indicates considerable distinctions between the different parts of the investigated area.

4.2. Summary: Sea level and settlement development since 2000 cal. BC

The changes of the economic system during the Neolithic led to the displacement of the living space from the maritime zone to the areas away from the coast with favourable agricultural conditions. Only specialised settlements, such as boat-landing and market places as well as fishing or hunting camps were established during the last 4,000 years immediately in the maritime zone. With the end of the Littorina Transgression the relative rise of the sea level of the Baltic Sea slowed down remarkably, so that the drive of threats to settlements increased generally. Nevertheless, phases of inundations and displacements of settlements can be proven by the archaeological record in both areas east and west of the Darss Sill. But due to the differing intensity of the rebound to the isostatic uplift of northern Scandinavia, the consequences were less dramatic in the area around Rügen Island than in the coasts along the Bay of Mecklenburg which were sinking relatively.

5. Results (H. Lübke, D. Heinrich, S. Hartz, H. Jöns and U. Schmölcke)

5.1. Development of the palaeo-landscape in the respective research areas

5.1.1. Mecklenburg Bay

5.1.1.1. Eastern Holstein

As far as the reconstruction of the environment of the sites in the Oldenburg Graben lowland is concerned, the results were not obtained by research funded by the SINCOS project. Geological core drilling and the recording of sections in the excavation trenches, which complemented the archaeological fieldwork, were conducted by O. Jakobsen (then based at GEOMAR Kiel) as part of his dissertation at the University of Kiel (Jakobsen 2004). His work has provided insights into the evolution of the Holocene landscape and the ever-changing relation between the transformation of the coastline and the development of the settlement during the Littorina Transgression in the 6th and 5th millennium cal. BC. In addition, archaeological, coastal geological and geographical investigations were re-evaluated and a graph of sea level changes in the western Mecklenburg Bay developed (Jakobsen et al. 2004).

There has been no research with regard to the palaeo-environment of the submarine site Neustadt LA 156. Maps and data concerning the Holocene organogenic sediments in Neustadt Bay and their relevance to the formation of the western Mecklenburg Bay only cover those areas which lie lower than 8 m below MSL. They are the result of a series of diploma theses on the development of the Holocene coast between Fehmarn and Travemünde which were completed at the Institute of Geosciences at the University of Kiel. However, the sediment structure and the faunal remains from the marine to brackish find layers at Neustadt suggest that the site was not situated on the open sea but at a more sheltered location, on a peninsula next to a lagoon.

Precise data on the mean sea levels in the Oldenburg Graben lowland at the time of occupation have come from Wangels LA 505 and Grube-Rosenfelde LA 83 as well as the submarine site Neustadt LA 156 in Neustadt Bay. Thus, it can be assumed that around 4000 cal. BC, the sea level in the western part of the lowland ranged between 3 m and 3.5 m below MSL. This conclusion corresponds with values around 3.5 m below MSL from Neustadt Bay. At Grube-Rosenfelde LA 83, a shoreline dating to the time of occupation around 5000 cal. BC could be established at a depth between 4 m and 4.5 m below MSL.

5.1.1.2. Wismar Bay

The earliest securely stratified and absolutely dated sites are the stations Jäckelberg-Huk (Neuburg / Poel 45, Ostsee II) and Jäckelberg-NNW (Neuburg / Poel 49, Ostsee II) on the northern tip of the Jäckelberg. At Jäckelberg-Huk, the cultural layer could be traced in the fossil humic topsoil as far as the marginal test trenches, where it descends to a depth of 10 m below present sea level. According to palaeobotanical and archaeozoological research, this station, which has been dated to c. 6500–6000 cal. BC, was not situated directly on the coast but on the shore of a freshwater inland lake with a level lower than 10 m below present sea level. Consequently, the sea level in Mecklenburg Bay at that time must have been accordingly lower. This assumption is confirmed by observations made at the contemporaneous site Jäckelberg-NNW (Neuburg / Poel 49, Ostsee II), where tree stubs and the remnants of a sunken fireplace were found at a depth of almost 12 m below water surface during the last

cruise with the research vessel "Professor Albrecht Penck". This is also in accordance to geological data based on calcareous fossil, which show the first appearance of marine waters in the Mecklenburg Bay about 6000 cal. BC (Rössler et al. 2011).

In the ensuing centuries, though, the sea level must have risen dramatically, as, according to palaeobotanical / sedimentological investigations, the main cultural layer at Jäckelberg-Huk was overlain by brackish-marine sediments as early as 5800 cal. BC.

The following transgression contact could be registered at a depth of 7 m below water surface at Jäckelgrund-Orth (Neuburg / Poel 42, Ostsee II), where again a settlement area was covered by marine mud. Radiocarbon dates retrieved from tree stubs found *in situ* within the site area range between 5900 and 5700 cal. BC, providing a *terminus post quem* for the inundation of this area. This result corresponds with evidence from Jäckelberg-Nord (Neuburg / Poel 16, Ostsee II), where, between 6.5 m and 7 m below water surface, a reed peat could be documented which was overlain by marine mud. The finds recovered from the marine sediments date between 5400 and 5100 cal. BC.

Further insights into the chronology of the Littorina Transgression have been provided by the sites off Timmendorf-Strand. For example at the station Timmendorf-Nordmole II, a fireplace was unearthed at the bottom of the trench, *c.* 5.8 m below water surface, which could be dated to 5400 cal. BC. It was covered by up to 0.8 m thick marine sediments which contained archaeological finds dating between 5200 and 4800 cal. BC. Thus, by 4800 cal. BC at the latest, the sea level must have been higher than 5.0 below MSL, which, considering the evidence of the fireplace, implies a rise by almost 1 m within a period of 600 years.

In the following centuries this process must have continued with the same speed, because at Timmendorf-Nordmole III the lower, earlier cultural layer dates to 4800–4600 cal. BC. The finds were recovered from a marine coarse detritus mud which had accumulated at 3.8 m below water surface in front of the prominent edge of a reed peat bank which probably represents an ancient shoreline. Only then the sea level rise seems to have slowed down, since at the adjacent site Nordmole I, the archaeological objects from the marine shore sediment in trench 5, which was deposited slightly higher, at 3.5–3.3 m below MSL, date as early as between 4400 and 4100 cal. BC.

The Early Neolithic finds from the main find layer at Timmendorf-Nordmole III, dating to 4000–3800 cal. BC, were also embedded in marine shore sediments, at 3.1–3.3 m below water surface.

The sequence concludes with the Early Neolithic finds from Timmendorf-Tonnenhaken-Süd, which according to archaeo-typological criteria have to be assigned to the period between 3800 and 3500 cal. BC. They were retrieved from a largely decomposed reed peat at 1.8–1.9 m below MSL, and thus from an environment which had not yet been submerged at the time of their deposition.

All in all, the new data on the sea level rise in Wismar Bay acquired at the sites Jäckelberg-NNW (Neuburg / Poel 49, Ostsee II), Jäckelberg-Huk (Neuburg / Poel 45, Ostsee II) and Jäckelgrund-Orth (Neuburg / Poel 42, Ostsee II) as well as Timmendorf-Nordmole III (Neuburg / Poel 12b, Ostsee II) seem to confirm the results of the SINCOS I report (Lampe et al. 2007; Jöns et al. 2007) and to comply very well with the graph of the coastline changes in Wismar Bay presented in that paper. These data and the sediment cores retrieved from the excavations clearly demonstrate how Wismar Bay evolved from a lake-dotted inland terrain at around 6000 cal. BC to a fjord landscape and finally to the open bay of today.

5.1.2. Rügen Island and the coast of the Strelasund

Within the SINCOS research unit and the SINCOS II project bundle new data about sea level rise and environmental changes during the Littorina Transgression and the following periods have been obtained also for the area east of the Darss Sill. Most of them were produced in the frame of geo-archaeological investigations. Based on calcareous fossil they show that in the Arkona Basin the first marine signals are recorded approximately 800 years later than in Mecklenburg Bay, i. e. about 5200 cal. BC (Rössler et al. 2011). In addition an AMS-^{14}C-dating programme was set up, aiming to build a reliable fundament for the chronology of the investigated archaeological sites and – given that they can be considered as sea level index points – also for the contemporaneous sea level. Furthermore, archaeozoological, palynological and geological investigations were carried out, leading to new data about the development of landscape and habitats (see also 5.2).

Even if from the research area east of the Darss Sill the contact zone of land and sea could only be localised for a limited number of sites, there can be no doubt, that the earlier published models of the sea level change have to be fundamentally revised (summarising Lübke / Terberger 2004, 244 ff.). This is especially valid for the well known sites Ralswiek-Augustenhof and Lietzow Buddelin that have been the object of surveys, trial trenches and drilling programs in the frame of SINCOS. These investigations showed that both sites were at least temporarily oriented to the fresh water environment of lakes or dammed up parts of the bays without direct connection to the Baltic Sea. Consequently is the evidence of flooding and inundation recorded on-site only of limited significance for the determination of the sea level during their time of occupation.

Valuable data about the development of sea level could be obtained during the investigations at several other sites from Rügen Island and the Stralsund coast. They shall be discussed in chronological order. After a rapid increase during the 6th millennium cal. BC, sea level reached around 5000 cal. BC already a level of roughly 2 m below the recent state (Lübke / Terberger 2004, 245). For the following centuries only a moderate rise can be observed, yielding 1.80 to 1.50 m for the period 4800–4500 cal. BC and 1.30 to 0.90 m below the recent sea level for the period 4500–4000 cal. BC (Jöns et al. 2007, 101 ff.). These overall conclusions are generally in accordance with the archaeological record from the sites, investigated within SINCOS. On the site Stralsund-Mischwasserspeicher the position of the find layer of the older Ertebølle Culture (5100 and 4800 cal. BC) indicates a sea level of 2.2 m below its present state (Lübke / Terberger 2004, 244). The find layers of the submerged site Kamminer Ort, representing the older Ertebølle Culture and dating to the period 4900–4700 cal. BC, and strata from the site Breetzer Ort, which was occupied by a community during the early phase of the younger Ertebølle Culture in the period 4800–4500 cal. BC, point to a sea level of 2.0 to 1.8 m and 1.8 to 1.5 m, respectively, below its recent state. For the reconstruction of the sea level during the period between 4300 and 3800 cal. BC the stratigraphy of Baabe on Rügen is of special importance. It proves, that the terminal Ertebølle community living here between 4300 and 4100 cal. BC (Phase 1–3 according to Hirsch et al. 2007, 18 ff.) had to face a slow sea level rise from 1.5 to 0.8 m below the recent state, whereas the following Early Neolithic people between 4100 and 3800 experienced sea level changes (Phase 4–5), that was firstly shaped by a moderate decrease before again since 4000 cal. BC a low level transgression ended up at a level of 0,5 m below the recent state.

The sea level data from Baabe from the south-eastern part on Rügen Island for the period around 4000 cal. BC do not correlate to the information from the contemporaneous sites Parow-Sporthafen and Stralsund-Mischwasserspeicher, both positioned northwest of

Stralsund on the Strelasund. On both sites the Early Neolithic layers indicate a considerable lower sea level of 1.5 to 1.8 m below the present state.

Against the background of these data, the recorded depth of the dredged old to early young Ertebølle-find ensembles from Drigge (5000 cal. BC) of 5 m and Prohn (4600 cal. BC) of 3–4 m below the recent sea level have to be mistrusted (Lübke et al. 2000, Lübke / Terberger 2004, 243 ff.). Both sites are also positioned at the Strelasund, so that the difference in level between these data and the well documented data from Stralsund Mischwasserspeicher and Parow cannot be explained. Consequently the data from the dredged sites Prohn and Drigge should be excluded in the future for the calculation of the sea level curve development.

The current and the sea level rise especially during the Littorina Transgression led also in the coastal area east of the Darss Sill to a high rate of erosion, sedimentation and the formation of spits and beach ridges, so that the coast was a region of continuous changes. The transformation e. g. of marine / brackish bays to lagoons and fresh water lakes and vice versa was a frequently recorded process. Within the SINCOS research environmental changes of this kind have been recorded especially on Rügen Island at the sites Baabe, Lietzow Buddelin and Ralswiek-Augustenhof.

Human impact on the environment especially on the vegetation has been proved by pollen and macro fossil analysis (summarising Endtmann 2002). According to the analyses of a profile from Lietzow-Buddelin on Rügen Island hints for first human impact in the final Ertebølle period from circa 4400 cal. BC were discussed (Endtmann 2004). It was tentatively stated, that shrubs and bushes were economically used in different ways by the terminal Ertebølle-communities, and that this human engagement could also have been responsible for the elm-decline (summarising Terberger 2006, 118).

More significant man-made changes of the environment are recorded in the already mentioned pollen diagram for the turn from the 5th to the 4th millennium cal. BC, when an increasing opening of the landscape is detectable, probably caused by slashing and burning (see also Hartz et al. 2000, 137).

5.2. Development of the biosphere in the research areas

5.2.1. Short overview of the development of the vertebrate fauna in the southwestern Baltic area

Summarizing the current scientific state of knowledge about the faunal history of the whole Baltic area and based on the results of the SINCOS research group, an overview about "Holocene Vertebrate Palaeontology of the Baltic Sea area" was compiled (Schmölcke 2006). It highlights the progress of knowledge since the last decade of the 20th century especially concerning colonization routes and immigration times of animal species. The article reviews results of both morphological and genetic studies. In this connection must be seen also a study concerning the postglacial immigration of some fish species into the Baltic Sea area (Heinrich 2007).

Besides the archaeozoological analyses of the bone assemblages of the sites excavated in the course of the SINCOS project, the faunal development of the southwestern Baltic Sea area has been studied using exemplary species. In single investigations the occurrence of eel (*Anguilla anguilla*; Kettle et al. 2008) and cod (*Gadus morhua*; Barrett et al. 2008), amphibians (Winkler / Schmölcke 2005; Kisky 2007), the pond turtle (*Emys orbicularis;* Sommer et al. 2007), the osprey (*Pandion haliaetus*; Zachos / Schmölcke 2006), the moose (*Alces*

alces; Schmölcke / Zachos 2005), the roe deer (*Capreolus capreolus*; Sommer et al. 2009), the wild horse (Sommer et al. 2011), the porpoise (*Phocoena phocoena*; Sommer et al. 2008), and of seals (Schmölcke 2008; 2013a; Glykou 2013) was studied using the new records. These investigations demonstrate the different parameters influencing the distribution of species in the southwestern Baltic area and also on the Scandinavian Peninsula.

Indeed, in nearly all cases the Littorina Transgression played a major role. It submerged the land connection between Central Europe and Scandinavia, which had existed since the end of the Ice Age and prevented or reduced faunal exchange and immigration. Furthermore, it created isolated island populations much more vulnerable to environmental changes. It is significant that the recent distribution of many species borders on the present southern coastal line of the Baltic Sea. Examples for such species, which obviously reached northern Central Europe spreading from their glacial refuge areas after the Littorina Transgression had started, can be found among amphibians and micro mammals (Winkler / Schmölcke 2005; Schmölcke 2006; Kisky 2007). Furthermore, game species such as moose *(Alces alces)* disappeared soon from the newly established Danish Islands because of habitat fragmentation (Schmölcke / Zachos 2005). On the other hand, the new water way rendered possible

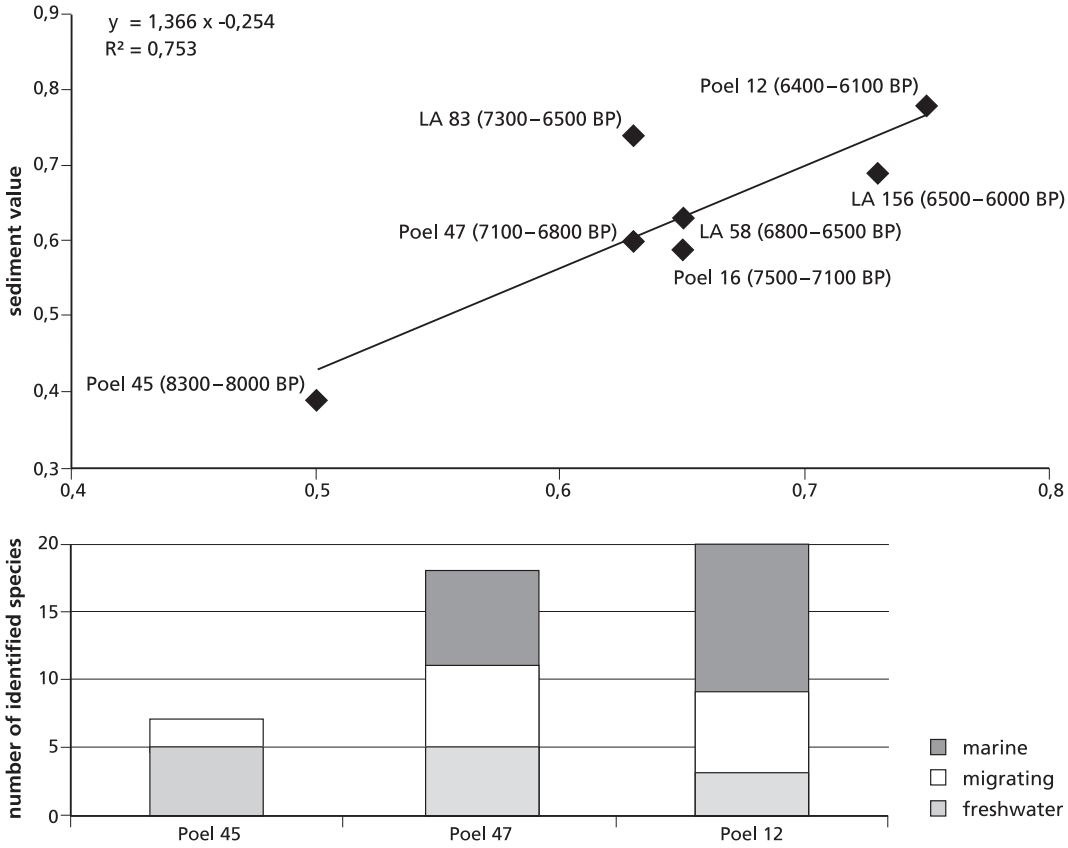


Fig. 40. Sediment and salinity values determined from the fish communities recorded at mid-Holocene hunter-fisher-gatherer settlements in the southwestern Baltic Sea and the number of identified species from subsequent sites in the area of Wismar Bay
(from Schmölcke subm.; digital drawing U. Schmölcke).

the immigration of both marine fish *(fig. 40)* and marine mammals (Schmölcke 2008; Sommer et al. 2008) from the Atlantic Ocean into the Baltic basin. Several of them obviously immigrated in the wake of the strong cooling event that occurred 6200 cal. BC (Schmölcke 2008).

After the establishment of agriculture in northern Central Europe one the one hand, game populations came under pressure from deforestation, husbandry and a growing human population. As a consequence, for instance, moose disappeared from many parts of its former area outside the above mentioned islands (Schmölcke / Zachos 2005). On the other hand side, species preferring open landscapes such as roe deer and wild horse profited from the environmental change caused by the economical reorientation. These speices become more frequent in the assamblages in comparison to Mesolithic times (Hartz / Schmölcke 2103), or expanded their distribution area (Sommer et al. 2011).

5.2.2. A chronological model of the consequences of the Littorina Transgression

Reviews concerning the environmental development of Mecklenburg Bay were presented as interdisciplinary articles using not only data from faunal history but also from vegetation history, archaeology and geology (Harff et al. 2007; Schmölcke et al. 2006). These studies demonstrate the changeful interrelation between different biotic and abiotic parameters. The connection of dates of samples from ancient coastlines, supported by geostatistical methods to estimate sediment transport processes, allow modelling palaeo-coastlines and they make it possible to reconstruct the recorded fauna in the original palaeo-topography, which regularly influence the distribution, frequency, and community of the animal species.

The comparison of the composition of the fish species community with known salinity data (Sohlenius et al. 2001; Gustafsson / Westman 2002) and the general environmental shift (Schmölcke et al. 2006) during the transgression stage of the southwestern Baltic Sea shows agreement. The investigations of fish remains proved that in Wismar Bay, and most probably in the whole area of interest, a typical Holocene Central European community of freshwater fish species existed during the pre-Littorina period *(fig. 40)*. According to calcareous fossil dates, the onset of the transgression in the central Mecklenburg Bay began c. 6000 cal. BC (Rössler et al. 2011; cf. Rössler 2006; Rössler et al. 2009), and these geological results are supported by the recorded fish species communities. At site Jäckelgrund-Orth, which the humans had to leave between 6000 to 5700 cal. BC due to the rising sea level, the fish fauna indicates already marine conditions.

Although the fish fauna mirror an increasing salinity from the beginning up to the end of transgression, it also demonstrates that no full marine conditions developed in the small bights of the new coastal line of the emerging Mecklenburg Bay. Nevertheless, at the contemporaneous sites Timmendorf-Nordmole I and Rosenhof a couple of species characteristic for full marine conditions have been recorded. Freshwater species comprise only a few per cent of the identified fish remains at these sites. However, perch *(Perca fluviatilis)* and several cyprinids persisted in the new ecosystem. In summary, the fish community moderately changed from a brackish to a brackish-marine community (Schmölcke / Ritchie 2010). Moreover, because of this, the number of species increased (cf. Schmölcke 2013b).

The increasing species diversity from pre-transgression to end-transgression times in Wismar Bay is noteworthy: Following the results of Gustafsson / Westman (2002), the maximum salinity in the Central Baltic Sea was between 10 and 15 ‰ during the 5th millennium cal. BC, and presumably it was something less in coastal regions. The increasing species diversity revealed in *figure 40* is the consequence of two factors: First, there is an increasing

number of seasonally migratory species that exhibit changing salinity preferences with ontogeny, such as eel *(Anguilla anguilla)*, or spawning activity, like trout *(Salmo trutta)* or shad (*Alosa* sp.). Second, many of the freshwater-affiliated species of Central and North Europe are tolerant to brackish conditions. This has been studied in detail by Neubaur / Jaeckel (1936) and Nellen (1968) in the Schlei (Schleswig-Holstein, Germany), a narrow inlet of the Baltic Sea in its western part. The rise of the water level was during the transgression phase extraordinary strong and made processes of erosion and accumulation nearly impossible. Thus, lots of islands, bights, and inlets, which later on also drowned, characterised the shoreline (Meyer / Harff 2005; Schmölcke et al. 2006). As the development of the fish communities show, this caused in the area of Wismar Bay already at the beginning a change of the bottom structure from muddy to sandy sediment (Schmölcke / Ritchie 2010). Later, at the time of Timmendorf-Nordmole and Rosenhof when the intense transgression period ended, the composition of the fish fauna documents the presence of nearly stony bottom conditions. It made the coastal area suitable for new species like eelpout *(Zoarces viviparus)*, turbot *(Psetta maxima)*, and the anadromous trout *(Salmo trutta)*. The abundance of tench *(Tinca tinca)* or pike *(Esox lucius)* as indicators for muddy conditions is less at these sites or these species are even missing.

Sediment values indicating sandy conditions have been found by fish fauna analyses for several sites. Obviously, such values are characteristic for wave and wind protected mid-Holocene coastal environments. In contrast, in eastern Holstein, two narrow arms of the sea had created a fjord-like landscape, and the human hunter-gatherer settled there on small islands or peninsulas (Hartz et al. 2004). For this area, special habitat features are assumable, in contrast to the conditions at sites near the open sea such as Rosenhof and Timmendorf-Nordmole I. At these latter sites also the salinity values are high.

In the eastern part of the study region the development of the environmental shift cannot up to now be reconstructed in detail, due partly to alterations of landscape and seascape and partly to the small number of sites of which remains have been analysed so far. Only Parow, Lietzow-Buddelin (Saiser 1), Baabe, and Breetzer Ort – located in different parts of Rügen Island – can be mentioned in this context. Although Lietzow-Buddelin and Parow are relatively young – the dates point to an occupation around 4400–4100 cal. BC and 4500–4000 cal. BC respectively and are thus corresponding to Timmendorf-Nordmole I and Neustadt – the marine component in both fish bone materials is relatively low: in Lietzow-Buddelin, it amounts only to 33 %, in Parow only to 17 %. In both cases pleuronectids dominate marine-affiliated species with cod taking the second place. Perch, on the other hand, as the main freshwater species amounts to 60 %, and 69 % respectively. However, as far as mammals are concerned there are some differences: whereas marine mammals are totally lacking at Parow, some remains out of a small sample at Lietzow-Buddelin were found.

Breetzer Ort, occupied between 4750 and 4550 cal. BC, yielded a rich fishbone material with mainly perch: 94 % of all identified fish remains are from this species. The marine component only comprises some remains of pleuronectids and one single bone of garfish. As far as the mammal assemblage with its 68 identified remains is concerned, marine species are represented only by two seal bones. At Breetzer Ort, according to the stratigraphy, a limnic phase was followed by a marine one, which was covered by limnic-brackish sediments, thus pointing to further alterations of the seascape. These alterations were probably caused by drift with small-scale cliff-building erosion, but partly also with accumulation of barriers nearby, processes, which may have influenced the faunal components.

Although the vertebrate material from the Rügen area on the whole is not yet sufficient for definitive statements, the comparison with the materials from Mecklenburg Bay shows that the marine influence probably occurred later in the Rügen area than in Mecklenburg

Bay. Perhaps this is a sign with regard to the faunal remains that the Littorina Transgression has preceded via the Great Belt. It is noteworthy in this respect, too, that Stone-Age sites at the former coast of the Rügen area are situated not so deep below the present sea level compared with those in Mecklenburg Bay. This points to small-scale differences in the geological development.

5.3. Development of the anthroposphere in the research area

5.3.1. Chronological development from the Late Mesolithic to the Early Neolithic in Mecklenburg Bay

5.3.1.1. Introduction

Since 1996 wetland settlements of the 5th and early 4th millenium cal. BC have been excavated in eastern Holstein. In Mecklenburg-Vorpommern submerged sites have been uncovered in Wismar Bay since 1998. These sites date back to the 7th, 6th and 5th millenium cal. BC. Both areas are part of Mecklenburg Bay. Together with Lübeck Bay, Wismar Bay and the Fehmarn Belt, Mecklenburg Bay forms the southwestern part of the Baltic Sea. Due to detailed stratigraphic excavation methods and systematic AMS-^{14}C-dating of archaeological finds, various settlement phases, each not longer than a few hundred years, could be defined (Hartz/Lübke 2004; 2006). The correspondence of artefact assemblages from contemporary sites in both parts of the study area is noteworthy. In addition a first chronostratigraphic division of the Terminal Mesolithic Ertebølle Culture and of the oldest Early Neolithic Funnel Beaker Culture in the southern Mecklenburg Bay based on radiocarbon dates will be discussed *(fig. 41)*. The descriptions of the artefact assemblages, especially for the older phases, are limited to stone tools so far, because at the moment only preliminary results are available for the organic artefacts.

5.3.1.2. Late Mesolithic period

The earliest Mesolithic sites in Mecklenburg Bay were discovered in Wismar Bay. They are situated north of Poel Island, on the so-called Jäckelberg, at 11 m to 7 m below water surface. Dated tree trunks and the archaeological finds from the area indicate that these sites date to the Late Mesolithic period of the late 7th millennium cal. BC and the first half of the 6th millennium cal. BC. Thus, by means of intensive geo-archaeological research a continuity of settlement over more than 1,000 years could be established at the Jäckelberg. The flint inventory of the two earliest securely dated sites, Jäckelberg-NNW and Jäckelberg-Huk, corresponds to that of the stations Blak II and Musholm in Denmark and Seedorf LA 296, pit C, in Schleswig-Holstein (Sørensen 1996; Fischer 1995; Bokelmann 1999). These stations mark the introduction of the Late Mesolithic trapezoid microliths in the southwestern Baltic area. The inventories are characterised by quadrangular microliths including trapezoids, oblique transverse arrowheads and especially rhombic arrowheads as the prevailing type of arrowhead. In some cases, they are complemented by the odd example of a plain microlithic point or a long, narrow triangular microlith. Other diagnostic features are regularly shaped core adzes with a pointed-oval cross section, and the dominance of burins among the blade implements. Macro-blades are represented by long, narrow blades with parallel edges, which were produced by soft-hammer percussion. Specialised handle cores and micro-blades made by pressure flaking are also present.

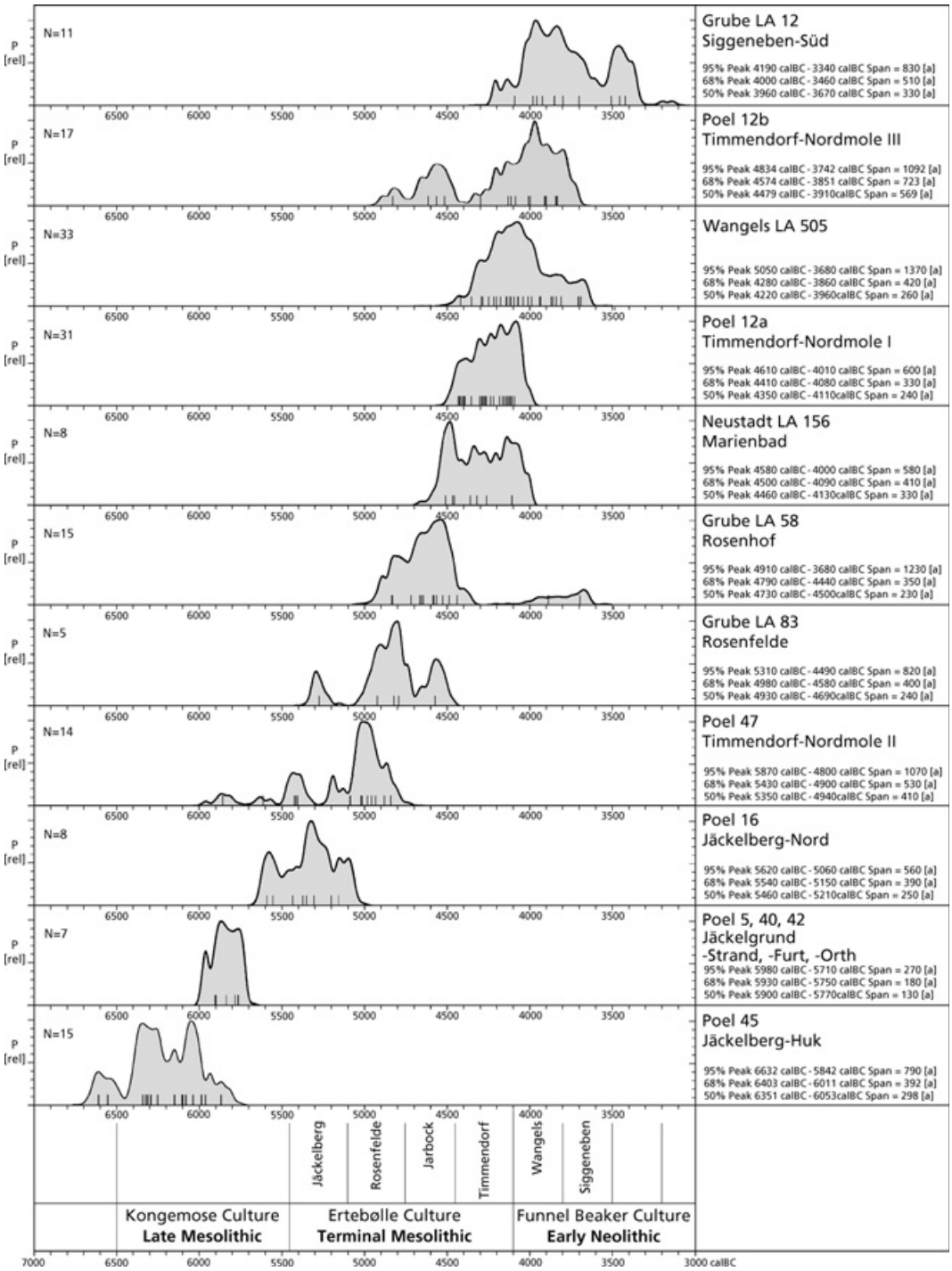


Fig. 41. Group calibration of radiocarbon dates of Mesolithic and Early Neolithic coastal settlements in the south of Mecklenburg Bay. The calibration was conducted with the programme Calpal of O. Jöris and B. Weninger (cf. www.calpal.de) and the calibration curve Intcal98 (Stuiver et al. 1998; digital drawing H. Lübke).

Regarding the cultural assignment of the Late Mesolithic sites in Wismar Bay, the close relation between Jäckelberg-Huk and Blak II on Zealand is of special importance, since the latter was eponymous for the first phase of the Danish Late Mesolithic Kongemose Culture, dating to 6550–6150 cal. BC. This shows that at the beginning of the Late Mesolithic the southwestern Baltic area formed a homogenous cultural region. The contemporaneous inventories from the Central European inland – e. g. from the site Coldinne 13 near Aurich, dating to *c.* 5500 cal. BC (Kitz 1986) – on the other hand are still dominated by trapeze microliths, which later were increasingly replaced by transverse arrowheads.

A similar, though less striking connection becomes visible if one looks at the inventories from the stations on the island off Jäckelberg, i. e. Jäckelgrund. Dating between 6000 and 5700 cal. BC, these settlements existed at the same time as Danish sites assigned to the Villingebæk phase of the Kongemose Culture. There are indeed parallels as to the composition of the find material, such as the dominance of core adzes and the rareness of atypical flake adzes, or the frequent occurrence of blade or flake burins. But the inventories so far recovered in Wismar Bay lack characteristic features such as heavy pointed weapons or rhombic arrowheads. Whether the settlements in Wismar Bay dating to a later phase of the Late Mesolithic actually belong to the coast-bound Kongemose Culture, which in this case would have spread over the entire southwestern Baltic area, can only be decided when the diagnostic types of arrowheads, which are missing so far, have been retrieved in adequate numbers.

5.3.1.3. Terminal Mesolithic period

Jäckelberg phase 5450–5100 cal. BC

According to research results in Denmark (Petersen 1984; Sørensen 1996) and Schleswig-Holstein (Hartz 1997) the transition from the Late to the Terminal Mesolithic period took place around 5450 cal. BC. Finds from the not yet stratified settlement site Neustadt-Wintershagen (Neustadt LA 160, Kr. Ostholstein), which is situated at a depth of 5–6m, from the outher Kiel Fjord (Strande LA 163) and from the site Jäckelberg-Nord (Neuburg / Poel 16, Ostsee II) in Wismar Bay, were dated to this period (5600–5100 cal. BC).

The settlement Jäckelberg-Nord today situated in 6.5m depth of water represents the initial phase of the Ertebølle Culture. As just a small part of the outcast layer was preserved in the formerly shallow waters, only a few stratified finds could be recovered. This does not yet allow a differentiation of the artefacts from the final phase of the Late Mesolithic period. According to the information gained so far, this early phase of the Ertebølle Culture in Mecklenburg Bay is still dominated by flint stone tools such as core axes with pointed-oval cross section, while flake adzes are not present in the period. The most common blade tools are blade knives with diagonal or straight truncations, as well as burins. Borers and burins were made out of flakes. Transverse arrowheads were used instead of Late Mesolithic trapezoids. Compared to the older Late Mesolithic stages, changes are most recognizable in the appearance of arrowheads and the declining number of blade and flake burins.

Rosenfelde phase (5100–4750 cal. BC)

The following phase, which has so far been identified on the sites Rosenfelde (Grube LA 83, Kr Ostholstein) and Timmendorf-Nordmole II (Neuburg / Poel 47, Ostsee II), can be described in much more detail. The ^{14}C dates from the main cultural layer of Nordmole II cover the period between 5100 and 4800 cal. BC (Lübke 2004a, 100 tab. 3), and the samples from Rosenfelde date to 5000 and 4800 cal. BC (Hartz 2004, 64 tab. 1). Due to the absence of ceramics on both sites, this period must have still been part of the aceramic older Ertebølle

Culture. Core axes with rough rectangular or rhombic cross sections and thick core borers with triangular or pointed-oval outline are characteristic amongst the flint tools. While flake adzes are completely missing at Rosenfelde, some pieces, of remarkably small size, could be recovered from Nordmole II. Arrowheads are mostly made of blades and belong to the transverse type. They can not be assigned to any of the standard schemes according to shape and size. Besides symmetrically shaped samples with straight or vaguely concave sides, asymmetrical arrowheads were found.

Among the tools there are straight and bevelled truncated knifes and burins, both made on blades made in soft-hammer technique. Between indifferent, partly retouched or rough denticulated flakes, flake borer and blade-like flake scrapers were recovered. The organic find inventory consists of leister prongs with short or long, curved rungs, as well as relatively long and slightly curved pressure flakers made of antler tines.

Jarbock phase (4750–4450 cal. BC)

The appearance of pottery from c. 4700 cal. BC onward is the most important change in the material culture of the coastal Ertebølle settlements. With a technological change in the flint tool industry, this phase could be described as the transition to the Late Ertebølle Culture. In Mecklenburg Bay, the Jarbock phase is mainly represented by the site Rosenhof (Grube LA 58, Kr. Ostholstein). The results of excavations conducted on this site in 2000 and 2001 allow the Ertebølle occupation layers to be dated from 4750 to 4450 cal. BC (Goldhammer 2008). In Wismar Bay only the lower cultural layer of Timmendorf-Nordmole III has finds of this phase. The small number of archaeological finds allows no detailed archaeo-typological analyses but generally the flint artefacts delivered comparable dates.

Coarsely tempered pointed-base cooking vessels with U-joins and a weak S-shaped profile are typical for the Jarbock phase. The pointed bases vary from heayy cone-like to flattened, rounded forms. Oval lamps are another typical type of ceramics. Of these, types with finger nail impressions and stabbing on the rim are commonly found.

Flint inventories are again dominated by blades in soft-hammer technique, of which blade scrapers with a partly asymmetric front, concave and straight truncated blades as well as burins (rare) and denticulated pieces were produced. Arrowheads are also made of blades, but as in the Rosenfelde phase they do not give a uniform impression, either according to their size or shape. Oblong-oval "flake adze-like" core axes with rough pointed-oval cross section and trapezoidal, flat-trimmed flake adzes appear in equal shares. Larger implements include thick core borer swith partly heavy handles, ground stone tools such as round-pecked axes (Walzenbeile) and Danubian shaft-hole axes.

The inventory of organic implements consists of leister prongs with differently shaped rungs, long fish spears, paddles with heart shaped and oval blades, T-shaped axes, harpoons made of deer and red deer antler, elbow daggers (ulna points), chisels and bone awls made from bird bones.

Timmendorf phase (4450–4100 cal. BC)

The Timmendorf phase can be differentiated from the Jarbock phase as the latest development stage of the Ertebølle Culture. This phase is represented by finds from the site Neustadt LA 156, Kr. Ostholstein, in Lübeck Bay and Timmendorf-Nordmole I (Neuburg / Poel 12, Ostsee II) in Wismar Bay. The site Neustadt LA 156 can now be dated to 4500 to 3800 cal. BC by several AMS-^{14}C-dates (Hartz 2004, 64 tab. 1). Therefore some of the finds already belong the younger Wangel phase. However, more than 30 radiocarbon dates were obtained for the site Nordmole I, where the main settlement was occupied between 4400–4100 cal. BC (Lübke 2004a tab. 4; 5). The oldest Ertebølle finds (pottery, paddles, T-axes etc)

from the mainly Early Neolithic site Wangels LA 505, dating to 4300–4100 cal. BC, also belong to the Timmendorf phase (Hartz 2004, 64 tab. 1).

The ceramics of this period consist of the traditional, coarsely tempered, thick-walled pointed-base cooking vessels and oval lamps, which are similar to those from the Jarbock phase. Additionally pot sherds of a thin walled, undecorated ware made using the slab-forming rather than the coil-building technique are commonly found.

The flint inventory is dominated by trapezoidal, flat-trimmed flake adzes as opposed to oblong-rectangular flake adzes. Core adzes appear only rarely as atypical samples. Within the flint inventory, only thick-handled borers show a connection with the previous phase. The symmetrical transverse arrowheads have straight or slightly concave retouched edges and are partly made from blades and partly from flakes. Amongst the blade implements are soft-hammered scrapers of regular, and often noticeably narrow basic forms. Moreover there are concave retouched truncated blades with or without worked handles, short and long borers, as well as edge-retouched and denticulated pieces. Burins continue to be an exception on Ertebølle sites both in Eastern Holstein and Mecklenburg-Vorpommern. An independent group of thick flake scrapers appear for the first time. Among the ground stone tools, round-pecked axes, Danubian shaft-hole axes and mace heads are still common.

The organic implements, such as various bone points, awls, slim bone chisels, elbow daggers, T-shaped axes, single indented harpoons made of deer or red deer antler, pressure flakers, chisels, as well as arrows with piston-like wooden heads, slim fish spears, variable leister prongs and heart shaped paddles, also show continuation from the previous phase.

5.3.1.4. Early Neolithic period

Wangels phase (4100–3800 cal. BC)

Just as for the Terminal Mesolithic Ertebølle Culture different phases can be defined, the same applies to the Funnel Beaker Culture of the Earlier Neolithic Period. Numerous new AMS-^{14}C-dates allowed the specification of previous chronologies. Again this background the oldest phase of the Funnel Beaker Culture in Mecklenburg Bay could mainly be identified in eastern Holstein. This phase is represented in this region by the site Wangels LA 505 (Kr. Ostholstein) and some Early Neolithic potsherds from the Rosenhof site (Grube LA 58, Kr. Ostholstein) excavated by Schwabedissen (1994). In Wismar Bay the upper cultural layer of Timmendorf-Nordmole III belongs to it. In this oldest Early Neolithic phase a differentiated spectrum of ceramics, consisting of broad funnel beakers with imprints at and beyond the rim, or down-turned arcade rims, funnel bowls, lugged beakers and lugged amphorae with dented handles, as well as thin walled dishes, spherical bowls, flasks and clay disks is to be found (Grohmann 2010).

The antler, bone and wooden implements of this phase show a significant similarity to the implements found in the Timmendorf phase. The functional tradition of these tools obviously continues. The same applies to the flint inventory with regular, soft-hammered blades and the stone tools which were produced from them. Amongst the larger tools trapezoidal flat-trimmed flake adzes are still existent. Additionally core-axes with trimmed (specialised) edges and small, polished ground stone axes (Walzenbeile) merit mention as new elements. Polished flint axes are still unknown in this period.

Siggeneben phase (3800–3500 cal. BC)

In the study area, the subsequent Siggeneben phase is only represented by the eponymous site Siggeneben-Süd (Grube LA 12 Kr. Ostholstein) (Meurers-Balke 1983) and the heavily disturbed site Timmendorf-Tonnenhaken (Neuburg / Poel 15, Ostsee II) (Lübke 2002a). The

funnel beaker from Tarnevitz (Bastian 1938, 37 fig. 8,2; Preuss 1966) was found during dredging work in the Wohlenberger Wiek west of Wismar Bay. The site it originated from has not yet been located. Potsherds found on inland sites, for example Meimersdorf (Hoika 1994) and Klein Meinsdorf (Graf 2003) and a newly discovered site at Lübeck-Genin (unpublished), also date to this phase, but were not found in a stratified context.

Siggeneben phase settlements are distinguished by their ceramic inventory, 90 % of which consists of undecorated funnel beakers. The rare ornaments are limited to notches in the rim edge made with a stick or fingernail, and/or to a simple ornamentation below the rim consisting of one or two rows of closely set impressions from a stick or a small irregular stamp, or else of a row of short vertical lines or horizontal lines either engraved by a stick, or executed in stab-and-drag technique, two-ply cord or whipped cord. Apart from funnel beakers, bottles, lugged flasks and clay disks, all characteristic for the Wangels phase, can also be found. Whether oval lamps are part of the ceramic inventory can not be answered. Those found in Wangels date to layers with pointed-bottom pottery and do not seem to have been used later.

The stone implement inventory is dominated by flake adzes, which occur in different variations; flat-trimmed as well as edge-trimmed pieces were discovered. Compared to the Wangels phase the adzes are smaller and less carefully prepared. Apart from some atypical core axes and core tools a new tool form, the all-round polished thin-butted flint axe must be noted. Except for a few scrapers, traditional blade tools are very rare. Additionally there are truncated and edge-retouched pieces, borers and transverse arrowheads. Flint-knapping techniques during the Wangels and Siggeneben phases differ considerably. The number of soft-hammered regular blades with parallel edges and their corresponding production remains decreases rapidly in Siggeneben-Süd.

The organic material consists of bone points as well as polished ribs, elbow daggers and pressure flakers, which are already known from the Wangels phase.

5.3.2. Chronological development from the Late Mesolithic to the Early Neolithic on Rügen Island and Western Pomerania

5.3.2.1. Introduction

Compared to the great number of newly discovered and at least partly investigated sites from the late 7th to the 4th millennium cal. BC in the area west of the Darss Sill, for the area east of the Darss Sill the the number of sites that produced new data about the settlement history, and with it of the chronological development, is rather limited (see also ■■3.2). New, well documented and stratified find complexes that have produced statistically valuable numbers of objects, and that could be used for the reconstruction of the chronological development are only available from a few sites, whereas the majority of objects derives from excavations done in the 1920s to the 1960s or from dredged out complexes without any information about their original stratigraphical position. Against the background of this situation, the AMS-^{14}C-dating of samples from these sites within the framework of SINCOS are of special importance, because they form the foundation for the chronological placement for most of the sites *(fig. 42)*. However, a detailed description of the development of the material culture is actually not possible, because the detectable chronological differences of the sites are not clearly reflected in the material culture recovered from them. For that reason, no further division into culturally based phases – comparable to those outlined for the Bay of Mecklenburg – is actually possible for the research area east of the Darss Sill.

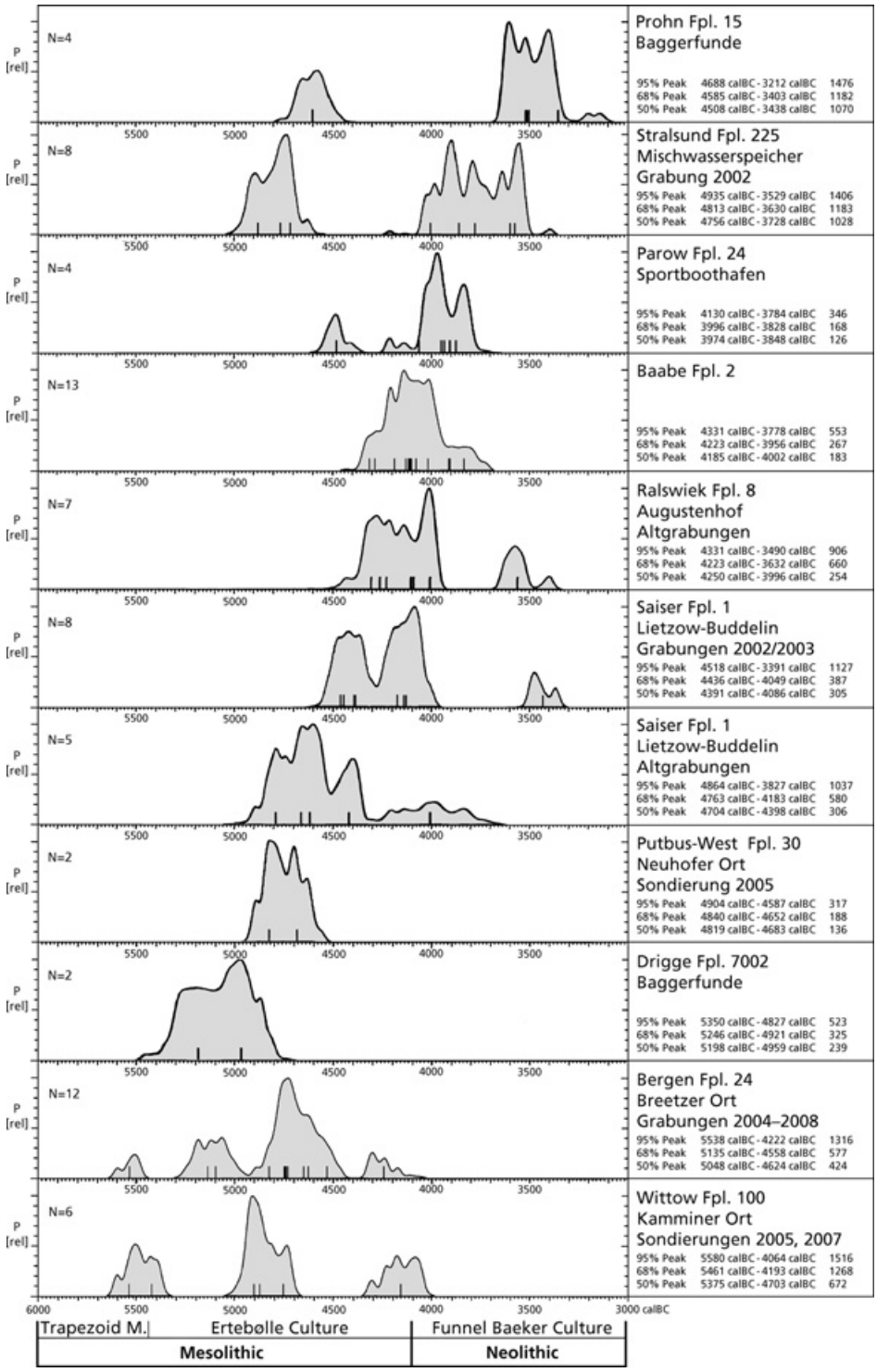


Fig. 42. Group calibration of radiocarbon dates of Mesolithic and Early Neolithic coastal settlements at the coastal area between the Darss Sill and the Oder estuary. The calibration was conducted with the programme Calpal of O. Jöris and B. Weninger (cf. www.calpal.de) and the calibration curve Intcal98 (Stuiver et al. 1998; digital drawing H. Lübke).

5.3.2.2. Late Mesolithic period (6500–5200 cal. BC)

The evidence of settlement on Rügen Island and the adjacent mainland during the Mesolithic periods is rare. Until now it is based on a few unstratified artefacts made of stone, bones or antler, that can mostly be attributed typochronologically to the Maglemose Culture (Heidelk-Schacht 1983, 11 ff.). It has been stated that human presence in the area prior to the 7th millennium could also be proved by palynological investigations (Lange et al. 1986, 130 ff.), but recently published palynological investigations failed to confirm this (Endtmann 2002, 137 ff.).

For the following Late Mesolithic period, with its typical trapezoid assemblage, until now no sites from Rügen Island and the Strelasund area are clearly detectable, even though single trapezoid microliths are known from a few find spots (Lübke / Terberger 2004, 247 ff.). It is argued that the rare evidence is the result of the fact that the settlements of the fisher and hunter communities had generally been placed near the shore, so that they were inundated and eroded by the rising waters of the Littorina Transgression (Terberger 2006, 136).

So it has to be regarded as a peace of luck that within the framework of SINCOS at least one Late Mesolithic site could be identified and investigated. This is the submerged site Breetzer Ort on Rügen Island. Here the remains of a campfire could be documented that had been in use in the period between 5600 and 5500 cal. BC, based on AMS-^{14}C-datings. Apart from this feature the site was completely eroded, so that no find material of the period could be recovered. So it can only be assumed that the people from Breetzer Ort used predominantly core adzes and remarkably less atypical flake adzes, as well as blade or flake burins that characterised the material from the contemporaneous site Jäckelgrund in Wismar Bay (see also ■■5.3.1.2).

5.3.2.3. Terminal Mesolithic period (5200–4100 cal. BC)

Early Ertebølle Culture (5200–4800 cal. BC)

Thanks to AMS-^{14}C and dendrochronological dating within the SINCOS project we know that the find collection from the older phase of Stralsund-Mischwasserspeicher was deposited in the period between 5100 and 4800 cal. BC (Kaute et al. 2004; Lübke 2004c). This material is at least partly comparable to the dredged find ensemble of Drigge, that was dated by two AMS-^{14}C to the period between 5200 and 4950 cal. BC. But because the material from Drigge does not derive from a documented excavation, its homogenous composition can not be fully confirmed without further 14C-datings. However, it seems that it was buried over a relatively short period of time, and that the site probably was not reoccupied again in the following centuries. So it has to be assumed, that the material derives from undisturbed deposited layers and represents the material culture of the early Lietzow-Ertebølle phase (Lübke / Terberger 2004, 248).

Therefore the material from the sites Drigge and Stralsund Mischwasserspeicher (1st phase) have to be considered as two sites, illustrating the material culture from the Early Ertebølle Culture in the research area. Consequently, T-shaped antler axes, core axes with rhombic cross section and small flake axes, as well as blades, produced in soft-hammer technique, can be regarded as typical for the phase. Furthermore, large truncated blades and burins can also be considered as typical tools of the period; the characteristic projectile point was the transverse arrow head.

Furthermore, it can be stated that in this phase the communities living on Rügen Island, along the Strelasund and on or near Greifswalder Bodden had already contacts with Neolithic communities in more southern areas that already practised agriculture. This can be de-

duced from the evidence of a number of foreign objects not locally produced, such as fragments of ceramics of a younger Linear Band Pottery pot, as well as flat adzes and pierced axes of solid amphibolite (in summary, Terberger 2006, 139 ff.). According to Klassen (2004, 59 ff.) these objects have to be considered as gifts that indicate an exchange with societies already practising a Neolithic productive economy.

Middle Ertebølle Culture (4800–4500 cal. BC)

The beginning of the younger Ertebølle Culture is generally characterised by the frequent presence of fragments of thick-walled pots with pointed bottoms and sparse decoration on sites of this period (Terberger 2006, 140). Also fragments of lamps can be considered as typical for the period in the southwestern Baltic area. Whereas this is valid in almost all southern Scandinavia as well as in the area west of the Darss Sill (see also ■■5.3.1.3), on Rügen Island as well in the adjacent mainland areas, comparable ceramic fragments are only known from a few sites such as Parow and Lietzow Budddelin (Hirsch et al. 2007, 30).

This lack of ceramic finds on Rügen Island is already well known for decades and was one of the reasons for considering that the Lietzow Culture in the Rügen area was a regional group of the Ertebølle Culture and had its own cultural identity (Lübke et al. 2000, 439 ff.).

AMS-^{14}C-dating gives evidence that the oldest part of the dredged find ensemble from Prohn, as well as the main cultural layer from the submerged site Breetzer Ort, originate from the period between 4800 and 4500 cal. BC. Consequently the inventory of these sites can be considered as representative for the material culture of a middle phase the Ertebølle phase.

The lithic material is dominated by core axes with a mostly rhombic or rhomboid cross section. But also edge-trimmed or flat-flaked flake axes with trapezoidal shape are well represented. On both sites there are traces of flint working. The blades were produced with soft as well hard-hammer blade technique. Tools made of blades, such as scrapers, truncated blades and different kinds of borers form part of the material as well. Especially from Breetzer Ort a great variety of tools and production remains made of organic material such as wood, bones and antler were also recovered. One complete, one fragmented and a few prefabrications of T-shaped axes together indicate that this tool still was commonly in use. Furthermore, these objects show the enormous significance of fishery and hunting. This is above all illustrated by bone daggers, fish leister prongs, bone points of eel spears, arrow fragments, roe deer harpoons, deer antler mauls, and last but not least by an antler chisel.

Also the red deer antler fragments with typical working traces found in a small shallow pit on the site Neuhofer Ort (Ostsee VI, Putbus-West 30), dating between c. 4850 and 4650 cal. BC, are of the same age (cf. Jöns et al. 2007, 101).

Also in this phase supraregional contacts of the communities living on and around Rügen Island have to be presumed. So single fragments of Stroke Band pottery and shaft-hole axes, found in Prohn, Parow and Baabe point to exchange and communication with the neighbouring areas before or around 4500 cal. B. C. (summarising Klassen 2004, 100–108; Terberger 2006, 141; Terberger / Seiler 2004, 160).

Late Ertebølle Culture (4500–4100 cal. BC)

Also for the second half of the 5th millennium cal. BC in the regions west and north of the research area, pottery belongs to the material characteristic of settlements. The thin-walled and undecorated pottery can easily be distinguished from the thick-walled material of the previous phase already discussed.

The AMS-^{14}C-datings prove that most of the sites discovered or investigated within SINCOS existed in this phase and that its material culture is represented by numerous finds.

Apart from the famous sites Ralswiek-Augustenhof and Lietzow Buddelin, the youngest phase of the submerged site Breetzer Ort (fishing fence) also existed in this phase, as well as the phases 1–3 at the site at Baabe, also on Rügen Island. Because nearly all material from this site could be recovered almost completely according to its stratigraphical placement, it is of high potential for further chronological analyses.

Apart from the lack of ceramics which is typical of this phase also, the composition of the lithic material differs to that of the adjacent areas. Whereas in southern Scandinavia and the area west of the Darss Sill flake axes replace the core axes as most frequently used tool, this cannot be observed in the area around Rügen Island (Hirsch et al. 2007, 23 ff.). The reason for this is unknown, but it has been suggested that the easy availability of high quality flint raw material is the reason for the development (Terberger 2006, 142 ff.). As in the phase before, transverse arrowheads remain the typical projectile. Truncated blades and harpoons made of roe deer antler also form elements of continuity.

In the final phase of the Ertebølle Culture the subregional contacts of the people on Rügen is still evident. Especially decorated tools and weapons, e. g. the bone plate with geometric decoration from Ralswiek-Augustenhof, point to contacts with the Vistula area (Terberger 2006, 143).

5.3.2.4. Early Neolithic period (4100–3500 cal. BC)

The early phase of the Neolithic is in the first instance marked by the increasing amount of ceramic material in the archaeological record. Most of these sherds are fragments of mainly undecorated vessels with flat or round bottoms, bowled bodies and funnel-shaped rims. They mark the cultural change from the Ertebølle to the Funnel-Beaker Culture.

AMS-^{14}C dating of charred incrustations of ceramic fragments, animal bones or artefacts of organic material proves for Ralswiek-Augustenhof, Parow, Prohn, Stralsund-Mischwasserspeicher and Baabe an Early Neolithic phase of occupation between 4100 and 3500 cal. BC. Thus it can be assumed that in this phase still at least seasonal fishing and hunting in the maritime environment was practiced, although agriculture became successively increasingly important from the end of the 5th millennium cal. BC. These data suggest also that the earliest Neolithic pottery was used in the Rügen area contemporaneously to the area around the Bay of Mecklenburg, where several Neolithic settlements of the period are known (Terberger 2006, 144, see also ■■5.3.1.4.).

5.3.3. The Mesolithic and Neolithic sites in Mecklenburg Bay and their significance for the neolithisation process on the southwestern Baltic coast

The profound transformation of the ecosystem in the area around Jäckelberg that took place when the rising sea drew near is impressively reflected by the changing proportions of the fish species exploited. While the inhabitants of Jäckelberg-Huk mainly fished for freshwater species such as perch, pike and cyprinids in the nearby waters, only a few centuries later, their descendants at Jäckelgrund-Orth primarily caught saltwater fish, including cod and herring. Obviously, the area around the Jäckelberg was affected by transgression shortly after 6000 cal. BC, between the occupation of Jäckelberg-Huk and Jäckelgrund-Orth. However, in the period when Jäckelberg-Huk was inhabited, the sea must have already been within reach. This is indicated by individual finds of saltwater fish and two seal bones.

Apparently, the adoption of new fishing techniques adapted to the new, marine habitat did not present a major problem to the Late Mesolithic population. The acceptance of new

species of prey, however, seems to have been a rather slow process. Although individual seal bones were found at the earliest site Jäckelberg-Huk, the hunting of marine mammals appears to have played a minor role during the entire Late Mesolithic period, since the faunal remains from all sites are dominated by typical forest animals such as red deer, roe deer, wild boar and in some cases also aurochs. It was not until the Terminal Mesolithic that the proportion of sea mammals started to rise, until it even became dominant in the final phase.

Without question, the possibility of sealing posed new challenges for the people, and in the few centuries of the Mesolithic-Neolithic transition phase, it temporarily became highly important. Possibly, this is connected with the immigration of large groups of harp seals *(Phoca groenlandica)* into the western Baltic Sea coastal regions, but neither the reasons for the beginning of sealing nor the exact process or the causes of its abrupt end are yet understood (Glykou 2013; Hartz / Schmölcke 2013). Although the general importance of hunting and sealing decreased with the beginning of the Funnel Beaker Culture, both play still an important economic role (Lübke et al. 2011) with even a wider spectrum of animals hunted (Hartz / Schmölcke 2013).

Principally, it can be assumed that the Late and Terminal Mesolithic communities did not, or at least not only, experience the environmental changes caused by the rapidly rising sea level as a threat to their habitat, but also as a challenge or even chance to take advantage of a completely altered environment offering many new opportunities. Moreover, archaeotypological comparison shows that the groups living on the present German Baltic coast belonged to the Late Mesolithic Kongemose and the Terminal Mesolithic Ertebølle Culture, which occupied the complete southern Scandinavian area. Therefore they did not have to create their own techniques in order to be able to exploit the marine resources. The necessary knowledge could simply be adopted from their neighbours in the north, who had developed their skills on the shores of the Kattegat centuries earlier. The detailed analysis of the palaeobotanical samples clearly indicates that already during the Terminal Mesolithic the wooded landscape was considerably modified by human interference. Especially the construction of stationary fishing weirs required a large quantity of suitable wood, which could not be acquired from a natural forest. Apparently, the growth of hazel was encouraged in particular, and the bushes were coppiced at regular intervals in order to obtain the large numbers of hazel shoots which were needed for the construction of the wattle fences. Thus, there is evidence for a systematic woodland management already centuries before the actual neolithisation took place. Possibly the new resources which had been opened up along the indented coastline with its diversity of species were one reason why the neolithisation of the southwestern Baltic area took place a millennium and a half later than in the Central European inland.

Being confronted with a continually rising sea and drowning landscapes must have influenced the thinking and the ideology of the Mesolithic people. Although other socio-economic factors have to be taken into account too, and the neolithisation of the region has to be regarded in a multicausal context, it is obvious that this process did not start before the rise of the sea level had decelerated considerably and become less of a threat.

Academic debate on neolithisation in North Germany has long been characterised by strongly opposing views with regard to the lifespan and economy of the Ertebølle Culture. In the Scandinavian part of its distribution area the economy seems to have focused on hunting and gathering until the end, though recent evidence from the Danish Islands and Scania indicates that cereals were being used as early as the end of the 5th millennium cal. BC. However, according to stratified settlement layers, domestic animals did not appear until shortly after 4000 cal. BC (Hartz et al. 2007).

The excavation results from Mecklenburg Bay suggest that the introduction of agrarian elements was accompanied by a new ceramic tradition. This means that the Neolithic transi-

tion was a comparatively abrupt process which did not take several centuries. Whether diagnostic features such as pointed-base and funnel beaker pottery existed parallel to each other for some time will probably have to remain open to question, even if charred food crusts preserved on the sherds can be dated directly (reservoir effect).

Bones from domestic animals play an important role in the investigation of the neolithisation process. This mainly concerns evidence of domestic cattle and pigs, the bones of which can be distinguished only by metric criteria from those of their wild, indigenous ancestors, the aurochs *(Bos primigenius)* and the wild boar *(Sus scrofa)*. Other significant evidence is provided by sheep and goat, which can always be interpreted as domestic animals, since these species were completely foreign to our region.

Untill recently there was an ongoing discussion concerning early cattle husbandry which so far was proposed for the Mesolithic sites Rosenhof and Rosenfelde in eastern Holstein, because this evidence is quite exceptional for Northern Europe. In all other regions north of the river Elbe the transition from the traditional economic system, which so far was based on hunter-gatherer activities and the exploitation of maritime resources, to a productive way of life began after 4100 cal. BC, whereas the Rosenhof and Rosenfelde bones are about 700 years older. In collaboration with colleagues throughout Europe (Edwards et al. 2007), and especially together with molecular biologists from the University of Mainz (Scheu et al. 2008; Scheu / Burger 2008), we have investigated the origin of the first European cattle and reanalysed the doubtful records from the sites mentioned above in order to determine the beginning of cattle husbandry in northern Central Europe. The first study demonstrates that nearly all European cattle originate from a special near East subpopulation of extinct aurochs *(Bos primigenius)*. The latter study, focussing on the discussion of an independent local domestication of aurochs in eastern Holstein, revealed that the presumed domesticated individuals from Rosenhof are unusually small female aurochs, and that there is no evidence of local domestication or hybridisation. It seems to be evident now that also in the area of Mecklenburg Bay livestock husbandry began in connection with the transition to the Neolithic Funnel Beaker Culture about 4100 cal. BC, and this is reflected by the earliest direct proof of an imported Neolithic cattle descendant from the near East subpopulation of aurochs at Rosenhof at about 4000 cal. BC (Hartz / Schmölcke 2006). The findings of several questionable bones from possibly domesticated, but more probably wild female specimens, for example at Timmendorf-Nordmole (trenches 1 and 3), do not change this general trend.

The earliest bones in the research area securely determined as deriving from domestic animals come from Wangels LA 505 and Neustadt LA 156. The preliminary analysis of a representative quantity of bones from Wangels shows that the proportion of domesticated species already made up more than 50 % of all mammal remains (Heinrich 1997/98). The finds also comprise almost 60 bones from sheep or goats, three of which were dated by means of the AMS-^{14}C-method. Two bones provided data from 4207 to 4077 cal. BC (KIA 7129; sheep) and from 4228 to 4080 cal. BC (KIA 7127; sheep / goat), confirming sheep (and goat?) husbandry probably in the earliest Wangels phase. The third bone, dating between 3931 and 3815 cal. BC (KIA 7128; sheep), belongs to the final part of the Wangels phase or the beginning of the Siggeneben phase.

The recent excavations at Grube-Rosenhof LA 58 did not yield any bones of domestic animals, while at Neustadt LA 156 about a dozen bones of goat/sheep and domestic cattle were found of which some date to around 4000 cal. BC and later. In the final report on the finds from the earlier excavations at Grube-Rosenhof by D. Heinrich (pers. comm.), two sheep or goat bones are mentioned. One of these, a phalanx 1, was radiocarbon dated to *c.* 3800 cal. BC, firmly placing it in a late phase of the settlement. The second sample, which could be definitely identified as sheep, was shown to be even younger, with a date around

3000 cal. BC, and can already be assigned to the Middle Neolithic. This date, however, suggests an occupation by the Middle Neolithic Funnel Beaker Culture, which in the archaeological record of Rosenhof could be traced so far only sporadically by surface finds from the higher area.

With regard to the first appearance of cereals, the excavation of the coastal site Wangels LA 505 is of special interest. Even though pollen analysis has not been completed yet, a couple of cereal grains and a charred emmer grain from the inside of a thick, locally produced wall sherd show that cereals were being processed at the site. This evidence is complemented by impressions from ears on another pottery fragment and several bowl-shaped grinding stones of coarse-grained granite which were re-used as stepping stones on the soft ground of the shore area.

During the Timmendorf phase there was apparently no marked chronological difference between the coastal and the inland area with regard to the utilisation of cereals, but from 4100 cal. BC, crop cultivation seems to have spread more rapidly across the coastal sites than the inland territory. Whether this also applies to animal husbandry, has to remain open to question as long as there are no faunal assemblages from inland sites dating to the same period. Along the coast, however, the keeping of livestock played an important role at the time, as is illustrated by finds from Wangels and Neustadt.

The vegetation history of the Siggeneben phase is characterised by elm decline, a common and synchronous phenomenon detectable all over Northern and Central Europe. So far it has been explained by either phytopathogenic or anthropogenic causes. At present it seems that, at least in the late phase, the interaction of both factors was responsible for the drastic reduction of elm trees. Along the coast and further inland the impact of human settlement now becomes clearly noticeable. In the forests oak *(Quercus)*, ash *(Fraxinus)* and lime *(Tilia)* were gradually replaced by light-demanding pioneer species such as birch *(Betula)*, poplar *(Populus)*, willow *(Salix)*, hazel *(Corylus)* and alder *(Alnus)*. These changes can only be explained by an increasing exploitation of the woodland by browsing cattle and by pollarding or coppicing. Although there are no continuous curves for cereal pollen and anthropogenic indicators such as *Plantago lanceolata* in the diagramme from the Belau Lake, there is firm evidence of arable farming and forest clearing (Wiethold 1998), which now also become a regular feature in other diagrams from the eastern hill zone. One indicator is the increasing frequency of charcoal dust, which was now deposited within a wider area in coastal and inland sediments and which was produced by small-scale slash-and-burn cultivation. It is a remarkable fact that Siggeneben-Süd itself, which has to be assigned to this phase, did not yield any cereal grains or impressions of grains on potsherds, while evidence of this kind has become a frequent phenomenon in southern Scandinavia.

Statistically relevant faunal remains dating to the Siggeneben phase have so far only been retrieved at the eponymous site. However, due to the small number of finds, the high proportion of domestic animals has been regarded as less conclusive. Considering the evidence from Wangels, though, a percentage of domestic animals higher than 60 % does not come as a surprise in this period and only confirms the picture outlined above. In addition to domestic cattle, domestic pigs, which at Wangels occur only in small numbers, now became more important as a source of meat, while goats/sheep played a minor role at Siggeneben-Süd.

Zusammenfassung · Summary · Résumé

ZUSAMMENFASSUNG Der vorliegende Artikel stellt die Ergebnisse der DFG geförderten Sincos-Forschergruppe und des Sincos II Projekt- Bündels zu den Veränderungen des

sozioökonomischen Systems der im Bereich der südwestlichen Ostseeküste lebenden Siedlungsgemeinschaften für den Zeitraum vom mittleren Holozän bis zum frühen Mittelalter dar. Der Schwerpunkt liegt dabei in der Phase der Littorina Transgression zwischen 6000 und 2000 cal. BC, als die Menschen in der maritimen Zone zwischen der Odermündung im Osten und der Insel Fehmarn im Westen mit permanenten Veränderungen der Küstenlinie und Landverlusten konfrontiert waren, so dass sie ihre Siedlungen in regelmäßigen Abständen landeinwärts verlegen mussten, um sie vor der Überflutung zu schützen.

Wegen der regional sehr unterschiedlichen Intensität der isostatischen Ausgleichsbewegung als Reaktion auf die Landhebung im nördlichen Skandinavien, waren die Küstenräume an der Mecklenburger Bucht von diesem Phänomen sehr viel stärker betroffen als jene im Bereich des Arkona Beckens oder der pommerschen Bucht. Die Grenze zwischen diesen beiden Räumen bildete die Darsser Schwelle.

Um die menschlichen Siedlungs- und Subsistenzstrategien in den Regionen östlich und westlich der Darsser Schwelle miteinander vergleichen zu können, wurden beide Regionen als Arbeitsgebiete gewählt und mit den gleichen Methoden untersucht. In ihnen wurden alle verfügbaren Informationen über ursprünglich an der Küste gelegene und damit das jeweilige Niveau des Meeresspiegels reflektierende Siedlungen systematisch in der Sincos-Datenbank erfasst. Sie bildeten die Grundlage für alle weiteren Untersuchungen. Mithilfe systematisch eingesetzter geophysikalischer Prospektionsmethoden ist es außerdem im Rahmen von SINCOS und SINCOS II gelungen, zahlreiche bislang unbekannte, submarine Fundstellen in beiden Untersuchungsräumen zu entdecken. Einige waren durch außergewöhnlich gute Erhaltungsbedingungen für organische Materialien geprägt, so dass Steingeräte und Werkzeuge aus organischen Materialien aber auch das umfangreiche Spektrum von Siedlungsabfällen in großen Mengen während der Prospektionssarbeiten, Sondagen und Ausgrabungen geborgen werden konnte. Die Geländearbeiten beschränkten sich auf Fundstellen aus dem Zeitraum zwischen dem späten Mesolithikum und dem späten Neolithikum, also den Zeitraum zwischen 6000 und 2000 cal. BC., da ihre Erforschung die Gewinnung zahlreicher neuer Erkenntnisse über die menschlichen Reaktionen auf die Littorina Transgression erwarten ließen.

Insbesondere in der Wismarbucht, die einen Forschungsschwerpunkt innerhalb des Untersuchungsraums Mecklenburger Bucht darstellte, gelang es nicht nur eine große Anzahl von Fundstellen dieses Zeitraums zu lokalisieren, eine Auswahl von ihnen konnte darüber hinaus auch in Ausschnitten archäologisch untersucht werden. Das Material dieser Fundplätze bildet nicht nur die Basis für eine detaillierte Rekonstruktion der chronologischen Entwicklung vom späten Mesolithikum bis zum frühen Neolithikum und damit der Besiedlungsgeschichte des Zeitraums von 6000 bis 4000 cal. BC., sondern auch für die Geschichte des Eindringens von Salzwasser in die Wismarbucht während und nach der Littorina Transgression.

Die archäozoologische Analyse von Tierknochen in Verbindung mit der Untersuchung der Sedimentationen, insbesondere der Transgressionskontakte, lieferte eindeutige Belege des Eindringens von Salzwasser im Raum nördlich der Insel Poel für die Zeit um 6000 cal. BC. Einige Jahrhunderte später zeigt die Zusammensetzung der natürlichen Fischpopulation genauso wie die vom damaligen Menschen getroffene Auswahl an bevorzugt verzehrten Fischarten, dass die Littorina Transgression nun auch die Insel selbst erreicht hatte.

Im östlichen Untersuchungsraum sind insbesondere die Boddengewässer der Insel Rügen detailliert untersucht worden. Die Veränderungen der Umwelt während und nach der Littorina Transgression waren dort sehr viel weniger dramatisch. Entsprechend mussten günstig gelegene Siedlungsplätze nicht im gleichen Umfang und mit der gleichen Dynamik aufgegeben werden wie im westlichen Untersuchungsgebiet. Tatsächlich wurden diese Plätze

zum Teil über Jahrhunderte besiedelt, so dass eine chronostratigraphische Differenzierung des Fundmaterials häufig nur in begrenzten Umfang möglich ist.

Es kann als gesichert gelten, dass sowohl östlich als auch westlich der Darsser Schwelle ab der Mitte des 5. Jahrtausends cal. BC. die Verwertung der maritimen Ressourcen an Bedeutung gewann. Nun wurde die Jagd auf Seehunde und die Küstenfischerei die ökonomische Basis der Küstenbewohner und zugleich ein Charakteristikum der endmesolithischen Ertebøllekultur.

Diese Situation blieb für einige Jahrhunderte unverändert auch wenn um 4000 cal. BC. erste Nutztiere wie Rinder, Schafe und Ziegen an der gesamten südwestlichen Ostseeküste gehalten wurden. Untersuchungen von aDNA-Proben haben gezeigt, dass die frühen Rinder Vorfahren im Nahen Osten besaßen, so dass sie aus den vollneolithschen Gebieten importiert worden sein müssen, und dass sie nicht das Ergebnis einer lokalen Domestizierung einheimischer Arten sein können. Gleiches gilt für die frühen Schafe und Ziegen, die ebenfalls auf Vorfahren aus dem Nahen Osten zurückgehen.

Während der letzten 4000 Jahre haben die Veränderungen der Küstenlinie und die Transgression im Raum östlich der Darsser Schwelle die an der Küste gelegenen Siedlungen nur in geringem Maße beeinflusst, auch wenn es auch hier insbesondere während des Mittelalters zu einer leichten und moderaten spätsubatlantischen Transgression gekommen ist. Im Gegensatz dazu sind für die Mecklenburger Bucht auch für diesen Zeitraum markante Veränderungen festzustellen. Die isostatische Ausgleichsbewegung führte hier gemeinsam mit dem spätsubatlantischen Meeresspiegelanstieg während des Mittelalters zu starken Küstenveränderungen und deutlich erkennbaren Erosionen im Bereich von Küstensiedlungen und deren Häfen.

Zusammengefasst kann festgestellt werden, dass die Arbeiten der Sincos-Forschergruppe und des Sincos II-Projekt Bündels zur Entwicklung von neuen Forschungsmethoden und standardisierten Untersuchungskonzepten maritimer bzw. ertrunkener Landschaften und Siedlungsplätze geführt haben. Auch wenn diese zunächst auf die südwestliche Ostseeküste beschränkt sind, lassen sie sich zumindest zum Teil auch auf andere, von Meeresspiegelveränderungen geprägten Landschaften übertragen.

SUMMARY The article presents the results of the SINCOS research group and the SINCOS II project bundle concerning the changes of the socio-economic system of the communities and societies living on the shore of the southwestern Baltic rim from the mid-Holocene Mesolithic and Neolithic period to the Early Medieval Age. The main focus is laid on the stage of the Littorina Transgression from 6000 to 2000 cal. BC, when the people living in the maritime zone between the Oder estuary and the Oldenburg Rift were facing a continuous shore displacement and a coastal decline, forcing them to move their settlements successively to pretect them from inundation. Because of the regionally differing intensity of the isostatic rebound to the isostatic uplift of northern Scandinavia, the coasts of the Bay of Mecklenburg were affected by this phenomenon to a much larger scale than those of the Arkona Basin and the Pomeranian Bay. Both areas were separated by the Darss Sill, which acted as a threshold between them. To be able to compare the environmental developments and human strategies employed in these regions, both of them were chosen as research areas and investigated with the same methods. In both research areas all available information about settlement remains originally positioned on the shore and indicating the relative sea level at their particular period of utilisation – and which thus can be used as sea level index points – were systematically recorded in the SINCOS database and formed the foundation for further research. A systematic survey based on geophysical measurements led to the discovery of numerous submerges sites in both research areas. Some of them offer exceptional

conditions for the preservation of organic material, so that artefacts as well as tools and multifaceted settlement refuse in large quantities could be recovered during surveys and excavations. Field work was restricted to sites from the Late Mesolithic until late Neolithic period between 6000 and 2000 cal. BC, because their remains should reflect the human reaction to the Littorina Transgression in a particular manner. Especially for Wismar Bay – forming one of the most important regional nuclei of research in the Bay of Mecklenburg – a large number of well preserved coastal sites was located, surveyed, and in some cases partly excavated. The material from these sites forms not only the basis for a detailed reconstruction of the chronological development from the Late Mesolithic to the Early Neolithic and the settlement history for the period from 6000 until 4000 cal. BC, but also for the reconstruction of the intrusion of marine waters into Wismar Bay during the Littorina Transgression. Animal remains in combination with sediment conditions such as transgression contacts provide evidence of the appearance of the transgressing Baltic Sea at some distance from the present Island of Poel at about 6000 cal. BC. Some centuries later, both the fish species community and the frequency of the recorded species prove that the Littorina Transgression had reached this area. In the eastern research area – well investigated especially for the shores of the Bodden waters on Rügen Island – less dramatic changes of the environment meant that specialised sites with favourable general conditions related to their topographic setting were not abandoned as fast as in the western area. In fact, these sites stayed in occupation for centuries, so consequently a chrono-stratigraphic division of the archaeological material is only possible in a limited way.

Definitely from the middle of the 5th millennium cal. BC, east as well as west of the Darss Sill the exploitation of the Baltic Sea – the hunting of seals and coastal fishery – became the economic basis of the human communities, and an important feature of the late Terminal Mesolithic Ertebølle Culture. Apparently this stayed true for a period of time, although around 4000 cal. BC the first livestock has been established in the entire southwestern Baltic Sea area. Investigations of aDNA samples have proved that the first cattle had Near Eastern ancestors, so that they must have been imported and did not result from the local domestication of autochthonous specimens. The same must be true for the contemporaneous first sheep and goats, whose ancestors are in any case of Near Eastern origin.

During the last 4,000 years shoreline displacement and transgression east of the Darss Sill only affected the coastal settlements to a low degree, even though the sea level also rose here moderately during the Middle Ages as a consequence of the Late Subatlantic Transgression. This contrasts with the Bay of Mecklenburg, where the isostatic rebound together with the Late Subatlantic Transgression led during the Middle Ages to shoreline displacements and considerable erosions of settled and waterfront areas.

Within the SINCOS research unit and the SINCOS II project bundle, methods and standards on interdisciplinary research on maritime and submerged prehistoric landscapes and sites could be developed and established for the southwestern Baltic area that may be transferred to other coastal areas affected by sea level changes and shoreline displacement.

RÉSUMÉ Cet article présente les résultats du groupe de chercheurs de SINCOS, soutenu par la DFG, et du faisceau de projets SINCOS II sur les changements du système socio-économique des communautés établies sur la côte sud-ouest de la Baltique depuis le milieu de l'Holocène jusqu'au début du Moyen Age. L'accent est mis sur la phase de la transgression à Littorines entre 6000 et 2000 cal. BC, lorsque les hommes vivant dans la zone côtière entre l'embouchure de l'Oder à l'est et l'île de Fehmarn à l'ouest étaient confrontés à des fluctuations permanentes du rivage et à des pertes de terres, ce qui, à intervalles réguliers, les obligeait à déplacer leurs habitats vers l'intérieur pour les protéger de l'inondation.

Suite à l'intensité, très variable localement, de la compensation isostatique en tant que réaction au relèvement de la Scandinavie septentrionale, les zones côtières de la baie de Mecklembourg furent bien davantage touchées par ce phénomène que celles du bassin d'Arkona ou de la baie de Poméranie. Le seuil de Darss délimitait alors ces deux régions.

Elles furent sélectionnées comme terrains de travail, étudiés avec les mêmes méthodes, en vue de pouvoir comparer les stratégies d'implantation et de subsistance des communautés à l'est et à l'ouest du seuil de Darss. Pour chaque région, toutes les informations disponibles sur les habitats établis à l'origine sur la côte, et reflétant de ce fait le niveau respectif de la mer, furent encodées systématiquement dans une banque de données de SINCOS. Elles servirent de base aux recherches postérieures. Grâce au recours systématique de méthodes de prospection géophysiques, on a pu, dans le cadre de SINCOS et SINCOS II, repérer de nombreux sites sous-marins jusqu'alors inconnus dans les deux régions étudiées. Certains d'entre eux étaient caractérisés par des conditions de conservation exceptionnelles pour les matériaux organiques, de sorte qu'il fut possible de recueillir une grande quantité d'outils en pierre et matières organiques ainsi que tout l'éventail de déchets présents dans un habitat. Les interventions sur le terrain se limitèrent aux gisements situés entre le Mésolithique récent et le Néolithique tardif, soit entre 6000 et 2000 cal. BC, car leur étude promettait de nombreuses découvertes sur les réactions de l'homme face à la transgression à Littorines.

En particulier dans la baie de Wismar, qui est un point fort de la recherche menée dans la baie de Mecklembourg, il fut possible de localiser de nombreux sites, dont un échantillon a fait l'objet d'investigations archéologiques partielles. Le matériel issu de ces sites sert non seulement à reconstruire en détail l'évolution chronologique du Mésolithique récent au Néolithique ancien, et donc l'histoire du peuplement de cette région entre 6000 et 4000 cal. BC., mais aussi l'histoire de la pénétration de l'eau de mer dans la baie de Wismar pendant et après la transgression à Littorines.

L'analyse archéozoologique d'ossements animaux en lien avec l'étude des sédimentations, particulièrement des contacts opérés durant la transgression, a clairement démontré une pénétration de l'eau de mer dans les terres situées au nord de l'île de Poel vers 6000 cal. BC. Au vu de la composition des populations naturelles de poissons et des préférences affichées par l'homme dans sa consommation, la transgression à Littorines avait atteint l'île quelques siècles plus tard.

Dans la partie orientale de l'aire considérée, ce sont particulièrement les lagunes (« Bodden ») de l'île de Rügen qui furent étudiées en détail. Les changements subis par l'environnement pendant et après la transgression à Littorines y furent beaucoup moins dramatiques. Ainsi, les habitats bien situés ne durent pas être abandonnés à la même échelle et la même vitesse que ceux de la partie occidentale. En fait, ces sites furent occupés en partie durant des siècles en sorte qu'une différentiation chronostratigraphique du matériel archéologique n'est souvent possible que dans une faible mesure.

On peut dire avec certitude que l'exploitation des ressources maritimes gagna en importance dès le milieu du 5e millénaire cal. BC tant à l'est qu'à l'ouest du seuil de Darss. La chasse aux phoques et la pêche côtière devinrent alors la base économique des populations établies sur la côte et une caractéristique de la culture d'Ertebølle du Mésolithique final.

Cette situation ne change guère durant quelques siècles, même si l'on enregistre les premiers animaux domestiques vers 4000 cal. BC – bovins, moutons et chèvres – sur toute la côte sud-ouest de la mer Baltique. L'analyse d'échantillons aDNA a révélé que les premiers bovins avaient des origines au Proche-Orient, qu'ils furent donc très probablement importés de régions entièrement néolithisées et donc pas domestiqués à partir d'espèces autochtones. Ceci vaut également pour les moutons et les chèvres, dont les ancêtres venaient du Proche-Orient.

Les changements de la ligne côtière et la transgression à l'est du seuil de Darss n'ont guère influencé les habitats situés sur la côte durant ces derniers 4000 ans, même si une légère transgression subatlantique tardive s'est manifestée ici durant le Moyen Age. La baie de Mecklembourg présente par contre pour la même période de profonds changements. La compensation isostatique, doublée de la montée subatlantique tardive du niveau de la mer au Moyen Age, provoqua de profonds changements sur la côte et des érosions bien visibles aux abords des agglomérations côtières et de leurs ports.

En résumé, on constatera que les travaux du groupe de chercheurs SINCOS et du faisceau de projets SINCOS II ont permis de développer de nouvelles méthodes de recherche et des concepts standardisés pour les régions et habitats maritimes ou submergés. Limités certes pour le moment à la côte sud-ouest de la Baltique, ces acquis peuvent s'appliquer, du moins partiellement, à d'autres régions marquées par des variations du niveau de la mer. (Y.G.)

Tables 1–24

Campaign	Date	Area
PAP 40/05/05	03.05.–07.05.2006	Darss-Falster barrier and Wismar Bay
Goor 2006/06	05.06.–30.07.2006	Timmendorf-Nordmole III (Ostsee II, Neuburg/Poel 12b)
Goor 2006/08	14.08.–08.10.2006	Timmendorf-Nordmole III (Ostsee II, Neuburg/Poel 12b)
Goor 2007/04	16.04.–05.05.2007	Kamminer Ort (Wittow 100, Ostsee VI)
PAP 07 PE/07/11	21.05.–25.05.2007	Darss-Falster barrier (Fischland, Darss, Zingst)
Goor 2007/06	11.06.–14.07.2007	Breetzer Ort (Bergen 24, Ostsee VI)
Goor 2007/08	30.07.–05.09.2007	Timmendorf-Nordmole III (Ostsee II, Neuburg/Poel 12b)
PAP 07 PE/07/21	07.09.–18.09.2007	South-eastern Baltic (Poland, Lithuania)
Goor 2007/10	24.09.–18.11.2007	Timmendorf-Nordmole III (Ostsee II, Neuburg/Poel 12b)
Goor 2008/03	03.03.–23.03.2008	Breetzer Ort (Bergen 24, Ostsee VI)
Goor 2008/04	31.03.–20.04.2008	Breetzer Ort (Bergen 24, Ostsee VI)
PAP 08 PE/07/11	21.04.–25.04.2008	Mecklenburg Bay (Warnemünde, Fischland, Heiligendamm)
Goor 2008/05	13.05.–15.05.2008	Breetzer Ort (Bergen 24, Ostsee VI)
Goor 2008/06	16.06.–27.07.2008	Timmendorf-Tonnenhaken-Süd (Ostsee II, Neuburg/Poel 15) Timmendorf-Tonnenhaken-Nord (Ostsee II, Neuburg/Poel 57) Jäckelgrund-Orth (Ostsee II, Neuburg/Poel 42)
Goor 2008/06	11.08.–12.10.2008	Jäckelgrund-Orth (Ostsee II, Neuburg/Poel 42)
07PE0910	14.04.–23.04.2009	Arkona Basin (Fischland, Zingst), Wismar Bay (Jäckelberg), Lübeck Bay

Table 1. Field campaigns 2006–2009 of the archaeological work group (sub-project 4)

FISH	NISP (n)	NISP (%)	BIRD	NISP (n)	MAMMAL	NISP (n)	NISP (%)
Gadus morhua (M)	2778	72,2	Anatinae	16	*Cervus elaphus*	113	37,5
Anguilla anguilla (F/M)	255	6,6	*(Somateria mollissima)*	(4)	*Sus scrofa*	45	15,0
Pleuronectidae (M)	245	6,4	*(Bucephala clangula)*	(1)	*Lutra lutra*	27	9,0
(Platichthys flesus)	(76)		*(Mergus albellus)*	(1)	*Capreolus capreolus*	27	9,0
(Pleuronectes platessa)	(1)		*Pelecanus crispus*	25	*Martes martes*	20	6,6
Cyprinidae (F)	157	4,1	*Podiceps ruficollis*	2	*Bos primigenius*	16	5,3
(Abramis brama)	(45)		*Larus* sp.	1	Phocidae	12	4,0
(Tinca tinca)	(6)		*Haliaeetus albicilla*	1	*(Halichoerus grypus)*	(5)	
(Rutilus rutilus)	(1)		*Corvus* sp.	1	*Sus scrofa* (f. domestica?)	10	3,3
Myoxocephalus scorpius (M)	118	3,1		46	*Apodemus* sp.	8	2,7
Clupea harengus (M)	89	2,3			*(Apodemus flavicollis)*	(3)	
Perca fluviatilis (F)	55	1,4			*Bos primigenius* (f. taurus?)	7	2,3
Esox lucius (F)	49	1,3	AMPHIBIAN	NISP (n)	*Canis lupus* f. familiaris	6	2,0
Gobius niger (M)	25	0,7	*Rana* sp.	1	*Bos primigenius* f. taurus	6	2,0
Gasterosteus aculeatus (F/M)	20	0,5	*Bufo* sp.	1	*Equus ferus*	2	0,7
Scomber scombrus (M)	18	0,5			*Sus scrofa* f. domestica	1	0,3
Alosa sp. (F/M)	17	0,4			*Phocoena phocoena*	1	0,3
Salmo sp. (F/M)	15	0,4	REPTILE	NISP (n)		301	100
Zoarces viviparus (M)	4	0,1	*Emys orbicularis*	1			
Belone belone (M)	1	<0,1					
	3846	100					

Table 2. Grube-Rosenhof LA 58 (4500–4800 cal. BC). Numbers of identified animal bones (NISP) and their frequency in percent. The fish species are labelled in the categories marine (M), migrating (F/M) and freshwater (F).

FISH	NISP (n)	NISP (%)	BIRD	NISP (n)	MAMMAL	NISP (n)	NISP (%)
Anguilla anguilla (F/M)	150	72,5	*Corvus* sp.	1	*Cervus elaphus*	174	34,8
Gadus morhua (M)	33	15,9	*Phalacrocorax carbo*	1	*Bos primigenius*	122	24,4
Gasterosteus aculeatus (F/M)	11	5,3	*Philomachus pugnax*	1	*Sus scrofa*	103	20,6
Pleuronectidae (M)	9	4,3		3	*Capreolus capreolus*	34	6,8
Perca fluviatilis (F)	1	0,5			*Bos primigenius* (f.) taurus?)	32	6,4
Salmo truttax (F/M)	3	1,4			*Canis lupus* f. familiaris	15	3,0
	207	100			*Sus scrofa* (f. domestica?)	11	2,2
					Lutra lutra	3	0,6
			AMPHIBIAN	NISP (n)	Phocidae	3	0,6
			Rana sp.	1	*Arvicola terrestris*	2	0,4
					Microtus sp.	1	0,2
						500	100

Table 3. Grube-Rosenfelde LA 58 (4800–4900 cal. BC). Numbers of identified animal bones (NISP) and their frequency in percent. The fish species are labelled in the categories marine (M), migrating (F/M) and freshwater (F).

Inventory-no.	Sample-no.	BP	cal. BC	$\delta^{13}C$	Square unit / layer	Object
2002/1526-0035,1	KIA-23699	7416 ± 43	6295 ± 63	–22,5	N100/E103/-	Red deer
2002/1526-0035,2	KIA-23700	7469 ± 39	6322 ± 58	–20,5	N100/E103/-	Roe deer
2002/1526-0035,2	KIA-23701	7387 ± 42	6251 ± 85	–15,5	N100/E103/-	Pike
2002/1526-0045,1	KIA-23940	7239 ± 37	6103 ± 63	–20,7	N100/E109/-	Mammal undet.
2002/1526-0053,1	KIA-23941	7108 ± 37	5964 ± 47	–18,1	N100/E115/-	Pike
2002/1526-0109,1	KIA-26403	7238 ± 35	6102 ± 62	–25,3	N100/E107/A2	Hazelnut shell
2002/1526-0277,1	KIA-26404	7210 ± 32	6082 ± 58	–25,3	N100/E107/A4	Hazelnut shell
2002/1526-0398,1	KIA-26405	6989 ± 34	5868 ± 56	–22,6	N100/E114/A1	Hazelnut shell
2002/1526-0601,1	KIA-26406	7806 ± 33	6611 ± 46	–27,3	N100/E114/A5	Hazelnut shell
2002/1526-0826,1	KIA-26409	7309 ± 41	6150 ± 54	–25,9	N100/E114/A7	Charcoal
2002/1526-0656,1	KIA-26396	7446 ± 32	6311 ± 54	–22,4	N100/E112/A6	Wild boar
2002/1526-0656,2	KIA-26397	7179 ± 35	6038 ± 40	–21,3	N100/E114/A1	Red deer
2002/1526-0817,1	KIA-26398	7140 ± 30	5988 ± 46	–15,4	N100/E114/A1	Seal
2002/1526-0818,1	KIA-26393	7505 ± 30	6342 ± 68	–24,1	N100/E114/A5	Pike
2002/1526-0602,1	KIA-26394	7738 ± 41	6553 ± 55	–21,7	N100/E114/A5	Mammal undet.

Table 4. Jäckelberg-Huk (Ostsee II, Neuburg / Poel 45). Radiocarbon datings. The calibration was conducted with the programme Calpal of O. Jöris and B. Weninger (cf. www.calpal.de) and the calibration curve Intcal98 (Stuiver et al. 1998).

Core section and master depth	Depth below sea level	Material dated	Lab.-Nr.	14C-Age conv.	Calibrated Age (1 σ) Median
45/117 cm	883 cm	buds, seeds and fruits of terrestrial plants, brown moss	Poz-35674	6810 ± 40	5735–5670 cal. BC5710 BC
45/129–30 cm	895–896 cm	Bud scales, leaf fragments, seeds and fruits of terrestrial plants, brown moss	Poz-35675	6940 ± 40	5845–5755 cal. BC5805 BC
45/139 cm	904–905 cm	Bud scales, seeds and fruits of terrestrial plants, brown moss	Poz-35676	7020 ± 40	5920–5835 cal. BC5870 BC
45/264–65 cm	930–931 cm	bud scales, seeds and fruits of terrestrial plants, brown moss, *Sphagnum*	Poz-35677	6960 ± 40	5980–5865 cal. BC5910 BC
45/283 cm	949 cm	seeds and fruits of terrestrial plants	Poz-35678	7180 ± 50	6065–5990 cal. BC6030 BC

Table 5. Jäckelberg-Huk (Poel 45). Radiocarbon dates from profile Poel 45. The dates were calibrated using Intcal09 data set (Reimer et al. 2009) and the sequence method of the OxCal 4.1 deposition models (Bronk Ramsey 2008) and are rounded by 5 years.

FISH	NISP (n)	NISP (%)	MAMMAL	NISP (n)
Perca fluviatilis (F)	1340	61,0	*Arvicola terrestris*	37
Esox lucius (F)	386	17,6	*Cervus elaphus*	22
Cyprinidae (F)	304	13,8	*Capreolus capreolus*	13
(Tinca tinca)	(3)	(0,1)	*Sus scrofa*	2
(Rutilus rutilus)	(5)	(0,2)	*Erinacaeus europaeus*	2
(Scardinius) erythrophthalmus	(2)	(0,1)	*Felis silvestris*	2
Anguilla anguilla (F/M)	122	5,6	Phocidae	2
Pleuronectidae (M)	7	0,3	*(Halichoerus grypus)*	(1)
Gadus morhua (M)	4	0,2	*Bos primigenius*	1
Coregonus sp. (F/M)	24	1,1		81
	2197	100		

Table 6. Jäckelberg-Huk (Ostsee II, Neuburg / Poel 45). (6300–6000 cal. BC). Numbers of identified animal bones (NISP) and their frequency in percent. The fish species are labelled in the categories marine (M), migrating (F/M) and freshwater (F).

Inventory-no.	Sample-no.	BP	cal. BC	$\delta^{13}C$	Water depth	Object
2002/0977-0005	KIA-18209	6969 ± 33	5835 ± 49	–24,4	7,20 m	Tree stump
2002/0977-0025	KIA-19240	7022 ± 44	5900 ± 62	–24,1	6,50 m	Tree stump
2002/0977-0026	KIA-19241	7014 ± 36	5898 ± 60	–22,9	6,70 m	Tree stump
2002/0977-0027	KIA-19242	6888 ± 35	5767 ± 38	–21,5	6,60 m	Tree stump
2002/0977-0028	KIA-19243	6916 ± 35	5783 ± 40	–24,3	7,20 m	Tree stump

Table 7. Jäckelgrund-Strand (Ostsee II, Neuburg / Poel 5), -Furt (Ostsee II, Neuburg / Poel 40) and -Orth (Ostsee II, Neuburg / Poel 42). Radiocarbon datings.
The calibration was conducted with the programme Calpal of O. Jöris and B. Weninger (cf. www.calpal.de) and the calibration curve Intcal98 (Stuiver et al. 1998).

FISH	NISP (n)	NISP (%)	MAMMAL	NISP (n)
Gadus morhua (M)	299	55,1	*Sus scrofa*	8
Anguilla anguilla (F/M)	162	29,9	*Cervus elaphus*	4
Clupea harengus (M)	43	7,9	*Capreolus capreolus*	2
Pleuronectidae (M)	19	3,5	*Bos primigenius*	1
Cyprinidae (F)	8	1,5	*Bos primigenius* (f. taurus?)	1
(Rutilus rutilus)	(1)	(0,2)	*Sus scrofa* (f. domestica?)	1
(Scardinius erythrophthalmus)	(1)	(0,2)	*Arvicola terrestris*	1
Zoarces viviparus (M)	4	0,7	*Martes martes*	1
Salmo trutta (F/M)	2	0,4	*Canis lupus* (f. familiaris?)	1
Coregonus sp. (F/M)	2	0,4	Muridae indet.	1
Perca fluviatilis (F)	1	0,2		12
	542	100		

Table 8. Poel 42, Jäckelgrund-Orth (6000–5700 cal. BC). Numbers of identified animal bones (NISP) and their frequency in percent. The fish species are labelled in the categories marine (M), migrating (F/M) and freshwater (F).

Inventory-no.	Sample-no.	BP	cal. BC	$\delta^{13}C$	Water depth	Object
2000/0308-0012	KIA-10401	6201 ± 41	5158 ± 77	−27,1	6,60 m	Wooden post
2000/0308-0011	KIA-10402	6325 ± 35	5305 ± 45	−20,0	6,50 m	Wild boar
2000/0308-0037	KIA-11616	6253 ± 39	5202 ± 80	−22,6	6,70 m	Red deer
2000/0308-0038	KIA-11617	6353 ± 46	5352 ± 59	−27,5	6,60 m	Wooden post
2000/0308-0052	KIA-16024	6494 ± 33	5434 ± 44	−27,7	7,20 m	Wooden tool
2000/0308-0066	KIA-16025	6673 ± 28	5590 ± 35	−21,3	6,70 m	Wild boar
2000/0308-0083	KIA-16026	6377 ± 30	5373 ± 52	−16,8	6,80 m	Wild boar
2000/0308-0090	KIA-16027	6620 ± 34	5554 ± 48	−20,4	6,80 m	Mammal undet.
2000/0308-0162,2	KIA-24221	6867 ± 35	5748 ± 40	−26,5	6,80 m	Tree trunk
2000/0308-0163,2	KIA-26402	6806 ± 34	5687 ± 31	−22,4	6,70 m	Tree trunk
2000/0308-0165,2	KIA-26401	6809 ± 35	5688 ± 32	−25,4	6,70 m	Tree trunk

Table 9. Jäckelberg-Nord (Ostsee II, Neuburg / Poel 16). Radiocarbon datings. The calibration was conducted with the programme Calpal of O. Jöris and B. Weninger (cf. www.calpal.de) and the calibration curve Intcal98 (Stuiver et al. 1998).

FISH	NISP (n)	MAMMAL	NISP (n)
Gadidae (M)	10	*Sus scrofa*	4
(Gadus morhua)	(9)	*Cervus elaphus*	3
Anguilla anguilla (F/M)	4	*Arvicola terrestris*	2
Clupea harengus (M)	4	*Bos primigenius*	1
Perca fluviatilis (F)	3	*Vulpes vulpes*	1
Abramis brama (F)	1	*Clethrionomys glareolus*	1
Belone belone (M)	1		12
Pleuronectidae (M)	1		
	24		

Table 10. Poel 16, Jäckelberg-Nord (5500–5100 cal. BC). Numbers of identified animal bones (NISP) and their frequency in percent. The fish species are labelled in the categories marine (M), migrating (F/M) and freshwater (F).

Inventory-no.	Sample-no.	BP	cal. BC	$\delta^{13}C$	Square unit/layer	Object
2002/1758-0001,1	KIA-20427	6009 ± 36	4882 ± 54	–30,1	N101/E103/A1	Fish trap, wooden stick
2002/1758-0001,2	KIA-20428	6054 ± 31	4934 ± 59	–28,0	N101/E103/A1	Fish trap, bast binding
2002/1758-0004	KIA-20431	5966 ± 42	4842 ± 59	–25,0	N101/E104/A1	Fishing fence, post
2002/1758-0005	KIA-20432	6072 ± 32	4959 ± 59	–28,8	N101/E105/A1	Fishing fence, post
2002/1758-0002	KIA-20429	6110 ± 30	5018 ± 56	–27,6	N101/E103/A1	Fishing fence, post
2002/1758-0003	KIA-20430	6137 ± 38	5088 ± 94	–27,3	N101/E103/A1	Fishing fence, post
2002/1758-0660	KIA 24231	6088 ± 33	4984 ± 55	–28,2	N101/E107/A8	Leister prong
2002/1758-0462	KIA 24230	6108 ± 35	5022 ± 67	–33,3	N101/E107/A4	Leister prong
2002/1758-1030	KIA-24076	6439 ± 46	5405 ± 50	–18,7	N100/E107/A4	Cod
2002/1758-1034	KIA-24080	6476 ± 37	5424 ± 42	–15,9	N100/E107/-	Cod
2002/1758-0589	KIA-24077	6136 ± 35	5088 ± 92	–22,2	N100/E107/A5	Roe deer
2002/1758-1081	KIA-22800	6319 ± 43	5293 ± 56	–26,8	N099/E112/A0	Tree stump
2002/1758-1061	KIA-22799	6532 ± 44	5487 ± 60	–28,8	N092/E106/A0	Tree stump
2002/1758-0516	KIA-24075	6455 ± 37	5415±43	–23,1	N100/E106/A1	Mammal undet.
2002/1758-0533	KIA-27255	6463 ± 26	5421 ± 38	–24,5	N101/E104/A11	Charcoal, fire place
2002/1758-1060	KIA-27256	6506 ± 42	5450 ± 56	–23,9	N100/E106/A11	Antler harpoon
2002/1758-0806	KIA 24232	6652 ± 27	5575 ± 37	–28,0	N100/E106/A11	Wood
2002/1758-0970	KIA-24078	6705 ± 38	5613 ± 46	–20,0	N100/E107/A11	Wild boar
2002/1758-0831	KIA-24079	6983 ± 36	5858 ± 56	–18,4	N100/E107/A12	Mammal undet.
2002/1758-1045	KIA 24233	6931 ± 32	5791 ± 41	–26,5	N100/E106/A15	Splitted wood

Table 11. Timmendorf-Nordmole II (Ostsee II, Neuburg / Poel 47). Radiocarbon datings. The calibration was conducted with the programme Calpal of O. Jöris and B. Weninger (cf. www.calpal.de) and the calibration curve Intcal98 (Stuiver et al. 1998).

Core section and master depth	Depth below sea level	Material dated	Lab.-Nr.	14C-Age conv.	Calibrated Age (1 σ) Median
47/125–26 cm	566–567 cm	bud scales, seeds and fruits of terrestrial plants	Poz-35679	6190 ± 40	5300–5110 cal. BC5180 BC
47/140 cm	581 cm	bud scales, seeds and fruits of terrestrial plants	Poz-30504	6510 ± 40	5515–5380 cal. BC5475 BC
47/143 cm	584 cm	fruits of terrestrial plants	Poz-30505	6590 ± 50	5545–5485 cal. BC5520 BC
47/250 cm	591 cm	bud scales, seeds and fruits of terrestrial plants	Poz-35680	6590 ± 40	5615–5525 cal. BC5560 BC
47/267 cm	608 cm	bud scales	Poz-35681	6750 ± 40	5680–5620 cal. BC5655 BC

Table 12. Timmendorf-Nordmole II (Ostsee II, Neuburg/Poel 47). Radiocarbon dates from profile Poel 47. The dates were calibrated using Intcal09 data set (Reimer et al. 2009) and the sequence method of the OxCal 4.1 deposition models (Bronk Ramsey 2008) and are rounded by 5 years.

FISH	NISP (n)	NISP (%)	BIRD	NISP (n)	MAMMAL	NISP (n)
Anguilla anguilla (F/M)	1202	66,4	*Rallus aquaticus*	49*	*Capreolus capreolus*	19
Gobius niger (M)	297	16,4	Anatinae	5	*Arvicola terrestris*	8
Gadus morhua (M)	106	5,9	*Turdus* sp.	3	*Apodemus* sp.	5
Pleuronectidae (M)	52	2,9		57	*(Apodemus sylvaticus)*	(3)
(Platichthys flesus)	(1)				*(Apodemus flavicollis)*	(1)
Esox lucius (F)	40	2,2			*Cervus elaphus*	4
Perca fluviatilis (F)	30	1,7			*Sus scrofa*	4
Sander lucioperca (F)	22	1,2			Muridae indet.	2
Gasterosteus aculeatus (F/M)	18	1,0			*Castor fiber*	1
Cyprinidae (F)	18	1,0			*Myodes glareolus*	1
(Rutilus rutilus)	(1)				*Talpa europaea*	1
(Scardinius) erythrophthalmus	(1)					45
(Tinca tinca)	(1)					
Clupea harengus (M)	15	0,8				
Alosa sp. (F/M)	4	0,2				
Scomber scombrus (M)	2	0,1				
Psetta maxima (M)	1	0,1				
Belone belone (M)	1	0,1				
Salmo sp. (F/M)	1	0,1				
Coregonus sp. (F/M)	1	0,1				
Myoxocephalus scorpius (M)	1	0,1				
	1811	100				

Table 13. Timmendorf-Nordmole II (Ostsee II, Neuburg / Poel 47). (5100–4800 cal. BC). Numbers of identified animal bones (NISP) and their frequency in percent. The fish species are labelled in the categories marine (M), migrating (F/M) and freshwater (F).

FISH	NISP (n)	NISP (%)	BIRD	NISP (n)	MAMMAL	NISP (n)
Anguilla anguilla (F/M)	1178	75,3	Anatinae	69	Phocidae	10
Gadus morhua (M)	277	17,7	*(Bucephala clangula)*	(8)	*(Halichoerus grypus)*	(5)
Pleuronectidae (M)	51	3,8	*(Aythya fuligula)*	(8)	*(Phoca groenlandica)*	(2)
(Platichthys flesus)	(8)		(*Aythya* sp.)	(1)	*Arvicola terrestris*	7
(Pleuronectes platessa)	(2)		*(Mergus mergaster)*	(2)	*Capreolus capreolus*	6
Scomber scombrus (M)	18	1,2	*(Mergus serrator)*	(2)	*Cervus elaphus*	4
Gasterosteus aculeatus (F/M)	14	0,8	*Dendrocopos major*	1	*Microtus agrestis*	4
Clupea harengus (M)	11	0,7	Laridae	1	*Sus scrofa*	3
Perca fluviatilis (F)	2	0,1	*Turdus philomelos*	1	*Sus scrofa* (f. domestica?)	2
Zoarces viviparus (M)	2	0,1		72	*Myodes glareolus*	2
Salmo truttax (F/M)	1	0,1			*Lutra lutra*	1
	1567	100			Apodemus flavicollis	1
					Sorex araneus	1
					Bos primigenius (f. taurus?)	1
						43

Table 14. Timmendorf-Nordmole I (Ostsee II, Neuburg / Poel 12), trench 1.
Numbers of identified animal bones (NISP) and their frequency in percent.
The fish species are labelled in the categories marine (M), migrating (F/M) and freshwater (F).

	NISP (n)	NISP (%)		NISP (n)		NISP (n)	NISP (%)
Anguilla anguilla (F/M)	10339	47,2	Anatinae	289	Phocidae	172	32,3
Gadidae (M)	8401	38,4	*(Bucephala clangula)*	(54)	*(Halichoerus grypus)*	60)	
(Gadus morhua)	(8397)		*(Mergus albellus)*	(49)	*(Phoca groenlandica)*	(17)	
(Pollachius pollachius)	(2)		*(Aythya fuligula)*	(39)	*(Phoca hispida)*	(8)	
(Melanogrammus aeglefinus)	(1)		(*Aythya* sp.)	(5)	*Capreolus capreolus*	155	29,0
(Merlangius merlangus)	(1)		*(Mergus mergaster)*	(5)	*Sus scrofa*	46	8,6
Pleuronectidae (M)	2527	11,5	*(Aythya ferina)*	(4)	Muridae/Arvicolidae	33	6,2
(Platichthys flesus)	31)		*(Mergus* sp.*)*	(4)	*Cervus elaphus*	33	6,2
(Pleuronectes platessa)	6)		*(Mergus serrator)*	(4)	*Canis lupus* f. familiaris	24	4,5
(Limanda limanda)	2)		*(Anas platyrhynchos)*	(3)	*Vulpes vulpes*	23	4,3
Clupea harengus (M)	177	0,8	*(Anas querquedula)*	(3)	*Felis silvestris*	14	2,6
Zoarces viviparus (M)	155	0,7	*(Anas acuta)*	(2)	*Sus scrofa* (f. domestica?)	5	0,9
Gasterosteus aculeatus (F/M)	86	0,4	*(Anas clypeata)*	(2)	*Arvicola terrestris*	5	0,9
Scomber sombrus (M)	60	0,3	(Anseridae)	(2)	*Erinaceus europaeus*	4	0,7
Salmo trutta (F/M)	46	0,2	*(Somateria mollissima)*	(2)	*Martes martes*	3	0,6
Cyprinidae (F)	39	0,2	*(Anas crecca)*	(1)	*Canis/Vulpes*	3	0,6
(Rutilus rutilus)	(6)		*(Anas penelope)*	(1)	*Lutra lutra*	2	0,4
(Scardinius erythrophthalmus)	(5)		*(Anser anser)*	(1)	*Castor fiber*	2	0,4
Perca fluviatilis (F)	31	0,1	*(Aythya marila)*	(1)	Apodemus flavicollis	2	0,4
Myoxocephalus scorpius (M)	23	0,1	*(Clangula hyemalis)*	(1)	*Sciurus vulgaris*	1	0,2

Sander lucioperca (F)	4	<0,1	*(Melanitta fusca)*	(1)	*Microtus agrestis*	1	0,2
Psetta maxima (M)	3	<0,1	*(Tadorna tadorna)*	(1)	*Myodes glareolus*	1	0,2
Conger conger (M)	2	<0,1	*Cygnus cygnus*	2	*Canis lupus* (f. familiaris)	1	0,2
Coregonus sp. (F/M)	2	<0,1	*Podiceps griseigena*	2	*Bos primigenius*	1	0,2
Belone belone (M)	1	<0,1	*Podiceps cristatus*	2	*Bos primigenius* (f. taurus?)	1	0,2
Dicentrentracus labrax (M)	1	<0,1	*Gavia* sp.	2		532	100
	21897	100	*Larus marinus*	2			
			Grus grus	2			
			Cygnus sp.	3			
			Gavia arctica	1	REPTILE	NISP (n)	
			Larus fuscus	1	*Emys orbicularis*	3	
			Haliaeetus albicilla	1			
			Bubo bubo	1			
			Corvus corone	1			
			Sylvia sp.	1			
			Turdus sp.	1			
				306			

Table 15. Timmendorf-Nordmole I (Ostsee II, Neuburg / Poel 12), trench 5. Numbers of identified animal bones (NISP) and their frequency in percent. The fish species are labelled in the categories marine (M), migrating (F/M) and freshwater (F).

Inventory-no.	Sample-no.	BP	cal. BC	$\delta^{13}C$	Square unit/layer	Object
1999/0661-2718	KIA 31540	5024 ± 35	3834 ± 78	–27,7	N301/E51/A1	Wood with working traces
1999/0661-2846	KIA 31542	5130 ± 34	3899 ± 71	–28,6	N302/E49/A1	Wooden tool
1999/0661-2883	KIA 31543	5200 ± 33	4009 ± 37	–26,7	N302/E49/A2	Leister prong
1999/0661-2466	KIA 31537	5142 ± 35	3910 ± 73	–28,6	N302/E52/A3	Leister prong
1999/0661-2839	KIA 31541	5142 ± 35	3910 ± 73	–29,4	N301/E52/A3	Wooden tool
1999/0661-2940	KIA 31546	5022 ± 33	3832 ± 78	–26,0	N302/E49/A3	Wood with working traces
1999/0661-2930	KIA 31545	5136 ± 33	3904 ± 71	–24,5	N301/E51/A5	Leister prong
1999/0661-3110	KIA 31548	5243 ± 30	4087 ± 92	–22,5	N302/E48/A5	Leister prong
1999/0661-3382	KIA 31553	5319 ± 33	4132 ± 67	–26,2	N301/E49/A6	Ash spear
1999/0661-2915	KIA 31544	5182 ± 39	3997 ± 40	–30,4	N301/E51/A7	Pointed wooden stab
1999/0661-3313	KIA 31549	5681 ± 45	4517 ± 57	–26,6	N301/E51/A9	Charred wood
1999/0661-3366	KIA 31550	5765 ± 38	4616 ± 59	–30,9	N302/E49/A10	Leister prong
1999/0661-3368	KIA 31551	5720 ± 40	4567 ± 65	–29,2	N302/E49/A10	Leister prong
1999/0661-2479	KIA 31539	5956 ± 35	4831 ± 55	–25,9	N302/E54/A7	Charred wood
1999/0661-3371	KIA 31552	5463 ± 32	4298 ± 41	–27,3	N302/E49/A10	Wooden post
1999/0661-2475	KIA 31538	5029 ± 33	3841 ± 74	–27,6	N302/E51/A3-8	Wooden post
1999/0661-3082	KIA 31547	5286 ± 33	4114 ± 75	–19,9	N302/E48/A4	Antler axe

Table 16. Timmendorf-Nordmole III (Ostsee II, Neuburg / Poel 12b). Radiocarbon datings of trench 3. The calibration was conducted with the programme Calpal of O. Jöris and B. Weninger (cf. www.calpal.de) and the calibration curve Intcal98 (Stuiver et al. 1998).

FISH	NISP (n)	NISP (%)	BIRD	NISP (n)	NISP (%)	MAMMAL	NISP (n)	NISP (%)
Gadus morhua (M)	1150	46,8	Anatinae	314	95,4	Phocidae	53	28,5
Anguilla anguilla (F/M)	735	29,9	*(Bucephala clangula)*	(75)		*(Halichoerus grypus)*	(6)	
Pleuronectidae (M)	493	20,9	*(Mergus albellus)*	(38)		*(Phoca groenlandica)*	(6)	
(Platichthys flesus)	(19)		*(Aythya fuligula)*	(28)		*Capreolus capreolus*	43	18,9
(Pleuronectes platessa)	(2)		*(Mergus serrator)*	(13)		*Arvicola terrestris*	40	17,5
Salmo trutta (F/M)	16	0,7	*(Clangula hyemalis*	(7)		*Sus scrofa*	16	7,0
Perca fluviatilis (F)	10	0,4	*(Mergus mergaster)*	(7)		*Canis lupus* f. familiaris	11	4,8
Clupea harengus (M)	8	0,3	*(Anas clypeata)*	(5)		*Cervus elaphus*	9	3,9
Zoarces viviparus (M)	8	0,3	*(Aythya farina)*	(5)		*Sus scrofa* (f. domestica?)	8	3,5
Gasterosteus aculeatus (F/M)	6	0,2	*(Aythya marila)*	(4)		*Vulpes vulpes*	7	3,1
Sander lucioperca (F)	5	0,2	*(Melanitta fusca)*	(3)		*Felis silvestris*	6	2,7
Conger conger (M)	3	0,1	*(Anas acuta)*	(1)		*Martes martes*	6	2,7
Myoxocephalus scorpius (M)	3	0,1	*(Somateria mollissima)*	(1)		Apodemus flavicollis	5	2,3
Tinca tinca (F)	1	0,1	*(Anas crecca)*	(1)		*Talpa europaea*	2	0,9
	2459	100	*(Tadorna tadorna)*	(1)		*Canis/Vulpes*	2	0,9
			(Anas platyrhynchos)	(1)		*Lutra lutra*	1	0,4
			(*Aythya* sp.)	(1)		*Sciurus vulgaris*	1	0,4
			(Anas querquedula)	(1)		*Sorex araneus*	1	0,4
			(Melanitta nigra)	(1)		*Myodes glareolus*	1	0,4
			Cygnus cygnus	3	0,9	*Micromys minutus*	1	0,4
			Gavia arctica	2	0,6	*Bos primigenius* f. taurus	1	0,4
			Branta bernicla	1	0,3		228	100
			Branta leucopsis	1	0,3			
			Podiceps cristatus	1	0,3			
			Rallus aquaticus	1	0,3			
			Grus grus	1	0,3			
			Laridae	1	0,3	REPTILE	NISP (n)	
			Haliaeetus albicilla	1	0,3	*Emys orbicularis*	2	
			Bubo bubo	1	0,3			
			Ciconia sp.?	1	0,3			
			Alcidae?	1	0,3			
				326	100			

Table 17. Timmendorf-Nordmole III (Ostsee II, Neuburg / Poel 12b), trench 3. Numbers of identified animal bones (NISP) and their frequency in percent. The fish species are labelled in the categories marine (M), migrating (F/M) and freshwater (F).

FISH	NISP (n)	NISP (%)	MAMMAL	NISP (n)
Pleuronectidae (M)	26	57,8	*Arvicola terrestris*	1
Perca fluviatilis (F)	12	26,7		
Myoxocephalus scorpius (M)	7	15,6		
	45	100		

Table 18. Timmendorf-Tonnenhaken (Ostsee II, Neuburg / Poel 15), Numbers of identified animal bones (NISP) and their frequency in percent. The fish species are labelled in the categories marine (M), migrating (F/M) and freshwater (F).

Inventory-no.	Sample-no.	BP	cal. BC	$\delta^{13}C$	Square unit/layer	Object
2003/0523-0037	KIA-27246	5889 ± 26	4755 ± 36	–23,8	Surface	Charcoal
2003/0523-0039	KIA-27247	6005 ± 26	4875 ± 47	–26,0	Surface	Wooden shaft
2003/0523-0043	KIA-27248	6577 ± 32	5538 ± 47	–25,4	Surface	Oak stump
2003/0523-0173	KIA-35515	5347 ± 36	4159 ± 82	–13,1	N111/E100/A2	Mammal undet.
2003/0523-0112	KIA-35516	6473 ± 30	5423 ± 39	–20,4	N112/E100/A5	Mammal undet.
2003/0523-0113	KIA-35517	6031 ± 28	4904 ± 48	–26,5	N112/E100/A5	Charred wood

Table 19. Kamminer Ort (Ostsee VI, Wittow 100). Radiocarbon datings. The calibration was conducted with the programme Calpal of O. Jöris and B. Weninger (cf. www.calpal.de) and the calibration curve Intcal98 (Stuiver et al. 1998).

Inventory-no.	Sample-no.	BP	cal. BC	$\delta^{13}C$	Square unit/layer	Object
2003/0538-0121	KIA-24245	5393 ± 29	4245 ± 67	–27,5	N175/E100/A1	Wooden post, fishing fence
2003/0538-0102	KIA-24248	5802 ± 30	4653 ± 52	–21,3	N174/E100/A1	Wild boar
2003/0538-0102	KIA-26399	6145 ± 35	5099 ± 88	–15,9	N174/E100/A1	Seal
2003/0538-0118	KIA-24247	6574 ± 35	5537 ± 47	–26,2	N174/E100/A4	Charcoal, fire place
2003/0538-0143	KIA-24246	6181 ± 35	5139 ± 70	–26,0	N175/E100/A1	Oak trunk
2003/0538-0071	KIA-24249	5704 ± 30	4534 ± 47	–21,8	N174/E111/A1	Red deer
2003/0538-0137	KIA-24250	5879 ± 35	4748 ± 41	–23,1	N174/E111/A5	Roe deer
2003/0538-0267	KIA-35518	5883 ± 29	4751 ± 37	–27,2	N170/E099/A3	Leister prong
2003/0538-0192	KIA-35519	5862 ± 27	4733 ± 37	–27,5	N172/E099/A3	Leister prong
2003/0538-0215	KIA-35520	5873 ± 34	4742 ± 40	–20,3	N172/E099/A2	Mammal undet.
2003/0538-0426	KIA-35521	5778 ± 27	4628 ± 52	–25,5	N172/E099/A3	Mammal undet.
2003/0538-0283	KIA-35522	5953 ± 28	4827 ± 49	–23,2	N172/E099/A4	Mammal undet.

Table 20. Breetzer Ort (Ostsee VI, Bergen 24). Radiocarbon datings. The calibration was conducted with the programme Calpal of O. Jöris and B. Weninger (cf. www.calpal.de) and the calibration curve Intcal98 (Stuiver et al. 1998).

FISH	NISP (n)	NISP (%)	BIRD	NISP (n)	MAMMAL	NISP (n)
Perca fluviatilis (F)	2497	94,1	*Haliaeetus albicilla*	1	*Capreolus capreolus*	24
Sander lucioperca (F)	47	1,8	*Pandion haliaetus*	1	*Sus scrofa*	21
Pleuronectidae (M)	36	1,4	Anatinae	1	*Cervus elaphus*	20
(Platichthys flesus)	(1)			3	Phocidae	2
Cyprinidae (F)	34	1,3			*(Halichoerus grypus)*	(2)
Esox lucius (F)	34	1,3			*Lutra lutra*	1
Anguilla anguilla (F/M)	5	0,2				68
Gadus morhua (M)	2	<0,1				
Belone belone (M)	1	<0,1				
	2656	100				

Table 21. Breetzer Ort (Ostsee VI, Bergen 24). Numbers of identified animal bones (NISP) and their frequency in percent. The fish species are labelled in the categories marine (M), migrating (F/M) and freshwater (F).

FISH	NISP (n)	NISP (%)	BIRD	NISP (n)	MAMMAL	NISP (n)	NISP (%)
Percidae (F)	1321	59,6	*Cygnus* sp.	3	*Capreolus capreolus*	54	26,2
(Perca fluviatilis)	(1315)		Anatinae	2	Phocidae	44	21,4
(Sander lucioperca)	(6)			5	*(Halichoerus grypus)*	(17)	
Pleuronectidae (M)	540	24,4			*(Phoca groenlandica)*	(4)	
Gadus morhua (M)	126	5,7			*Cervus elaphus*	39	18,9
Cyprinidae (F)	107	4,8			*Sus scrofa* (f. domestica?)	26	12,6
(Rutilus rutilus)	(3)				*Sus scrofa*	15	7,3
(Leuciscus idus)	(2)				*Vulpes vulpes*	4	1,9
(Abramis brama)	(1)				*Bos primigenius*	3	1,5
Myoxocephalus scorpius (M)	49	2,2			*Canis lupus* f. familiaris	3	1,5
Esox lucius (F)	31	1,4			*Lutra lutra*	2	1,0
Clupea harengus (M)	15	0,7			*Phocoena phocoena*	2	1,0
Belone belone (M)	5	0,2			*Ovis / Capra*	2	1,0
Salmo trutta (F/M)	1	<0,1			*Bos primigenius* (f. taurus?)	2	1,0
	2024	100			*Apodemus flavicollis*	2	1,0
					Arvicola terrestris	2	1,0
					Martes martes	1	0,5
					Sciurus vulgaris	1	0,5
					Bos primigenius f. taurus	1	0,5
					Adopemus sylvaticus	1	0,5
					Apodemus sp.	1	0,5
					Micrimys minutus	1	0,5
						206	100

Table 22. Lietzow-Buddelin (Saiser Fpl. 1, Lkr. Rügen). Numbers of identified animal bones (NISP) and their frequency in percent. The fish species are labelled in the categories marine (M), migrating (F/M) and freshwater (F). After Hegge (2010).

FISH	NISP (n)	NISP (%)	BIRD	NISP (n)	MAMMAL	NISP (n)	NISP (%)
Pleuronectidae (M)	986	48,9	Anatinae	9	*Cervus elaphus*	170	28,5
Percidae (F)	555	27,4	*Cygnus* sp.	3	Phocidae	90	15,1
(Perca fluviatilis)	(545)		Accipitridae	2	*(Halichoerus grypus)*	(32)	
(Sander lucioperca)	(9)		*(Halliaeetus albicilla)*	(1)	*(Phoca groenlandica)*	(18)	
(Gymnocephalus cernuus)	(1)		*Anthus pratensis*	1	*Bos primigenius* (f. taurus?)	80	13,4
Clupea harengus (M)	139	6,9	Charadriiformes	1	*Sus scrofa* (f. domestica?)	66	11,1
Gadidae	132	6,5		16	*Bos primigenius*	44	7,4
Anguilla anguilla (F/M)	83	4,1			*Sus scrofa*	37,2	6,2
Myoxocephalus scorpius (M)	68	3,4			*Capreolus capreolus*	31	5,2
Cyprinidae (F)	27	1,3			*Canis lupus* f. familiaris	31	5,2
(Abramis brama)	(3)				*Bos primigenius* f. taurus	11	1,8
(Leuciscus idus)	(1)				*Ovis / Capra*	9	1,5
Esox lucius (F)	16	0,8			*Sus scrofa* f. domestica	5	0,8
Scomber scombrus (M)	10	0,5			*Martes martes*	4	0,7
Scorpaenidae	1	<0,1			*Arvicola terrestris*	4	0,7
	2017	100			*Felis silvestris*	2	0,3
					Phocoena phocoena	1	0,2
					Talpa europaea	1	0,2
					Sciurus vulgaris	1	0,2
					Lutra lutra	1	0,2
					Equus ferus	1	0,2
					Apodemus sylvaticus	1	0,2
						596	100

Table 23. Baabe. Numbers of identified animal bones (NISP) and their frequency in percent.
The fish species are labelled in the categories marine (M), migrating (F/M) and freshwater (F). After Hegge (2010).

FISH	NISP (n)	NISP (%)	BIRD	NISP (n)	MAMMAL	NISP (n)
Perca fluviatilis (F)	189	68,7	*Aythya fuligula*	4	*Capreolus capreolus*	10
Pleuronectidae (M)	35	12,7	*Aythya marila*	2	*Cervus elaphus*	4
Cyprinidae (F)	19	6,9	Anas clypeata	1	*Sus scrofa* (f. domestica?)	3
(Abramis brama)	(3)			19	*Sus scrofa*	2
(Rutilus rutilus)	(1)				*Canis lupus* f. familiaris	1
Sander lucioperca (F)	10	3,6			*Apodemus* sp.	1
Gadus morhua (M)	8	2,9				21
Esox lucius (F)	7	2,5				
Anguilla anguilla (F/M)	3	1,1				
Belone belone (M)	2	0,7				
Clupea harengus (M)	1	0,4				
Salmo sp. (F/M)	1	0,4				
	275	100				

Table 24. Parow. Numbers of identified animal bones (NISP) and their frequency in percent. The fish species are labelled in the categories marine (M), migrating (F/M) and freshwater (F). After Hegge (2010).

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