

Mesolithic Settlement sites on the East Frisian Peninsula. Landscape history and development with regard to pingo scars as preferred settlement sites

Mesolithische Siedlungsplätze auf der Ostfriesischen Halbinsel.

Landschaftsgeschichte und –entwicklung im Hinblick auf Pingoruinen als bevorzugte Siedlungsplätze

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ABSTRACT - Many Mesolithic settlement remains that have been surveyed on the East Frisian moraine area during the last decades have been described to be situated close to little bogs and former lakes. With the detection of pingo scars as landscape features East Frisia that in many cases have been filled by lakes during the early Holocene and showed traces of Mesolithic settlement in several cases the idea to compare those two phenomenon was born. This article gives an introduction to this idea by four case studies of Mesolithic sites at pingo scars and some ideas on the attraction of these landscape features to Mesolithic foragers.

ZUSAMMENFASSUNG - Für einige mesolithische Fundstellen, die in den letzten Jahrzehnten auf der Geestlandschaft Ostfrieslands nachgewiesen werden konnten, wurde eine topographische Lage unweit von kleinen Mooren oder ehemaligen Seen festgestellt. In den letzten Jahren wurden verstärkt Pingo-Ruinen als unter Permafrostbedingungen während der letzten Eiszeit entstandener Landschaftsmerkmale Ostfrieslands lokalisiert und untersucht, die in vielen Fällen im frühen Holozän mit Seen gefüllt waren und in einigen Fällen Spuren mesolithischer Besiedlung zeigten. Daraus entstand die Idee, diese beiden Phänomene zu vergleichen. Der vorliegende Artikel gibt hierzu eine Einführung anhand vier Fallstudien von mesolithischen Fundstellen auf Randwällen von Pingo-Ruinen sowie Anmerkungen zur Rolle dieser Landschaftsmerkmale für mesolithische Jäger und Sammler.

KEYWORDS - settlement structure, persistant places, peat bogs, kettle bogs, microliths, core axes
Siedlungsstruktur, persistente Stellen, Hochmoore, Kesselmoore, Mikrolithen, Kernbeile

Introduction

Although there are some traces of human activities during the Pleistocene, Mesolithic settlements are the earliest sites that appear regularly in East Frisia. Beginning with the onset of the Holocene the Mesolithic way of life as hunter-gatherers is expected to have lasted until the start of the first farming culture in the area, the Trichterbecher Culture, around 3'500 calBC.

The peninsula of East Frisia is a coastal landscape situated between estuaries of the River Ems in the west and River Weser in the east. The northern edge

is formed by the shoreline of the North Sea. The central part of East Frisia is characterized by Saalian ground moraines that build a flat, sandy dryland up to little more than 24 m above sea level. The moraine area defines the watershed with little streams draining to the north east and south west into lower parts of the landscape. Marshy sediments stemming from Holocene marine sedimentation processes characterize the lower terrain. Until 6'000 calBC the North Sea level rose dramatically and reached approximately -5m below recent sea level (Behre 2003: Fig. 7; Bungenstock & Weerts 2010). There, marsh was deposited and subsequently covered a large area of the former postglacial landscape, shaping today's very flat topography.

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The environmental changes also came along with rising ground water level and increasing soil wetness during the second half of the Mesolithic. Additionally, the growth of peat bogs starts during this period, indicating climatic changes from dry and continental to humid and coastal conditions (Petzelberger et al. 1999).

The vegetation development from the late Palaeolithic and early Holocene is described by Behre (1966) using a pollen profile at the location of Westrhaudefehn, where he states a reforestation during the Preboreal with birch and pine trees. With the transition to boreal times pine is dominating. An increase of hazel pollen is recorded later than in other areas. During in the second half of the Boreal, thermophile trees appear. Especially elder can be found among the tree pollen, while the typical oak-mix-forest is proved to a lesser extent.

History of research

The region of East Frisia belongs to the Mesolithic technocomplex of the so-called Northwest Group. First described by Schwabedissen (1944) and mainly characterized by the absence of flake and core axes, an impression that has changed a bit during the last decades. It became more obvious that Mesolithic axes

are present – even if rare – in the area of northwestern Germany and the northeastern Netherlands. There, the Mesolithic material culture is different from that of the neighbouring Rhine-Delta area to the west and the northern Mesolithic to the northeast. While the Rhine-Maas-Scheldt-Group uses surface retouched, leaf-shaped points (Crombé 2002) and the Northern Group produces standardized microliths whose appearance changes through the different Mesolithic periods (Vang Petersen 1984), the Northwest Group shows none of these characteristics. Here, the microlithic spectrum ranges from micropoints to triangles that appear during the whole period, while the introduction of trapeze shaped points can be dated to around 6'000 calBC (Lanting & Van der Plicht 2000).

On the East Frisian peninsula Mesolithic settlement sites have never been the object of a focused research in the sense of survey and excavation. Much to the contrary, most sites were discovered by accident or due to long-standing surveys by volunteers (Kitz 1988: 25). This can be observed easily by regarding distribution maps of Mesolithic sites in East Frisia (Fig. 1): Clusters of sites do often fit with the respective research areas of the volunteers.

Within the last thirty years two main publications summarize the state of research by following two

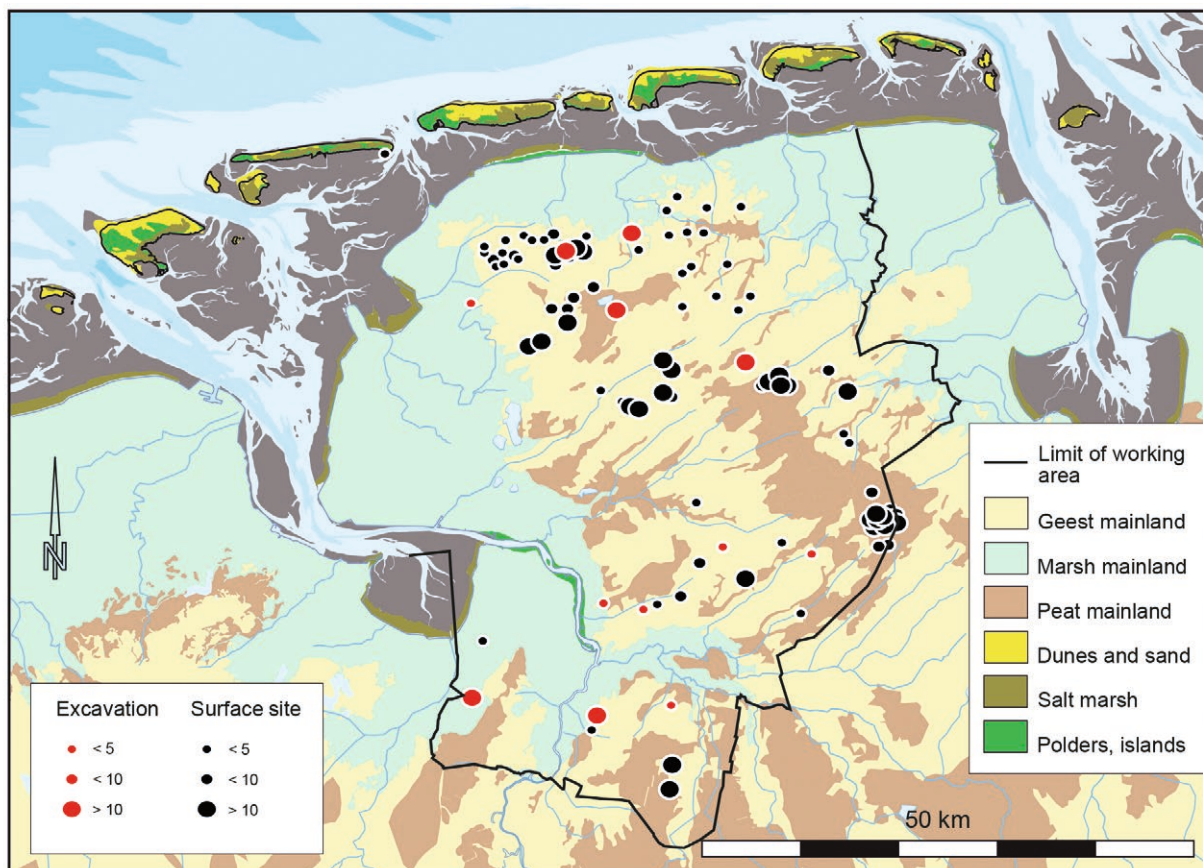


Fig. 1. Mesolithic sites in East Frisia by number of finds and kind of investigation (graphics: J. F. Kegler & H. Reimann/Ostfriesische Landschaft).

Abb. 1. Mesolithische Fundstellen in Ostfriesland nach Anzahl der Funde und Art der Untersuchung (Grafik: J. F. Kegler & H. Reimann/Ostfriesische Landschaft).

different approaches. A more technical description of lithic assemblages was presented by W. Schwarz in 1990, whereas one of the authors of this paper discusses chronological and functional aspects as well as aspects of landscape use by the Mesolithic people in several sample areas in Lower Saxony (Mahlstedt 2015).

Mesolithic sites in East Frisia can be separated into roughly three different types of sites: Surface sites that have been surveyed more or less regularly and where only lithic material has been collected. The second type is resembled by sites such as Nüttermoor (Kegler 2013a), Loga (Kegler 2012) or Hesel (Bärenfänger 1997), where several pits filled with charcoal and partly burned cobblestones (cooking stones) have been discovered. Lithic material could hardly be observed in those pits, but radiocarbon dating refers the sites to the Mesolithic period.

The settlement site of Brockzetel was one of the first sites discovered in East Frisia, close to the former Brockzeteler Meer, a shallow inland water (Zylmann 1937). This site is one of the few that has not only delivered lithic material, but also obvious features like fireplaces. It therefore represents the third type, along with "Narper Feld" (Schwarz 1993) and Menstede-Coldinne (Kitz 1987). At these rather rare sites, Mesolithic lithic material has been discovered together with hearths and pits used for cooking.

East Frisia shows a permanent settlement of human hunter-gatherers during the Mesolithic Period. Recent research by two of the authors indicates that some of the Mesolithic settlement sites were situated close to pingo ruins (Hüser et al. 2017).

The sites

As mentioned above, Mesolithic sites from Eastern Frisia are mostly known from surface collections, only very few sites have been excavated, showing single find layers without chronological sequence and only few structures like hearth pits (Kitz 1988; Schwarz 1993).

While in other parts of north western Germany Mesolithic sites seem to be located mainly along streams and streamlets, the sites in East Frisia at first sight seem to scatter more or less randomly in the landscape. Some are associated to larger and smaller peat bogs, which might have been partly open waters or wet zones with reed and alder swamps during the time of site use.

In an earlier study S. Mahlstedt (2015: 123 ff.) could show that 35 Mesolithic sites from the central part of East Frisia were distinctively chosen to provide certain environmental conditions. Therefore, she compared the landscape features of the sites with 388 randomly chosen places in the area. The Mesolithic sites of this study were situated in significantly higher and more exposed places than the comparison group. The soil conditions on the sites show a preference of sandy, permeable soils. The sites are mostly placed farther away than 500 m from the next stream. To get a

comparable value for the wetness of a site, a flow accumulation raster from a digital elevation model was created, showing the amount of raster cells in the surrounding of a site draining through the site. Using this model, it could be shown that the flow accumulation on the Mesolithic sites is significantly smaller than within the comparison group, indicating dryer than average conditions.

Generally, a strong tendency towards the use of places that are higher, dryer and more exposed than the average landscape of East Frisia could be proved. As most investigated sites of the study are situated on the sandy moraine area, while the comparison group is also distributed in the surrounding marsh areas, this can be interpreted as preferred choice of the Mesolithic inhabitants. However, it must be taken into account, that especially the marshy areas with their thick cover of marine sediments may hide former Mesolithic places underneath. Thus, the possible habitation of lower and wetter, but more sheltered places by Mesolithic people is a loose end that will have to be tied up by coming research.

Another interesting feature concerning the distribution of sites in the landscape is the fact that they cluster together in two or three find concentrations on one elevation. In several cases, these elevations can be reconstructed as shores of lakes, ponds or wet zones. This shows that the proximity to water still played a role apart from bigger streams. Due to the unspecific characteristic of such surface sites, it is yet unclear whether these concentrations are traces of contemporaneous or repeated visits. In the latter case a certain tradition of use can be expected that is corresponding with the "persistent places" defined by Barton and colleagues (1995: 111 f.). They describe such places as fixed and frequently re-used for the same purpose. In the case of Mesolithic sites in East Frisia, we can expect hunting as possible main site function as well as other activities that might be connected with the proximity to water.

One example is the former lake „Kleines Wieseder Meer“, where a volunteer found a lot of different mesolithic flint tools in several concentrations over several years of active survey (Müller 1997; Mahlstedt 2015: Kat. Nr. 30-32). A comparable example is the Brockzeteler Meer (district of Aurich), a lake, which is drained today, and also just a few kilometers away. Flint finds as well as fireplaces (Zylmann 1937) characterize the site at its shore.

During the last years a landscape feature has come into focus of geologists and archaeologists in northern Germany, that obviously meets the requirements of Mesolithic occupation very well – dry exposed places by an open water body: The so-called pingos or pingo scars.

In this paper we are going to focus on the phenomenon of pingo scars as Mesolithic settlement areas.

Pingos: form and origin

The name „pingo“ is adapted from the native language of the Inuit of the Mackenzie delta in Canada and means *a growing hill*, but may symbolically also refer to a pregnant woman (Parriaux 2006: 330).

The geological name of this phenomenon is *Hydrolakkolith*. They are special features of permafrost areas with a continuous water supply and make up the largest geological formations in permafrost areas. Actually, the genesis of these structures can still be observed at recent pingos in parts of the northern hemisphere with similar permafrost conditions as in Canada (Mackenzie delta), Greenland, Siberia or Spitsbergen (Norway). With regard to their genesis, pingos are not to be confused with kettleholes. They are formed at places where locally occurring ground water encounters the frozen soil. The water freezes and – depending on the nature of the water supply – an ice lens is constantly growing due to the permafrost conditions. The lens can bulge the surface slowly by increasing the volume. In this way impressive conical frost hills arise from only a few metres up to 60 m in height and 300 m in diameter. The vaulted cover material slowly slips down – due to gravitation – during glacial summers and the sediments accumulate at the foot of the hill. During this process, the ice core is visible at some occasions. Then, the open ice core might melt at the appropriate temperature. In temperated climatic phases the growth rate of the ice stagnates or the complete ice core defrosts. After the final melting, a pingo is leaving behind a so-called pingo scar: A circular depression, often filled with water and surrounded by a rampart.

Investigations on recent pingos described by e.g. Makkay (1977), French (2007), Ehlers (2011: 202 ff.) or Ruiter (2012) define two different ways of its genesis: first a hydraulic system (open system pingos) and second a hydrostatic system (closed system pingos). Open system pingos are fed by groundwater from within or beneath the permafrost layer. The permafrost soil must be relatively thin or discontinuous. According to A. Ruiter (2012: 4–5), the process of an open pingo system is similar to the frozen form of an artesian well. The groundwater upwells and penetrates the uppermost permafrost layer. In contact with the frozen soil, the ice core begins to grow. This type of pingo is typical for areas with a significant difference in elevation.

The hydrostatic system pingos or closed system pingos, on the other hand, are common in areas with continuous permafrost. These pingos develop below the bottom of thermokarst lakes or at locations of old frost-heaved lake soils. Pingos are present not only in today's permafrost areas, instead scars of several pingos can be verified in all areas with former permafrost conditions. The distribution of pingos corresponds to areas, which were not covered by the ice shield during the Weichsel glaciation. This means for

the area of Northwestern Germany, presented here, that there has been a landscape shaping influence on the Saalian Morain landscape during the Weichsel glaciation additional to the known influences of extreme temperature, wind and melting water streams.

Proving pingos

The evidence of a pingo may be provided by two characteristics: the outer, oval-shaped hollow form with the circular remnants of the embankment on the one hand. However, the recognition and verification of a former pingo by its shape is not easy as the landscape in the north-western European plain has remarkably changed within the last 10'000 years, due to erosion processes, as well as recent, anthropogenic changes like peat digging and the intensive agricultural use.

On the other hand, a pingo can be identified by the sedimentation sequence of its deposits. At the bottom, usually a gyttia has deposited, stemming from organic material from a former lake. Here, the vegetation of the temperated late glacial Interstadials (Meiendorf/Bölling/Alleröd) can be detected. Less organic sediments accumulated during the Younger Dryas cold period (approx. 10'800–10'150 BP) cover these deposits. Holocene deposits (Preboreal) with organic clay and a final covering complete the sequence by peat layers.

The pingo phenomenon has been largely ignored for a long period of time by research in northern Germany and the large number of pingos in East Frisia is still occasionally doubted (K.D. Meyer, Hannover, pers. Comm.). K. Garleff first published about East Frisian pingos in 1968 (Garleff 1968). According to his assessment, there were only two pingo scars in the whole area of East Frisia.

One of the first pingos known in East Frisia is the „Doove Meer“ near Aurich-Rahe (Diameter approx. 200 m). Around the funnel-shaped pingo the rampart is still preserved. Studies of the vegetation environment by Holger Freund (1995) provided evidence for a lake in the Late Glacial and the Early Holocene that was covered by younger peat deposits. H. Freund interpreted this valley as a pingo (Freund 1995: 123). The Alleröd climatic phase is represented by a gyttia/mudd. During the late glacial interstadial, a lake existed in this depression already. During the following Younger Dryas the deforestation can be attested in the pollen diagram. After this, cold and dry period limnic sedimentation is detected again.

Still, a large number of pingos can be identified by their shape today (Fig. 2). Either they may be discerned on aerial photographs by examining typical growth characteristics of plants, or they are spared in agricultural areas due to waterlogged soils. In a few cases, the embankment in arable land can be differentiated from the environment by color, as sand is plowed onto the surface that can be easily distinguished from the filling

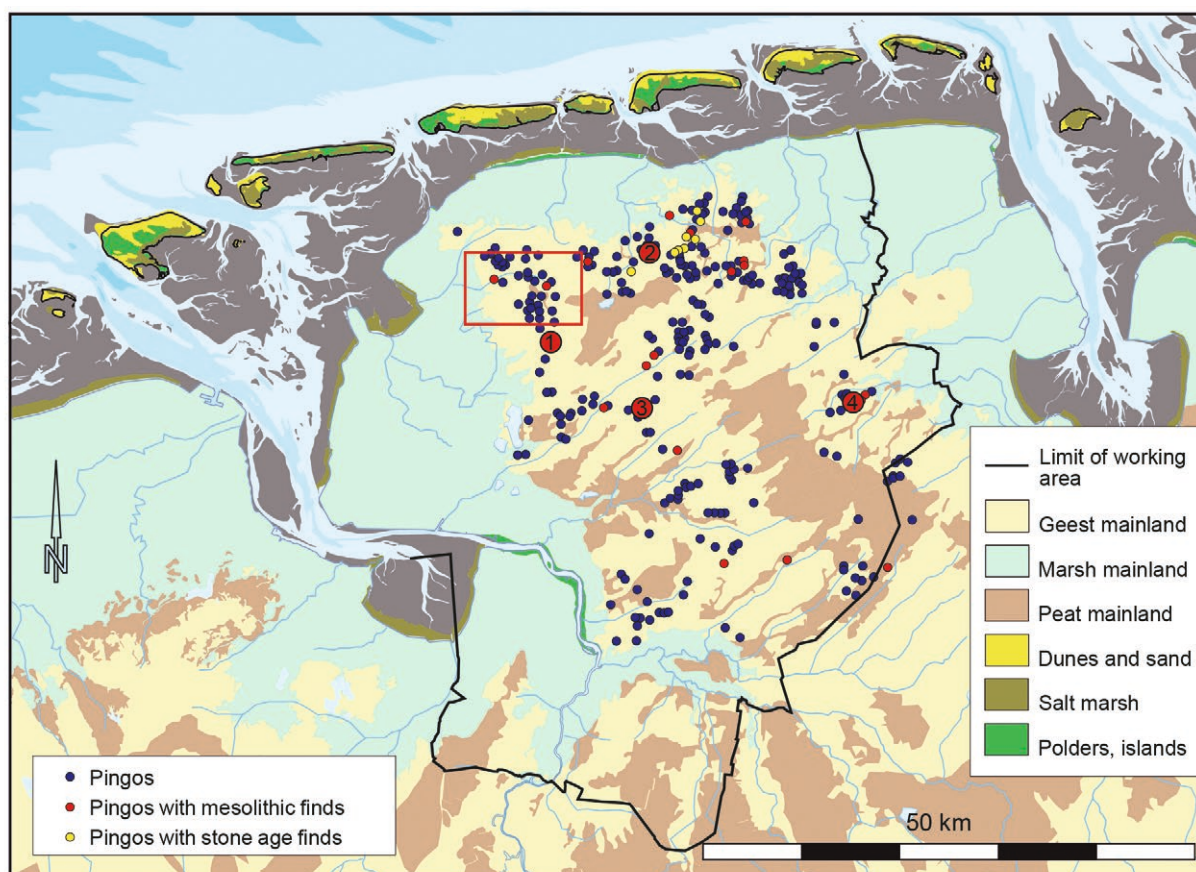


Fig. 2. Recorded pingo scars in East Frisia, sites described in the text marked by numbered dots: 1. Upende, 2. Uтары, 3. Kirchdorf, 4. Wrokmoor, red square: location of figure 3 (graphics: J. F. Kegler & H. Reimann/Ostfriesische Landschaft and A. Hüser).

Abb. 2. Kartierung bisher bekannter Pingo-Ruinen in Ostfriesland. Im Text genannte Fallbeispiele sind mit nummerierten Punkten hervorgehoben: 1. Upende, 2. Uтары, 3. Kirchdorf, 4. Wrokmoor, rotes Quadrat: Lage von Abb. 3 (Grafik: J. F. Kegler & H. Reimann/Ostfriesische Landschaft u. A. Hüser).

of the cone. After more than 10'000 years, the embankment slopes are largely ebbed today but are still observable in topographical maps or even better in high-resolution surface models. Best results can be gained by evaluating LIDAR data (Fig. 3). To finally identify a pingo apart from the outer shape, the stratigraphical analysis of the sequence is essential. For example, the sequence at "Timmeler Frauenmeer" shows a decline in grass pollen and a temporary increase in forest pollen in the Late Glacial (Hüser et al. 2017: 96, Fig. 4). The development is interrupted by the cold and dry Younger Dryas before birch, pine, hazel, oak and alder dominate the following times. The Younger Dryas, however, shows a short-term increase in grass pollen and crowberry, while tree pollen of birch and pine decline significantly. XRF-Scans can be used, additionally, to measure the mineral constituents of the sediments. Large variation ranges are not discernible, but as for the Younger Dryas, for example, an increased proportion of silicon and titanium was observed in the sands and clays that had apparently entered the pingo scar by wind activity at that time.

Obviously, not every pingo is showing all the characteristic features at once. There are realistic doubts that every pingo scar held a lake or pond

during the early Holocene. For example, at the pingo scar "Vagevuur" in the Netherlands several stubs of trees (Scots pine/*Pinus Sylvestris*) were discovered that are radiocarbon dated to the early eighth millennium (Woldring 2001). The trees probably grew on the edge of a then only tiny shallow bog or pool, not a complete water filled hollow shape.

For years, the former teacher Axel Heinze (Heinze et al. 2013), has stimulated the research of the phenomenon of pingos in East Frisia in cooperation with Dutch colleagues. He drilled a whole range of possible locations and these results have been incorporated into a series of theses, especially of Dutch universities (e.g. de Bruin 2012; Ruiters 2012; Tilly 2014). Heinze's research has expanded the known number of pingos from two to approximately more than 100 examples. It becomes more obvious that pingos seldom occur alone, but often in groups. During his fieldwork Heinze often came upon pingos in East Frisia that were holding archaeological sites, mostly Mesolithic ones (Heinze 2018). The craters of (collapsed) pingos – which are still visible in the landscape today – must have been visible more clearly in the landscape during the past. They were topographic markers in a wide postglacial landscape with no striking topography nor any granted fresh

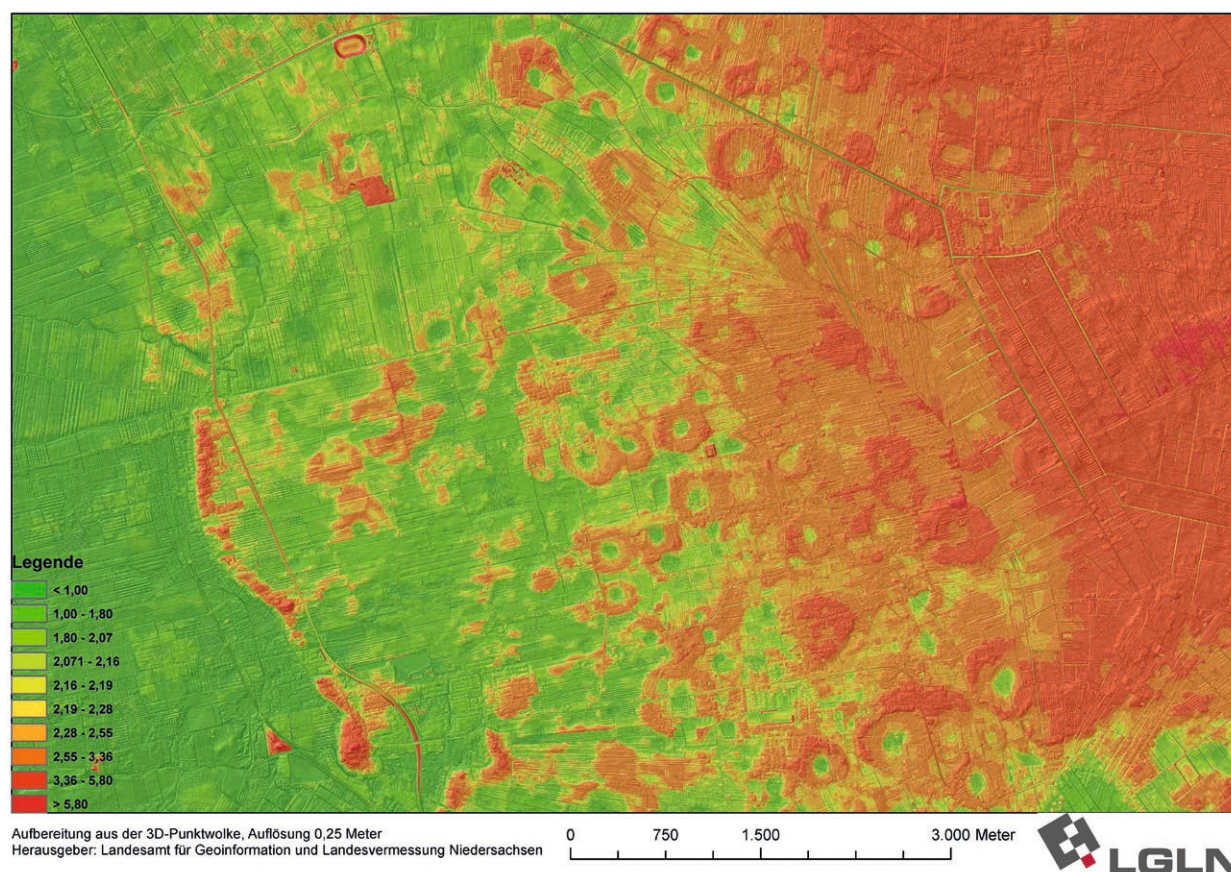


Fig. 3. Example of a pingo- landscape in western East-Frisia. Preparation from the 3D-point cloud, resolution 0.25 meters, for location see figure 2 red square (graphics: J.-U. Keilmann/State Office for Geoinformation and Land Surveying, Lower Saxony).

Abb. 3. Beispiel einer Pingolandschaft im westlichen Ostfriesland. Darstellung auf Basis von LIDAR-Daten, Auflösung 0,25 m. Zur Lokalisierung vgl. Abbildung 2 (roter Rahmen) (Grafik: J.-U. Keilmann/Landesamt für Geoinformation und Landesvermessung Niedersachsen).

water supply. It therefore does not seem too far-fetched to assume that they must have been of some interest to the Mesolithic people and we suppose that some of the Mesolithic sites were intentionally raised on the edge of a pingo. Obviously, during the early Holocene many of these depressions were filled with water and therefore offered suitable conditions for settlement sites in all ages.

Pingos and the Mesolithic – a pilot programme

This basic idea – the Mesolithic in connection with Pingos – has triggered a combined research program by the Lower Saxony Institute for Historical Coast Research (NIHK) in Wilhelmshaven and the Ostfriesische Landschaft (East Frisian Heritage Management) in Aurich. The aim is to have a first preliminary look at the interplay between pingos – as an outstanding landscape feature – and settlement sites – as the result of human activity. This research project takes into account results of the 50-year long archaeological survey by the Ostfriesische Landschaft and other archaeological services in the vicinity (Fig. 2). Samples taken from selected drilling cores at pingo sites form a basis for the reconstruction of the Holocene environmental conditions and will hopefully help to develop

an interpretation of how the landscape was utilized in the Mesolithic (Hüser et al. 2017). Although not all known Mesolithic sites have been examined with regard to their topographical relation to pingos yet and the settlement sites introduced below only provide a preliminary overview, the project has already led to a remarkably increasing number of verified pingos and similar structures with an evident Mesolithic settlement on the embankments.

In the following we would like to introduce some first observations of pingo-related Mesolithic sites and develop an idea of how the Mesolithic people set out to take advantage of what the landscape provided them with.

Wrokmoor (archive no. 2512/6:11)

The „Wrokmoor“ near Friedeburg-Hesel is one of the most impressive pingo ruins in East Frisia and one of the best known examples (Fig. 2: 4). It is located on the sandy Geest, and its depression with a diameter of a little over 100 meters is clearly visible in the landscape. The ground of this circular hollow shape is nearly 1.5 m deeper than the surroundings (Fig. 4: d). Even today, the Wrokmoor has an intact peat bog with characteristic vegetation (i.e. *sphagnum* moss). The biotope with natural flora and fauna is under protection.

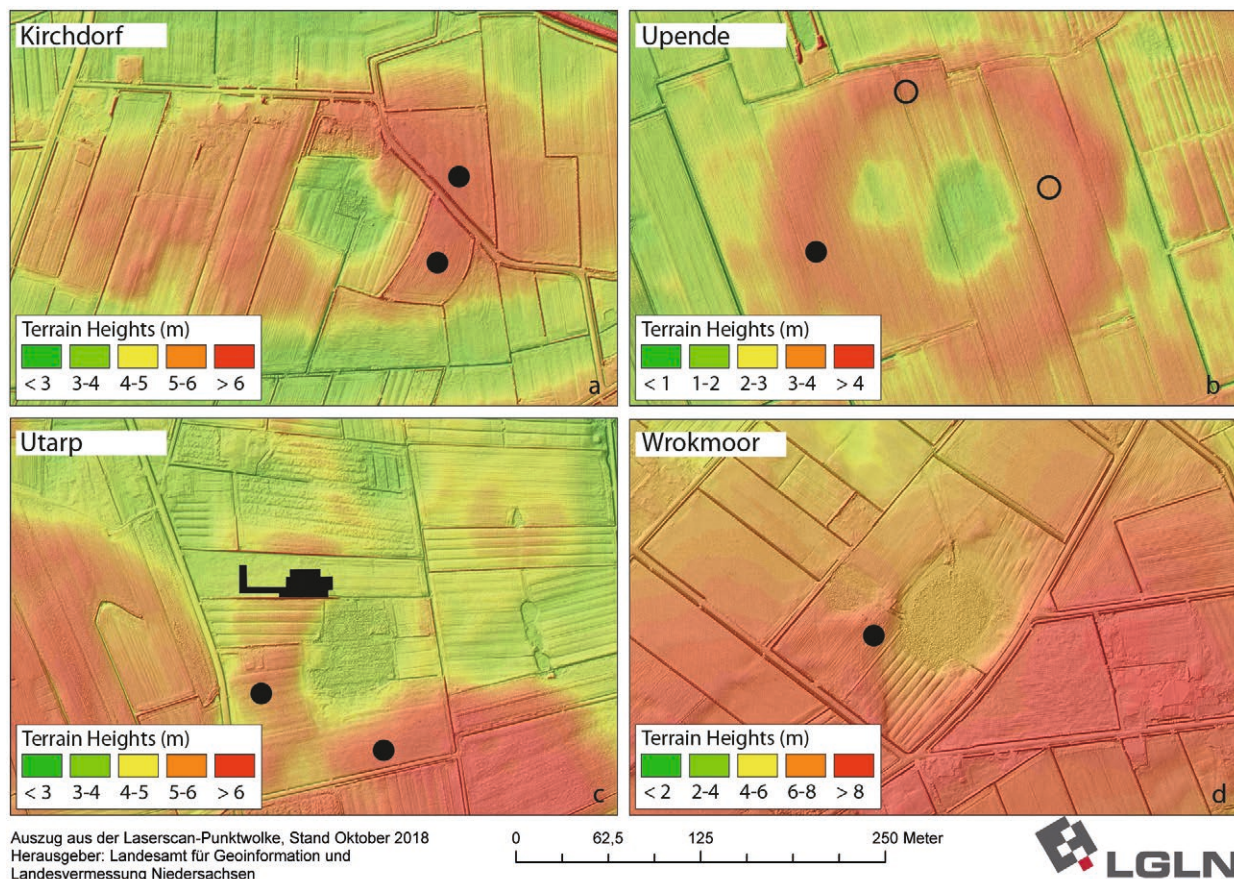


Fig. 4. Pingo scars with find concentrations: a) Kirchdorf, site 30 to the south, site 31 to the north; b) Upende, sites 7, 8, 9 from east to west, open signatures: sites with core axes, c) Utlarp, the black area marks the excavation of site 27, in the south further Mesolithic surface sites 37, 38, d) Wrokmooor with surface site 11. Preparation from the 3D-point cloud, resolution 0.25 meter (graphics: J.-U. Keilmann/State Office for Geoinformation and Land Surveying, Lower Saxony).

Abb. 4. Pingo-Ruinen mit Fundkonzentrationen: a) Kirchdorf, Fundstelle 30 im Süden, Fundstelle 31 nördlich davon, b) Upende, Fundstellen 7, 8 und 9, von West nach Ost, offene Signaturen markieren die Fundplätze mit Kernbeilen, c) Utlarp, der schwarze Bereich markiert die Grabungsfläche von Fundplatz 27, südlich davon die Oberflächenfundplätze 37 und 38, d) Wrokmooor mit der mesolithischen Oberflächenfundstelle 11. Darstellung auf Basis von LIDAR-Daten, Auflösung 0,25 m. (Grafik: J.-U. Keilmann/Landesamt für Geoinformation und Landesvermessung Niedersachsen).

Various coring investigations in the Wrokmooor show the distinctive structure of the pingo ruin. A. Ruiter (Ruiter 2012: 61-63) effectuated the first fieldwork. In connection with the NlHK's Pingo project, drilling cores were rescored in 2016, but their final analysis is still pending. As first results it can be pointed out, that the base was found in a depth of 5.5 m, where a sandy and a coarse detritic gyttja were deposited over Pleistocene sands. This gyttja was created in the early Holocene and indicates the existence of a lake. Over time, the lake silted up and was overgrown by a moor.

In 2012, a volunteer found Mesolithic flint artefacts on the embankment in two concentrations. Unfortunately, this spatial differentiation was only recognized in the course of the survey, so the finds of the concentrations have to be analysed together. Both concentrations are located in an elevated position on the rampart. Of the 110 flint artefacts, only a few pieces are indicative of the Later Mesolithic (Kegler 2013b). About two thirds of the silex finds consist of production waste from tool production, mostly flakes and debris.

Every fifth piece shows traces of fire contact. A third of all collected artefacts from Wrokmooor can be described as blades. With a length of little less than 4 cm in average and a thickness of 6 mm, they are short and massive in comparison to the regional blade industry. Most blades show a well visible bulb, a lip and an oval rest of the striking platform. These are characteristic striking features of a production by punch and hammer or pressure technique (Sørensen 2006). Except for a single bipolar blade, the regular negatives on the dorsal side show a monopolar striking strategy, something that is observable for the cores as well: Mostly only one striking platform is used. Most cores are irregular in shape and were discarded when a striking accident or a break in the material appeared (Fig. 5: 6).

Retouched tools are rare in the assemblage of Wrokmooor. Three retouched blades may be described as tools although they seem not to be worked into a certain shape of a distinct tool. Placed on the distal end and along the lateral edge, the retouches are situated in different areas of the blades and most

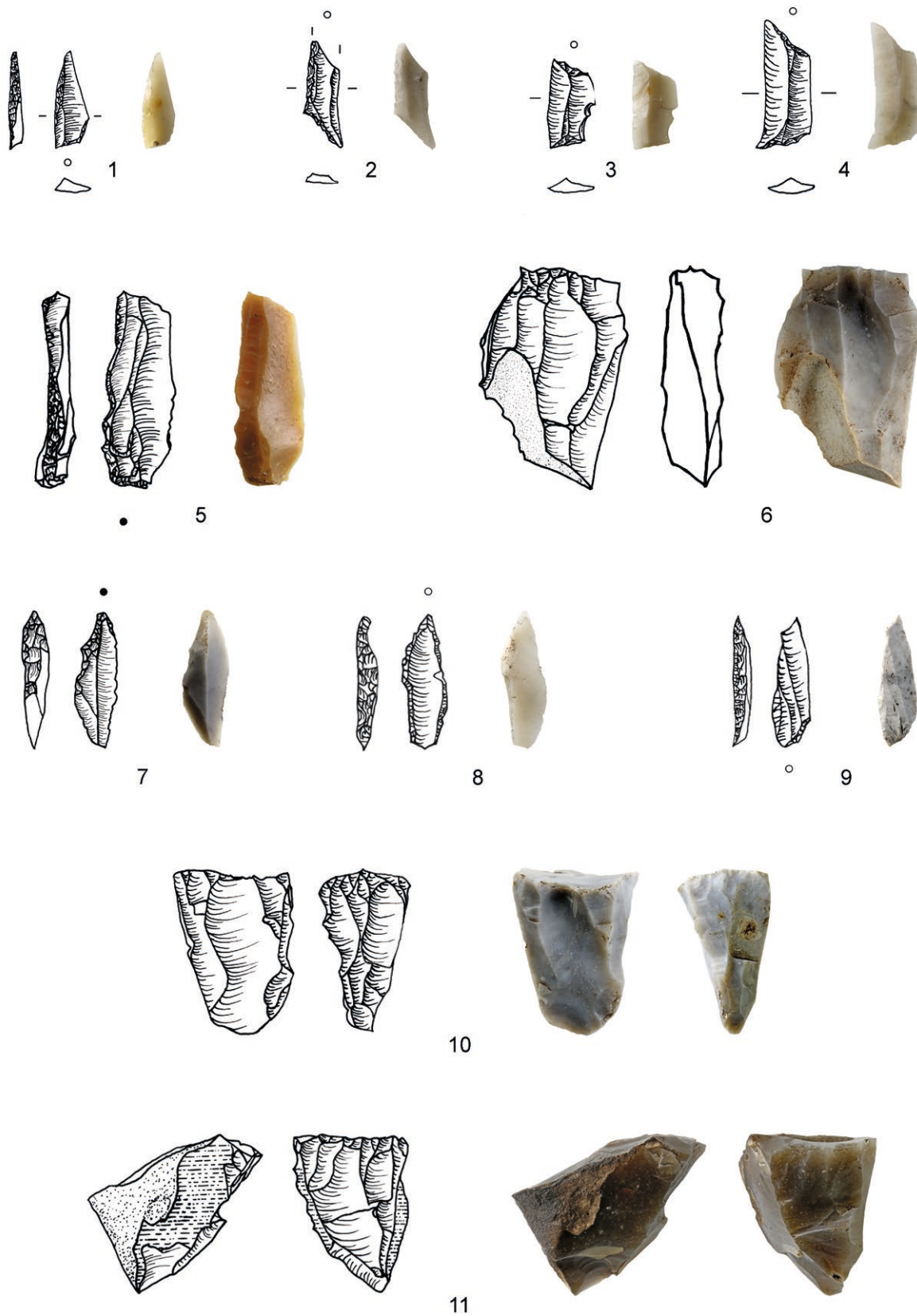


Fig. 5. Photos and drawings of stone artifacts from the sites of Kirchdorf (1-4), Wrokmoor (5-6), Utparp (7) and Upende 9 (8-11), scale 1:1. (photos: R. Kiepe; drawings: R. Daub & S. Mahlstedt/Lower Saxony Institute for Historical Coastal Research).

Abb. 5. Fotos und Zeichnungen von Artefakten von den Fundstellen Kirchdorf (1-4), Wrokmoor (5-6), Utparp (7) und Upende (8-11), Maßstab 1:1 (Fotos: R. Kiepe, Zeichnungen: R. Daub und S. Mahlstedt/Niedersächsisches Institut für historische Küstenforschung).

probably result from the use of the blade blanks as tools (Fig. 5: 5). A fourth piece is a blade fragment that shows small notches alongside the break, which gives the impression of a discarded trapeze microlith.

The combination of the clearly visible pingo ruin and the two small archaeological sites is a prime example of Mesolithic sites at pingos in East Frisia. However, archaeological investigations in the area of these two sites did not show any evident feature. If present, they must have been destroyed by agricultural activities.

A few kilometres east of the Wrokmoor two other possible pingo ruins with prehistoric flint finds exist. This once more illustrates the fact that pingos often do not occur alone, but in groups. This is a characteristic of pingos of the open type.

Kirchdorf "Ulenmoor" (archive no. 2510/6:30, 2510/6:31)

In Kirchdorf, today a part of Aurich, there is a pingo called "Ulenmoor" (Fig. 2: 3). Like Wrokmoor, Ulenmoor is a circular depression with a diameter of just over 120 m. Alongside the depression the former embankment is visible (Fig. 4: a). The centre of the pingo is humid year round. K. Tilly (2014) first described the pingo site in her diploma thesis. Further investigations, such as drill core analyses, have not been realised, yet.

The rampart of the pingo scar rises about 3 meters above the surrounding terrain. On the eastern embankment, two flint concentrations have been collected from the surface (Schwarz 2001a). Kirchdorf 30 is situated on the inner slope of the rampart-facing to the southwest while the other concentration Kirchdorf 31 is situated on the top of the rampart in the northeastern part of the pingo scar. The concentrations are found at a distance of 150 m from each other.

From the site of Kirchdorf 30 a total number of 321 flint artefacts have been collected. Most of these finds are unretouched flakes. Among 25 retouched tools, there are eight microliths: Four of these pieces are regular trapezes, a fifth is a scalene trapeze. The other microliths are broken pieces of triangles or micropoints (Fig. 5: 1-4).

Further, eleven blade tools are to be mentioned of which six are laterally retouched and partly notched, while the others show distal retouches. Three of the latter are scrapers. Additionally five scrapers on flake blanks complete the assemblage.

The blades as well as the core stones give an impression of a blank production by soft direct hammer (no bulb, strong lip) or punch respectively pressure technique (bulb and small lip). Both microliths typology (Mahlstedt 2015) and blade technology (Gehlen 2012; Heinen 2012) indicate an age of the site in the second half of the Mesolithic.

The find assemblage from the neighboring site Kirchdorf 31 shows a completely different composition. The largest part of it consists of burnt flint debris, flakes and some blades. The tools are restricted

almost completely to scrapers, which are applied to flake blanks in six of seven cases. Apart from a single fragment of a blade core, that shows traces of a regular reduction, the blade technology gives the impression of applying hard direct strikes. Together with the lack of microliths or a larger number of blades, the flaking technique might well date this flint concentration to younger than Mesolithic times or indicate a very different activity zone than in the neighbor concentration. This pingo scar is the only one so far, where there a spatial differentiation between individually equipped flintscatters can be made.

Upende (archive no. 2410/7:7-9)

North of the village Upende (district of Aurich, Fig. 2: 1) a 1 m high circular rampart is visible in the ploughed farmland, which can be traced very well in elevation maps (Fig. 4: b). The top of the rampart is cut by ploughing and became visible through the reprocessed sandy soil that came up in the otherwise dark-brown humus-rich soil. The round structure has a diameter of more than 200 m and is thus larger than most previously recorded pingo scars in East Frisia. Including the rampart, it has a width of 500 m. A variety of other similar structures exists in the wider neighbourhood that are interpreted as Pingo scars as well. Especially with the help of recent Airborn Laser-scanning (LIDAR) these landscape features become clearly visible.

Between 2000 and 2004, a hobby archaeologist detected three different sites with flint artefacts. The sites were first published by W. Schwarz (2001c, 2001d, 2001e). At that time the author spoke of a leveled and overgrown rest of an inland lake. His interpretation has not been proven wrong yet as a drilling investigation is still bearing out.

The three flint assemblages that are kept in the heritage record with the numbers 7, 8 and 9 are not very rich in retouched tools despite of two exceptional core axes and some microliths. Site no. 9 comprised the biggest amount of flint finds: 293 pieces of which 135 are flakes and 109 blade blanks. These pieces are quite small. The blades reach less than 3 cm in average length. That fits well with the blade cores, whose negatives are also comparatively small. There are all together 9 blade cores, 4 of those conical and very neatly shaped (Fig. 5: 10). The others are reduced using one single, almost flat reduction face (Fig. 5: 11). A large part of the blade production seems to come from a production process applying pressure technique. Among the tools the little core axe with a length of 6.4 cm is the biggest piece (Fig. 6: 1). Further, there are three scrapers and 16 microliths of which most are micropoints (Fig. 5: 8-9), as well as some triangles and a long narrow piece like a backed bladelet.

Site no. 7 has brought about 27 small flakes, a single blade blank and six core stones that often show



Fig. 6. Photos of the core axes from Upende site 9 (1) and 8 (2), scale 1:1 (photo: R. Kiepe/Lower Saxony Institute for Historical Coastal Research).

Abb. 6. Zwei Kernbeile von den Fundstellen Upende 9 (1) und 8 (2), Maßstab 1:1 (Foto: R. Kiepe/Niedersächsisches Institut für historische Küstenforschung).

traces of regular blade production. The only retouched tool is a segment-shaped microlith.

The inventory of site no. 8 is quite the opposite: there are only few burnt flakes that are much more massive than those from site no. 9 and no other retouched tools than the second core axe, which with a length of 8.6 cm is a bit bigger than the first one (Fig. 6: 2).

The two large core axes that were discovered in the context of the two surface sites no. 8 and no. 9 form by far the most outstanding characteristic of the three surface sites discovered on the round rampart of Upende. Core axes are very rare in Northwestern Germany. Schwabedissen (1944) even defined the Mesolithic Northwestern Group for this region by the

absence of this tool type. Meanwhile, it could be proven that core axes appear regularly in North-western Germany and the Northern Netherlands (Niekus et al. 1997; Gerken 2001: 36 ff.; Schwarz 1990: 45 f).

Utarp "Narperfeld" (archive no. 2410/3:27)

A larger excavation was conducted at „Narperfeld“ – south of Utarp – in 1991 prior to local sand mining activities. There, 17 hearth pits, lithic and ceramic material were discovered together with some postholes (Schwarz 1993). The site is situated on the slope of a pingo ruin with approx. 120-140 m in diameter. In the digital elevation model the onset of the rampart north of the later expanded excavation area (Fig. 4: c). During the excavation of little more than 1'800 m², 402 lithic finds were found mostly in the ploughing horizon above the pits that were dug into the Pleistocene sandy layers. With 259 pieces, most of the lithics are flakes, further 84 blades and 31 core stones are part of the assemblage. A single micro-liths indicates that the lithic assemblage fits well into a Mesolithic context (Fig. 5: 7). The presence of ceramics indicates a longer or repeated use of the site that reaches well into Neolithic or Bronze Age times though. Comparable pits are known from Mesolithic sites in the vicinity, but although the hearth pits contained a certain amount of charcoal, their age was never confirmed by radiocarbon datings. With regard to the postholes, it is not possible to clarify whether or not they belong to Mesolithic dwellings.

Drilling samples show that the lowest backfill layer of the pingo scar was formed during the Pleistocene (Tilly 2014: 40 No. 1.9). The pollen analysis confirms a late Pleistocene age of the earliest vegetation remnants at the base of the structure. Unfortunately, the excavation did not get close to the pingo infill, thus an area where Mesolithic finds might have been preserved by a waterlogged surrounding is yet unknown.

Utarp "Narperfeld" is the only excavated site on a pingo remnant in East Frisia. From the rampart of this pingo, two other Mesolithic surface sites are known.

Other sites

Some Mesolithic sites have been discovered earlier without the observation of their location in direct context to pingo scars. It was the recent topographic study that showed these sites to be located at the rim of round landscape structures which might well turn out to be pingos.

The Mesolithic site "Kloster Barthe" was discovered during the excavation that originally focussed on younger structures: The Mesolithic campment was found during excavations of the monastery of Barthe near Hesel (district of Leer) between 1988 and 1992. Some few lithic artefacts and four hearth pits were found below the medieval find horizon. ¹⁴C dates of the pits date them to the time span between 7'575

and 6'385 calBC (Bärenfänger 1997: 37-40). The Mesolithic site as well as the monastery is located on the bank of an oval bog (Bärenfänger 1997: 23, Fig. 13) that is not finally proven to be a pingo. H. Freund examined pollen from a drilling core of this bog and was able to determine that limnic sediments were deposited over Pleistocene sands. During the Younger Dryas a peat had developed. In the Preboreal the change from limnic to organogenic sediments can be testified. Freund (1997: 255-256, Fig. 2) supposed that the bog is the remnant of a part of a larger peatland that is largely destroyed by scabbing and drainage today. The round depression and the evidence of stagnant water during the post-glacial period might indicate a pingo. At its embankment the Mesolithic hunters and gatherers settled and much later the monastery was founded.

East of another oval depression with a diameter of approx. 100 m near Berumerfehn (district of Aurich), on a small sickle-shaped elevation, three surface sites were discovered in 1986 where Mesolithic artefacts were collected by an amateur archaeologist (Kitz 1987). At all sites microlithic tools and cores of both, blade and a flaking technique have been found. The landscape in the area – around the villages of Berumerfehn, Rechtsupweg and Halbmond – is characterized by a variety of pingos; of which the ramparts are quite well recognizable (Fig.3).

In 2014 during the building of an electric cable, a scientific survey revealed a Mesolithic site near Halbmond/Nadörst (district of Aurich). More than 93 flint artefacts were collected from the surface; also some microlithic tools (Thiemann 2016). Digital elevation models of the landscape situation suggest that the site is situated at the edge of a possible pingo ruin.

A further Mesolithic site close to a potential pingo exists at Meinersfehn (district of Leer). A few flint artefacts from a surface site date to the early Mesolithic. A part of the flint assemblage is burned.

Near Holtrop (district of Aurich) some Mesolithic finds on the rampart of the former pingo "Rötelmoor" have been discovered. A pingo ruin in Dunum has brought some finds pointing to a late glacial artefact spectrum. Concerning the typology of some high quality blades from bipolar reduction and a burin, this site may be the oldest settlement on a possible pingo scar we have discovered so far.

The phenomenon of pingo ruins is not unique for East Frisia. It is also proved in the wider area of northern German and the Netherlands. Settlements along the ramparts are known through all times, too.

Eastern of East Frisian Peninsula, possible pingo scars are known in Düdenbüttel (district of Stade) and Uthlede (district of Cuxhaven). In addition, a possible pingo is known in the district of Gifhorn some 150 km southeast of the North Sea coast. All of those are characterized by roundish peaty depressions in the landscape, and show Mesolithic sites along their surrounding ramparts.

In the Netherlands the phenomenon of Pingo scars has been regarded for quite a while. Woltinge (2012) has had a closer look on eight sample areas. Her research focused on the statistical significance of stone age sites on the ramparts. Just as in East Frisia, stone age sites along pingo scars are only known from surface collections. She could prove that there is no higher frequency of sites along pingos than in other landscape situations.

In the area of East Frisia Pingos ruins were not inhabited during the Mesolithic period only. The ramparts seem to have offered dry ground for settlements during all times. Burial mounds of different eras are occasionally found on these small bogs. One example is the cemetery of the late Pre-Roman Iron Age and Roman Imperial Period in Holtgast (district of Wittmund) (Hüser 2016). Even from the Roman Imperial Period ceramic finds are known from Mamburg, a Pingo scar in the district of Wittmund, which could maybe be interpreted as sacrificial deposition (Heinze et al. 2013: 52). Additionally, several examples of farmsteads, a church (Timmel, district of Aurich) and even a monastery (Holtgast, district of Wittmund) were founded on Pingo ramparts. The well-known meeting point of the free Frisians in the Middle Ages called Upstalsboom is situated on the edge of the pingo named "Dove Meer", too.

Discussion: The potential of "Pingo sites"

In this paper, we very intensively draw the attention to pingo ruins and similar landscape structures. The most important characteristic of these features in respect to settlement sites is the existence of open water in Mesolithic times. Pingos represent open habitats in an otherwise increasingly wooded landscape. A pingo with its higher peripheral ramparts of dry, sandy underground therefore offered some advantages for the choice as a settlement site: Apart from the access to an open water resource the pingo shores certainly offered a greater variety of plant and animal resources than the forests around. So the aspect of fishing or hunting of waterbirds may not be insignificant. Plants not only contribute to nutritional needs, their parts may also be utilised for everyday objects such as birch tar, floor mats, baskets, etc. Obviously, the Holocene foragers took advantage of the natural opportunities that such a site offered and most possibly Mesolithic people did not prefer to settle on pingos in special but close to water in general. It is just that Pingo scars were among the most frequent waterbodies in the area of East Frisia. Still the sites are quite small. A possible explanation for their size is that the hunter and gatherer groups stayed longer and more intensively at certain places outside of the East Frisian dry sandy area. Another possibility is that bigger sites were regularly situated in lower places in the landscape like at the edge of gullies that

are today often covered by alluvial sediments or raised bogs and are therefore not detectable by archaeological surveying. The Pingos with their small lake or bog center may have been visited for seasonal short stays, probably in search of specific resources. The sites presented here show diverse traces of use. The exceptional finds of core axes in Upende may be interpreted as hints to plant processing on the one hand. On the other hand, Mesolithic axes of this size are so rare in the area that these pieces could be seen as a proof of long distance contacts to good flint sources. The sites at Kirchdorf Uhlenmoor show that in a short distance of a 150 m very different activities have taken place along the rim of a pingo scar, whether contemporaneous or in a timely distance.

For the Netherlands a statistical analysis showed that for certain test regions pingos do not show a significantly higher frequency of settlements during the Stone Age than other landscape features (Woltinge 2012). As far as we understand, this study refers to all available Stone Age sites of eight different study areas. Although it might be a bit too general approach, to look at all Stone Age sites together, it would still be interesting to conduct corresponding tests for Mesolithic sites in East Frisia as soon as enough material for a well-investigated microregion is available.

We neither know how intense the Mesolithic communities used the small lakes or wet hollow shapes in the Pingo ruins. So far, only one site – Utarp – along a possible pingo has been excavated and only in the rampart area was investigated. The detection of hearth pits there is not specific for a pingo scar as such features were also found in other relations. At none of the pingo scars, a closer look at the former shallow water area in front of the sites has ever been taken. There, good preservation conditions might lead to a better insight into the possible site function. Food residues, but also any other everyday objects could be conserved. Surveys on the rampart and drilling cores to explore the pingo deposits alone are not enough to fill that gap. Instead, the transitional area between them must be considered in more detail in future investigations.

Pingo ruins are also ideal archives for the reconstruction of the climatic and environmental conditions of the Late Pleistocene and the following Early Holocene. The evaluation of drilling cores from the pingo "Timmeler Frauenmeer" (district of Aurich) during the NIhK-Project mentioned above, illustrates the variety of information hidden in pingos. Because pingo scars have formed only small peat bogs, there are more local deposits to be found there, suggesting the immediate environment. Thus, multi-proxy investigations help us to determine the environmental conditions. The examination of head capsules of the chironomids is suitable for the detection of temperature anomalies. The more pingos are examined in such intensity, the more detailed the postglacial

environment can be reconstructed. So far, the detection of indicators of Mesolithic hunter-gatherers in drilling cores is still missing. Nevertheless, with the focus on this issue, and with the involvement of a broad multi-proxy analysis and the collaboration of archaeologists, botanists, mineralogists, and other natural sciences, the pingo archives will help us to grasp early human environmental impacts on a local scale, in future. The potential for this is certainly present in the pingo scars.

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