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WHAT HAS THE SEA TAKEN FROM US? COGNITIVE POSSIBILITIES OF STUDYING ARTEFACTS FROM NEWLY-DISCOVERED SUBMERGED PREHISTORIC SITES IN PUCK BAY (GULF OF GDAŃSK, BALTIC SEA)

ABSTRACT

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The article presents the latest results of research in the area of the Bay of Puck. After the last glaciation, the Bay of Puck was gradually flooded by sea water. As a result, we can expect submerged Stone Age sites in this area. The article discusses the latest results of underwater research in this area and analyses in detail four new underwater sites from this region, including a loose find of a *bâton percé* from Hel dated to about 7000 BC, a collection of flint artefacts, including a flint dagger and pottery from Late Neolithic/Protobronze Age site on Seagull Sandbar and two antler adzes from Site 23 in Puck. A typological and technological analysis of the artefacts was carried out, including analyses of working traces and radiocarbon dating.

Keywords: Baltic Sea, Puck Bay, submerged Stone Age sites, flint dagger, bâton percé, absolute chronology
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1. INTRODUCTION. SEARCHING FOR SUBMERGED PREHISTORIC SITES

During the last glacial and post-glacial periods, the southern Baltic area was dry land, with the terrain morphology characteristic for modern-day Pomerania, but was later submerged and partially destroyed by the sea. The southern Baltic area was free of ice approximately 15 500-15 000 BP (Gałka *et al.* 2018; Uścinowicz 2014). The retreat of the ice sheet between the Słupsk Bank and the southern Middle Bank approx. 15 000-14 500 BP led to the creation of the Baltic Ice Lake. In the period 11 700-11 500 BP, the sea level dropped to 55 m below the present day, which designates the maximum land area of the southern Baltic (Gałka *et al.* 2018, 23). These changes led to the transformation of the freshwater Baltic Ice Lake into the saltwater Yoldia Sea, which, during the subsequent geological changes, approximately 10 800-10 700 BP transformed into the freshwater Ancylus Lake (Gałka *et al.* 2018, 23; Uścinowicz 2014). The next phase of the evolution of the Baltic was the gradual forming of the brackish Littorina Sea. During the first stages (9 500-7 500 BP), the sea level was approximately 9-10 m lower than today (Gałka *et al.* 2018, 23; Uścinowicz 2014).

The early Holocene (Pre- Boreal and Boreal period) was also a time in which, thanks to the improvement of environmental conditions, forests with pine dominance developed (Gałka *et al.* 2018, 23). Sea water, for the first time, reached the contemporary Puck Lagoon region approximately 7.500 years ago. About a thousand years later, waters reached the contemporary Rzucewo Deep, marking the beginnings of the Puck Lagoon (Gałka *et al.* 2018, 24). Large areas of the region between Piaski Dziewicze and Piaski Zachodnie in Puck Lagoon still remained dry land with many areas of wetlands (Gałka *et al.* 2018, 24, 25, fig. 12d; Miotk-Szpiganowicz and Uścinowicz 2016).

After connecting with the ocean, the water level in the southern Baltic rapidly rose, and approximately 6000 BP it was 4 m lower than today. The last 6000 years were marked only with small changes to the sea level. At the end of the Atlantic period (about 6000 BP), most southern Baltic spits, bays and shore lakes were formed, and the coastline became “similar” to the modern one (Uścinowicz 1999; 2014).

The rising sea level is the reason why there are well-preserved remains of fossil submerged forests present in the Baltic Sea. These grew in the early Holocene and their remains lie on the seabed in Polish, Lithuanian, Danish, German and Swedish maritime areas, potentially indicating the areas with preserved sunken cultural paleolandscape (Fischer 1997; Žulkus and Girininkas 2020; Uścinowicz *et al.* 2011).

There is a possibility of discovering the underwater archaeological sites from the Stone Age on the submerged land in the southern Baltic Sea, especially in the Puck, Vistula and Szczecin Lagoons. This lagoon-maritime environment was undoubtedly alluring for the Stone Age hunter-gatherers. To this day, the maritime areas of Denmark are one of the better surveyed, namely the shores of the Jutland peninsula, the Danish archipelago and

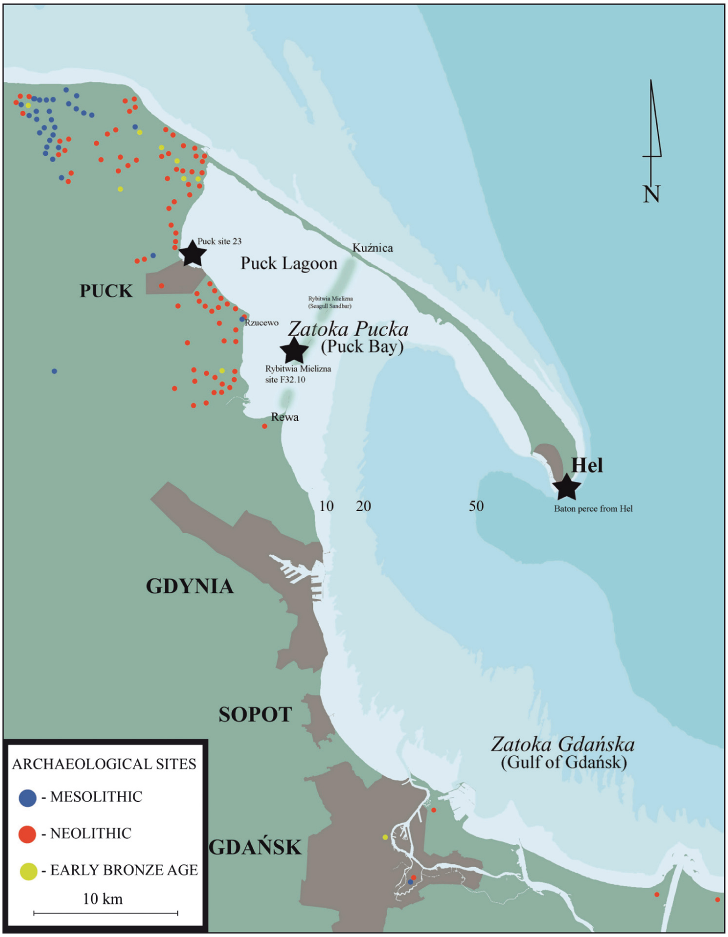


Fig. 1. Location of the sites from Puck Bay with the context of dry-land Stone Age-Early Bronze Age sites from Pomerania (after Król and Rudnicka 1990; Król 2015 with authors' modifications)

the Holstein shoreline, with the numerous underwater Stone Age archaeological sites studied and documented (Fischer and Vang Petersen 2018). The latest work has brought more discoveries in Mecklenburg-Vorpommern and on the southern coast of Sweden (Fischer 2018; Lübke *et al.* 2011). However, until recently, the Polish maritime areas have not been studied extensively.

Despite its potential, the land area around the Bay of Puck (the Kashubian Coast and the Hel Spit) is still an area with a poor state of archaeological research on the settlement of the Stone Age communities (Fig. 1). The settlements of the Rzucewo culture are relatively best recognized (in Rzucewo, Osłonino and Rewa), but there is still no complete monograph on the entire pottery material from the eponymic site in Rzucewo (Król and

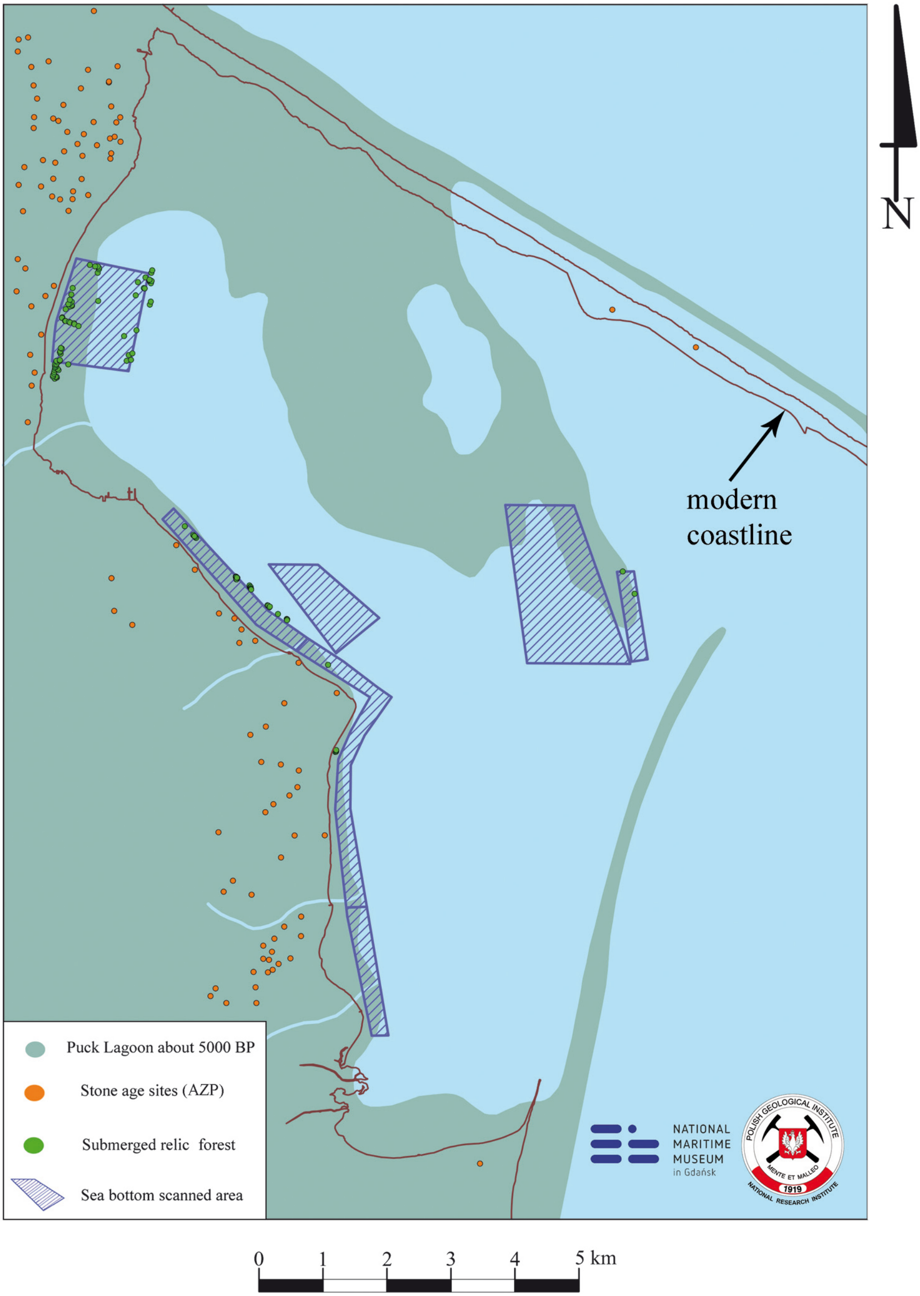


Fig. 2. Paleogeographic reconstruction of the shoreline c. 5000 BP (Puck Lagoon) with correlation of the sea scanned areas, drowned relic forest and terrestrial Stone Age sites from the Polish Archaeological Record (paleogeographic base map after Uścinowicz 2019 with modifications by J. Różycki and K. Kurzyk)

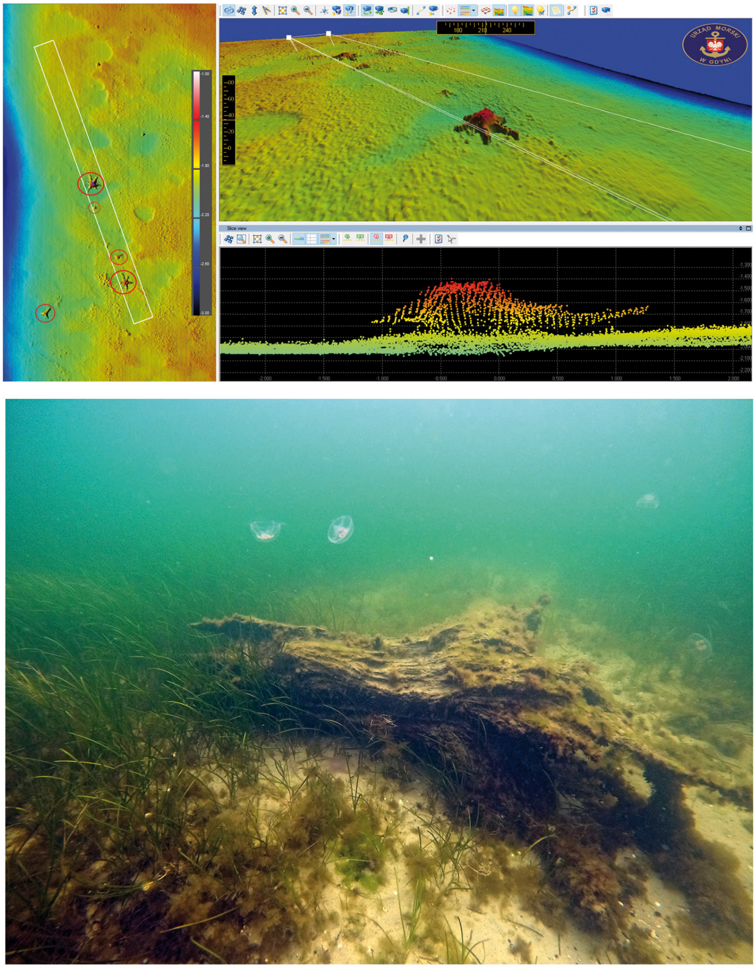
Schild 2009; Król 2018). Geologically it is the youngest region of the coastline, which could be inhabited only after the ice sheet had receded. During the latest research, several sites on the Kashubian Coastline region in the Żarnowiecka Upland have been found and dated to the Late Palaeolithic (Wąs 2009; 2012; 2018). From the perspective of current archaeological knowledge, the first more intensive traces of settlement in the areas surrounding the present Bay of Puck date back to the Atlantic period (Mesolithic, subneolithic communities and the first farmers), but the highest number of sites are probably associated with the Rzucewo culture from the Late Neolithic period, unfortunately, most of them are settlement traces discovered on the surface in a research program called (AZP) Polish Archaeological Record (Król 2015; 2017; Król and Rudnicka 1990).

The existence of as yet undiscovered submerged archaeological sites in this area is probable. Because of the erosive effects of water movement, the areas of the seabed with preserved Stone Age paleo landscape relics such as peat layers and remains of submerged tree trunks are especially interesting as a place with the greatest potential to preserve hard-to-discover submerged Stone Age artefacts.

During the last few years, our team from the Underwater Archaeology Department of the National Maritime Museum in Gdańsk (NMM) has analysed the land Polish Archaeological Record (AZP), correlating their location with the paleogeographic analysis of the prehistoric coastline performed by the Polish Geological Institute (Uścinowicz 2019). Several test areas in Puck Lagoon were selected and scanned with the side-scan sonar (Fig. 2). The initiating research was conducted by the team of the NMM as a part of the Interreg project Baltic RIM, which has contributed to the integration of coastal and underwater cultural heritage into maritime spatial planning in the years 2017-2020 (Lehtimäki *et al.* 2020). The scanning results were later verified by underwater archaeologists by field survey. The discovered remains of the submerged stone age forests (mostly roots and lower parts of tree trunks) and peat layers were found on the seabed, at small depths of 1.5 to 4 metres (Fig. 3, 4: A). During the field survey, samples were taken from the submerged tree trunks and peat, of these 26 have been radiocarbon dated in the Laboratorium Datowań Bezwzględnych in Kraków by Marek Krąpiec: in the Swarzewo area, dates span from 9580±50 BP (MKL-4590) to 9000±50 BP (MKL-4755), in the Puck-Rozgard area, they are 9610±40 BP (MKL-5062) and 9260±35 BP (MKL-5062); in the Jastarnia area, dates of 6360±40 (MKL-5385) and 6310±40 BP (MKL-5384) and in the Rzucewo area, from 7070±50 BP (MKL-4596) to 5930±50 BP (MKL-4597).

Since 2019, a team of underwater archaeologists from the NMM has been investigating these areas, several small underwater test trenches in the seabed were carried out using a set of sieves connected to an ejector in the area of Rzucewo (Fig. 4: B). Unfortunately, so far, no Stone Age artefacts have been discovered at the bottom at any of the sites with preserved submerged palaeolandscapes.

Since 2017, a search has also been carried out in the NMM collections. As a result, it was possible to discover two prehistoric antler adzes from an underwater site – the remains of



A

B

Fig. 3. A – Seabed sonar scan with the visible drowned forest from the Stone Age near Jastarnia (Maritime Office in Gdynia, Jacek Koszałka), B – The underwater photography of one of the Stone Age radiocarbon-dated drowned tree trunks – Pinus sylvestris (K. Kurzyk) (Illustration by K. Kurzyk)

the medieval harbour in Puck (Figs 6-7). Both adzes were found in 1997-1998, during the underwater research and inventory of medieval wooden port structures (piles and elements of quays and piers), which was led by Iwona Pomian. Both artefacts had been found on the sea bottom without context in two separate spots on the measurement grid, hectares 9G/44/A (adze no. P/92/97) and 9F/100/B (adze no. P/136/98).

The year 2022 was a lucky season for us. Holidaymakers enjoying the charms of the Bay of Puck have found and enriched the NMM's collections with some new, very interesting artefacts.

A

B

Fig. 4. A – Submerged relic forest and fossil peat near Rzucewo, B – Test trenches in seabed with use of a set of sieves connected to an ejector near Rzucewo (Illustration by K. Kurzyk)

At the beginning of August 2022, an antler *baton percé* was found on a sandy beach in Hel City (Fig. 8). This artefact (no. Hel/1/2022) was discovered without archaeological context; probably, it was washed up by the sea from an eroded submerged Stone Age site.

At the end of August 2022, we received from another two members of the public information for verification about new underwater site in Puck Bay. This was the Rybitwia Mielizna [Seagull Sandbar], site no. F32.10 in the Register of Underwater Archaeological Sites of the National Maritime Museum in Gdańsk (EPSA). The official name of the site in Polish is Rybitwia Mielizna, but local traditional names like Mewia Rewa or Ryf Mew are

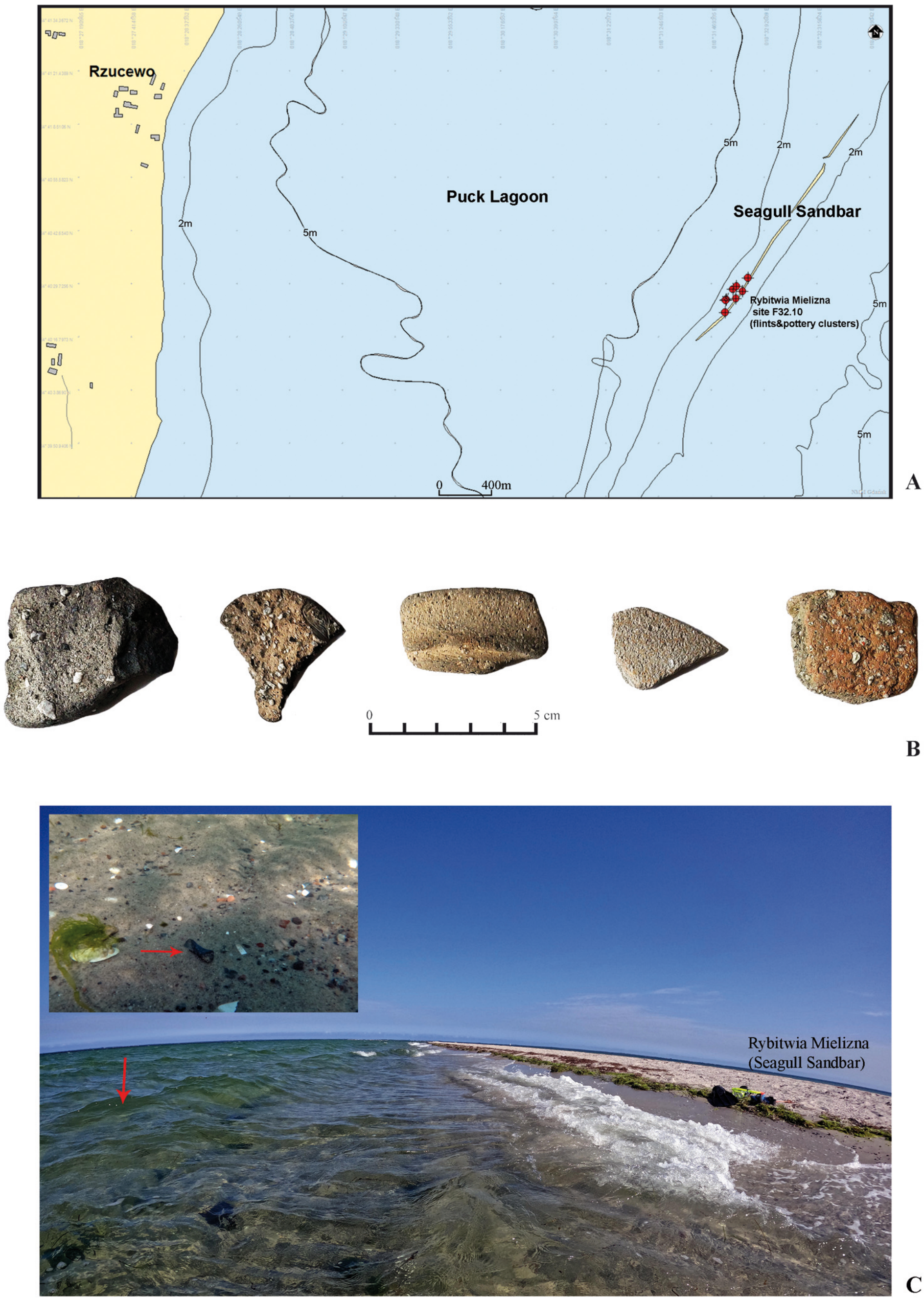


Fig. 5. A – Seagull Sandbar, a view direct to Kuźnica, B – Late Neolithic/Proto-Bronze pottery, C – One of the flint artefacts visible on the seabed (red arrow) (Illustration by K. Kurzyk)

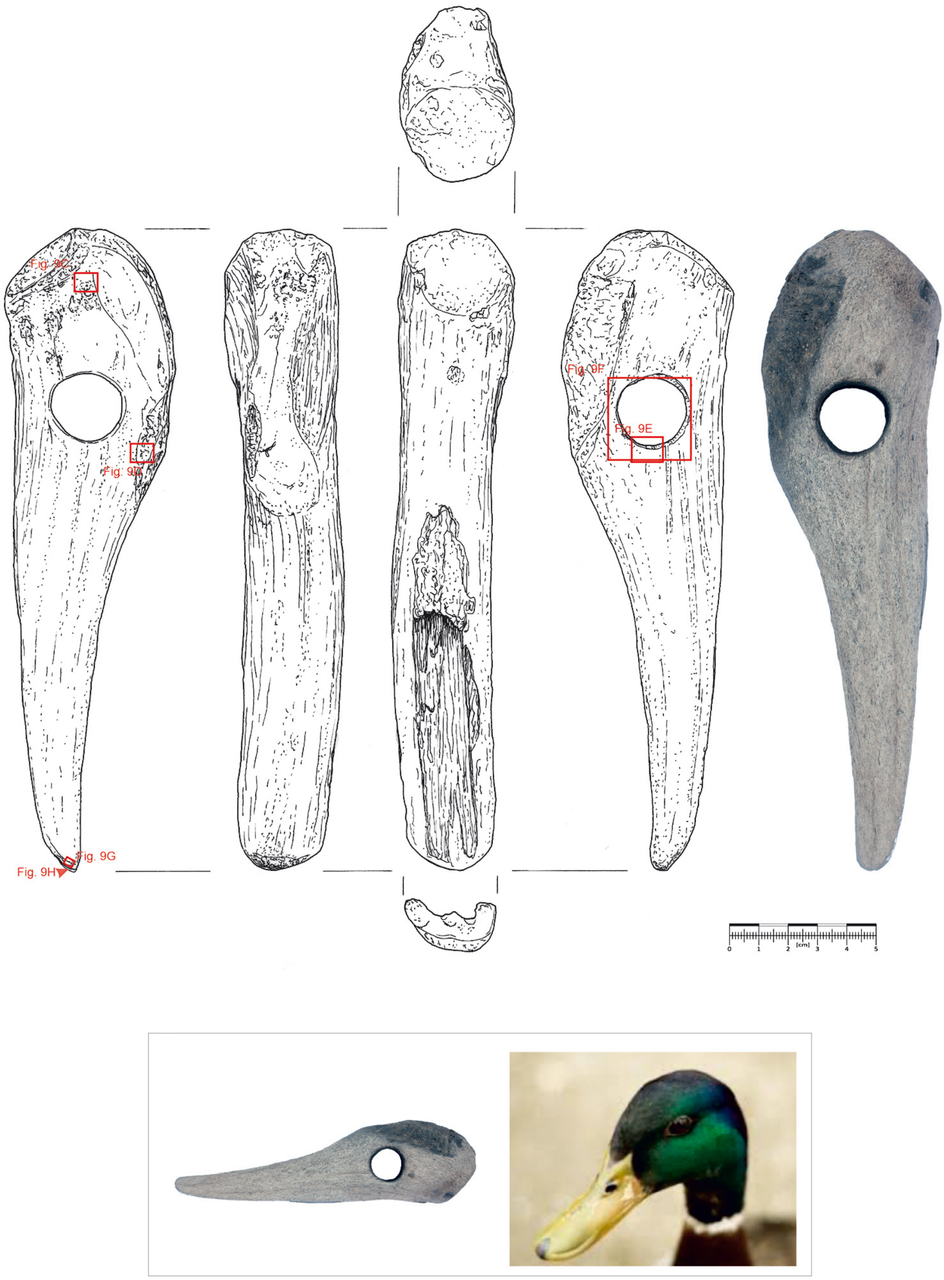


Fig. 6. Puck, Site 23 (Puck Lagoon), antler axe (no. P/143/98)
(drawing P. Dziewanowski; illustration by G. Osipowicz)

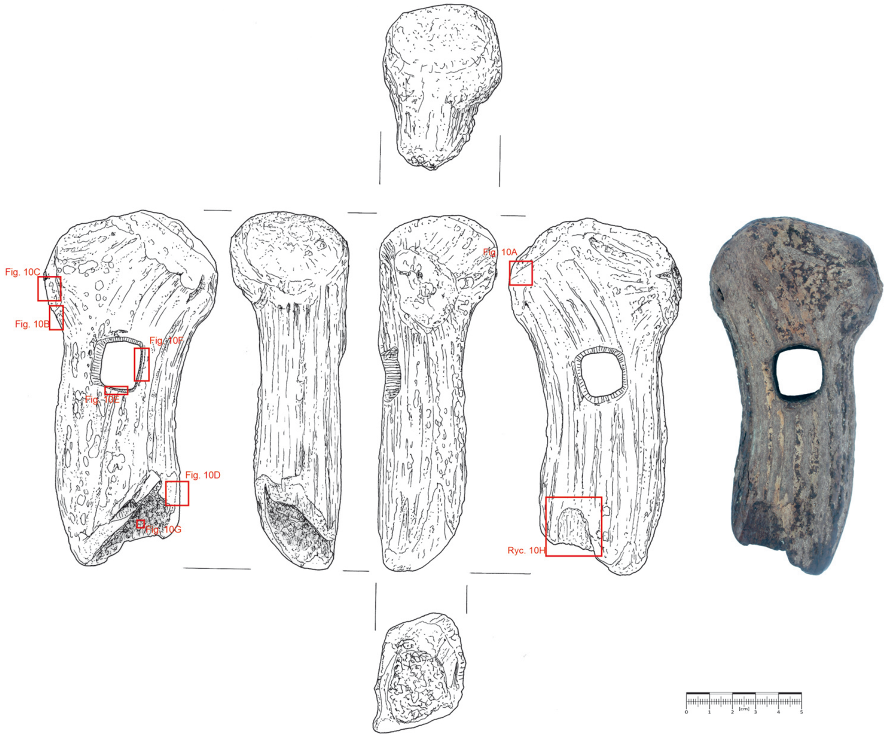


Fig. 7. Puck, Site 23 (Puck Lagoon), antler adze (no. P/892/97 (drawing P. Dziewanowski; illustration by G. Osipowicz)

also still in use. During a holiday cruise along this sandbar in the middle of the Puck Lagoon, Sylwia and Jacek Klekowicki discovered a collection of 86 flints with traces of processing, including a flint dagger (Fig. 14: 6). On the 24th of August our team of underwater archaeologists conducted a surface and underwater inspection. The site is located in shallow water (up to 0.5 m deep) in the coastal zone of a small sandbank forming the Seagull Sandbar. During the inspection, another 98 flints, 6 fragments of pottery and a fragment of an animal tooth (destroyed wild boar's tusk?) were found. The artefacts occur on the surface of the sandbank and in the surf zone (Fig. 5). During the underwater survey, no remains of archaeological features were observed. A small fragment of eroded fossil peat bed was also located at the bottom.

It is very difficult to clearly define the function of the site Rybitwia Mielizna, site F32.10, but we can probably interpret the discovered artefacts as evidence of a short-term encampment, probably in connection with seasonal fishing and hunting for birds and seals. Until the 20th century, the Seagull Sandbar was a place of seasonal seal hunting. In fact, this feature is a natural sandy shallow connection in the direction from Rewa to Kuźnica in the Hel Peninsula; when the water level is low, it is possible to cross the Bay of Puck on foot.

2. MATERIALS AND METHODS

The subject of the research reported in the article is a collection of flint artefacts (184 specimens) originating from the archaeological Rybitwia Mielizna, Site F32.10 and three finds of loose artefacts made of antler: two adzes (inv. no. P/143/98; Fig. 6; in. no. P/92/97; Fig. 7) from Site 23 in Puck, and a so-called *baton percé* (inv. no. Hel/1/2022) found on the Hel Peninsula, washed ashore by the sea on the beach in the town of Hel (Fig. 8).

These artefacts underwent a comprehensive analysis, including typological, technological, and traceological tests, as well as dating through the AMS method for antler artefacts.

Fig. 8. *Bâton percé* from the Hel city's beach (no. Hel/01/2022) (Illustration by G. Osipowicz)

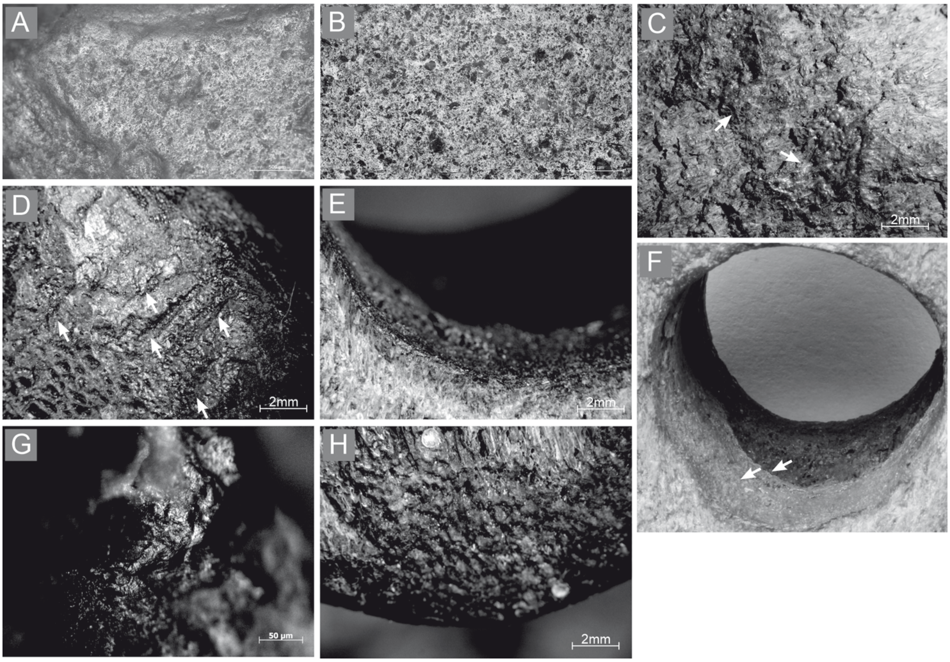


Fig. 9. Examples of post-depositional damage observed on flint artefacts from Rybitwia Mielizna, site F32.10 (A, B) and technological traces (C-F) and possible use-wear traces (G, H) visible on antler adze from Puck, Site 23 (inv. no. P/143/98) (Illustration by G. Osipowicz)

The flint materials were subjected to technological and typological analysis based on the dynamic technological analyses (DTA) method (Schild *et al.* 1975), considering its adaptation to Neolithic materials (Domańska and Kabaciński 2000) and the specifics of the assemblage under study. In the case of the description of bifacial forms, the bifacial points classification system proposed by J. Libera (Libera 2001) was used.

Due to macroscopically noticeable extensive post-depositional damage to the surfaces of the flint artefacts from the site Rybitwia Mielizna, site F32.10, in the preliminary (test-verification) traceological examinations, only the objects morphologically classifiable as tools included in the collection were subjected to analysis. For the antler items, all artefacts mentioned in the article were analysed. Two of them (both adzes) had undergone conservation processes of unspecified scope earlier, and the third artefact (*baton percé*) was provided for analysis in a "wet" state (recently recovered from water).

The prehistoric artefacts described in the article were discovered over several years, and as a result, different microscopic equipment was used for their traceological analysis (depending on what was available to the authors at the time). The antler adzes from the Puck 23 site were analysed using three microscopes. Technological studies and initial stages of functional analysis were conducted using a microcomputer set Nikon SMZ-2T. This

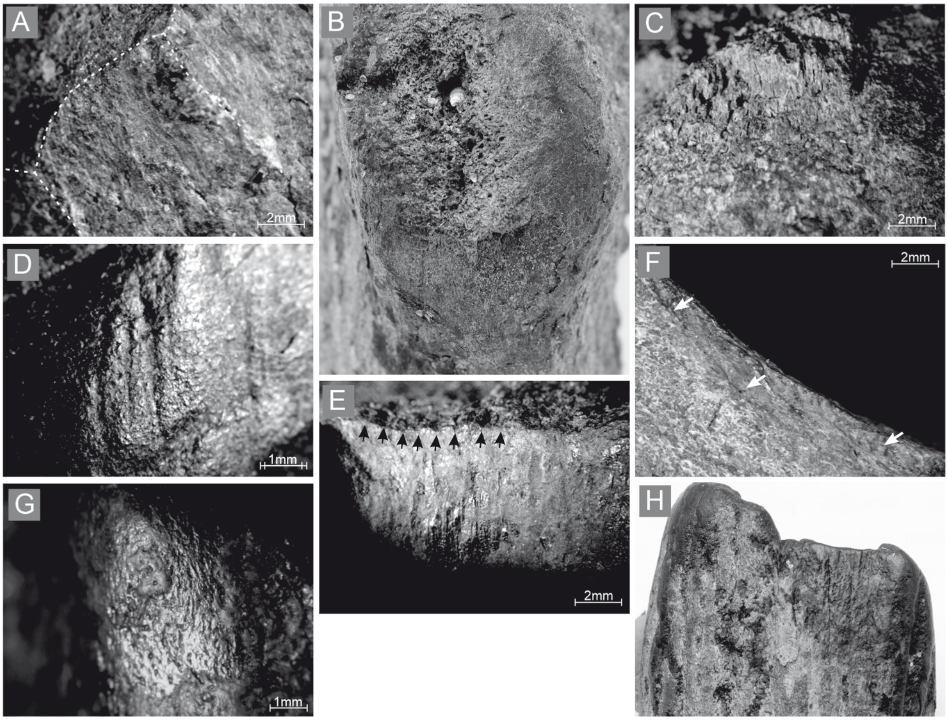


Fig. 10. Examples of technological traces (A-F) and possible use-wear traces (G, H) visible on antler adze from Puck, Site 23 (inv. no. P/892/97) (Illustration by G. Osipowicz)

allows obtaining objective magnifications up to 12.6x (actual magnifications up to 120×). At this stage of work, a microscope Carl Zeiss™ SteREO Discovery V8 was also used (actual magnifications up to 80×), equipped with a photographic camera Canon A620. With its help, photographs presented in Fig. 9: C-E, G, H and Fig. 10: A, C-G were taken. Observations of polish were conducted using a Zeiss-Axiotech, which allows obtaining objective magnifications up to 50× (actual magnifications up to 500×). It was also used to take photographs presented in Fig. 9: A, B.

Different equipment was used for the analysis of the flint artefacts from the "Mewia Rewa" site and the *baton percé* from the Hel Peninsula. The condition assessment of these artefacts, as well as the preliminary analysis of technological and functional traces present on the antler artefact, were conducted using an optical microscope Nikon SMZ-745T (up to 65× magnification) fitted with a Delta PixInvenio6EIII camera. The latter was used to take the photomicrographs presented in Fig. 11: A-I. Observations of polish were conducted using a Zeiss Axioscope 5 Vario microscope fitted with an Axiocam 208 camera. This allows obtaining objective magnifications up to 50× (actual magnifications up to 500×). Microphotographs were taken using it and presented in Fig. 11: J, K. The remaining pho-

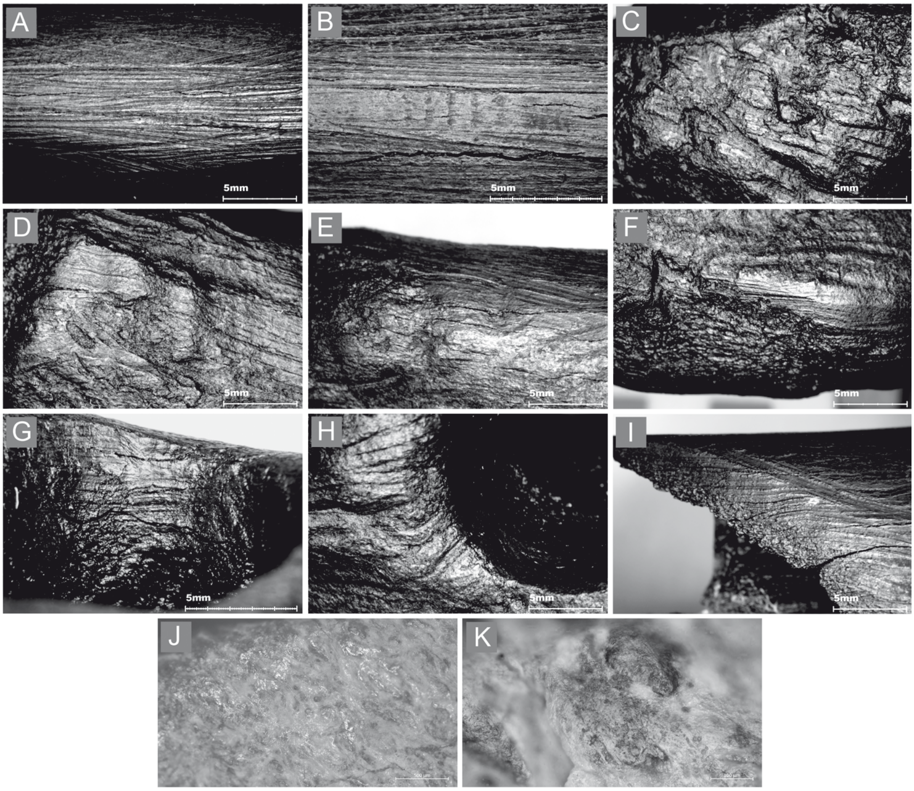


Fig. 11. Examples of technological traces (A-I), post-depositional damage (J) and possible use-wear traces (K) visible on the *bâton percé* from Hel (inv. no. Hel/01/2022) (Illustration by G. Osipowicz)

tographs included in the study (Fig. 9: F; Fig. 10: B, F, H) were taken using a Canon EOS 550D digital camera.

The terminology applied in the presented studies was based on the published conceptual system (Vaughan 1985; Van Gijn 1989; Sidera 1993; Juel Jensen 1994; Korobkowa 1999; Legrand 2007; Osipowicz 2010; Buc 2011), adjusted to the purposes and requirements of the analysis.

The samples for dating were taken from the three artefacts made from antlers. To do this we used a high-speed multi-tool with a core drill bit. Before sampling, the drill bit was cleaned using acetone. Care was taken to avoid damaging any technological, functional, or diagnostic traces and parts of the artefacts during the sampling process in order to preserve as much information as possible for future studies. The samples were dated in the Poznań Radiocarbon Laboratory, Poland. The ^{14}C age was calibrated using IntCal20 (Reimer *et al*. 2020) with OxCal ver. 4.4.4 (Bronk Ramsey 2021). Calibrated dates are reported within 95.4% highest probability density function.

3. RESULTS

3.1. Pottery

The six pottery sherds discovered (Fig. 5: B) with a mineral, sand and mica slimming admixture, were made in a technology typical for the Late Neolithic/Proto-Bronze Age in Pomerania (2300-2000 BC – Bokiniec 1995; Czebreszuk 2001; Czebreszuk and Kozłowska-Skoczka 2008). The surface of the vessels had been destroyed by the sea. The technology of pottery is typical for the Late Neolithic/Proto-Bronze sites from Pomerania (Late Corded Ware culture horizon, Grobsko-Śmiardowska culture) and for so-called "kitchen pottery" of Iwno culture settlements sites in Eastern Pomerania and Chełmno land (Bokiniec 1995; Kurzyk and Ostasz 2015; Wadyl and Kurzyk 2018).

3.2. Results of the typological and morphological analysis of the flint artifacts

A total of 184 flints discovered in eight small clusters were submitted for analysis. Within this collection, 129 flints were identified as man-made artefacts, while 54 specimens were categorised as natural forms (omitted in the present study). Due to the origin of the materials from a mixed context and their relatively homogeneous nature/uniform character, the collection was analysed as a whole, without attempting to divide it into individual clusters.

Out of the 129 flint artefacts, 89 specimens were crafted from Pomeranian flint (constituting 69% of the collection), 37 from Baltic flint (28.7%), 1 from banded flint (0.8%), and in the case of 2 specimens (1.6%) determining the raw material was not possible due to intense patina on their surface.

In the group of items from the preparation and early stages of core processing, only one cortical flake was identified, similar to the group related to flakes reduction, to which one flake from the changed orientation core was assigned (Table 1). The contribution of both groups to the total/overall material is negligible at 0.8% each.

Seven flint artefacts were assigned to the blades' reduction group, accounting for 5.4% of the collection. Two single platform blade cores were distinguished here. The first is a single platform blade core, conical with a rounded flaking face and prepared striking platform measuring 30 × 14 × 11 mm (Fig. 12: 1). The second is a heavily exploited single platform blade core measuring 35 × 11 × 10 mm (Fig. 12: 2). The material also included three blades from single platform cores measuring 22 × 9 × 3 mm (Fig. 12: 3), 40 × 11 × 3 mm (Fig. 12: 4), 21 × 5 × 4 mm, and a fragment of the proximal end of a blade, as well as one bladelet measuring 17 × 6 × 3 mm knapped from a changed orientation core.

The splintered pieces' reduction group constitutes the most numerous technological group in the analysed collection. A total of 99 flint artefacts were classified into this group, accounting for 76.7% of the entire collection (Table 1). This includes 3 unipolar one-sided

Table 1. The technological structure of the flint assemblage from the Rybitwia Mielizna Site F32.10

Group	Amount	%	Category	Amount	%
Group I – Preparation and early stages of core processing	1	0,8	Cortex flakes	1	0,8
Group II – Flakes' reduction	1	0,8	Flakes from the changed orientation cores	1	0,8
Group III – Blades' reduction	7	5,4	Single platform blade cores	2	1,5
			Blades from the single platform cores	4	3,1
			Blades from the changed orientation cores	1	0,8
Group IV – Splintered pieces' reduction	99	76,7	Unipolar one-sided splintered pieces	3	2,3
			Bipolar one-sided splintered pieces	7	5,4
			Unipolar two-sided splintered pieces	2	1,5
			Bipolar two-sided splintered pieces	14	10,8
			Diagonal two-sided splintered pieces	1	0,8
			Combined two-sided splintered pieces	22	17
			Cortex flakes from the splintered pieces	12	9,3
			Flakes from the splintered pieces	37	28,7
			Blades from the splintered pieces	1	0,8
Group V - Repairs	1	0,8	Overpassed blades	1	0,8
Group VI – Indeterminate specimens, chipping debris and retouch	10	7,7	Indeterminate flakes	3	2,3
			Wastes	7	5,4
Group VII – Tools and characteristic wastes from their production	10	7,7	Endscrapers	3	2,3
			Scrapers	1	0,8
			Perforators	1	0,8
			Borers	1	0,8
			Sidescrapers	1	0,8
			Bifacial points	1	0,8
			Truncated blades	1	0,8
			Flakes from axes	1	0,8
Total	**129**	**99,9**		**129**	**100**

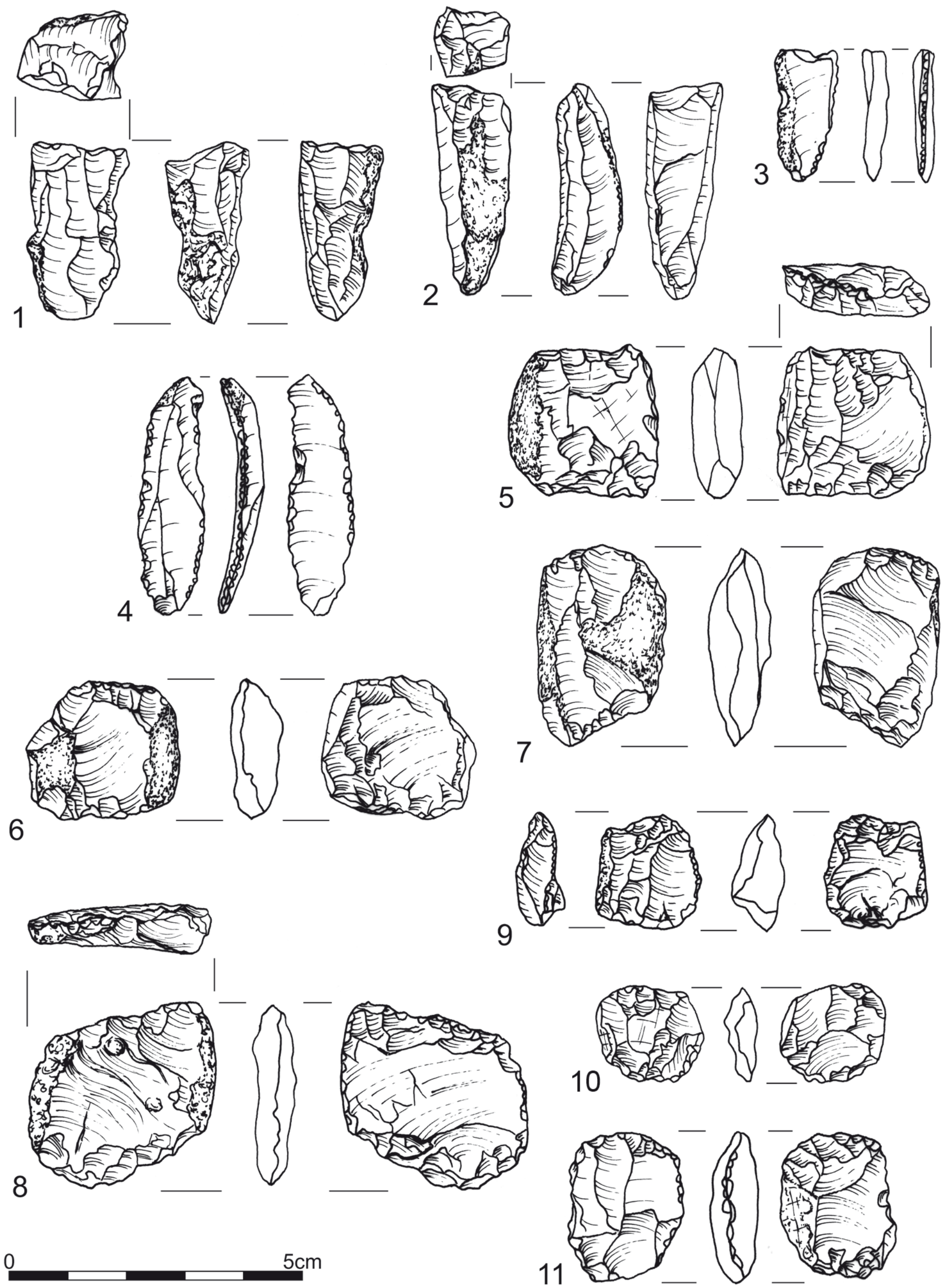


Fig. 12. Rybitwia Mielizna Site F32.10.
Selection of flint artefacts: 1, 2 – cores, 3, 4 – blades, 5-11 – splintered pieces
(drawing D. Nowak)

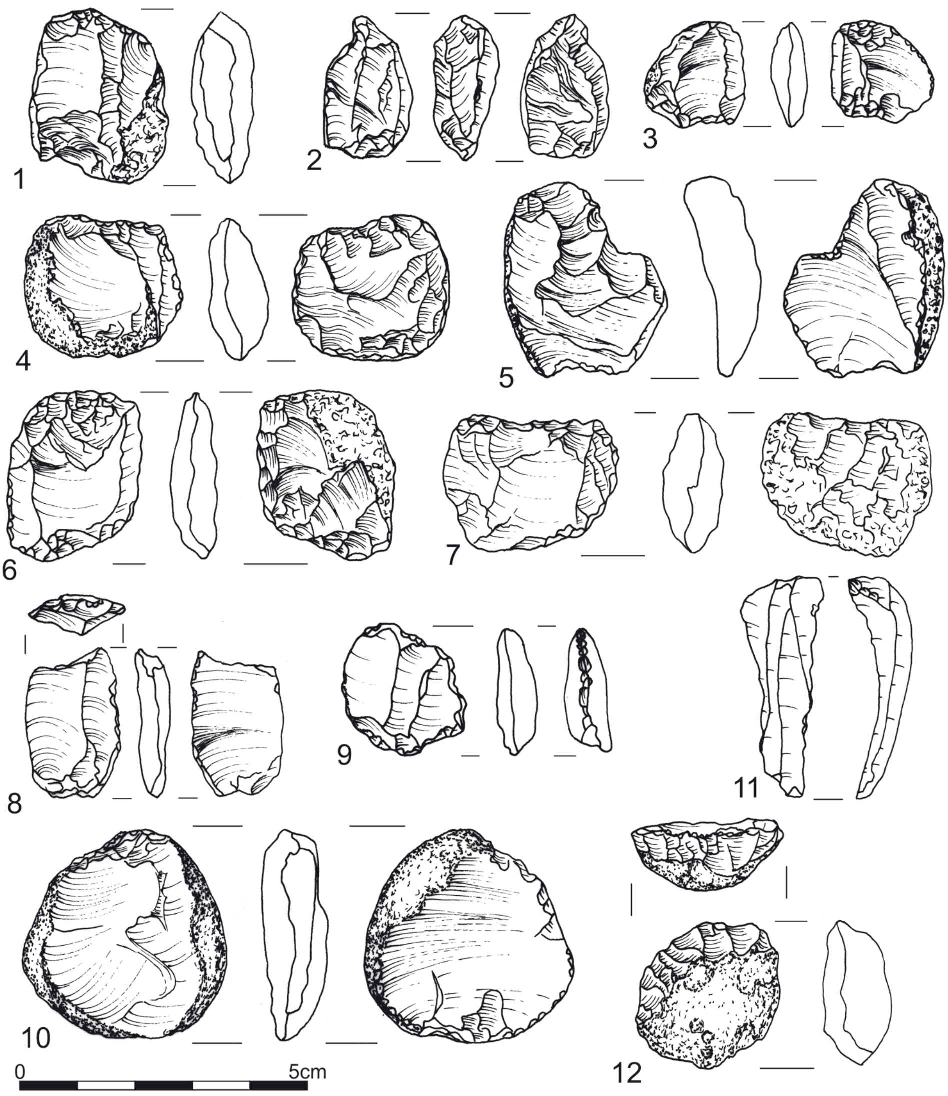


Fig. 13. Rybitwia Mielizna Site F32.10.
Selection of flint artefacts: 1-7 – splintered pieces, 8-10 – flakes, 11 – overpassed blade, 12 – end scraper (drawing D. Nowak)

splintered pieces, 7 bipolar one-sided splintered pieces, 2 unipolar two-sided splintered pieces, 14 bipolar two-sided splintered pieces (Fig. 12: 5-11; Fig. 13: 1), one diagonal two-sided splintered piece, and 22 combined two-sided splintered pieces (Fig. 13: 2-7). The dimensions of the mentioned splintered pieces range from 16 to 45 mm in length (average 25 mm), 10 to 38 mm in width (average 22 mm), and 3 to 12 mm in thickness (average 7 mm)

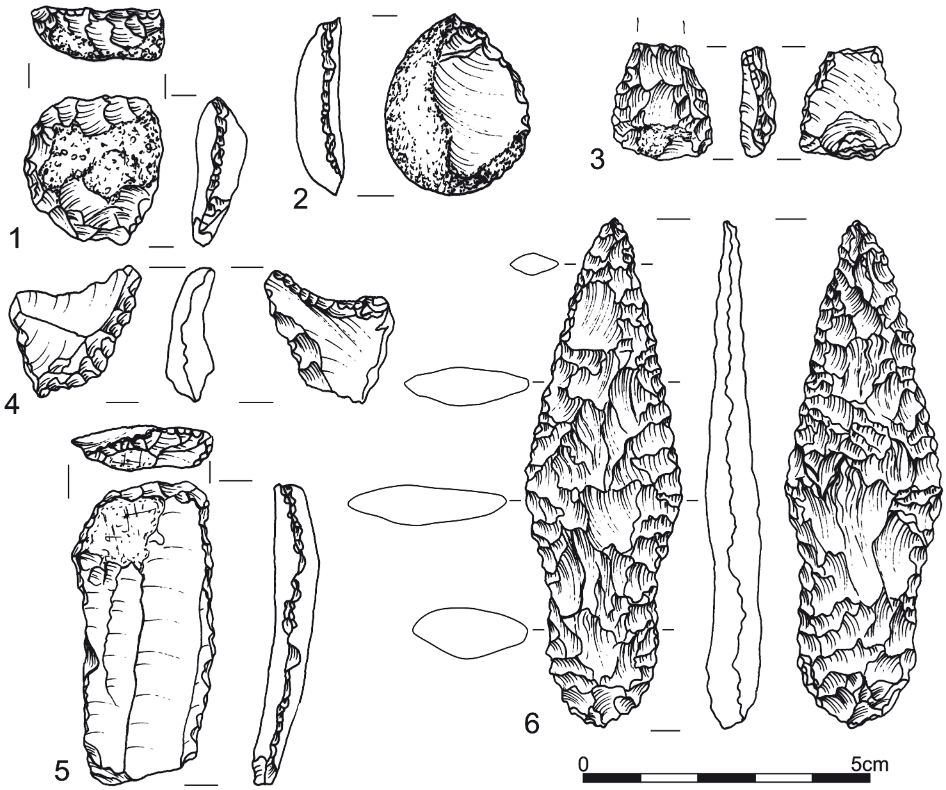


Fig. 14. Rybitwia Mielizna Site F32.10. Selection of flint artefacts:
1 – end scraper, 2 – scraper, 3 – perforator, 4 – borer, 5 – truncated blade, 6 – bifacial point
(drawing D. Nowak)

(Fig. 15). In this group, there are also 12 cortex flakes from splintered pieces ranging from 20 to 34 mm in length (average 27 mm), 12 to 31 mm in width (average 21 mm), and 3 to 8 mm in thickness (average 5 mm). The most numerous category in both the group and the entire collection (28.7%) consists of 37 negative cortical splintered piece flakes and their fragments, among which there are 10 unipolar flakes (Fig. 13: 8) measuring from 15 to 29 mm in length (average 23 mm), 13 to 35 mm in width (average 20 mm), and 3 to 10 mm in thickness (average 6 mm); 14 bipolar flakes (Fig. 13: 9, 10) with a length ranging from 17 to 35 mm (average 25 mm), width from 12 to 35 mm (average 20 mm), and thickness from 3 to 10 mm (average 6 mm); and 8 diagonal flakes measuring from 14 to 29 mm in length (average 21 mm), 16 to 24 mm in width (average 18 mm), and 2 to 6 mm in thickness (average 4 mm) (Fig. 16).

In the repairs group, only one overpassed blade from a single platform core, measuring 38 × 11 × 4 mm, was identified (Fig. 13: 11).

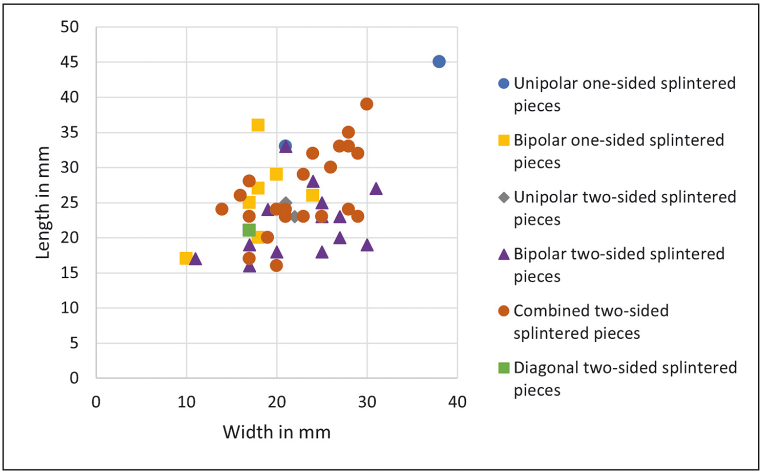


Fig. 15. Metric diagram of splintered pieces from the Rybitwia Mielizna Site F32.10

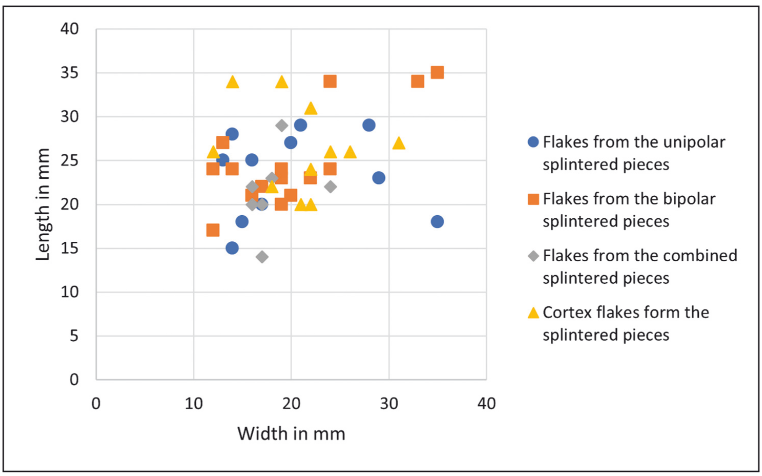


Fig. 16. Metric diagram of flakes from the splintered pieces from the Rybitwia Mielizna Site F32.10

The group of indeterminate specimens, chipping debris and retouch, is represented by three indeterminate flakes and seven wastes.

The group of tools and characteristic waste from their production include 10 flint artefacts, accounting for 7.7% of the entire collection. The most numerous category in this group was end scrapers, represented by three specimens – two end scrapers measuring 22 × 15 × 5 mm and 25 × 23 × 10 mm made from flakes (Fig. 13: 12) and one round end scraper measuring 25 × 23 × 8 mm with incomplete retouch (Fig. 14: 1). Among the tools, a scraper measuring 30 × 25 × 7 mm made from a flake was also identified (Fig. 14: 2), as well as a single specimen of a perforator with broken point measuring 19 × 18 × 6 mm (Fig. 14: 3). There is also one borer on a flake (which could be classified as a scraper with alternate retouch and both sides converging) measuring 28 × 19 × 7 mm (Fig. 14: 4), as well as a bilateral double side scraper with parallel, straight and curved sides made on a cortical flake measuring 40 × 26 × 7 mm, and a truncated blade on a blade from a single platform core measuring 53 × 23 × 6 mm (Fig. 14: 5) made of Baltic flint with patinated surface. In this group, one specimen of a bifacial point with a length of 87 mm and a width of 28 mm, featuring a poorly defined long tang and a leaf tip, was also distinguished (Fig. 14: 6). Detailed measurements of the tool allowed its classification in J. Libera's typology as a bifacial point of subtype B, variety BA, subvariety II, variant 2 (BA II 2) – bifacial point with a weakly differentiated tang at the base, a leaf tip, and a slender form. In this group, there is also a flake from a polished axe made of banded flint measuring 32 × 21 × 5 mm.

3.3. The results of the morphological-typological analysis of the included antler artefacts

The adze included in the study (inv. no. P/143/98) from site 23 in Puck (Fig. 6) was crafted from the base of a red deer antler beam (beam base), namely from the vicinity of the burr and the place where its branch, known as the brow tine, originates. The object is characterised by a longitudinal, diagonally cut blade opposite a blunt-ended head and a relatively large shaft hole (diameter approximately 2.4 cm). The orientation of the blade and the hole are consistent.The length of the adze is 22 cm, the width is 5.8 cm, and the height is 4 cm. The tool can be classified as Type IA, according to Jolanta Ilkiewiczowa (2010). The form of the specimen is quite unusual and may represent a kind of zoomorphic stylisation, possibly imitating a bird's head, perhaps that of a duck or swan (Fig. 6).

Similarly, the second of the analysed antler artefacts (adze, inv. no. P/92/97 – Fig. 7) was made from the base of a shed antler. Its blade is very short and partially damaged. It is difficult to unequivocally determine its orientation relative to the axis of the shaft hole, whose cross-section is close to a rectangle. The length of the specimen is 15.5 cm, the width is 7.6 cm, and the height is 5.1 cm. The dimensions of the perforation are 2.3 × 2.1 cm. The tool can be classified as Type IA or IB, according to Jolanta Ilkiewiczowa (2010).

The analysed *baton percé* from Hel (such artefacts are also referred to as *bâton de commandement, lochstab, or mattock*; *cf.* Płonka 2003, 28) is characterized by a diagonally cut blade (partially broken) and a relatively large hole (diameter approximately 1.7 cm) located close to the burr (Fig. 8). The blade is oriented perpendicular to the axis of the hole. The specimen has a length of 22 cm and a diameter of about 2.5-3 cm (in the central part). This artefact, too, was crafted from the beam base of a red deer antler.

It is generally accepted that early Holocene *batons percés* can be relatively dated based on their size, diameter, and the method of perforation (Płonka 2003). Boreal and early

Atlantic specimens typically have a length of about 40-50 cm and a width of about 3.3-4.3 cm. Younger *bâtons* are usually longer (about 50-70 cm) and narrower (about 2.7-4 cm), with smaller holes. The specimen analysed in the article should be classified among early Mesolithic forms, noting that it is significantly smaller than "standard" forms.

3.4. The results of absolute dating

All three antler artefacts included in this study underwent absolute dating using the AMS method (Table 2, Fig. 17).

The data obtained for the *bâton percé* from Hel: 7326-7052 cal BC (Poz-168045, 8160 ± 50 BP) indicates a Boreal origin of the artefact or the AT1 phase of the Atlantic period, according to Starkel *et al.* (2013).

The datings of the other two artefacts are similar. Adze inv. no. P/143/98 obtained dating of 1436-1264 cal BC (Poz-93212, 3095 ± 35 BP), and adze no. P/92/97 obtained a dating of 1601-1418 cal BC (Poz-93211, 3225 ± 35 BP). Both dates indicate the Subboreal period

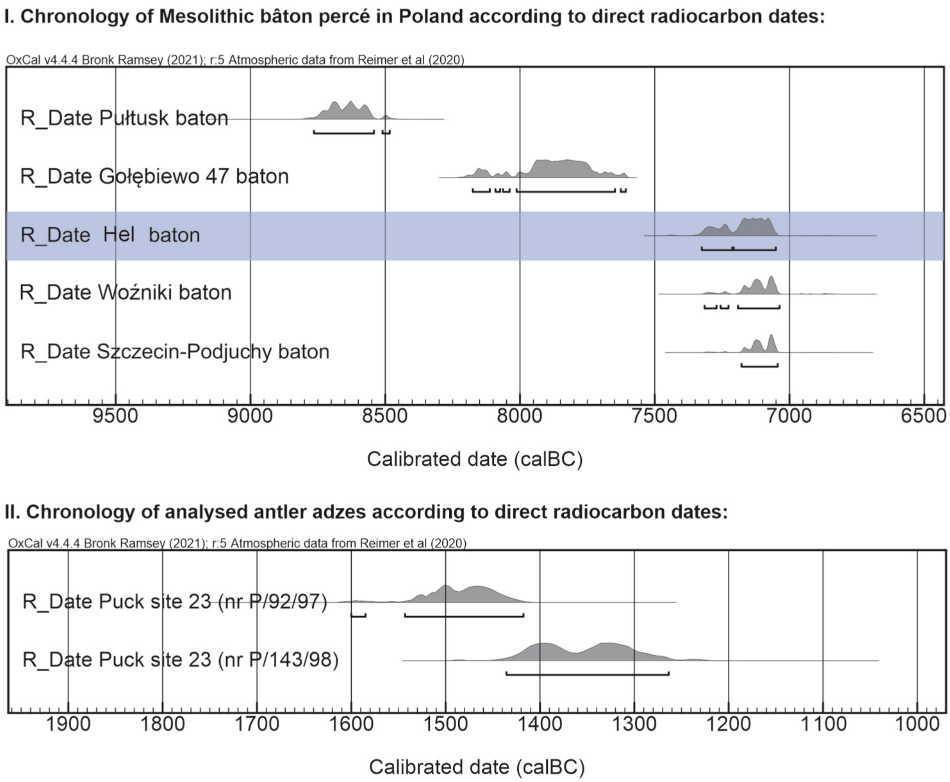


Fig. 17. Results of radiocarbon dating of antler artefacts

Table 2. Antler artefacts, results of the radiocarbon dating

Site	Type of tool, inv. No.	Laboratory code	Date uncal BP	cal BC (95.4%)	Collagen yield (%)	Nitrogen fraction in bone (%)	Carbon fraction in bone (%)	Chrono-stratigraphic phase	Chronology
Hel	Bâton percé, inv. No. Hel/1/2022	Poz-168045	8160 ± 50 BP	7326-7052	0.17g + additional mater	4,2	11,1	Boreal	Mesolithic (Maglemose culture)
Puck 23	Antler adze, inv. No. P/92/97	Poz-93211	3225 ± 35 BP	1601-1418	14	6,4	16,9	Subboreal	Middle Bronze Age (Pre-Lusatian culture?)
Puck 23	Antler adze, inv. No. P/143/98	Poz-93212	3095 ± 35 BP	1436-1264	11	6,2	16,3	Subboreal	Middle Bronze Age (Pre-Lusatian culture?)

(SB2 phase according to Starkel *et al.* 2013), falling within the II period of the Bronze Age according to Oscar Montelius (1986), or the Bronze Age B-C according to Paul Reinecke (1965).

3.5. Results of traceological analysis

The test-verification traceological analyses conducted on selected flint artefacts from the Rybitwia Mielizna Site F32.10, revealed exceptionally extensive fracturing and rounding of all edges, along with the coverage of their surfaces with a type of patina that completely destroyed potential use-wear traces (Fig. 9: A, B). Consequently, it rendered functional studies impossible. For this reason, the traceological analysis of the remaining artefacts in this collection was abandoned. Microscopic examinations of the antler artefacts were also hindered by significant post-depositional damage and the presence of various contaminants on their surfaces, including sponge remains and residues from other marine organisms. The results of the analysis of individual items will be discussed independently.

Adze from Puck, site 23 (inv. no.P/143/98, Fig. 6)

The original surface of the specimen is almost entirely peeled off. It is preserved in small fragments only in the head area, at the end of the blade, and around the cut antler tines (Fig. 9: C; the original surfaces are indicated by arrows). On the remnants of one of the tines, within the preserved original surface, traces of cutting were observed (Fig. 9: D; arrows indicate the cut marks). After the initial shaping, the tool's blade underwent grinding/scraping with a sharp implement, traces of which are now only visible in a small fragment near its base. Here, as well, a few weakly visible cut marks from this part of the tool's shaping process are preserved.

The visible hole on the artefact was drilled from two sides. In its outer parts (near the edge), it has a slightly polygonal cross-section (Fig. 9: E), which is probably the result of widening its diameter through scraping (but it may also result from the work of the tool's shaft during use). Inside the hole, clear "steps" are visible, resulting from the "non-concentric" drilling from both sides of the artefact (Fig. 9: F). To create the perforation, drills with a width smaller than the diameter of the drilled hole were likely used, as inferred from the outline of the curves they created (the diameter of the drills was probably around 1 cm, while the diameter of the hole is about 2.6 cm). The presence of steps inside the perforation clearly indicates the use of drills with a "flat" end (without a blade), as can be inferred from experiments, most likely made of bone or black elder (Osipowicz 2007). In this case, the use of flint drills can be ruled out with a high degree of probability (*cf.* Orłowska 2015).

The blade of the tool is strongly rounded. On the upper side, to its right, partially preserved delicate relief microfeatures of the antler are observed, along with a rather faint polish of unspecified origin, possibly of a functional nature (Fig. 9: G). On the lower side of the blade, on the preserved fragment of the original surface, there is a noticeable dulling (Fig. 9: H), the origin of which could be varied (use, repair, post-depositional processes).

Adze from Puck, site 23 (inv. no. P/892/97, Fig. 7)

The specimen is relatively well-preserved, with a largely readable, unpeeled original surface. The burr of the utilised red deer antler was calibrated and almost entirely removed through knapping/chiselling (Fig. 10: A). The brow tine was separated through circumferential knapping strikes (Fig. 10: B), resulting in the breaking of the spongy mass (Fig. 10: C). The blade of the tool was also shaped by the chiselling technique, and its remnants are deep incisions on its surface (Fig. 10: D).

The hole made in the specimen currently has a rectangular cross-section, and it is clearly visible that it has been secondarily chiselled. This is evidenced primarily by the distinct linear traces inside and on the edges of the hole (V-shaped grooves in cross-section), which are traces of the blade of the tool used (Fig. 10: E – indicated by arrows). Clear signs of chiselling/knapping are also observed on the edges of the hole (Fig. 10: F – marked with arrows). The characteristics of the technological traces, especially those visible inside the perforation, suggest that a metal tool was used for this process. The hole has a slightly oval cross-section, raising the possibility that it was originally drilled and subsequently chiselled.

The state of preservation of the tool allows for certain suggestions regarding its primary function. Its cutting edge is strongly rounded and entirely covered with a glossy polish with an invasive degree of intrusion (Fig. 10: G). However, a detailed analysis of its structure using a metallographic microscope was not possible due to the artefact's large size. The spongy mass visible along the working edge is damaged. Clear breakages and crushings of (presumably) functional origin were observed on the cutting edge (Fig. 10: H). The overall characteristics of the use-wear observed on the specimen suggest that it was associated with woodworking.

***Bâton percé* from Hel (inv. no. Hel/01/2022, Fig. 8)**

The overall state of preservation of the artefact is good, although it is cracked and slightly smoothed post-depositionally. However, this does not affect the clarity of the technological traces.

In essence, the entire surface of the object has been precisely scraped (Fig. 11: A). Chatter marks are clearly visible in many places (Fig. 11: B). Remnants of the burr bear traces of nicking/knapping (Fig. 11: C), but it is challenging to determine unequivocally whether its (partial) removal occurred intentionally or, for example, as a result of using the *bâton percé*. In some places, there are scraping marks on the burr (Fig. 11: D), which, however, is most likely a result of the process applied to the entire surface of the artefact rather than specifically to this part. The brow tine was removed using knapping of cortical tissue (Fig. 11: E), followed by breaking within the spongy tissue. Irregularities resulting from this were removed by scraping (Fig. 11: F).

The hole visible in the object could have been drilled using a flint tool, as evidenced by its asymmetrical shape and irregular traces of drilling inside it (Fig. 11: G). Before starting the perforation, the antler surfaces were prepared by knapping (Fig. 11: H). After drilling the hole, its edges were probably scraped (widened?). Scraping marks were also observed on the blade of the *baton* from the lower side (Fig. 11: I).

Investigations into the function of the specimen proved to be essentially impossible due to the covering of its surface with plant remains (algae?; Fig. 11: J). There are no visible signs of functional breakage on its blade, and the connection of the clearly visible linear polish in some places (Fig. 11: K) to the function of the specimen is uncertain. No more definitive signs of use were observed in the perforation of the specimen.

4. CONCLUSIONS

Among the analysed flint materials from Rybitwia Mielizna, site F32.10, attention is drawn to two blade cores (Fig. 12: 1, 2) that may be associated with the flint industry of the Mesolithic community of the Chojnice-Pieńków culture. The overwhelming majority of the collection consists of a relatively uniform set of flint artefacts, primarily related to the processing of flint using the bipolar technique. This technique, appearing in earlier periods, was intensively utilised from the Neolithic (*e.g.*, in the Funnel Beaker culture) to the Bronze Age inclusive. It is also well represented at the Late Mesolithic (Chojnice-Pieńków culture) site Jastrzębia Góra 4 and other sites of Kępa Ostrowska region (Ruta 1997). However, unlike the situation observed at the Jastrzębia Góra 4 site, the flint collection analysed here did not contain microliths or other tool forms that could be assigned to Mesolithic communities. This makes it impossible to connect this collection more confidently with the activities of early Holocene hunter-gatherer-fishers. In turn, the presence of Neolithic pottery at the site requires considering its relationship with the communities of that period.

In the published collections of flint artefacts from the sites of the Łupawa group of the Funnel Beaker Culture, the Rzucewo culture and the Late Neolithic/Proto-Bronze sites in Pomerania – the scaled method of exploitation, based mainly on the use of Pomeranian flint, definitely dominates in all better-recognized sites (Domańska 1987; Kabaciński 2018; Małecka-Kukawka 2009). In the case of the flint dagger from the Rybitwia Mielizna Site F32.10 (Fig. 14: 6), the closest analogies from Pomerania come from a loose find of a flint dagger from Wrześcienko, Lębork district (type Ig according to Czebreszuk and Kozłowska-Skoczka 2008; type BA II according to Libera 2001). From Eastern Pomerania, we currently know 10 flint daggers (Wąs and Klimaszewski 2015), which is rather a small number compared to slightly more than 200 flint daggers from Western Pomerania (Czebreszuk and Kozłowska-Skoczka 2008). Most of these flint daggers were dated to the Late Neolithic/Proto-Bronze in Western Pomerania (2300-2000 BC, Czebreszuk and Kozłowska-Skoczka 2008). The form of the flint Dagger from Rybitwia Mielizna F53.10 also finds some analogies in the BAII 2 types from the village of Klon (part of the village of Zełwągi) in the Mrągowo district (see: Libera 2001, 144) and in two BBI2 types from Szczytno, Szczytno district, and from Trękus, Olsztyn district (see Libera 2001, 147). All three artefacts are loose finds, but both types, BAII 2 and BB I 2 are associated with the early phase of the Mierzanowice culture (Libera 2001, 125). The typo-chronological analysis of the pottery, combined with the characteristics of the collection of flint artefacts (dominance of the scaled method of exploitation with the absence of distinctive microlithic forms) and analogies in the case of flint daggers, allows us to connect the analysed collection with the period of the Late Neolithic/Proto-Bronze in Pomerania (2300-2000 BC). The origin of the collection from probably a mixed context from the seabed may explain the presence of a few older forms like chip cores and a flake from a polished axe, but their synchronicity with the rest of the collection cannot be unequivocally ruled out. The adzes made of antlers presented in the study belong to a group of artefacts referred to as heavy-duty bevel-ended tools (Orłowska and Osipowicz 2017). Tools of this type were mainly produced from the base of the red deer antler, *i.e.*, the area around the burr and the place where its branch grows, the so-called brow tine, and from the middle part of the antler at the height of the so-called bez tine. They are characterised by a diagonally cut blade, opposite to a blunt-ended butt, and a relatively large hole for inserting a handle. Due to differences in the orientation of the working edge relative to the axis of the hole (*cf.* Pratsch 2006), these tools can be divided into adzes (blade parallel or slightly inclined) and hoes (blade oriented perpendicularly). The chronology of the use of such artefacts is very long and spans from the Mesolithic to the Iron Age (inclusive).

Heavy-duty bevel-ended tools from the Pomorze region are mainly stray finds, lacking a broader archaeological context and precise chronology, often associated with the Mesolithic or Neolithic periods (Ilkiewicz 2010). The only archaeological site where more artefacts of this type have been found is Dąbki (see Kabaciński and Terberger 2015). However, at this site, heavy-duty bevel-ended tools are represented only by T-shaped axes, which makes them irrelevant to the analyses conducted here.

The results of AMS dating for both artefacts of the discussed type place their chronology around 1600-1260 cal BC. In the Pomorze region, this period corresponds to the development of the so-called pre-Lusatian culture, which is classified within the circle of tumulus cultures and urnfield cultures (Gedl 1975; Bukowski 1998). The "ubiquity" and intercultural character of the discussed artefacts, as well as the lack of direct radiocarbon dating for artefacts of this type from the Pomorze region (*cf*. Ilkiewicz 2010), make finding direct analogies for tools from Puck very challenging.

Bronze Age antler adzes exhibit a continuity of form known from the Mesolithic. However, they also show some differences compared to earlier artefacts. Significant features in their case include the parallel orientation of the blade to the axis of the hole, the treatment of the base (removal of protruding elements of the burr), and the often-encountered rectangular cross-section of the hole for the shaft (Drzewicz 2004; Frost 2020). In many cases, these perforations were originally circular/oval, but they were modified secondarily to give them a square cross-section (Riedel *et al*. 2004). A similar modification is likely to have been applied to one of the tools from Puck.

In the section dedicated to the results of the morphological-typological analysis of the antler artefacts, it was suggested that adze no. P/143/98 may represent a kind of zoomorphic stylisation, possibly referring to the head of a bird (duck or swan). This is, of course, only a hypothesis; however, it should be noted that during the Middle Bronze Age (and more frequently in its later phase), artistic representations in the population inhabiting the area of Poland included many bird figurines (Gediga 1970, 193-197). Ornithomorphic motifs were one of the most popular decorative themes in the art of the Lusatian culture, used in the ornamentation of ceramic and bronze objects (Kaczmarek 2002, 102). These representations often take a simplified form (as possibly seen in the discussed antler artefact) and serve more for symbolism than for a realistic portrayal of the natural world (Gediga 1970, 194). Unfortunately, direct analogies for the described artefact from Puck could not be found.

The analysed bevel-ended tools from Puck exhibit varying states of preservation. However, as a result of the conducted technological analyses, it was possible to reconstruct a general outline of the operational chain performed during their production. The range of activities included:

a) Removal of antler tines using circumferential chiselling to the depth of the spongy tissue, followed by subsequent removal of unwanted prongs through breaking. Remaining irregularities were eliminated using scraping.

b) Shaping the tool's blade using chiselling. Irregularities were removed through scraping/grinding the surface.

c) Shaping the surface of the "coronet", probably by removing it circumferentially, most likely through chiselling/knapping.

d) Forming the hole through double-sided drilling. Its edges could be widened through scraping. Additionally, perforations were secondarily chiselled, giving them a rectangular shape.

The described technological procedures were commonly employed in prehistory for heavy bevel-ended tools (Pratsch 1994; Jensen 2001; Elliott 2012). Secondary chiselling of holes is known from the Bronze Age (Riedel *et al.* 2004).

Unfortunately, the results of the conducted analyses did not provide much information regarding the use of these artefacts. Only in the case of one of them was it possible to suggest its connection to wood processing. Similar artefacts dated to the Bronze Age from Italy (Durante *et al.* 2022) and artefacts with an earlier chronology from Poland (Orłowska and Osipowicz 2017), Germany (Riedel *et al.* 2004), the Netherlands (Van Gijn, 2005), or Denmark (Jensen, 2001) were used in a comparable way. The described *bâton percé* from the Hel Peninsula is considered interesting for several reasons. Its small size and the absence of decoration are undoubtedly noteworthy, which is quite unusual in the context of other artefacts of this kind from Poland, Germany, or Denmark (*cf.* Płonka 2003, 29-32; Osipowicz *et al.* 2017).

The oldest *bâton percé* from northern Poland is an artefact from Pułtusk, which received a radiocarbon date of 9370±45 BP (8765-8484 cal BC, OxA-25759; Sulgostowska 2019). This places it at the transition between the Preboreal and Boreal periods (Fig. 17). The dating of the analysed artefact from the Hel Peninsula (7326-7052 cal BC) is one of four currently available Boreal radiocarbon dates for *bâtons percés* from Poland. The other three artefacts with Boreal dates come from the sites Gołebiewo 47 (8176-7608 cal BC, Poz-73613; Osipowicz *et al.* 2017), Woźniki (7316-7038 cal BC, OxA-25760; Sulgostowska 2019), and Szczecin-Podjuchy (7179-7045 cal BC, OxA-40218; Płonka 2022). Culturally, the analysed *bâton percé* can be associated with the classic assemblages of the Maglemosian culture (Galiński 2019, 120).

Batons produced by Mesolithic hunter-gatherers have been well recognised in terms of the techniques used in their production (*e.g.*, Sulgostowska 2019; Płonka 2017). The method of crafting the analysed artefact does not differ significantly from other artefacts of this kind (*e.g.*, Osipowicz *et al.* 2020).

As a result of the transgression of the Baltic Sea, part of the former Stone Age coast has now been submerged. Research in other areas of the Baltic Sea indicates a frequent concentration of prehistoric sites along estuaries, water reservoirs (lakes, bays), as well as places of narrowing between the land and islands and sandbanks, as well as the edges of promontories entering the water. These are areas where there are usually periodic concentrations of aquatic organisms, *e.g.*, fish or marine mammals. Such areas were attractive to prehistoric societies. This type of model of searching for submerged sites from the Stone Age (the so-called "fishing model") has been successfully applied during exploration and research in the area of the southern Baltic Sea (Benjamin 2010; Fischer 2007; Uldum *et al.* 2018 – further literature there).

Unfortunately, the search for submerged sites from the Stone Age on the Polish coast is a bit like searching for a needle in a haystack. Due to the difficulties in recording underwater the relatively slight remains from the Stone Age sites, the long and relatively straight modern Polish coastline and the dynamics of the southern Baltic Sea, potentially the most promising areas are the modern lagoons and bays in our seacoast (the Bay of Puck, the Vistula Lagoon and the Szczecin Lagoon). We hope that the artefacts presented in the article are a promising beginning of the process of retrieving some more "gifts" from our sea in the near future and a small step for better protection of submerged paleolandscape, which is a unique testimony of the past.

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