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ENVIRONMENT, ECONOMY AND HABITATION DURING THE MESOLITHIC AT DUDKA, GREAT MASURIAN LAKELAND, NE-POLAND.

A reconstruction of the palaeoenvironmental conditions at Dudka, an island of the early and middle Holocene in the former Great Masurian Lake, is presented in relation to the history of human settlement. The paper explores all changes, even very weak, in order to interpret the interaction between man and the environment during the Mesolithic and aspects of geomorphology, hydrology, climate, vegetation and fauna through time are discussed. For many generations prehistoric people came to camp on Dudka island, that was included in their annual round for its resources of fish, tortoise, birds and edible plants; these were exploited on a seasonal basis, during discrete periods from early spring to early autumn.

KEY WORDS : palaeoenvironment, Mesolithic economy, Masuria (NE-Poland)

1. INTRODUCTION

Dudka, Wydminy commune, Suwałki district (Figs. 1 and 2) is an island situated in the centre of an extensive peat-bog called Staświńskie Łąki (= Staświny Meadows; German name: Röster Wiesen; former name in Polish archaeological literature: Moczyska). The site became initially known as a Zedmar culture settlement (Kilian 1938; Kempisty & Sulgostowska 1986; Gumiński & Fiedorczuk 1988; 1990; Gumiński 1995a; d), but although Dudka island was intensively inhabited in Zedmar times, evidence of settlement through the entire Mesolithic and Neolithic is present.

The paper presents a preliminary discussion of the Holocene evolution of the Great Masurian Lake, hereafter called Lake Staświny, and of the Mesolithic habitation on Dudka. The site provides unusual opportunities for research in a restricted area, of both natural history and human activities during the entire Holocene prehistory. Unfortunately this exceptional site, so suitable for scientific exploration, has been subjected to few natural science analyses. Moreover, all of these are preliminary or not yet finished and prospects for further research are slim because of financial and administrative restraints now imposed on archaeological research (Gumiński 1993: 450).

The palaeoenvironmental and paleoeconomical reconstructions presented in this paper are based mainly on three data sets. The first is the lithostratigraphical

sequence which has been arranged with the help of 24 C¹⁴-dates. The C¹⁴-dates have not been calibrated and all dates in the present paper are hence presented in BC (bc) conventional, not calibrated version. For the lighter text the laboratory numbers of the C¹⁴-dates are not cited, since these are in Table 1. The second data set consists of a pollen diagram and its interpretation (Nalepka 1995, this volume), however partly reinterpreted in chapter 3 of this paper. The third set consists of the preliminary archaeozoological analysis of the excavated mammalian and fish bones. Other restricted and incomplete data and preliminary results were used complementary. The colleagues and people who contributed directly or indirectly to this paper are listed in the acknowledgments.

This study combines all observed changes, even if they are very weak, and all proposed interpretations should be considered as such. However, any attempt to picture the interaction between man and environment in prehistory, in particular in the period before neolithisation, is exciting, however hard it may be. The principal intention is to concentrate on Dudka island and data, almost exclusively from this site, have been used. Thus, all suggestions and interpretations refer to this specific locality, but it is not excluded that some of them prove to be more general in character and applicable to other sites.

1A. EXCAVATIONS

Nine excavation seasons have been carried out at Dudka, from 1985 till 1994, except 1992. Until the 1991 field works were financed by the Voivodeship Service for Monuments Preservation in Suwałki and by the Institute of Archaeology and Ethnology, Polish Academy of Sciences, Warsaw. From 1993, only the Institute of Archaeology and Ethnology, covered the expenses. Ten trenches or cuts have been dug, with a total area of 268 m². Finds were recorded and plotted in a three-dimensional coordinate system. Each trench was excavated by one meter squares and 5 cm thick units. If necessary, these units were additionally split up with each distinguished layer. Each unit was carefully described, paying attention to both natural and cultural features, using a partly modified system of Troels-Smith (1955; cf. Gumiński & Fiedorczuk 1988: 115, footnote 2; 1990: 52). All sediment was dry sieved through a 2-4 mm mesh.

A complex stratigraphy and evidence of Mesolithic occupation have been recorded mainly in trench I and III and to a lesser extent in trench II; in trenches V and VII only a single Mesolithic flint artefact was found. It seems that generally speaking only the SE-bank of Dudka island has been occupied during the Mesolithic (Fig. 3).

1B. LAKE AND ISLAND

According to the current geographic regional division, the Masurian Lakes belong to the East Baltic Lake District which is part of the East European Lowland. The outflow of the Great Masurian Lakes which are linked, goes in two directions: north through the Węgorapa (Angrapa) river into the Pregoła (Pregel), and south through the Pisa river into the Narew and the Vistula. The southern way connects the Great Masurian Lakes with the Central European Lowland (Fig. 1; Kondracki 1978: 334, 1991: 602).

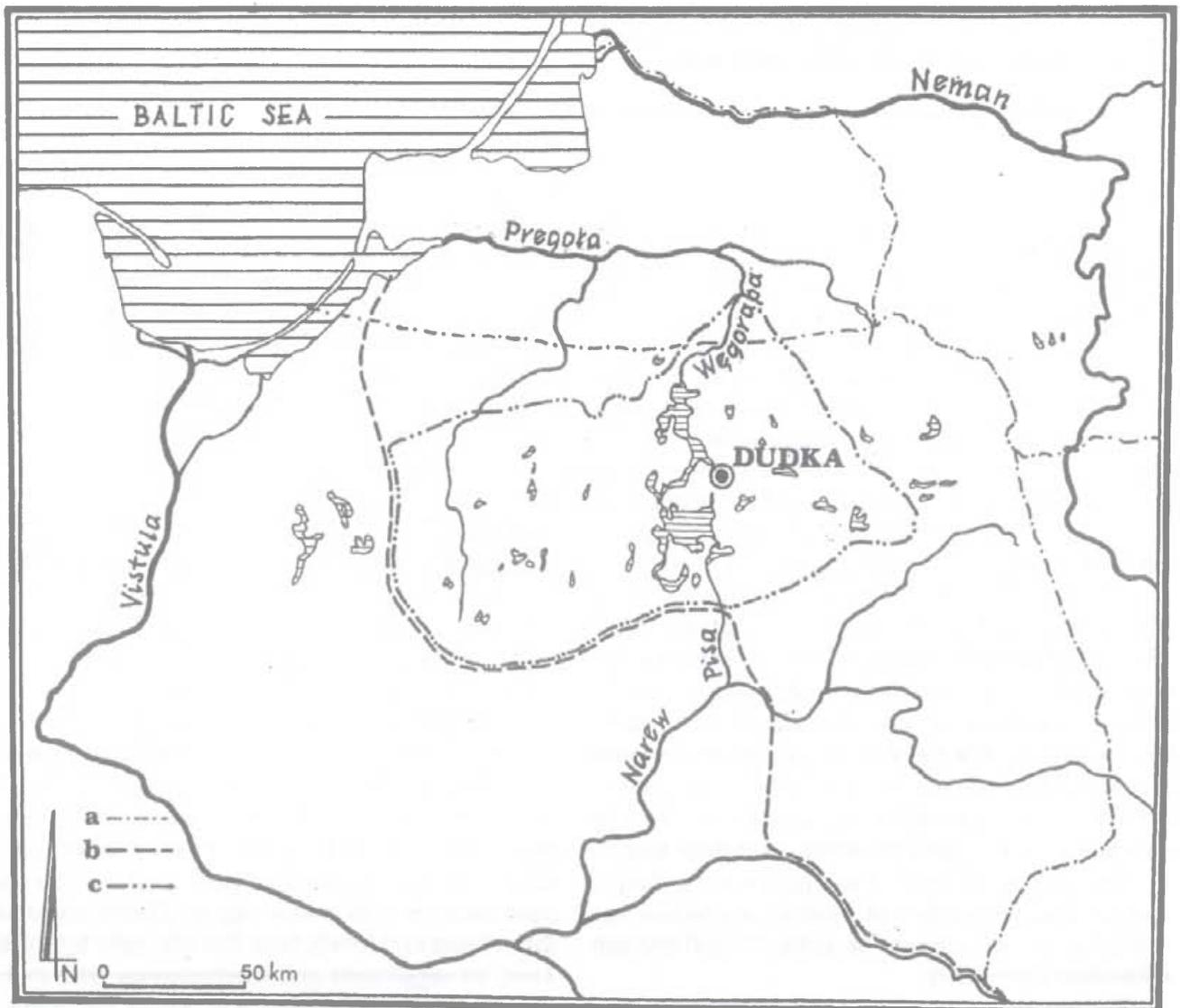


Fig. 1. The location of Dudka in NE-Poland. Key: a – state borders, b – border between Western and Eastern Europe, c – extent of the Masurian Lake District (after Kondracki 1978)

Former Lake Staświny (Fig. 2) was extensive (about 25 km²) and shallow with an average depth of 2.5-4 m and a maximum depth of some 9 m (Kempisty & Sulgostowska 1986: 58, Fig. 1). In the beginning of the Holocene, the lake rapidly warmed up because of its shallowness and aquatic vegetation, plankton, invertebrates, and fish developed rapidly as well as their preda-

tors, mainly birds and tortoise stayed on Dudka island. Later the lake became eutrophic and soon thereafter began overgrowing and drying up. The last process was accelerated by the outflow of the Pamer river into the Niegocin lake basin (Fig. 2). During the early and middle Holocene, the water-level of Lake Staświny fluctuated between 132-134 m above sea-level. Therefore, the

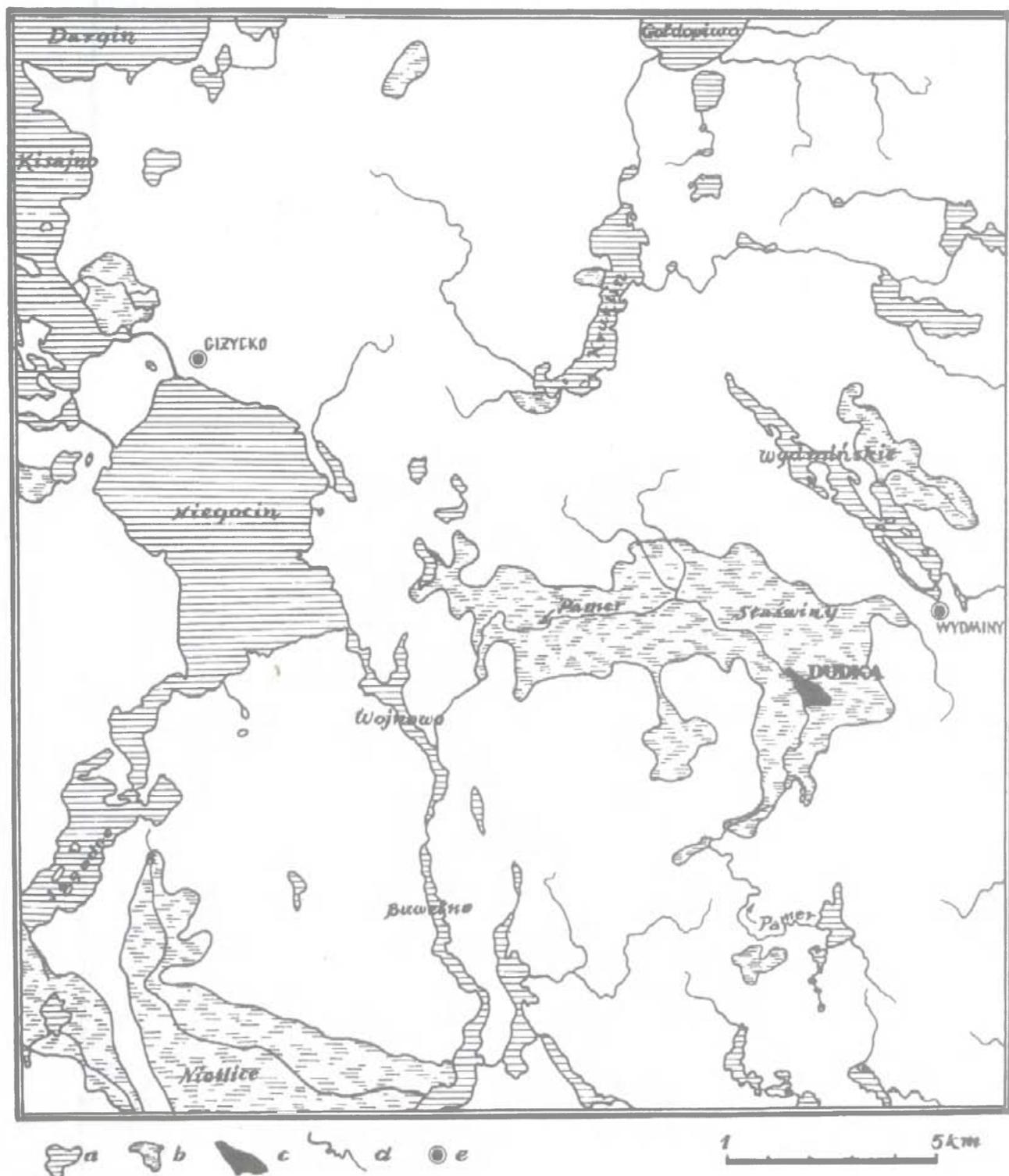


Fig. 2. The surroundings of the Staświny meadow and location of Dudka island. Key: a – lake, b – peat-bog, c – Dudka island, d – stream, e – town

maximum depth of Lake Staświny was still some 8 meters above present-day water-level of the linked Great Masurian Lakes (116 m). Nowadays the ground-water level of the Staświny peat-bog is at 132-132.5 m a.s.l. depending on the precipitation and vegetation of the year.

Dudka island is in contour an elongate triangle, with a main SE-NW axis (Fig. 3). It measures about 600 m in length and 200 m in width along the SE-base and covers about fifteen hectares. Its surface is nearly flat, rising overall 1-1.5 m (2 m at the highest place) above the present-day surrounding peat-bog. During prehis-

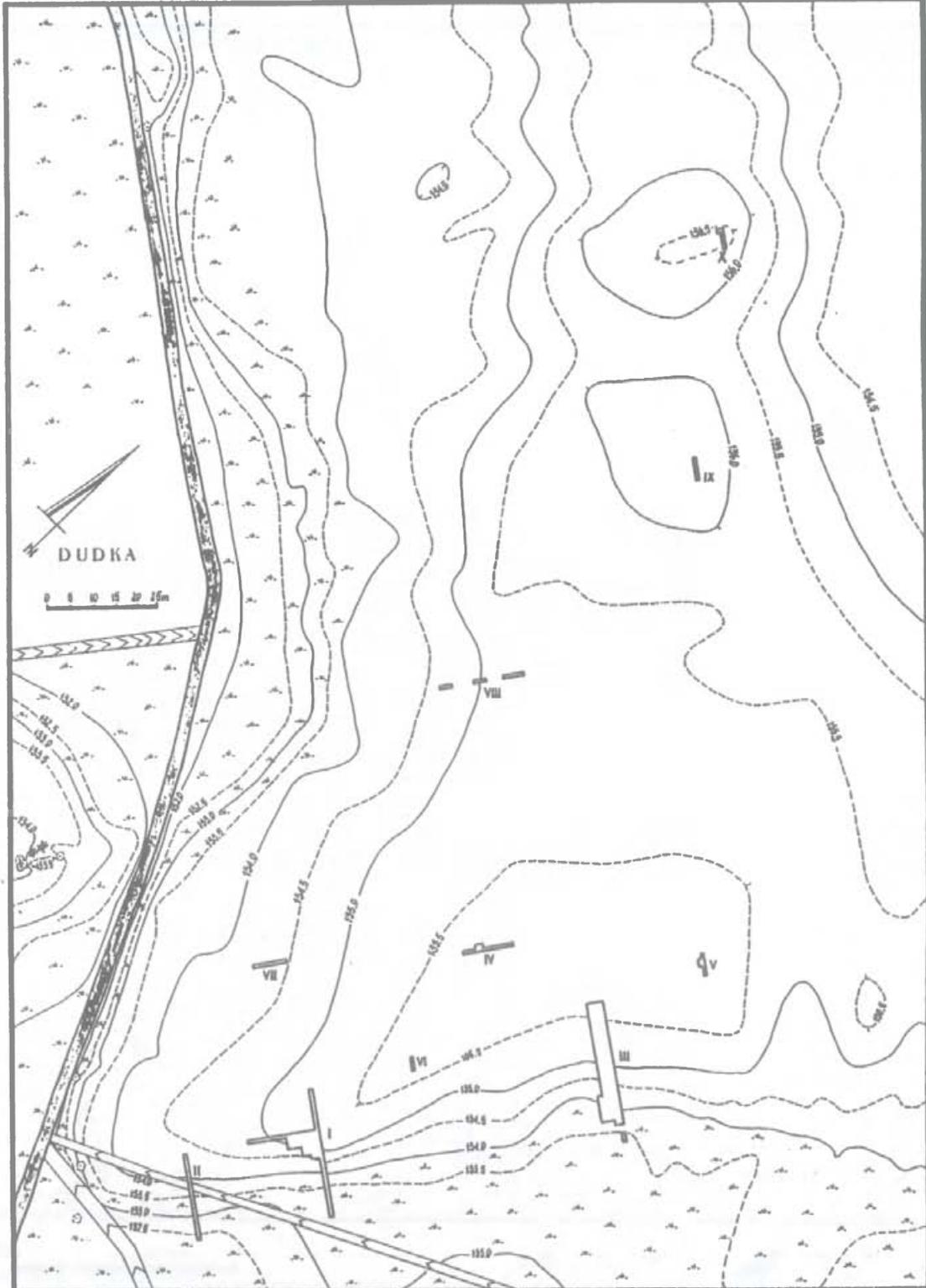


Fig. 3. Dudka island and location of the trenches I to X, SE- and SW-parts of the island

toric times, the surface would have been between 1.5 and 3 m above the fluctuating level of the former lake. The shortest distance from the island to the mainland (in SW-direction) is about 550 m. The Mesolithic site is located on the wider, south-eastern part of the island (Fig. 3).

Along the western shore of the island runs the Pamer river, the main outlet of the Staświny peat-bog. Unfortunately, its exact origin is unknown. Some test-boring in the area between trench VIII and the river produced grey silt down to 4-5 m deep. Without analysis, it is difficult to say whether this is lake gyttja or fluvio-glacial silt (Dr. A. Musiał, pers. comm.). The last option seems to be more plausible, considering the thickness of this silty deposit and its dissimilarity with the typical gyttja encountered in cuts along the SE-bank of the island (Table 2; Fig. 4, 5; chapter 2c.). Before

the Second World War, the Pamer river received a drainage and flood-control system, thanks to which the site was discovered (Kilian 1938: 87). At that time, some stretches of the stream were no doubt dug off, probably also between the SW-bank of Dudka island and another, small round island. Because of its maximum height (134 m a.s.l.), this small island must have been rather a sandbank during prehistory, but it may well have been connected with the main island.

The NE-bank of Dudka island is only weakly distinguishable, because it is presently wooded, but also because the surface below contourline 134.5 m goes down very gradually. Anyway, the borders of the island were situated above the quoted level, for exposures on the outside of the mentioned contourline, show only greyish-yellow pure sand of lacustrine origin. The SE-bank of the island is discussed below.

2. STRATIGRAPHY AND CHRONOLOGY

Dudka site can be divided into three topographic-geomorphologic zones: the flat plateau of the island interior (I), the slope of the island bank (B) and the swampy peat-bog edge or former littoral lake zone (L). The stratigraphy differs between these zones and it is

usually difficult to make correlations; other difficulties arise from the differences between the trenches or even between parallel sections in the same trench. Moreover, some of the C¹⁴-dates do not fit well in the sequence (Table 1). Therefore, the summary of strati-

No	Lab. No	Years conv		Stand dev.	Cut No	Layer No	Material	Expected	
		BP	BC					age	range
1	Gd-5945	4180	2230	±70	III	B.4	peat	m.older	4<1=10<7
2	Gd-4871	4320	2370	±120	III	B.3	charc.	older	4<2
3	Gd-2593	4870	2920	±110	I	L.3	charc.	o.k.	3<5
4	Gd-4457	4880	2930	±120	III	B.2	charc.	younger?	4<2<1=10
5	Gd-2878	4960	3010	±90	II	L.4	charc.	o.k.	3<5<6
6	Gd-5365	5540	3590	±60	II	L.5	charc.	o.k.	5<6<7
7	Gd-5944	6270	4320	±70	III	L.7	charc.	o.k.	6<7<9
8	Gd-6470	6480	4530	±150	III	B.6a	charc.	m.older	15<8<16
9	Gd-5942	6510	4560	±80	III	L.8	charc.	o.k.	7<9<11
10	Gd-6702	7060	5110	±120	III	?L.8	charc.	? o.k.	4<10<15
11	Gd-5575	7420	5470	±80	III	L.8	charc.	o.k.	9<11<12
12	Gd-6469	7650	5700	±150	III	L.9	charc.	o.k.	11<12<18
13	Gd-6468	7660	5710	±110	II	B.6	charc.	o.k.	6<13<14
14	Gd-5943	7820	5870	±90	II	B.6	charc.	o.k.	13<14
15	Gd-5732	8000	6050	±90	III	B.6a	charc.	o.k.	10<12<15<16
16	Gd-6701	8220	6270	±120	III	B.6a	charc.	o.k.	15<16<17
17	Gd-4583	8430	6480	±190	III	B.6b	charc.	o.k.	16<17<18
18	Gd-6250	8460	6510	±130	III	L.12	charc.	o.k.	12<17<18
19	Gd-7155	8470	6520	±70	I	L.15a	charc.	m.older	20<23<19
20	Gd-5733	8590	6640	±80	I	L.13	charc.	older	21<20<23
21	Gd-3309	8740	6790	±70	I	L.12	charc.	o.k.	21<20<23
22	Gd-6698	9130	7180	±130	I	B.8	charc.	o.k.	22<24
23	Gd-3310	9610	7660	±70	I	L.14a	charc.	o.k.	21<20<23<19
24	Gd-4305	9710	7760	±150	I	B.8	charc.	o.k.	22<24

Table 1. Dudka. C¹⁴-dates (not calibrated) and expected results

Table 2. Dudka. Diagram with stratigraphy, chronology and main geomorphological and settlement data

Key: - ↑ the date could be a little younger, ↓ - the date could be a little older, ↓↓ - the date should be much older (see Table 1). CWC - Corded Ware culture, FBC - Funnel Beaker culture, GAC - Globular Amphora culture, Ph - acidity.

Years conv. BC	Period	Bank zone stratigraphy & chronology			Littoral zone stratigraphy & chronology			Geomorphology	Settlement history at Dudka	
		Layer		C-14 dates conv. BC	Layer		C-14 dates conv. BC			
		No.	Lithology (only cut)		No.	Lithology (only cut)				Ph
1750	e.SB	B1	Black sandy peat soil	12930±120 12370±120	L1 →a	Black peat soil →clay lenses (I)	6.5	2920±110 3010±90 3590±60	Lake overgrowing Peat spread over island Peat increasing Peat decomposing	Island abandoned CWC all over island GAC Zedmar & GAC FBC & GAC visiting Zedmar flourish Zedmar first pottery
2000		B2	Black-brown lumpy peat (III)		L2	Brown loose peat (III)				
2250		B3	Grey peat, humus & sand		L3	Black lumpy peat	5.0			
2500	l.AT	B4	Black lumpy peat & gravel	12230±70	L4	Black-brown cohesive peat	5.0	4320±70 4560±80	Peat spread to bank Peat rapidly increasing Lake shrinking High eutrophic water High water level	Late Mesolithic wooden, bone & antler finds among branches in cut III
2750		B5	Sand & gravel, humus & brown peat traces		L5	Brown not decomposed peat	6.5			
3000		B6	Silt, peat, sand & gravel (II)		L6	Black decomposed peat	7.0			
3250	m.AT	B6a	Brown peat, sand & silt (III)	5710±110 5870±90 6050±90 14530±150 6270±120 6480±190	L7	Dark livid-brown sapropel	6.5	5110±120 5470±80 5700±150 6510±130 6790±70 16640±80	Water polluted by rough organic mater Duff washing Alder forest on bank Sand washing Shore abrasion Lagoons, floods Gyttja depositing Terrestrial inwash	Middle Mesolithic big game bones & human burial unit in cut III
3500		B6b	Silt & brown peat (III)		L8 →a	Black detritus (III) →dark gyttja (II)	7.0			
3750		B7	Sand & brown peat traces		L9	Dark brown detritus	7.5			
4000	e.AT	B8	Brown peat & gravel bands (I)	7180±130 7760±150	L10	Sand (III)		7660±70 16520±70	Peat growing Reeds appearing Dense pine forest Sand blowing, dunes Dead-ice melting Sand blowing, dunes	Early Mesolithic flint & bone finds in cut I First occupation
4250		B8	Brown peat & gravel bands (I)		L11	Sandy brown detritus (III)				
4500		B9	Gravel interbeddings		L12 →a	Brown peaty detritus → →livid gyttja	7.5			
4750	l.BO	B9	Gravel interbeddings	7180±130 7760±150	L13	Gravel & brown peat	8.0	7660±70 16520±70	Peat growing Reeds appearing Dense pine forest Sand blowing, dunes Dead-ice melting Sand blowing, dunes	Early Mesolithic flint & bone finds in cut I First occupation
5000		B9	Gravel interbeddings		L14a	Brown peat: a-cones (I)	7.5			
5250		B9	Gravel interbeddings		L14b-c	→b-reeds-beige gyttja (III)				
5500	e.BO	B9	Gravel interbeddings	7180±130 7760±150	L14a	Brown peat: a-cones (I)	7.5	7660±70 16520±70	Peat growing Reeds appearing Dense pine forest Sand blowing, dunes Dead-ice melting Sand blowing, dunes	Early Mesolithic flint & bone finds in cut I First occupation
5750		B9	Gravel interbeddings		L15a	Fine yellow sand (I)				
6000		B9	Gravel interbeddings		L15b	Sandv shell gyttja (I,?III)	8.0			
6250	e.BO	B9	Gravel interbeddings	7180±130 7760±150	L15c	Fine sand (I)		7660±70 16520±70	Peat growing Reeds appearing Dense pine forest Sand blowing, dunes Dead-ice melting Sand blowing, dunes	Early Mesolithic flint & bone finds in cut I First occupation
6500		B9	Gravel interbeddings		L15c	Fine sand (I)				
6750		B9	Gravel interbeddings		L15c	Fine sand (I)				
7000	Yr.D	B9	Gravel interbeddings	7180±130 7760±150	L15c	Fine sand (I)		7660±70 16520±70	Peat growing Reeds appearing Dense pine forest Sand blowing, dunes Dead-ice melting Sand blowing, dunes	Early Mesolithic flint & bone finds in cut I First occupation
7250		B9	Gravel interbeddings		L15c	Fine sand (I)				
7500		B9	Gravel interbeddings		L15c	Fine sand (I)				
7750	e.PB	B9	Gravel interbeddings	7180±130 7760±150	L15c	Fine sand (I)		7660±70 16520±70	Peat growing Reeds appearing Dense pine forest Sand blowing, dunes Dead-ice melting Sand blowing, dunes	Early Mesolithic flint & bone finds in cut I First occupation
8000		B9	Gravel interbeddings		L15c	Fine sand (I)				
8250		B9	Gravel interbeddings		L15c	Fine sand (I)				
	AL	B9	Gravel interbeddings	7180±130 7760±150	L16	Shell grey gyttja (I)	7.5	7660±70 16520±70	Gyttja depositing	Early Mesolithic flint & bone finds in cut I First occupation
		B9	Gravel interbeddings		L16	Shell grey gyttja (I)	7.5			
		B9	Gravel interbeddings		L16	Shell grey gyttja (I)	7.5			

graphy, chronology and geomorphological events presented in Table 2 should be viewed as a working hypothesis. Anyhow, each layer of the bank and littoral zone has been assigned to the commonly used chronostratigraphic subdivisions of the Holocene (Mangerud *et al.* 1974: 122, Table 5). For the Preboreal however, a more precise subdivision has been used (Behre 1967: 154, Table 1, 1978: 101, Table 2).

The number of C¹⁴-determinations is limited and several layers have not been dated (Table 1). According to the stratigraphy sequence, three of the dates are incongruous. Another two or three seem not to be accurate, but are more or less acceptable, if we consider the standard deviations.

The choice of samples for dating depended on the occurrence of charcoal concentrations but, unfortunately, also on financial considerations. It should also be stressed that the presence of charcoal is not necessarily coupled with a high density of other finds. Accordingly, the extreme dates do not indicate respectively the earliest and latest human occupation. Also, the clustering of dates does not necessarily point to the most intensive occupation phases.

In the following sections, a short description of the stratigraphy of the three zones is given. Profiles of the bank and littoral zones of trench I, II and III are given in Figs. 4 and 5.

2A. INTERIOR ZONE

The lake and island originated in ground moraine sediments of the Pomeranian phase of the Vistulian glaciation (Kondracki 1978: 332, Fig. 121). The island is made of boulder clay (layer I5) in which frost wedges are recorded. The clay is covered by limestone gravel (I4) (more than 0.5 m thick in trench IV) or by calcareous silt (I4a) in other places (part of trench V and IX). The gravel contains plenty of Silurian fossil crinoids and mollusca, as well as Mesozoic belemnites. The limestone gravel and silt cap are probably fluvio-glacial in origin.

The whole island, even in the highest places where trench IX and X were dug, is covered by sandy black peat soil (I1), not less than 15-20 cm thick. Below it occurs yellow-grey sand with humus (I2) or sand with humus and patches of yellow clay (I2a). Between layers I2 or I2a and I4, an intermediate layer of yellowish sand with gravel (I3) occurs. In some places of these layers, limestone fossils and concentrations or speckles of iron oxide can be seen. Layers I1, I2 and I2a contain Neolithic materials. Layers I3, I4 and I4a are devoid of any finds. Peat, nowadays turned into a black peat sandy soil (I1), spread over the island not before the early Subboreal and the highest places (trench IX

and X) were covered with peat during or after the last stages of prehistoric settlement on the island, at the end of the Neolithic. The grave pit of the Corded Ware culture in trench IX, filled with sandy humus, was not cut into the peat but was covered by peat (Gumiński 1995b).

2B. BANK ZONE

The SE-bank of the island is covered by black peat soil (B1), containing middle and late Neolithic materials. Layer B2 is a very thin black-brown lumpy peat, seen only in trench III. In this layer, an assemblage of the Globular Amphora culture was discovered, consisting of a crushed, not ornamented amphora with chamotte temper, and an amber button with V-shaped hole. The assemblage gave an unexpectedly early C¹⁴-date: 2930±120 BC. However, the chamotte temper, typical for the Funnel Beaker culture, and other features make the date acceptable within the bounds of probability (Gumiński 1995c).

Another layer, directly under B1, in trench I is formed by dark grey peat with humus and sand (B3). This deposit can be interpreted as a «cultural layer», i.e., a deposit testifying to intensive human activity. The layer is full of ash-like dust, but no pieces of charcoal, small fragments of probably fired rock, stones collected by people, many bone remains and Neolithic artifacts. In trench I, only Zedmar culture finds were recovered, while in trench III a mixture of Zedmar with middle and late Neolithic origin (Funnel Beaker, Globular Amphora, Corded Ware, Neman) was recovered. The C¹⁴-date: 2370±120 BC of trench III seems to be too young, particularly in comparison with the above cited date of layer B2 (Table 1). However, the sample is less reliable, because it consists of small charcoal pieces collected from several squares and layer B3 of trench III is not pure Zedmar, as in trench I.

The lowest black peat B4 has a lumpy structure and contains some gravel. Apart from bones and flints, some Zedmar sherds were collected in it. In trench I, this layer occurs as very thin lenses, but it is thicker in trench III and one can follow it down to the littoral zone apparently joining layer B3. Two C¹⁴-dates taken close to the early Zedmar sherd in the bottom part of the joint layers B3 and B4 are doubtful (Table 1). The first date, exceptionally obtained from a peat sample, is 2230±70 BC and obviously too young by about 1500 years. The second date, 5110±120 BC, seems to be about 1500 years too old. Most likely, the first sample is contaminated by much younger plantroots. The second date refers probably not to the bottom of layer B4, but in fact to the non-pottery layer L7 or L8. In this part of trench III, both L7 and L8 are very thin, more peaty than in

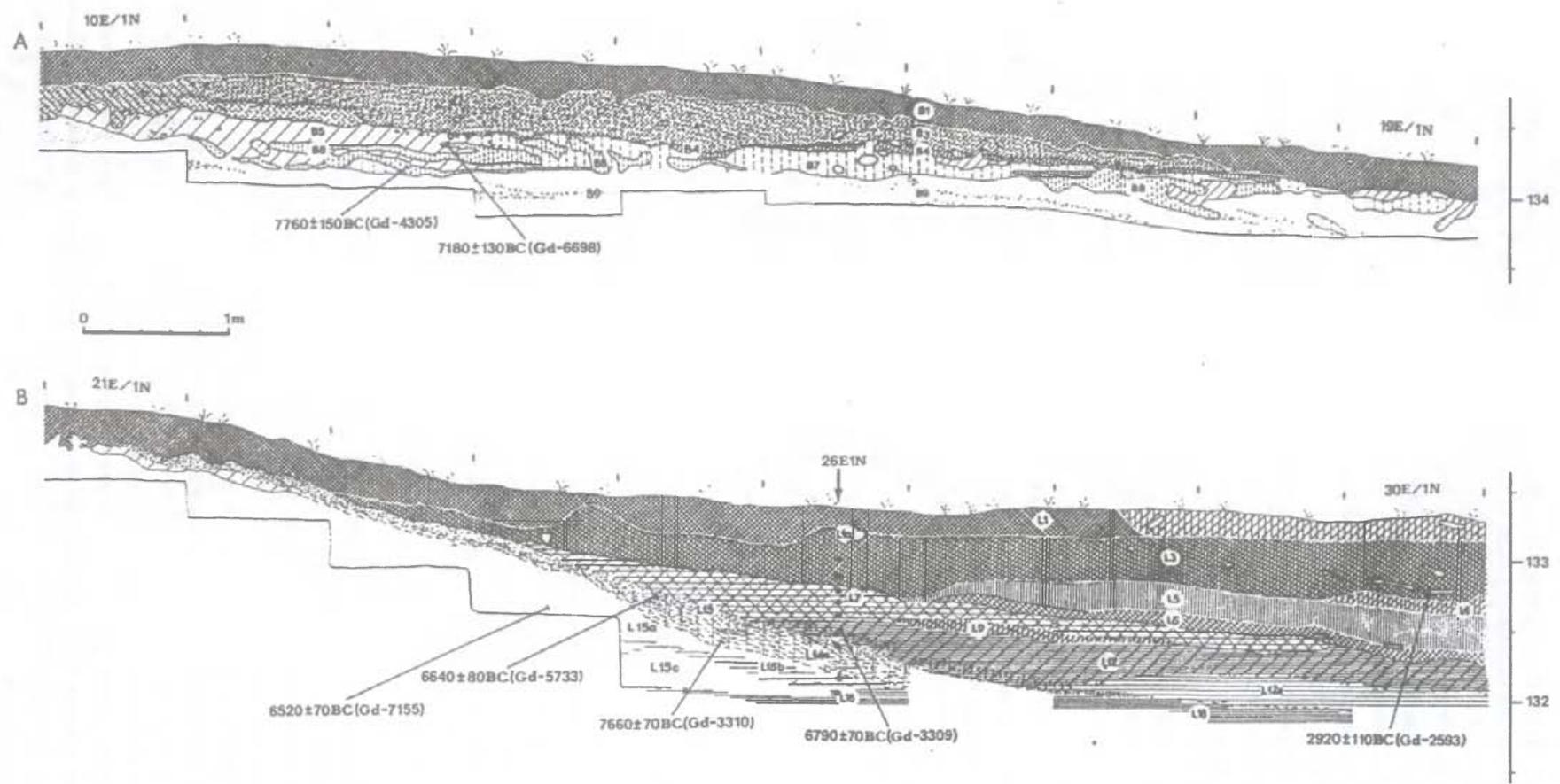


Fig. 4. Dudka. Profile of trench I, A – bank zone, B – littoral zone. An arrow and dots marks the location of the pollen samples

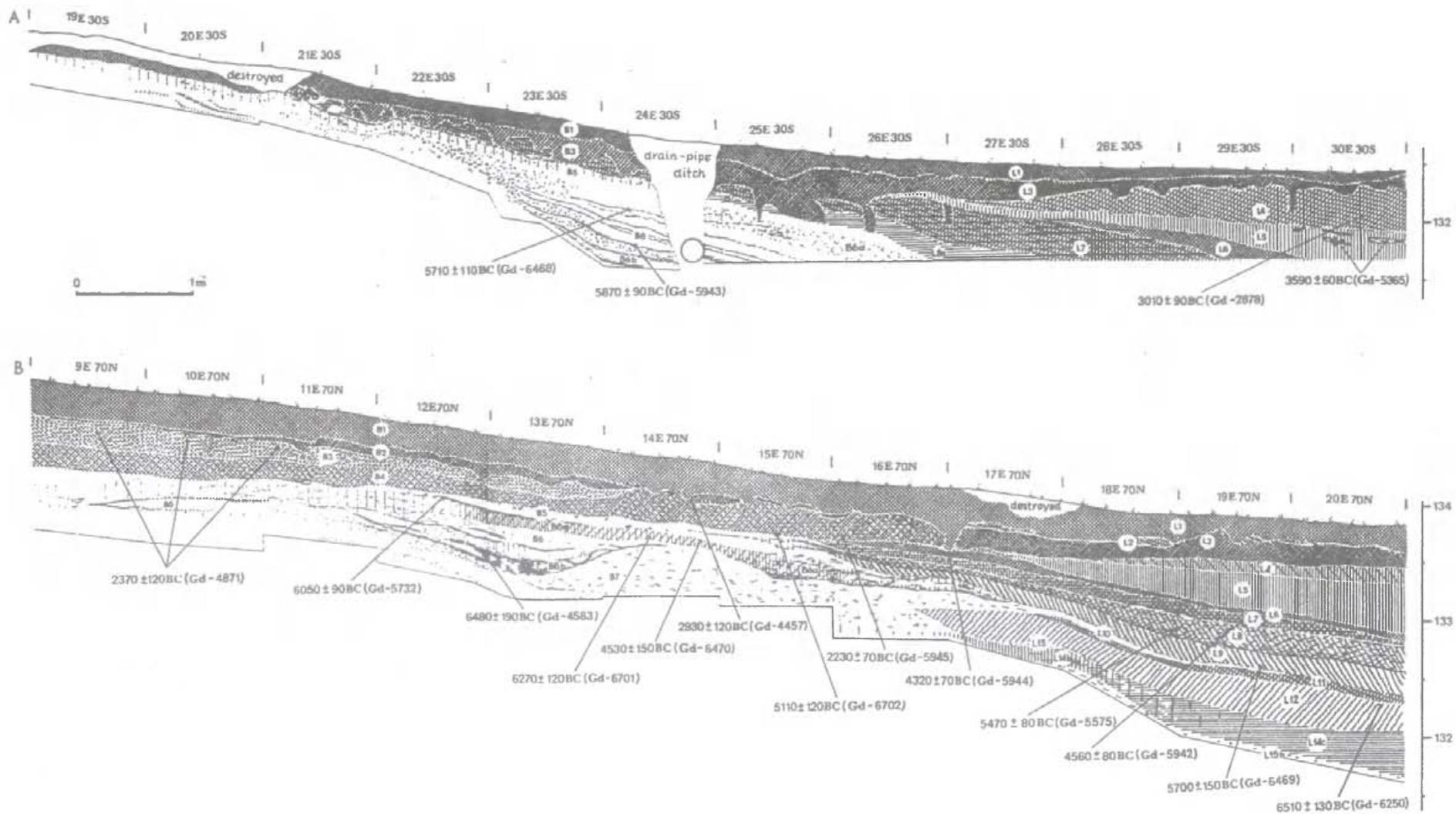


Fig. 5. Dudka. Profile of trench II (A) and of trench III (B)

the littoral zone and lay directly under layer B4. They are hard to distinguish from the latter.

Further down one encounters sandy-gravel layer(s) with humus or brown peat traces (B5) devoid of any pottery. In the bank zone and counting down from the top, this is the first deposit belonging to the pure Mesolithic. Layer B5 should be older than the late Atlantic but younger than the beginning of Atlantic (trench II) or the end of late Boreal (trench III). Generally speaking, layer B5 is of early and middle Atlantic origin.

The foregoing sands are delimited at the bottom by a complex of layers grouped as B6. They form a series of thin, interbedded silt, brown peat and sand. This is the only deposit at Dudka, showing a downward bent stratification in sections perpendicular to the shore, instead of sloping towards the lake. This feature indicates that the layers in question were formed in shallow lagoons filling erosional depressions. In a few places, there are sediments of the lagoon (B6) and its dam made of sediments of layer B7 described in next paragraph, which have been sharply breached and replaced by sand. In trench II, these processes are dated by C^{14} to the beginning of the Atlantic period: 5710 ± 110 BC and 5870 ± 90 BC and in trench III to the entirely late Boreal: 6050 ± 90 BC, 6270 ± 120 BC, 6480 ± 190 BC. The fourth date from the same lagoon in trench III, from the top of the upper, more peaty part of the layer (B6a), is 4530 ± 150 BC and evidently too young by some 1500 radiocarbon years (Table 1). Lagoons formed recurrently in the same place (trench II; middle lagoon 12-13E of trench III), higher and further away from the shoreline (9-10E in trench III) or lower and closer to the lake (15E of trench III)(Fig. 5).

In layer B7, below the lagoon deposits in trench II and III, occur sands with brown peat traces containing small remnants of reed, and almost devoid of finds. Lower down, one observes only pure sand with interbedded gravel (B9).

In trench I, sand layers B7 and B5 are hardly distinguishable (Fig. 4). Below them, brown peat with gravel (B8) occurs in the form of bands or lenses in trench I. Layer B8 is of late Preboreal origin and the upper part gave a C^{14} -date of 7180 ± 130 BC, the lower a date of 7760 ± 150 BC. Most of bands and lenses of B8 contain bones, pieces of charcoal as well as flint and bone artifacts. B8 is the oldest layer of the bank zone with evidence of early Mesolithic occupation. Below B8 gravel layers (B9) are found, which are the same as the already mentioned layers 13 or 14 of the island interior, although in the bank zone gravel bands clearly slope down toward the lake. The only finds in these gravels are strongly worn pieces of much fossilized bone (perhaps pre-Quaternary), clusters of bones of recent frogs or

toads, small insectivores or rodents, lumps of chalk and red ochre, Palaeozoic and Mesozoic fossil invertebrates.

2C. LITTORAL ZONE

A black peat soil, L1, forms the upper layer in the littoral zone. This layer L1 dates probably from the end of the early Subboreal, as suggested by Corded Ware sherds found in it. In some places, chiefly in trench I and at the bottom of layer L1, separate lens-like or large patchy occurrences of clay or similar fine compact clastic (L1a) occur (Gumiński & Fiedorczuk 1988: Fig. 4). These clayey deposits seem to be younger than the black peat in which they are found. The «clay» could have percolated through fissures as the finest mineral fraction washed away from the soil during high water-level. This process could occur in the beginning of the Subatlantic (cf. Starkel 1977: 201). Another explanation could be connected with chemical reactions in sediments. Both layers below the «clay» lenses have very high acidity - Ph 5.0 (Table 2). It permits to dissolve minerals and elements from peat. Such solutions, usually diffuse to layers above and settle as a mineral deposit in an environment with distinctly lower acidity (higher Ph) (Cieśla 1981: 25-26; Pawlikowski *et al.* 1982: 97). Already at the bottom of layer L1, where most of the «clay» appears, Ph rapidly increases to 6.5.

Probably of similar age as layer B2 is the brown loose peat L2 distinguished in trench III only. The next layer, a black lumpy peat, L3, must be of early Subboreal origin, as indicated by its Zedmar pottery and the C^{14} -date from its bottom : 2920 ± 110 BC. Below lies a black-brown cohesive peat, L4, also with Zedmar pottery, which grew at the end of the late Atlantic as the C^{14} -date shows: 3010 ± 90 BC. Extremely high acidity (Ph - 5.0 for both peat layers L3 and L4; Table 2) badly attacked even such resistant materials as flint. Some of the flint artifacts consist of completely dissolved silica and look as if they were made of chalk. All others show a white patina, not brown as is normally assumed of flint found in bog context. The high percentage of corroded sporomorphs from these layers (Nalepka 1995, this volume) is no doubt also due to the high acidity.

The main sediment of the late Atlantic origin is a brown peat, L5, without signs of decomposition and which contains rushes and branches of deciduous trees with still preserved leaves. It is the oldest layer to be included to the Neolithic (Paraneolithic). The charcoal found in association with the piece of Zedmar pot in this layer gave a value of 3590 ± 60 BC. So far, it is the earliest C^{14} -date for Zedmar pottery (Gumiński & Fiedorczuk 1990: 64; Gumiński 1995d; cf. Timofeev 1991: 18). The black decomposed peat, L6, is probably still of late Atlantic origin. Well marked, although thin,

it is to be regarded as the final deposit of the Mesolithic in the littoral zone and yielded very few finds.

Further down, the first layer of lacustrine origin is L7. It consists of a dark livid brown sapropel, mainly of algal origin, which forms a jelly-like, laminated, dark and still smelling silt with some small branches, reedstalks, charcoal and animal bones. The sapropel was deposited during one of the very high Holocene lake levels (ca. 133.7 m a.s.l.), at the end of middle Atlantic. The C^{14} -date for L7 is 4320 ± 70 BC.

During the main part of the middle and early Atlantic, layers of plant detritus were deposited (L8 and L9). The upper, black layer, L8, was deposited during a period of about 900 years, if we accept the C^{14} -dates: 4560 ± 80 BC, 5110 ± 120 BC and 5470 ± 80 BC. The lower, dark brown layer, L9, has a date of 5700 ± 150 BC. The beginning of this layer cannot be earlier than 6000 BC, because it is located above the lagoons (B6) in trench III. Both detritic layers contain branches, rush chaff, partially decayed material which originally covered the forest floor (duff) with hazel nuts, pine cones and acorns, as well as plenty of hazel nut shells, charcoal, some stones left by people, relatively numerous bones of large mammals, and most spectacular antler and wooden artifacts. The frequency of these finds is highest in L8. Probably the dark gyttja, L8a, of trench II has a similar age as the black detritus, L8, of trench III. Both must have been deposited after 5700 BC.

During the late Boreal, sedimentation in the littoral zone seems to have been very limited. To this period could be assigned a thin bed of sand, L10, and a not much thicker sandy brown detritic layer, L11; in trench I, these layers cannot be separated. Quite intensive geomorphological activity can be noted higher up at the shore-line (layer B6). High water-levels, fluctuating between 133.3 and 133.8 m, water flowing down from the island bank as well as strong waves and lake current action removed organic deposits formed in the littoral zone. It is likely that particularly strong storms washed out all earlier sediments from the shore in the area around trench I to replace them with pure sand. This could be the reason, why no early Holocene sediments occur between the bank and the littoral zone in trench I.

In early Boreal times, brown peaty detritus (L12) was deposited in which reeds were preserved. Downward this peat changes into a livid-olive calcareous gyttja with algae (L12a). The detritus contains reed stalks, hazel nuts and nut shells, pine cones, charcoal, as well as some bones and bone artifacts. The top of layer L12 is dated 6510 ± 130 BC, while the bottom yielded a date of 6790 ± 70 BC. L13, consisting of gravel with brown peat, should still be included in the very

early Boreal, although the C^{14} -date: 6640 ± 80 BC is a little to young for the layer in question (Table 1). In layer L13 of trench I, pine branches and cones, charcoal and a fragmentary, not fully developed red deer antler were found. In trench III this layer consists of almost pure sand and gravel.

During the whole late Preboreal, a brown peat, L14, was deposited, which in trench I contains abundant in not fully developed cones and twigs of pine trees (L14a). The bottom of L14, in which a piece of antler artefact was found, gave a C^{14} -date of 7660 ± 70 BC. This date is very similar to the one from the bottom of layer B8 in the bank zone and both layers, L14a and B8, undoubtedly formed in the same period. The brown peat in trench III (L14b) contains reedstalks but very few pine cones. Towards the lake zone, the peat turns into beige-greyish calcareous gyttja (L14c). Both sediments in trench III (L14b and L14c) have not any evidences of human activity.

Under the deepest brown peat L14, one finds white-yellowish fine sands (L15a) (Fig. 4), containing the stratigraphically oldest bone find: an almost complete rib of red deer. A charcoal sample from layer L15a gave a date of 6550 ± 70 BC, evidently about 1500 years too young (Table 1). Below this layer, a sandy white-greyish calcareous gyttja occurs with big bivalve shells (L15b), and still deeper, another pure fine sand layer (L15c). All three L15 sub-layers, i.e. both sands and the interbedded sandy gyttja, join and thin out towards the lake. The oldest uncovered deposit in the littoral zone is a white-greyish calcareous gyttja, again with big bivalve shells (L16).

There are two possibilities for dating layers L15 and L16. Both the sands and the interbedded sandy gyttja of L15 may correspond to the Younger Dryas (Dryas III), the shell gyttja (L16) being of Allerød age. It means that all layers in questions would belong to the late Pleistocene and this is the interpretation proposed by Nalepka (1995, this volume). If this is the case, sediments of early Preboreal times would be lacking and sediments of the Younger Dryas (Dryas III) would be quite well represented, but interrupted by a warmer oscillation. This seems to be a weak point for the interpretation given above. Another interpretation accepts that the upper sands L15a were deposited in the last cool oscillation of early Preboreal, known as the Youngest Dryas (Dryas IV or Piottino) and the sandy gyttja L15b belongs to the warmer phase known as the Friesland in the very beginning of the Holocene. Thus, the lower sands, L15c, would pertain to the Younger Dryas (Dryas III) of the final Pleistocene (cf. Behre 1967: 154; 1978: 101). It means that the lowest shell gyttja (L16) could be of Allerød origin, as in the first interpretation. Table 2 presents the second, in my opinion most probable

attribution, because all phases of the transition from the Pleistocene to the Holocene are adequately represented (see chapter 3a).

2D. ENVIRONMENTAL INTERPRETATION

The stratigraphical sequence presented above and its interpretation can be used to draw palaeoenvironmental conclusions relating to geomorphology, hydrology and landscape (Table 2; 9). From the end of the late Pleistocene to the very beginning of the Holocene (before the late Preboreal), environmental conditions seem to have been similar. In general, the lake water-level was very low, although fluctuating (Table 9). The highest level was reached during some warmer oscillation, when dead-ice remains finally melted. In the early oligotrophic lake exclusively calcareous gyttja with large bivalves was deposited. The oldest uncovered lacustrine sediment (L16) could be dated to the Allerød, the younger (L15b) to the Friesland oscillation of the beginning of the Preboreal. In the following cooler periods, lacustrine sedimentation was twice interrupted by fine sands, probably of eolian origin (L15a, L15c); these were laid down over the existing gyttjas in the littoral zone during low level phases of the lake. Similar situations at the end of the Pleistocene and the onset of the Holocene have been described for other lakes (Hjelmroos-Ericsson 1981: 76-78; Stupnicka 1981: 51; Pawlikowski *et al.* 1982: 112; Kabailiene 1987: 111; Sergeeva & Khomutova 1987: 118; Róžański *et al.* 1988: 47; Ralska-Jasiewiczowa & Starkel 1988: 106; Noryśkiewicz & Ralska-Jasiewiczowa 1989: Fig. 5; Ralska-Jasiewiczowa 1989: Fig. 2; Starkel & Ralska-Jasiewiczowa 1991: 181).

In both cold periods of the Younger Dryas (Dryas III) at the end of the Pleistocene (L15c) and of the Youngest Dryas (Dryas IV) already in the early Preboreal (L15a), the landscape remained a park-tundra. As the soils and vegetation were poor, sands could be blown and washed down to the shore and a large amount of sand from the gravel covered island (B9) was redeposited on the beach, forming small dunes (L15c, L15a). The first signs of human occupation at Dudka were found in a layer related to the early Preboreal and consists of scattered charcoal pieces and a red deer rib. The presence of red deer is a little surprising, since the animal is typical for wooded land. However, large red deer are known from cold open biotopes of the Pleistocene (Prof. Dr. A. Gautier, pers. comm.), as well as of some similar landscape in modern time, e.g. N-Scotland. Moreover, a small pine branch (Table 9) found in L15a shows that already in the early Preboreal (Youngest Dryas), some pine trees grew on the island (see chapter 3a).

The most abrupt and significant change in general environmental conditions took place at the transition from early to late Preboreal, at about 7750 radiocarbon years BC. Then, dense pine forest began to grow on the island (L14a) and the first narrow patches of reeds along the shore (L14b) can be seen. The lake seems still to have been rather oligotrophic and deposited calcareous gyttja (L14c). Peat began to accumulate on the low banks (L14a, L14b) and in eolian depressions on the island (B8). The peat contained washed in duff composed mainly of pine cones, twigs and needles (L14a). Underdeveloped undergrowth and still restricted soil cover enabled disturbances in gravelly surface (B9) and accumulation gravelly and peaty deposit (B8) in small depressions. Underdeveloped pine cones (L14a) suggest poor soil conditions (opinion of M.Sc. M. Michniewicz). The first broad leaf trees appear, including unexpectedly ash (see chapter 3a.; Table 3 & 9; cf. Pawlikowski *et al.* 1982: 108; Ralska-Jasiewiczowa 1989: 97-98). However, the identification of this tree concerns a wooden implement (Fiedorczuk 1995a: Fig. 6d), which may have been brought to the island from a distant locality. Ash is a very suitable raw material for making spears and arrows (Malmros 1987: 116) and people may have looked for it, even when the tree was still rare.

The beginning of early Boreal is marked by a strong gravel flow (L13) from the island bank, followed by a rising lake water-level (L12, L12a). Similar rapid terrestrial input and a higher water-level have been recorded for other Masurian lakes (Stupnicka 1981: 51, Plate VIII; Pawlikowski *et al.* 1982: 113; Ralska-Jasiewiczowa & Starkel 1988: 106-107). The lake became mesotrophic and later on eutrophic, as is shown by the increase of gyttja with algae (L12a). Reeds gradually began to protect the SE-bay, and this allowed the accumulation of duff washed in from the island (L12, L11). Pine forest became more mixed, especially with hazel, important for man. Soon later alder became most common deciduous tree species (Table 9) particularly along the shores, where separate alder communities originated. In the late Boreal, the lake-level reached its Holocene maximum (B6), but significant fluctuations occurred (Table 9). This last factor, together with strong wave action caused by strong winds apparently from S or SW, eroded lagoons parallel to the shore (B6). The lagoons filled with water and organogenic sediments during quiet times (B6b). Later, the lagoons were breached by new storms and filled with sands (B6a). These recurrent processes took place through the whole late Boreal and in the beginning of the early Atlantic (B6 in trench II). Although lake lagoons have not been recorded at other S-Baltic lakes, for some, strong hydrological activity: high water levels, sandy disturbances

and river inflows during the late Boreal have been described (Stupnicka 1981: 51; Hjelmroos-Eriksson 1981: 74; Pawlikowski *et al.* 1982: 113; Kabailiene 1987: 111; Sergeeva & Khomutova 1987: 118; Ralska-Jasiewiczowa & Starkel 1988: 107; Noryskiewicz & Ralska-Jasiewiczowa 1989: Fig. 5; Starkel & Ralska-Jasiewiczowa 1991: 181).

During the early and middle Atlantic, pine and deciduous trees (Table 9) grew on the island bank. Their branches, leaves and washed down duff could form a scum over the water in the sheltered bay, later it settled to the bottom (L8 in trench III). In the end of the middle Atlantic, another high water level occurred but now the lake was distinctly eutrophic (L7).

3. VEGETATION

3A. FOREST

The first palynological results from Dudka (Nalepka 1995, this volume) are promising but still far from providing final answers to the most important palaeobotanical problems. The pollen diagram was taken from the littoral zone close to the bank in trench I (Fig. 4) and eight samples have been analyzed from a 1 m thick profile. It means that, as yet, some of the layers have not been tested. The following discussion is based on the work by Nalepka and can be followed by consulting Table 3.

The lowest sample (-132 cm) is from the top of layer L16, the second sample (-118 cm) from the interface of L15a and L15b. Both spectra indicate periods before the late Preboreal. It is also clear that the climatic conditions deteriorated from layer L16 to L15a-b (Nalepka 1995). It should be stressed however, that layer L15c, thought to represent a cool phase between L16 and L15b, is missing. According to the pollen diagram of both samples, the examined period saw the emergence of birch-pine forest with shrubs of juniper, which becomes distinctly more frequent in the -118 cm sample, and little willow. Surprisingly, herbs (NAP) are rather low in percentages with values much as in the Atlantic and the beginning of the early Subboreal. It means, that open areas were restricted and that the island was rather wooded; this applies even for the upper sample. Also, single pollen grains of elm, oak and larch are arguments to include layers L15a-b in the early Preboreal (cf. Ralska-Jasiewiczowa 1983: 143, 151; 1989: 96-97; 1991: 108-114; Noryskiewicz & Ralska-Jasiewiczowa 1989: Fig. 1, 3). In this case, layer L15a would belong to the cooler Youngest Dryas (Dryas IV) oscillation, and L15b to the warmer Friesland (see chapter 2c; cf. Behre 1967: 154; 1978: 101). Similar pollen spectra, recorded at other sites of NE-Poland, have been

From the beginning of the late Atlantic, the lake shrunk considerably (L6). The littoral zone became overgrown by a broad belt of swamps with rushes, shrubs and trees (L5). Thick peat formation covered the island bank (B4, B3). Soon thereafter (early Subboreal), the whole island was covered by peat (I1, B2). Towards the end of the early Subboreal, the lake changed into strongly overgrown ponds (L1) connected by narrow channels. Later, these channels transformed into the former stream, the main outflow of the completely overgrown bog, which became probably impassable after the latest occupation in the end of the early Subboreal (Table 2; 9).

included in the early Holocene (cf. Hjelmroos-Ericsson 1981: 41-43; Latałowa 1982: 205, 216, 236; 1988: 50-51; Noryskiewicz 1982: 78, Fig. 3; Pawlikowski *et al.* 1982: 99, 107, Fig. 7). If we accept this interpretation, layer L15c, not present in the pollen analysis, would be of Younger Dryas (Dryas III). In any case, the lowest layer L16 seems to be of Allerød origin (see chapter 2c).

The next four samples, from higher up, give coherent results and complete the picture of the landscape as drawn from other evidence. The first sample (-97 cm) dates to the end of the late Preboreal (top of L14a). Then, dense forest (low NAP) with pine distinctly prevailing over birch, with some elm and poplar grew. Hazel is already present and reaches its Holocene maximum, apparently forming quite dense bushes (cf. Ralska-Jasiewiczowa 1983: 147).

The three following samples (-77, -67 & -57 cm) are typical for the Atlantic mixed dense primeval deciduous forest with some pine (average 22%) and dense alder communities (up to 26%) along the shores. Pine and birch keep losing in importance till the early Subboreal (Table 3; Nalepka 1995). The climatic optimum can be placed at the end of the middle Atlantic (-57 cm), when both mistletoe (*Viscum*) and reed of *Typha latifolia* (Starkel & Ralska-Jasiewiczowa 1991: 180; Hjelmroos-Ericsson 1981: 43) have their maxima (Table 3). This was also the time of the presence of the most varied tree spectrum in the surrounding area (Table 3; 9; Nalepka 1995: Fig.3).

The last two samples (-50 cm & -37 cm) come from layer L3, which according to the stratigraphic interpretation, C¹⁴-dates and archaeological finds should be dated to the very early Subboreal. Considering that this part of the section does not comprise layers L4 and L5 of the late Atlantic (Fig. 4), the sample -50 cm, from



Table 3. Dudka. Simplified and selected results of palynological profile D-1, given in % of NAP and AP, according to Nalepka 1995: Fig. 3.

Key: t – top, m – middle, b – bottom, ~ – somewhere near but not exact from the given layer, e – early, l – late, Zed – Zedmar, Mes – Mesolithic, Pal – Late Palaeolithic; Ju – juniper, Pi – pine, Bi – birch, Ha – hazel, Po/An – poplar/aspens, El – elm, Ah – ash, Oa – oak, Li – lime, Al – alder, Sp – spruce, La – larch, Ho – hornbeam, Bh – beech, Vi – *Viscum*, Ty – *Typha latifolia*, Pedias – *Pediastrum*, Pterid – *Pteridium aquilinum*, la – *lanceolata*, ma – *major*, me – *media*, ac – *acetosa*, la – *acetosella*;

+, S, L, H, B, V, T – occurrences in a very small number less than 1% of a given species, * – peak in frequency, but still less than 1%

Depth -cm	Layer	Period	C-14 conv. BC	Settle- ment	NAP %	Ju	Pi	Bi	Ha	Po/ An	El	Ah	Oa	Li	Al	Sp & La	Ho & Bh	Vi & Ty	Pe di as	Gr am in	Er ic ac	Pt er id	Ur ti ca	Plantago			Rumex		Ca ll un	
																								la	ma	me	ac	la		
37	L3 m	e.SB		Zed.	18		13	14	9		4	2	6	7	12	S				7		1	+							
50	L3 b	AT/SB	2920	Zed.	10		9	8	15	+	7	3	10	5	22	S		T	6	4		+	*				1	*	+	
57	L7 t	m.AT		Mes.	6		16	11	18	+	8	4	5	3	26	S	HB	VT	6	2		*	*	+	+	+	+	+	+	
67	L7 m	m.AT		Mes.	8		25	15	12		5	4	4	3	25	S	H	T	8	1		+	+	*	1	*	+	+	*	
77	L8-9 ~	e.AT	6790, 6640 7660	Mes.	8		26	14	11	1	9	3	5	4	19	S		T		5	1	2	*							
97	L14a t	l.PB		Mes.	7	+	42	24	19	2	5	+	+		+					4	+		+							
118	L15b t	e.PB		?Pal	18	10	30	41			+		+			L	H			6	+	+	*				+			
132	L16 t	AL		–	9	2	39	48		+								T		2	+		*							

the bottom of L3 may have to be placed chronologically near to layer L4, dated to the end of the late Atlantic - ca. 3000 BC. According to Nalepka (1995) though, both samples still belong to the Atlantic, even almost 1000 years before the end of the period. The disagreement with the C^{14} -date 2920 ± 110 BC is explained by Nalepka by the 4 m distance between pollen and charcoal samples. In my opinion, both pollen spectra fit well with the above cited date and the general situation at the transition from Atlantic to Subboreal times in the Great Masurian Lakes. There, the marked decline of elm, often used as a marker for the beginning of the Subboreal, takes place much later and/or not as rapid as in other parts of Poland (Ralska-Jasiewiczowa 1983: 143-145; 1989: Fig.1; Pawlikowski *et al.* 1982: 100-101,109, Fig. 6). Furthermore, a simultaneous slow decline of ash in the beginning of the early Subboreal some authors relate to the similar causes, decreasing humidity and the acidification of the soils (cf. Table 2, 3 and 9). These same factors would affect oak and lime positively, what is typical for the beginning of the Subboreal. This is also a period of Holocene minima for pine and birch and soon thereafter the reduction of hazel and alder. Also, the virtual lack of spruce, hornbeam, and beech pollen, in spite of an earlier weak appearance, are characteristic for the transition from the late Atlantic to the early Subboreal. All above features can be seen in diagram from Dudka (see Table 3; cf. Pawlikowski *et al.* 1982: 109, Fig.6; Ralska-Jasiewiczowa 1983: 143-145, 152-155; 1989: 96-99; 1991: 118-121; Latałowa 1992: 207-210).

Leaving out the absolute and the palynological dating, both highest samples (-50 & -37 cm) are undoubtedly connected with the Zedmar occupation. According to the density of bone remains (Gumiński 1995a: Fig. 2) and archaeological finds, Dudka island was then most intensively inhabited. The distinctly rise of NAP (Table 3) at that time seems to be connected with the settlement activity, which concentrated particularly on the SE-part of the island nearby the shore (Gumiński 1995d), so then close to the pollen profile. In majority anthropogenic deforestation is the only dissimilarity with the diagram from Lake Mikołajki (also Great Masurian Lakes). There, the early Subboreal increase of NAP is more subdued and later than at Dudka (Ralska-Jasiewiczowa 1989: Fig. 1).

3B. HUMAN INFLUENCE

Palynological investigations provide some valuable information concerning human influence on the vegetation. The presence of such taxa as *Plantago lanceolata*, *Plantago major*, *Plantago media*, *Urtica*, *Chenopodiaceae*, *Artemisia*, *Rumex acetosella*, *Rumex acetosa*, *Pteridium aquilinum* and *Polypodiaceae*, as

well as the rising number of corroded sporomorphs (see chapter 2c) can be connected with some clearings in the forest and forest burning, nitrification of habitat, soil degradation and impoverishment (Nalepka 1995). It should be stressed, however, that in the middle Atlantic during the pure Mesolithic, some of cited taxa (excluding *Artemisia*, *Chenopodiaceae*, *Rumex acetosa*) attain values similar to or even higher than those at the beginning of the early Subboreal during the Zedmar culture, when herbs (NAP) are distinctly on the rise (Table 3; Nalepka 1995: Fig. 3).

The first anthropogenic impact on local vegetation appears already in the early Atlantic (-77 cm), at the time of layers L8 and L9. Distinct maxima of some plants, can be observed: nettle (*Urtica*), fern (*Pteridium aquilinum*), shrubs of the heath family (*Ericaceae*) perhaps carrying berries, as well as grasses (*Gramineae*) (Table 3). They could indicate the presence of trodden soil, paths and ruderal communities around the encampments, but also the existence of fallow after forest burning and clearing (cf. Latałowa 1992: 136-143; Kruk 1980: 132-198). Intentional forest clearing by fire could be indicated by the abundance of charcoal in layers L8, L9 and B6 of trench II, dated to the early Atlantic (see chapters 2b and 2c); these clearings were probably made to make space for camping. Burning in order to attract browsing or grazing game appears less likely in the case of Dudka island, which is too small for this type of forest management (cf. Larsson 1978: 188; Göranson 1986: 143-150; Latałowa 1992: 205-207). However, perhaps the island was large enough to attract elk, who could easily cross the lake in search of a suitable feeding ground, with shrubs, reed swamps, tall grasses and deciduous wood coppices with aspen (Larsson 1983: 111; During 1986: 110). Perhaps, it is no coincidence, that elk is the most frequently hunted game at Dudka precisely in the early Atlantic (Table 9; see chapter 4c).

Interestingly, in the next pollen sample (-67 cm, L7), dated to the younger part of the middle Atlantic, all the taxons mentioned above (*Gramineae*, *Ericaceae*, *Pteridium aquilinum*, *Urtica*) fall to their lowest Holocene level or vanish totally (Table 3). At the same time, poplar and aspen disappear completely and elm decreases markedly (Table 3; cf. Latałowa 1992: 207). Instead, three species of ribwort (*Plantago*) and heather (*Calluna vulgaris*) appear for the first time, immediately with maximum frequencies. Similarly, both sorrel species (*Rumex*) appear and ferns (*Polypodiaceae*) as well as sedges (*Cyperaceae*) increase considerably (Table 3; Nalepka 1995: Fig. 3). All these changes may point to some new activity. Perhaps, too frequent forest burning caused the destruction of undergrowth communities

(*Pteridium*, *Ericaceae*, *Gramineae*, *Urtica*), followed by the appearance of *Calluna* and *Rumex acetosella*, species typical for degrading soils. The use of the same locations for encampment and paths caused the rise of meadow patches with new kinds of ruderal and nitrophilous plants (*Plantago lanceolata*, *P. media* and *P. major*, *Rumex acetosa*). As to the question of the connections between changes in forest undergrowth with the first decline of elm, poplar and aspen, it is far from resolved (cf. Latałowa 1992: 152, 159, 166, 171, 182, 191, 205).

The youngest Mesolithic pollen sample (-57 cm) can be dated to the transition from the middle to the late Atlantic (Table 3). Former tendencies in vegetation persisted in a subdued way. Some species of undergrowth expanded again (*Urtica*, *Pteridium aguilinum*). The lowest Holocene value for NAP and the maxima for hazel and alder (Table 3) could be a consequence of the natural succession of hazel and alder invading disturbed and abandoned places along the shore. Lesser human pressure on the environment, as suggested by the few archaeological finds of that period, may also have permitted the extension of elm. However, a significantly high water-level (see chapter 2c and 2d; Table 9) may have been contributed to the increase of alder and elm, as well.

The progressing deforestation from the beginning of Subboreal (distinct increase of NAP, minima for pine and birch) concerns not only to the island but also to the mainland, as indicated by changes in the game spectrum: horse re-appears and roe deer is more frequent (see chapter 4c; Table 9; Gumiński 1995a: Table 4). The total lack of cereals (Nalepka 1995: Fig. 3), at least till the end of the pure Zedmar culture, excludes tillage as

a cause of deforestation. Animal husbandry, suggested by a small number of bone remains of livestock (Gumiński 1995a; b) or perhaps forest management practices for attracting game could give similar shifts in the pollen spectra. However, the extremely low number of cattle and aurochs bones (see chapter 4c; Gumiński 1995a: Table 4, 5) should keep us of making these suggestions too hastily. The question of anthropogenic deforestation in the beginning of the early Subboreal is still open, particularly when dealing with the details of the process.

On the basis of some, admittedly rather poor osteological evidences if are taken separately : morphology, microsections (M.Sc. M. Nawrocka, pers. comm.) and a curve of bone share, a possible pig „semi-husbandry” has already been suggested during the Zedmar occupation at Dudka (Gumiński 1995a; b). It is tempting to connect the pollen spectra -50 cm and -37 cm with the introduction of pig herds on the island and their subsequent disappearance. The pollen spectra of -50 cm suggests a vegetation suitable for pigs, wild or domestic: along the island banks, a broad belt of damp alder forest with elm (nuts?, sprouts?) and dense bushes of hazel (nuts) grew, while mixed deciduous forest with oak (acorn) was dominant in the island interior (Table 3). The island was certainly large enough (ca. 15 ha) for the keeping of semi-domesticated pig herds. Later, the tree species mentioned above decreased markedly in ratio (Table 3: -37 cm). This could be due to the climate which became rapidly drier or/and a lowering of the water level. However, oak should not decline as a result of drier conditions, but increase as did lime (Table 3). Perhaps the forest on Dudka island was over-exploited by pigs (see chapter 4c).

4. ECONOMY

4A. FAUNAL REMAINS

Most of the Mesolithic finds are bone remains (Table 4). Leaving out the microfauna and human bones, as being irrelevant to the economic activities, the remaining 1318 Mesolithic bones already studied are mostly food waste. These bones are intensively fragmented and occur much dispersed in the deposits; traces of burning are not frequent. The marked fragmentation is the result of processes of degradation and gives few or no indications of the ways of skinning, butchering or cooking. Burned and heavily fragmented bones are usually found in sandy or gravelly layers, while the few almost complete, well preserved bones come from pure organogenic sediments especially if were deposited at first in water conditions. In addition, bones found at short distances from each other in the same layer are

Category of bones	n	%
Game	772	53.4
Fish	546	38.0
Microfauna*	120	8.3
Man	4	0.3
Total	1442	100.0

Table 4. Dudka. Approximate absolute and relative frequencies of the main categories of Mesolithic bone finds based on the preliminary identification work. * Bones of frogs, toads, mice, voles, insectivores etc. are included to this category.

Table 5. Dudka. The ratio between game and fish bones in particular periods based on the preliminary identifications.

Category of bones	PB		BO		AT		Total	
	n	%	n	%	n	%	n	%
Game	192	75.9	211	60.3	369	51.6	772	58.6
Fish	61	24.1	139	39.7	346	48.4	546	41.4
Total	253	19.2	350	26.6	715	54.2	1318	100.0

usually from different animals. All this indicates that only a small part of the Mesolithic bones was preserved. No fire-places or other habitation structures have been uncovered, where concentration of bones might be higher.

The numbers of preserved bones increases during the Mesolithic almost three times, when one compares the Preboreal with the Atlantic (Table 5). But to state that this reflects a more intensive or more frequent occupation during the Atlantic than in the Preboreal is not warranted: the Mesolithic settlement period of the Atlantic (the early and middle) is twice as long as that of the whole Boreal and three times longer than that of the (late) Preboreal. The surface on which layer(s) from particular period occur should also be taken into account (Gumiński 1995a: Fig. 2, Table 2). Based on the bone material, the frequency (intensity) of occupation seems to have been quite constant during the entire Mesolithic.

4B. FISHING

Over forty percent of the excavated bones belong to fish (Table 5); moreover fishing becomes more important in the course of the Mesolithic (Tables 5 & 6). In the Preboreal, the share of fish bones amounts to almost one-fourth, in the Boreal to 40%, while in the Atlantic Mesolithic, it is almost half of all the bones. From the very beginning of the Mesolithic, fish was a very important source of food and probably one of the main reasons for people's visits to the island (Gumiński 1995a).

Pike (*Esox lucius*) was the most commonly fished species (Gumiński 1995a: Fig. 3, Table 3). In the Mesolithic, it comprised half of the identified fish (Table 6). In the late Preboreal, its share was smaller (37%) and comes much closer to that of perch, the second most often captured species.

The frequency of perch (*Perca fluviatilis*) shows a regular downward tendency from the late Preboreal (almost 30%) through the Boreal (almost 24%) to the middle Atlantic (15%) and even less (down to 9%) at

the end of the Atlantic (Table 6; Gumiński 1995a: Table 3). Perch is common in different kinds of water and changes of the trophic or other conditions of the lake do not explain its decline. Moreover, at the end of the early Subboreal, its relative frequency rises again to 16.5% (Gumiński 1995a: Table 3). Perch prefers open water of the shore zone, free of water plants. In the early Holocene, when the zone of vegetation was narrow and interrupted, perch could be taken easily from the banks. Later, the sublittoral vegetation belt became broader and more continuous, making fishing from the island difficult. As to the increase of perch in the Subboreal, it may be related to the common use of nets (Gumiński 1995a). Similarly, fishing from a canoe or a stage may then have been practised more often.

Wels (*Silurus glanis*) was less important during the Mesolithic (7.1%) than in the Zedmar culture (18.6%) (Gumiński 1995a: Table 3, Fig. 3). This increase reflects the excellent conditions for wels during the thermal optimum of the Atlantic period. Wels is thermophilous and needs a water temperature of not less than 18°C for spawning (Bryliński 1986b: 332). Thus, wels can be used as a indicator for how warm late springs and early summers were in the late Preboreal.

Among the cyprinids, roach (*Rutilus rutilus*) and bream (*Abramis brama*) predominate, each with 8-9% for the whole Mesolithic. Roach, typical for shallow, eutrophic and warm lakes, shows comparable frequencies throughout the early Holocene (Table 6), with a slight rise from the Atlantic on (Gumiński 1995a: Table 3). Unexpectedly, the ratio of recovered bream bones show a downwards trend. Normally bream thrives in similar conditions as roach, feeding on the silty bottom. Since bream prefers open waters outside reed zones (During 1986: 178; Jonsson 1988: 74), the explanation for the decline in bream could be similar to the one proposed for perch. As to tench (*Tinca tinca*), it is a good indicator for a rich vegetation on a silty bottom, while rudd (*Scardinius erythrophthalmus*) reflects the eutrophication of the lake (During 1986: 181; Jonsson

Table 6. Dudka. Amount and frequency of fish (minimum numbers of individuals) of identified species in particular periods.

Fish species	PB		BO		AT		Total		
	n	%	n	%	n	%	n	%	%
Pike	10	37.0	23	54.8	53	53.0	86	50.9	77.5
Perch	8	29.6	10	23.8	15	15.0	33	19.5	
Wels	2	7.4	-	-	10	10.0	12	7.1	
Roach	2	7.4	3	7.1	9	9.0	14	8.3	22.5
Bream	5	18.5	4	9.5	6	6.0	15	8.9	
Rudd	-	-	1	2.4	5	5.0	6	3.5	
Tench	-	-	1	2.4	1	1.0	2	1.2	
Crucian carp	-	-	-	-	1	1.0	1	0.6	
Total	27	99.9	42	100.0	100	100.0	169	100.0	100.0

1988: 73). Such conditions are found in the late Boreal. It may also be significant, that crucian carp (*Carassius carassius*) does not appear before the middle Atlantic, when water, particularly in the sheltered bay of the Dudka site, was extremely eutrophic and full of algae (layer L7). At that time, algae of *Pediastrum* suddenly appeared and reach their highest value (Table 3; Nalepka 1995: Fig. 3). Crucian carp is typical for overgrown, eutrophic lakes and is able to tolerate lower oxygen conditions than any other species.

All recovered fish species are typical for extensive, shallow, warm, meso- or eutrophic lakes such as Lake Staświny (Table 6). No doubt, this lake, linked with others by channels and streams, must have harboured many more species than those which were identified, including several cyprinids not yet found in our samples, as well as eel (*Anguilla anguilla*) or zander (*Stizostedion lucioperca*). All these are present later in the Neolithic (Gumiński 1995a: Table 3). The appearance of new cyprinids can be linked with the fact that the water became increasingly shallow, with a muddy bottom, eutrophic and rich in algae. The second important cause for the change of the fish spectrum was the gradual introduction of new fishing techniques. Already in the late Atlantic (the early Zedmar culture), netting and angling enabled to catch small species such as bleak (*Alburnus alburnus*) and gudgeon (*Gobio gobio*) (Gumiński 1995a: Table 3). However, the absence of zander, particularly in the early Holocene, is unexpected. At that time enough clear and extensive open water was available. But if most fishing was carried out directly from the island, whether by spear, angling or net, the chances were slim to catch zander.

The most important feature of the fish fauna is the predominance of predatory fish during the entire Mesolithic and later (Gumiński 1995a: Fig. 3, Table 3). These fish comprises three-fourth of all species (Table 6). Such high ratio reflects bias due to the fishing techniques, because the ratio between predatory and prey fishes in lakes is usually about 1:15 and maximum 1:10 (cf. Noe-Nygaard 1987: 26). This ratio is even ten times higher, if we take into account only the top predators, i.e. wels and pike, which feed exclusively on other fish. The average share of such predators is less than 1% in modern lakes (cf. Noe-Nygaard 1987: 27).

Probably the most common and effective fishing techniques were clubbing and spear fishing. This is particularly true for pike and wels during their spawning season, respectively early spring and end of spring/beginning of summer. Both species prefer spawning-grounds in very shallow, overgrown littoral waters (Bryliński 1986a: 178; 1986b: 332). Perch and bream could also be taken mainly during their spawning period, in middle and late spring respectively, when they come near to the shore to spawn among the reeds (cf. Larsson 1983: 113, 121; During 1986: 176). Summing up, it would seem that spring time was the best period for camping on the island and the limited number of identified species results from capturing larger fishes spawning very close to the shore.

Assemblages of wooden logs and branches in trench III seem to be partially anthropogenic in origin and are thought to have been used as a kind of rough stage for the purpose of fishing (Fig. 6). This supposition is supported by the fact that almost all antler axes found (Fiedorczuk 1995a: Fig. 4a, d, f, g, this volume) were col-

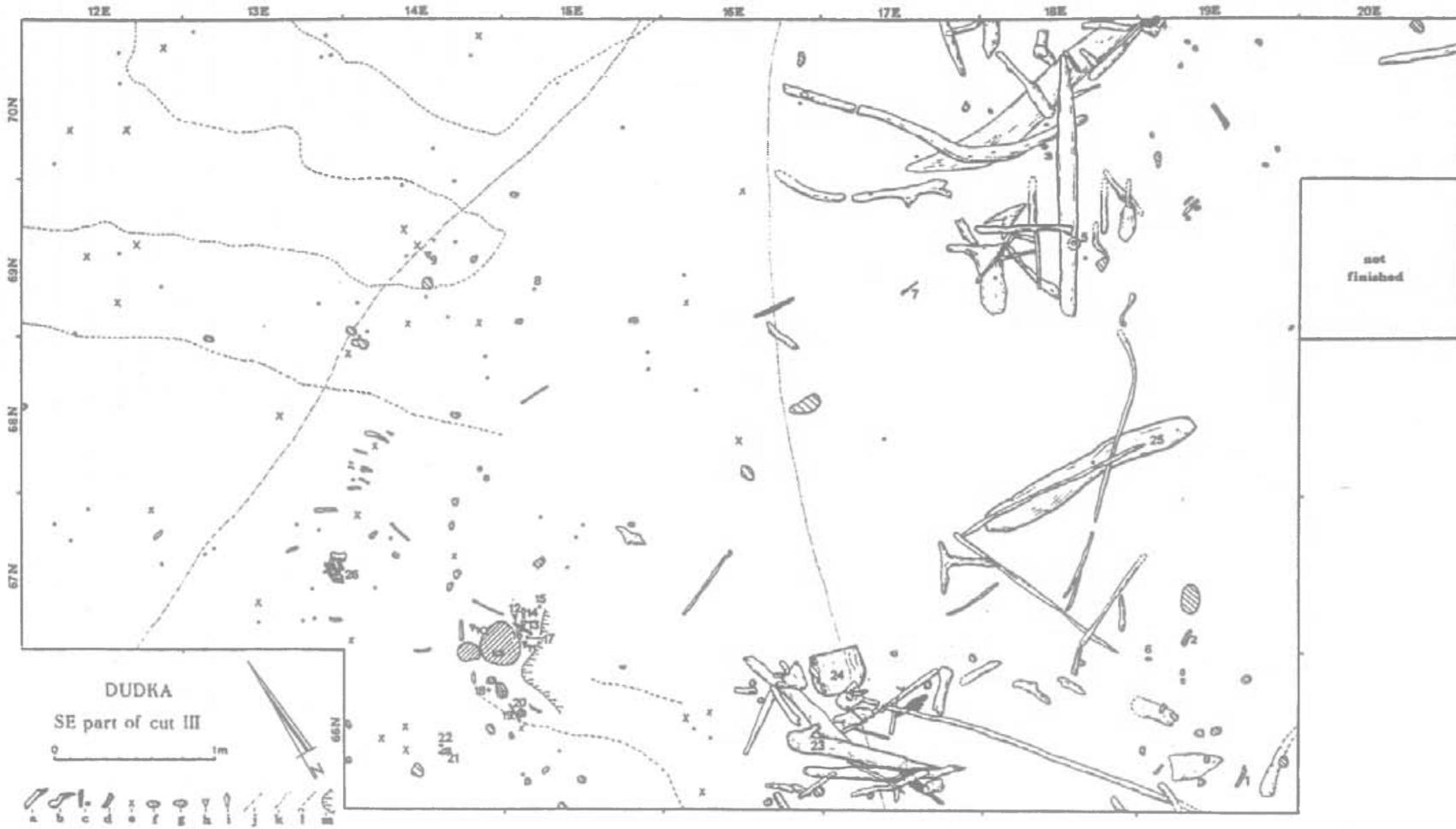


Fig. 6. Dudka. Trench III, littoral zone of the early and middle Atlantic and part of bank zone of the late Boreal

Key: a – wood, b – wooden implement, c – bone, d – antler artefact, e – flint artefact, f – stone, g – early/middle Atlantic stone just over the late Boreal burial unite, h – human bone or tooth, i – amber ornament, j – borderline of layer L7, k – borderline of layer L8, l – borderline of lagoon outflow, m – breach in lagoon.

lected in trench III, among the wood and logs of the assumed stage (Fig. 6, nos 1 and 2 and particularly nos 3 and 4). Moreover, both last mentioned tools (i.e., no 3 and 4; respectively a and f of Fig. 5 in Fiedorczuk 1995a) do not seem to be damaged, and no trace of wooden shafts were found, although in the discussed context and the layers above and below, preservation of wooden objects is good. Possibly, the axes fell from their shaft when being used and sank in the muddy water below, among the accumulated logs and branches where they were difficult to recover.

Outside the spawning season, pike may be spotted immobile near the watersurface and be speared. Wels hide near the lake bottom and are most active by night and perhaps these fish could be caught with baited fish-traps. In such case, the fish-trap will often be filled by eel as well, but eel was not recovered at prehistoric Dudka, except for one bone among the 24,500 fish remains, in a layer with foreign pottery, i.e. of the Funnel Beaker and the Globular Amphora cultures. It is important to point out, that the northern outlet of the Great Masurian Lakes (Fig. 1) is formed by the *Węgorapa* (also *Angrapa*) river, which name means the Eel river (eel = *węgorz* = *anguilla*). Clearly, neither differential preservation nor ecological factors explain well the absence of eel in the fish fauna from Dudka (cf. Prummel 1986: 116), but the explanation can be cultural. People did not eat (or even touch?) eel, perhaps considering this creature to be a snake (Gumiński 1995a). On the other hand, it may be no coincidence, that no traces of fish traps were recovered at Dudka. Such devices are useful close to estuaries and straits, where fish feed and congregate to pass, particularly migratory ones such as eel (cf. Bodker Enghoff 1986: 75, 1993: 116). Prehistoric Dudka yielded no bones of any migratory fish species, except the already mentioned solitary eel bone.

Although, at Dudka not one piece of net or fish-hook, which are known from other Mesolithic wet sites, have been found, both fishing techniques are partly confirmed by the presence of small cyprinids and that of a wooden ring net float and two wooden peg-like angling floats (Fiedorczuk 1995a: Fig. 6g, b, c). Both kinds of floats come from middle Atlantic layers, i.e. from the late Mesolithic; moreover the ring net float and one of the peg-like floats were discovered in the wooden structure (Fig. 6: nos 5 and 6), which might be a rough stage used by people as a help for fishing. Some other wooden implements could be fishing tackles. They include a barked, longitudinally split stick of rowan with a central groove along the cut and with a pointed tip which has been exposed to fire (Fig. 6: no 7; Fiedorczuk 1995a: Fig. 6e). Another pointed stick is made of pine and still carries a pointed short sprout below its point.

This implement resembles a one-barbed harpoon, with a pair of other small sprouts intentionally left for binding (Fiedorczuk 1995a: Fig. 6h). Such artifacts have been interpreted as kind of simple fish hooks with one barb; they are fixed in the gill and mouth of a small fish as bait for a large predator fish (Torke 1993: 53, Fig. 4). The Dudka stick was probably rather long and may have been used as another type of fishing gear, of which the function is described by Brinkhuizen (1983: 10): „A piece of bait is put on the nail. The baited stick is held in the water until the fisherman feels a fish biting. Then he suddenly flings up the stick with the fish on it out of the water.” A typical Mesolithic fishing-spear with two slots along both edges, for fitting flint microliths, was used at Dudka already in the late Preboreal, but instead of being made of bone, the Dudka find is made of ash-wood (Fiedorczuk 1995a: Fig. 6d); similar wooden examples have been uncovered in other sites (Petersson 1951: 125, Fig. 1; Larsson 1982: 131, Fig. 61:1).

4C. HUNTING

The quantitative data on the Mesolithic game of Dudka are summarized in Table 7. Hoofed mammals were the most commonly hunted game species and comprise three-fourth of all game finds. Red deer predominates during the whole Mesolithic, with a ratio 1:2 with respect to the total ungulates and 1:3 with respect to all animals. Only in the Preboreal, red deer was not so predominant, representing hardly one-fourth of all game. Probably the forested area was not fully developed yet (see chapter 3a). Anyhow, red deer is the first and only mammal, typical of Holocene wooded habitats, confirmed before the late Preboreal expansion of pine forest.

Elk occupies the second place, but is three times less frequent than red deer. Also, the fluctuations of its frequency are considerable. It appears in the early Boreal and shows a maximum during the Boreal and early Atlantic. In these periods, it increased to 25%, but it slips down to less than 2% in the late Atlantic, to stay so low till the end of the Stone Age (Gumiński 1995a: Table 4). The curve of elk should not surprise us and is comparable with its curve during the early and middle Holocene in the western and southern Baltic area from southern Scandinavia to NE-Masuria. There, elk was common only in the Boreal (Jonsson 1988: 61, 77; Aaris-Sørensen 1988: 150, 163; Brinch Petersen 1993: 47), while further to the north-east in the East Baltic Countries, elk still dominates during the Atlantic and the Subboreal (Rimantiene 1992: 108; Zagorska 1993: Table 1; Loze 1988: Table 21, 22; 1993: Table 2). Elk is a good indicator of biotope and landscape (see chap-

Table 7. Dudka. Number and frequency of bones (fragment counts) of game species in particular periods. * – bones identified as dog

Game species	PB		BO		AT		Total		
	n	%	n	%	n	%	n	%	%
Red deer	7	26.9	20	38.5	19	33.9	46	34,3	72.4
Roe deer	4	15.4	2	3.8	1	1.8	7	5.2	
Elk	-	-	10	19.2	5	8.9	15	11.2	
Bison/Aurochs	-	-	3	5.8	-	-	3	2.2	
Ruminants	2	7.7	3	5.8	7	12.5	12	9.0	
Wild boar	3	11.5	5	9.6	5	8.9	13	9.7	
Horse	1	3.9	-	-	-	-	1	0.7	
Beaver	-	-	1	1.9	-	-	1	0.7	5.2
Otter/Marten	-	-	1	1.9	1	1.8	2	1.5	
Wolf/Dog*	-	-	*2	3.8	2	3.6	4	3.0	
Birds	8	30.7	5	9.6	3	5.4	16	12.0	12.0
Tortoise	1	3.9	-	-	13	23.2	14	10.4	10.4
Total	26	100.0	52	100.0	56	100.0	134	100.0	100.0

ter 3b). This deer prefers swampy environments along water courses in mixed coniferous forest with birch and aspen and plenty of deciduous shrubs as well as patches of tall grass and reeds (Larsson 1978: 189; During 1986: 110; Jonsson 1988: 61).

The presence of bison/aurochs, most probably only aurochs, is attested only twice at Dudka: in the Boreal and at the very beginning of the Subboreal (Gumiński 1995a: Table 4). Bison and aurochs prefer open grasslands particularly along riverbanks (Larsson 1978: 189; Lepiksaar 1986: 59; Jonsson 1988: 60). Apparently, these large bovid were rare near Lake Staświny. The biotope around the lake was probably not very suitable, even in Boreal times, when good conditions for aurochs are attested in the northern part of Central Europe (Degerbøl & Fredskild 1970: 204; Aaris-Sørensen 1989: 150, 163; Ekström *et al.* 1989: 14-15). During the Atlantic far-distance hunting expeditions were replaced with nearby, so aurochs might become out of approach. In early Subboreal, aurochs appears again at Dudka, now together with domestic cattle, but both are rare. Later on, both vanish at about the same time (Gumiński 1995a: Fig. 5, Table 5; 1995b: Table 2, Fig. 8). In the beginning of the Subboreal, evidence for far-distance mobility or/and trading exchanges are present (Gumiński 1995c) and aurochs may have been bagged far from the site.

Roe deer appears in rather high frequency at the beginning of late Preboreal. At that time, patches of open land and not fully grown coppices still occurred in the pine forest with birch (see chapters 2d and 3a). The more dense and dark mixed Boreal forest and the Atlantic primeval broad-leaved forest (see chapter 3a) were perhaps less suitable for roe deer and this small cervid becomes the least frequently recovered ruminant in the Boreal; its decline continues during the Atlantic. The beginning of the Subboreal was marked by the deterioration of climate and/or more intensive human activities, resulting in more open biotopes (see chapter 3a and 3b); roe deer increased accordingly to about 8% (Gumiński 1995a: Table 4; 1995b: Table 2).

Wild boar came to the Dudka catchment, together with other typical Holocene forest game, from the beginning of the late Preboreal. Its share among bones at Dudka is more or less constant through the Holocene with an average value of 12% (Gumiński 1995a: Table 4), but during the Mesolithic, its percentage shows a slight downward trend. This is rather unexpected, particularly in the light of lithology and the pollen analysis which confirm suitable biotope for this omnivore: marshy alderwoods (with invertebrate in abundance), as well as mixed forest on higher ground with a good share of hazel (nuts) and oak (acorn) (see chapters 2d and 3, Table 3; Nalepka 1995). A distinct increase of wild boar

(from 9 to 14%) took place just at the turn of the late Atlantic when the Zedmar settlement was flourishing. Later, but still in Zedmar times, the wild boar curve fell again to the previous level of about 9% (Gumiński 1995b: Table 2). Much fragmented bones of wild and domesticated pigs are often difficult to distinguish, especially in prehistoric context. Therefore, it is possible that part of them from the Zedmar culture belongs to early domestic form (M.Sc. M. Nawrocka, pers. comm.). The transportation of pigs over the lake by Zedmar settlers can be taken into consideration (cf. Jonsson 1986: 126-128; Lepiksaar 1986: 59, 64). In my opinion, the palynological results from Dudka support the suggestion of a semi-husbandry holding a herd of swine on the island during the Zedmar occupation (see chapter 3b).

The sole Mesolithic bone of horse is dated to the Preboreal. In the beginning of the Holocene, horse can be considered rather a remainder of the former tundra-like environment than a newcomer (Lepiksaar 1986: 57; Aaris-Sørensen 1988: 130; 1993: 29). Horse re-appears in the early Subboreal, but again in very low number (Gumiński 1995a: Fig. 5, Table 4; 1995b: Table 2). As the increase in roe deer, the return of horse should be connected with more open land. Similar tendencies in the presence of horse can be seen in southern Scandinavia (cf. Lepiksaar 1986: 57; Richter 1989: 53; Aaris-Sørensen 1993: 30; Hatting 1993: 32).

Bones of fur-bearing animals seem to be rare at Dudka, particularly in the Mesolithic, and come only from a small number of species (cf. Gumiński 1995a: Fig. 4, Table 4). One can explain the foregoing by several factors, of which the first is differential preservation. However, numerous, much smaller and delicate bones of fish are preserved at Dudka. The absence of certain species may also be due to the season of occupation. As discussed elsewhere (see chapter 4e), Dudka would have been occupied in the warmer part of the year, but, it is generally said that fur-bearing game is best shot in winter because of the better pelt quality. This may be true, but beaver, badger, and brown bear are not well attainable in winter, because of their restricted activity or hibernation (cf. During 1986: 138, 140, 163; Sumiński 1989: 70-76, Fig. 41). Another factor may have been that people skinned animals hunted for their fur on the killing spot and left behind the uneatable carcasses. The foregoing might be apply to most of the mustelides (excluding badger) considering secretion of their glands and eventually to wild cat. Other species: badger, bear, beaver and lynx apart from pelts provide also tasty meat and good quality fat (cf. Larsson 1982: 133; During 1986: 81, 141, 153; Jonsson 1988: 68, 83; Bratlund 1993: 101). Anyhow, even if such

carnivora were not eaten, some of their remains should have be preserved. It concerns bones of digits often attached to the furs (see chapter 5c; cf. Larsson 1982: 133; Noe-Nygaard 1988: 34), as well as canine teeth extracted to make ornaments.

Another reason why fur-bearing game may be lacking is that these animals were not frequent in the Dudka catchment. To begin with the common hare (*Lepus europaeus*), this lagomorph appears at Dudka in the end of the late Atlantic (Gumiński 1995a: Table 4); similarly, it reached southern Scandinavia probably in the beginning of the Subboreal (Aaris-Sørensen 1988: 136). In both regions this is connected with the deforestation (see roe deer and horse; chapter 3a). On the other hand, the mountain hare (*Lepus timidus*) may have been present in Masuria before the Atlantic, since this lagomorph has been attested in Latvia (Zagorska 1993: Table 1).

Beaver is said to have found optimal conditions during the Boreal in Central Europe being a regular companion of elk and aurochs, since this rodent produces suitable grasslands and woody suckers (Lepiksaar 1986: 61; Jonsson 1988: 68). The above well agree to finds at Dudka. Beaver is confirmed only in the Boreal, actually by one find, but besides, confirmed indirectly also by a short post pointed at both ends, of which one end was apparently fashioned by beaver incisors. Anyhow, the low frequency of beaver during the Mesolithic at Dudka relates probably to the fact that the lake region around Dudka did not provide many suitable biotopes for this aquatic rodent.

As to the carnivores fur-bearers, it is possible that brown bear and lynx were really rare, particularly during the Atlantic, because they are both prefer rather boreal type biotopes (cf. Noe-Nygaard 1983: 321, 323; During 1986: 149; Lepiksaar 1986: 62; Jonsson 1988: 83; Iregren 1988: 295-301, 304; Andersen *et al.* 1990: 38). Badger found acceptable conditions during the early Subboreal (Gumiński 1995a: Table 4), when forest clearings became common (cf. Sumiński 1989: 56, Table 11). Otter or/and pine marten are the only evidence of smaller carnivores. Both were quite common among fur-bearing game hunted by Mesolithic man in the northern part of Central Europe. A final reason of the almost lacking the biggest predators might be also, that lonely hunter or one couple could prefer to avoid the encounter with most dangerous animals, as bear or pack of wolves.

To summarize, it seems that several factors had an effect on the small share of fur-bearing game, of which the most important one seem to be the spring-summer season of occupation. In the foregoing discussion, we did not include canids. Up to now, only four fragments

were attributed of wolf and its domestic form, the dog : two would belong to dogs of different size (M.Sc. M. Nawrocka, pers. comm.) and both are dated to the late Boreal, one to wolf and one to wolf or dog; the latter two are of Atlantic age. Apparently dog accompanied Dudka man from the beginning of the Mesolithic, i.e. from the late Preboreal. From these times, dogs are encountered regularly in Central and Western Europe (Clutton-Brock & Noe-Nygaard 1990: 645; Gramsch 1992: 69). Dogs scavenge and are often responsible for the disappearances of consumption refuse (cf. Mehl 1987: 92; Noe-Nygaard 1988: 35), but few traces of gnawing by these scavengers have been noted in the bone material at Dudka (Prof.Dr. A. Gautier, pers. comm.). It seems, that before the late Preboreal, in the end of the Late Palaeolithic the Dudka island was visited by people more likely without dogs. The whole red deer rib has not any traces of gnawing and could have rather slim chances to be untouched on the beach if dogs were introduced.

Whether dogs were skinned for their fur or eaten by man at Dudka cannot be established but appears questionable. The two finds, a canine or fang tooth of a medium sized to large individual and a rib of a immature, small to medium sized individual (M.Sc. M. Nawrocka, pers. comm.), come from the upper part of lagoon deposits in trench III (B6a). They were found in the vicinity of two assemblages with human remains, dated to the late Boreal and their possible connection with two human burials should be considered seriously (see chapter 5c). If people were buried with their dogs, these animals were probably not used as food or skinned after death. The same applies in the case of dogs which would have been buried separately. Mesolithic dog graves, some containing red ochre and grave goods, have been recently found in three regions of southern Scandinavia : Skateholm in Scania, Vedbæk on Zealand and Nederst on Jutland (Larsson 1982: 133; 1983-1984: 23, 31; 1989b: 42; 1989c: 219; 1990a: 153; Jonsson 1988: 67; Johansen 1992: 111; Kannegaard Nielsen & Brinch Petersen 1993: 78).

Fowling seems to be the second important reason for camping on the island, particularly during the late Preboreal (Table 7). Bird bones are probably underrepresented because of their fragility (Aaris-Sørensen 1980a: 146). The islands of the Great Masurian Lakes are still today favourite breeding-places, particularly for waterbirds, because the animals are not much disturbed by predators. It is hard to explain, why the relative number of bird bones is reduced five to six times during the Mesolithic, from about 30% in the late Preboreal to about 5% in the Atlantic (Table 7). In the late Atlantic (early Zedmar culture), the same level as in the

Boreal, almost 9% is attained again (Gumiński 1995a: Table 4). A change in the main occupation season might be one of the causes. Generally resident birds are easiest to bag during the spring breeding time, migratory species in autumn (cf. Larsson 1983: 133; During 1986: 173).

A good indicator of climate is the European pond tortoise. For breeding, it needs a minimum average summer temperature of 18°C for the three warmest months. As its name indicates, the favourite biotopes of this reptile are small waterbodies and swamps. However, it requires dry and warm summers and light sandy soils close to the shore, to bury its eggs for incubation. In winter, the animals hibernate on the bottom of their aquatic homes (Juszczak 1987: 30; Jonsson 1988: 72). At Dudka, tortoise is present already in the late Preboreal and, together with wells (see chapter 4b), indicates warm summers. In the Boreal, tortoise disappears but it is again markedly present in the Atlantic (Table 7), with a maximum in the late Atlantic (36.7%). Towards the end of the early Subboreal, its percentage falls again to 11%, similar to the average value for tortoise in the whole Mesolithic (Gumiński 1995a: Table 4). Such marked increases of tortoise in the Atlantic and the beginning of early Subboreal, can be connected with the climatic optimum and maybe also with a change in main occupation season toward the early summer, when tortoises searching suitable places for burying their eggs were easy to catch. One can collect tortoises not only for their tasty meat but also for their carapaces, which can be used as containers. Some exceptional finds of complete carapaces demonstrate this use of tortoise (Larsson 1982: 119, Fig. 81; cf. Jonsson 1988: 72; Jøger 1988: 245, Fig. 1; Gramsch 1992: 68). At Dudka, all the carapaces are much fragmented and very incomplete.

4D. GATHERING

At Dudka, the only certain evidence of gathering concerns hazel nuts, which are particularly nutrient and can be easily stored. On the island nuts may have grown more plentiful on the mainland, because less animals fed on this resource (Larsson 1983: 120). Broken nut shells are many times more numerous than whole nuts, but both occur from the early Boreal to the middle Atlantic. Gathering and cracking nuts more likely by hitting for easy access to the fruits and for better preservation, could be done in September (Larsson 1983: 120).

In the early and middle Atlantic layers, few acorns occur. Whether they are evidence for gathering is hard to confirm. The same question concerns the excavated pine cones. Unripe cones occur in great quantity in the late Preboreal layer L14a of trench I. Together with pine

twigs, they prove that a pine wood covered the island during the late Preboreal. Seventy meters away, in layer L14b of trench III, comparable pine cones were found only occasionally. The great accumulation of pine cones in the late Preboreal layer L14a might be the result of human activity, but why people would collect the cones remains mysterious.

4E. SEASONALITY

Resource scheduling refers to the fact that most of natural resources are strongly depend on annual periods of their occurrence or most easy of accessibility. Prehistoric people ought to be well adaptable and of big acquirement in their catchment regarding the best time and place for easily obtain sought resources in sufficient amount and in good quality. According to this general strategy some evidences, particularly bone remains may reflect the season(s) of encampment on the island, seasonal activity and preferences in economy, as well as tendency towards sedentary or mobility (cf. Larsson 1983: 116, 130-138; Rowley-Conwy 1983: 118; Noe-Nygaard 1974: 246; 1988: 13).

Most indicators of seasonality used in what follows were found in Larsson (1983: 81, 113-123, 131-138), During (1986: 91-185) and Richter (1982: 170). They are neither precise nor rigorous and one usually applies then together to delimit maximum periods of supposedly uninterrupted occupation. Our approach focuses on the overlap of optimal periods of access to particular species to define short periods, in which subsistence strategies were combined to take full advantage of the specific period. The results are summarized in Table 8.

Generally, fishing is the most effective during the spawning period of the species found, and this manner is well illustrated at Dudka (see chapter 4b). The pond tortoise spends most of its time in the water, and is extremely shy (Juszczak 1987: 26); therefore it must have been caught in the early summer breeding season, when the animals scramble on firm ground and bury their eggs for incubation (see chapter 4c). Also, hunting waterbirds may had been carried out mainly in spring during the breeding season, while autumn was perhaps a good season for hunting migratory birds. Beaver is easily caught particularly in spring and autumn, but not in winter (Matiskainen 1990: 214). As to the wooden constructions, if they were used as a rough stage for fishing, they indicate occupation outside winter, when the lake was not frozen. Of fur-bearing animals, especially carnivores, it is said that they were killed most likely in the winter, because of the better quality of their pelts during the cold season. However detailed examination of pine marten remains of the Late Mesolithic site Tybrind Vig proved that this mustelid

was killed exclusively in autumn (Trolle-Lassen 1986: 121-122). At any rate, bones of carnivores are too few at Dudka to take them into consideration. Red deer was the most important game, sought for its excellent meat and its antlers. This red deer is said to be the most easily bagged cervid, because of its sedentary and gregarious habits, but the best hunting periods fall during rut in early autumn and in late winter. Collecting shed antlers has generally to be carried out between February and the end of April, because later on antlers will be already seriously damaged by rodent gnawing etc. Other ungulates are also hunted most easily in winter, when they aggregate into herds and leave distinct traces in the snow. However, during the full Zedmar period, roe deer was also killed between late spring and late autumn too, as roe deer antlers still adhering to the skull prove. The best season to bag elk is rut (August/September) when, unlike the rest of the year, the animals come together during a few weeks in one place. This corresponds well with the season for gathering hazel nuts and maybe acorns. The unripe pine cones found seem to have accumulated in early spring (Kluk 1808: 187).

For the early Preboreal (end of the Late Palaeolithic?), only a very weak suggestion may be used to establish seasonal occupation at Dudka. The whole red deer rib, a fragile bone, could have a more chance to remain well preserved, if this was soon buried by blowing sand, more probably in early spring. It is also likely that people came to the island for one or some of the reasons which induced people later to camp on the island; probably fishing in the early warm season was the main incentive.

In late Preboreal (earliest Mesolithic), the main occupation season seems to be from spring to middle summer. The relatively low percentage of pike suggests an occupation shorter than the whole spawning period. It may have begun early in April (because of the maximum of perch) and probably continued until May and June (maximum of bream and birds). Presence of wels and tortoise prolong this period into July. The unripe pine cones, if collected by people, agree well with the season established. Roe deer and wild boar are the common game during late Preboreal and could have been shot in the mainland in spring and summer. In the beginning of the early Boreal hunting in early summer is confirmed by the presence of a not yet fully developed red deer antler.

Surprisingly, already in the Boreal, the main season of activity on the island seems to change. The maximum of pike, the still high share of perch and birds, the decline of bream and the lack of wels and tortoise suggest occupation in the beginning and the middle of

Table 8. Dudka. Indicators for seasonality and probable periods of occupation

Key: e-early, l.-late, m.-middle, v.e-very early, M-mainland, I-island

Indicator: ↑ – maximum frequency in Mesolithic and Zedmar period; ↗ – second place, distinctly high; * – sensitive;

Argument: very strong; === strong; --- moderate; ... weak.

Period	Indicator	Come from	Months												
			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
e. SB/ /l. AT Zedmar	probable period				Mar	Apr	May	Jun	Jul	Aug	Sep	Oc			
	pike	I			=====										
	perch	I				.....								
	wels*↑	I							---						
	roach	I				.....								
	bream	I					.....							
	tench*	I					-----								
	tortoise*↗	I						-----							
	beaver*	M			-----		.....		-----		-----			
	red deer	M	.....								.....
	-shed antler	M		=====											
	roe deer↗	M	.....											.....
-unshed antler*	M						-----								
swine↑	I?+M	.....			-----								.....
l. AT early Zedmar	probable period				Mar		yJun	Ju							
	pike	I			=====										
	wels*↗	I						---							
	bream↗	I					=====								
	tench*	I					-----								
	tortoise*↑	I						-----							
	birds↗	I					-----					.....		
beaver*↑	M					-----		.....		-----				
m. AT e. AT	probable period				Mar	Ap		unJu		Sep					
	pike↑	I			=====										
	perch	I				.....								
	wels*↗	I						---							
	tench*	I					-----								
	tortoise*↗	I						-----							
	red deer	M	.....							.....
	elk↗	M	.....								-----			
	nut shells*↑	I								---					
	acorns	I								...					
wooden stage	I						.....		.....			
l. BO e. BO v.e.BO→	probable period				Mar	Apr	May			Sep					
	pike↑	I			=====										
	perch↗	I				=====									
	bream	I					.....							
	tench*	I					-----								
	birds↗	I					-----					.....		
	beaver*	M				-----		.....		-----				
	nut shells*	I								---					
	wild boar neonate	M					---				=====				
	elk↑	M	.....								-----			
red deer↑	M	.....								-----				
-unripe antler*	M						-----								
l. PB	probable period					Apr	May	Jun	Ju						
	pike	I				=====									
	perch↑	I				-----									
	wels*	I						---							
	bream↑	I					=====								
	tortoise*	I					-----								
	birds↑	I					=====					-----			
	roe deer↑	M	.....											.....
	wild boar↑	M	.....												.....
unripe cones	I					.....								
e. PB	probable period				Mar	Apr									
whole red deer rib	I+M				-----								....	

spring. This is corroborated by the find of a bone of a neonate wild boar (M.Sc. M. Nawrocka, pers. comm.). Similarly, a beaver bone confirms the same period, particularly in the case, since this was found together with a pike bone in the human grave unite (see chapter 5c). After the late spring and summer gap, man came back to the island in September, mainly for gathering hazel nuts and probably other edible fruits, plants and mushrooms. It was also a good time for hunting migratory birds on the island. The highest share of elk and red deer bones well support late summer/early autumn returns from the mainland.

In the late Mesolithic, i.e. in the early and middle Atlantic, another change in occupation period took place. All the available data seem to be indicative of three relative short visits for few, but well-chosen, important food resources : pike and wels because of very big, tasty and easy to catch fish during their spawning seasons, tortoise for its tasty meat and maybe for carapaces easy collected when it came out of the lake for laying eggs, hazel nuts very nutrient and best storage fruit. So, the first visit in a year cycle may have been in March and half of April (pike). After a two months gap, the second visit at the end of June through July (wels and tortoise) could take place. The third visit to the island then occurred most likely in late September (hazel nuts, etc.), after collecting these on the mainland had stopped; on the island man could probably still find fruits, because less animals had access to them than on the mainland (cf. Larsson 1983: 120-121).

Seasonal occupation changed again in the late Atlantic or early Zedmar time. Three new important factors may have affected this change. First, the broad belt of reeds and rushes growing near the shores (layer L5) made access to open lake waters more difficult. In the remaining open spots among the reeds algae (*Pediastrum* in Table 3) were in full bloom in summer. Second, the wet peaty soil on the island was unsuitable for hazel (cf. Aaby 1993: 27). Third, pottery was introduced, which revolutionized the methods of preserving and storing food. In the early Zedmar culture, no evidence for late summer/early autumn occupation is found and only two seasons are confirmed : in March for pike fishing and, after a two months interruption, late spring/early summer for hunting birds and collecting eggs, fishing for bream and later for wels and catching tortoises.

One may wonder why, during the Atlantic man left the island in mid-spring, which is the best fishing season. There can be two reasons. Early spring is the time, when stags shed their antlers, a raw material of great value, in particular in this culture, which seems to have used almost no flint or stone axes (Gumiński 1995b; c).

Collecting shed antlers had to take place on the mainland. Thus, immediately after the spawning-season of pike, people may have left the island for this purpose. From the end of April, chances to find well preserved antlers decrease markedly (Larsson 1978: 188, 1983: 81) but people seem to have waited until the end of May to return to Dudka. Perhaps they did not want to frighten birds in the beginning of their nesting period. Soon after, the patience was rewarded by numerous eggs and easiest attainable fowl.

In the fully developed Zedmar culture, the reasons for camping on the island seem to have remained the same as in the late Atlantic. Only fowling lost its importance (from 8.8% down to 3.6%). This could be a consequence of a longer, non-interrupted and more intensive habitation which disturbed breeding birds. Indeed one could argue that Dudka was occupied without interruption for at least half a year in spring and summer, mainly, on the basis of the very marked increase of bone remains, up to 25 times more than in the early Zedmar period (Gumiński 1995a: Fig. 2, Table 2). Moreover, if people brought domestic pig to the island (see chapter 3b and 4c), these animals would have thrived there particularly in autumn, because of the acorns. Thus, it becomes possible to suggest occupation continuing into autumn.

Summing up, through the whole early and middle Holocene, the aborigines of the Great Masurian Lakeland were quite mobile, however most probably within a relatively restricted territory. They were camping on the Dudka island once, twice or even three times a year, between early spring and early summer or early autumn. They came to Dudka always for special purposes : spring fishing, particularly for pike at the beginning of this season and wels at its end. Between both periods or partly at the same time, they fished also other species in succession : perch, roach and bream. Camping in spring permitted also some hunting for waterbirds and perhaps the collecting of eggs from nests. Fowling was most intensively carried out in the very early Mesolithic (late Preboreal), decreased to the end of the Mesolithic and increased again to its Boreal level in the early Zedmar culture (late Atlantic). A third activity consisted of collecting tortoises in the beginning of summer. This activity, as well as fishing wels, was abandoned during the Boreal, most probably caused by climatic deterioration. The fourth main reason for visiting Dudka island was the gathering of hazel nuts and no doubt other plant products during late summer/early autumn. Maybe, at the same time people bagged some migratory birds. Early autumn occupation occurred mostly in the middle part of the Mesolithic (the Boreal and earlier Atlantic). During the visits to the island,



Fig. 7. Dudka. Trench III, details of wooden unit from Fig. 6: no 23 – pointed pole, no 24 – transom of dug-out

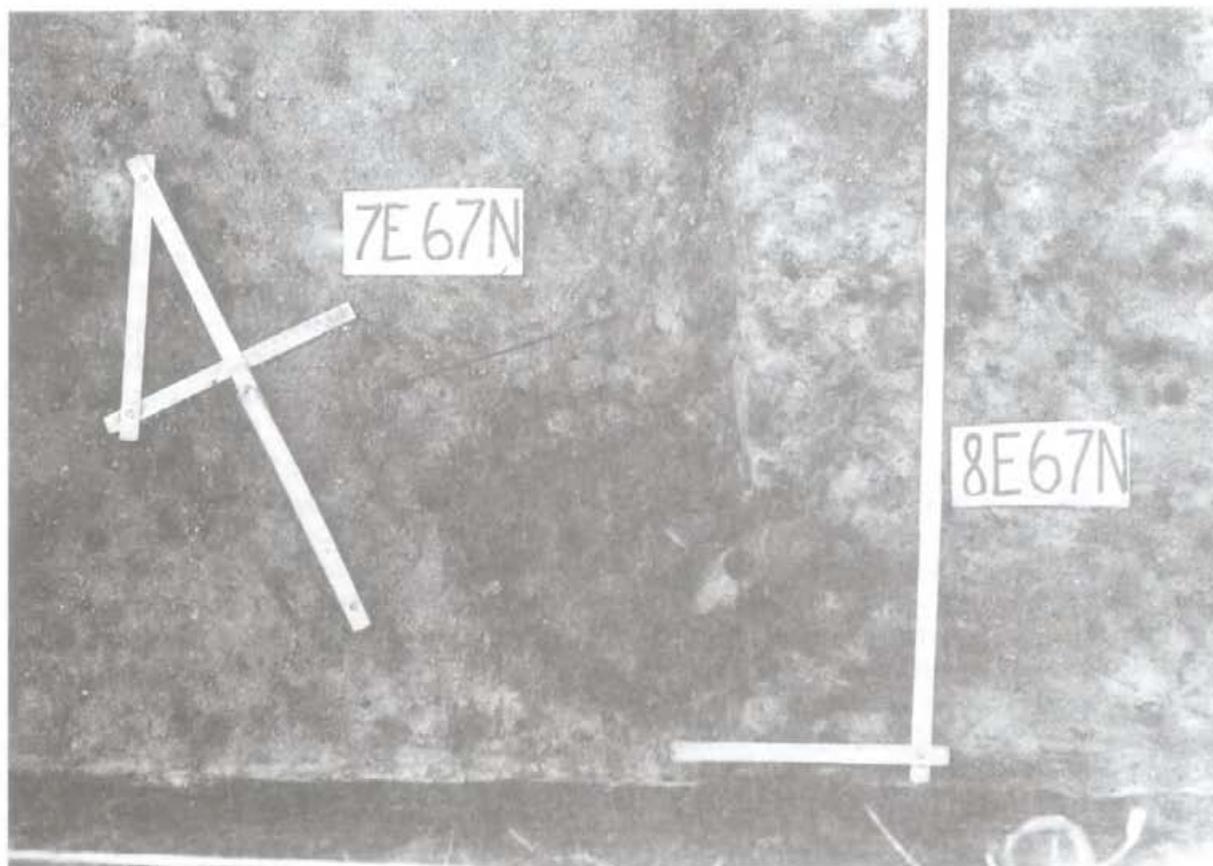


Fig. 9. Dudka. Trench III, bank zone, pit with antler axe and flint microlith *in situ* ca. 10 cm north of pit marked by a black arrow

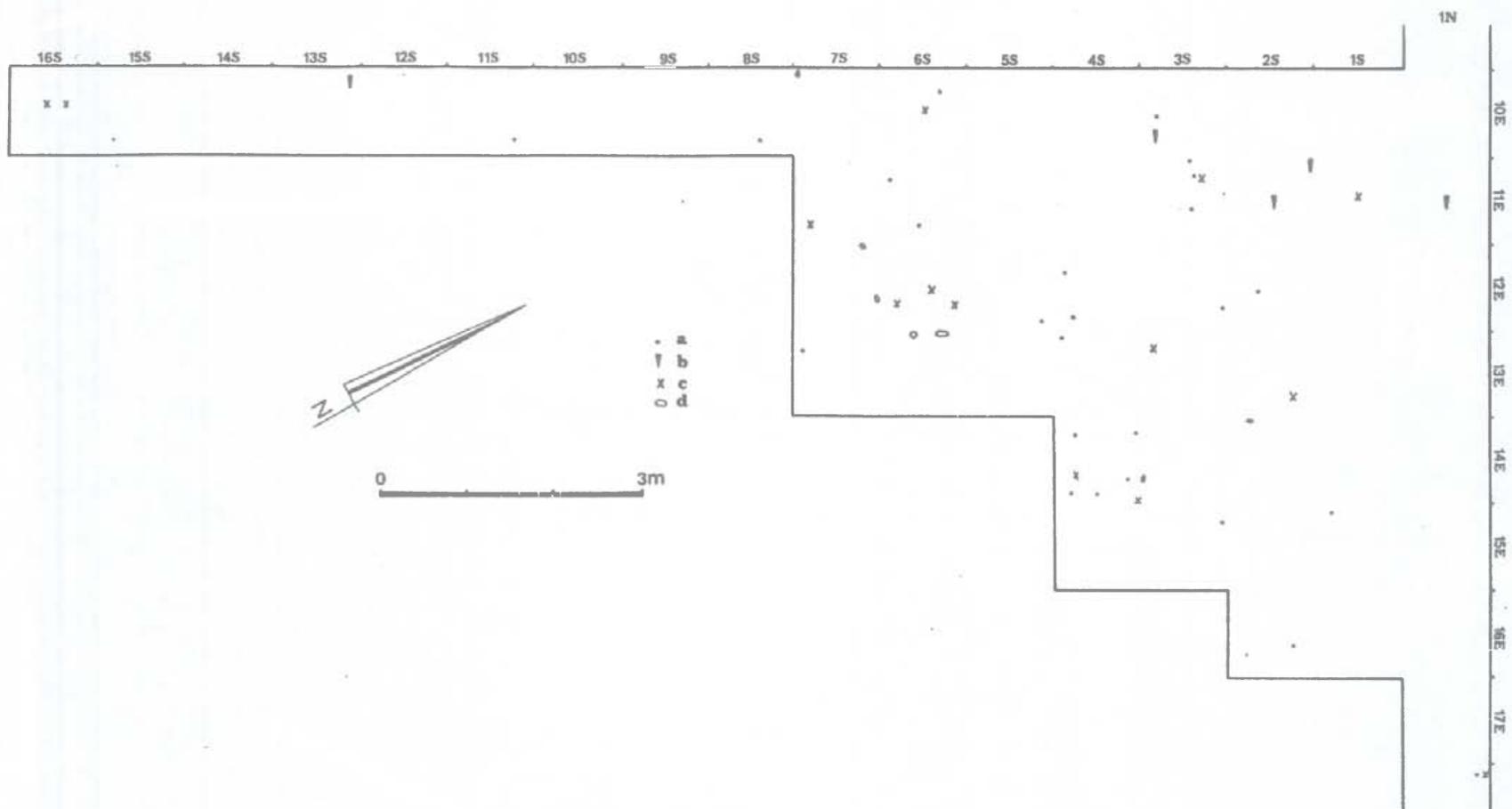


Fig. 8. Dudka. Trench I, bank zone, layer B8, distribution of late Preboreal finds
Key: a – bone, b – bone artefact, c – flint artefact, d – stone.

ungulates were hunted on the mainland and game was brought to the camp on the island. Because this took

place in the warmer seasons, transport of the hunters and their prey animals had to be done by boat or raft.

5. HABITATION

5A. CAMP LOCATIONS

From the early Preboreal until the end of the Atlantic, evidence of human activity have been found almost exclusively on the SE-shore of Dudka island (Fig. 3). Moreover, animal bones as well as all artifacts come mainly from the littoral and bank zones of trench I and III, less from II, and very scarcely slightly farther away from the shore but still close to the SE-bank (NW end of trench I and III, trench V). Elsewhere, no Mesolithic artifacts were excavated, except a piece of a long triangle or backed piece and a microburin redeposited in the Zedmar layer of trench VIII, on the SW-bank of the island, and maybe a similar find in trench IV (cf. Fiedorczuk 1995a, this volume). Apparently, the prehistoric visitors to Dudka selected camp sites near the water and sunny exposure. During the early and middle Holocene, encampments changed a few times along the SE-bank. Possibly this was connected with changes in the main direction of winds. On the extensive open areas of the larger Great Masurian Lakes (a dozen or so kilometres in diameter, Fig. 2) winds are usually permanent and very strong, blowing generally from a NW-direction. During the Holocene, the main wind directions probably were similar. The principal evidence for permanent NW-winds is the lack of organic sediments (gyttja, organic detritus, peat) along the northern shore of the island, a situation also partly true for the SW-shore (see chapter 1b). Strong and permanent winds from the same direction, for instance the north, induce waves and surface currents along the exposed shores, causing deep returning currents from the banks, in this case N-bank of the island. Particularly, if a lake is shallow, the returning currents can disturb and wash away organic material (cf. Odgaard 1991: 201). The SE-shore of Dudka seems to have harboured quiet waters, which did not impede organic sedimentation. No doubt, the island and its vegetation protected the SE-littoral. In the case of N-winds, this protective belt of wood was about one hundred meters wide and up to five hundreds meters, if winds blew predominantly from the north-west (Fig. 3).

The earliest camps, i.e. perhaps in the Late Palaeolithic and certainly in the early Mesolithic, were pitched on the eastern bank of the southern cape of the island (trench I). In the middle of the Boreal main, the principal cause for the displacement of human activity to the more quiet bay in the middle of the SE-bank (trench III), may have been strong winds blowing from the west or even from the southwest. At the end of the Mesolithic

(the middle Atlantic), northern winds return and thick lacustrine deposits and archaeological finds come mainly from trench II and I. During the Zedmar culture (decline of the Atlantic), intensive habitation occurs along the SE-bank (trench I and III), while the neighbouring belt of the island interior (trench IV and VI) and SW-bank (trench VIII) is occupied for the first time in the beginning of the early Subboreal (Gumiński 1995c; d). The last stage of settlement on Dudka island took place at the end of the Neolithic (Corded Ware culture). At the end of the early Subboreal, settlers occupied the whole island, including the island interior and particularly the NE-part (trench III, IV, V, IX, X) (Gumiński 1995b). It seems, that all these movements were caused mainly by strong winds, but the neolithisation may have played a role in the displacement of activities towards the interior of the island (Gumiński 1995c). Water-level or/and humidity rose (see chapters 2a and 2d) and the thinning out of forest on the island (see chapters 3a and 3b) may have influenced such changes as well (Table 9).

5B. CAMP STRUCTURES AND EQUIPMENT

So far no Mesolithic camp structures have been discovered and artefact finds are not numerous. This is probably caused by taphonomic processes as well as the location and very restricted area of the excavations (cf. Johansen 1992: 111; Brinch Petersen 1993: 48). Moreover, the temporal character of occupation and particularly the specific purpose for encampment on the island (e.g., no flint processing, see chapter 4e) should be emphasized.

The two largest concentrations of Mesolithic bones and implements are shown in Fig. 6 and 8. For trench I, the distribution of finds concerns exclusively the late Preboreal layer B8. It would seem that the main activity area at that time was somewhere close to a wider, middle part of trench I, probably towards the north or north-west (Fig. 8; see also Fig. 3). The finds from the lower part of trench III are less homogenous (Fig. 6). They come from the late Boreal as well as from the early and middle Atlantic. The belt-like distribution of the finds across the trench, parallel to the shore and mainly along the squares of 14E, could be the result of the erosion and filling of the lagoon of the late Boreal (see chapters 2b and 2d).

Two or perhaps three wooden structures of logs, branches and sticks in the littoral zone date to the early and middle Atlantic. They may be partly natural, partly

Table 9. Dudka. Confrontation of main palaeoenvironmental features according to periods

Key: faunal indicator of: C – climate (humidity or temperature), L – landscape, M – human activity, S – surface sediment, V – vegetation, W – water trophic level; indicator appearance: * – low frequency but sensitive, ↗ – increasing tendency, ↘ – decreasing tendency, † – maximum Holocene's share, †† – beginning of permanent occurrence, ††† – end of occurrence, † – soon break in occurrence, †† – confirmation of permanent? occurrence.

Years conv. BC	Period	Surface sediment		Water		Climate in summer			Vegetation		Fauna		Landscape		Settlement period	
		on island	on lake bottom	level m asl	trophic level	humidity	temperature	winds	main pollen	ident. wood	main ungulates	indicators	land	lakes		
2000-	e. SB	peat all over	silt & peat	retreat of extent		humid	cool	W, SW	NAP birch pine alder	pine	red deer wild boar roe deer L	sheep/goat*↗ ML gudgeon*M eel*↓ M cattle*↓ M tortoise↘C pig?*↓ VM wels↑↘C horse*† L	surrounding partly unforested	pond & stream, overgrowing lake	CWC	
							warm	N, NE								Z/Neol
						dry		N, NW	alder hazel oak NAP								Zedmar
3000-	L AT	peat at bank	silt & peat			dry	warm	N, NW		pine	red deer wild boar	pig?*↗ M hare*L bleak*M zander*† M tortoise↑C wels↗C	marshy alder woods along lake shores	broad rushes on peaty & silty bottom	early Zedmar	
4000-	m. AT	sandy soil	sapropel	133.7	max eu-	humid	max warm	N	alder hazel	pine alder hazel ash oak rowan juniper	red deer wild boar	crucian carp*VW	primaeval deciduous & pine forest	silt & algae at littoral	late Mesolithic	
dry			alder pine													
5000-	e. AT	sandy soil	detritus algae gyttja	133.4	eu-	dry	warm	SW, W	pine alder birch hazel elm	elk ↘ L red deer	wels↑↗C tortoise↑↗C		duff & branches scum on water bay			
6000-	L BO	sandy soil	detritus algae gyttja	133.5 133.3 133.8	eu-	humid	cool	S, SW gale	pine alder hazel	red deer elk L	tench↑SVW rudd↑VW dog 0 M beaver L	grassy, partly temporarily flooded	lagoons, abrasive shore	middle Mesolithic		
6500-	e. BO	sandy soil	algae/ calc. gyttja	133.0	meso-	humid	cool	N, NW	ash birch	elk L wild boar			reeds on sand			
7000-	L PB	peaty duff in depressions	calc. gyttja	132.7	oligo-	dry	warm	NE, N, NW	pine birch hazel	pine ash	red deer roe deer↘L wild boar	forest fauna↑L tortoise*↓C wels*↓C horse*↓L	pine forest coppices & patches of open land	narrow patches of reeds	early Mesolithic	
7500-	e. PB	gravel		132.2	oligo-	dry	cool	gale N, NE	birch pine NAP jun	pine	? red deer	big bivalves W	park forest juniper bushes	? late Paleolithic		
		sand	sandy gyttja	132.4		dry	warm									
8500-	Yr.D	sand & gravel	sand	132.0	oligo-	dry	cool	gale N, NE				big bivalves W	dunes	pure sandy beaches		
	AL		shell gyttja	132.2	meso-	humid	warm		birch pine				forest			

anthropogenic in origin. In the light of the associated finds of antler and wooden artifacts, and of fish bones, they can be interpreted as probable relics of rough wooden stages or platforms used for fishing (see chapter 4b). The pointed and singed oak pole with a piece of branch left at the distal end (Fig. 6: no 23; Fig. 7) may have been used to build such a platform (cf. Larsson 1982: 28, Fig. 21, 22).

Probably there was also an area where dug-out boats were beached. Close to the above mentioned oak pole, another wooden object was found: a very flat piece which may have been a transom inserted in the stern of a dug-out boat (Fig. 6: no 24; Fig. 7). It consists of a flat board, about 2 cm thick, with a sub-circular contour of some 35-40 cm diameter, of which part has been cut off. This shape and size agree well with a (dug-out) trunk cross-section. Most of the prehistoric dug-out boats so far known have open sterns which are closed by means of a wooden plate transom (Christensen 1990: 130, Fig. 15). The Dudka transom dates to the middle Atlantic (upper part of layer L8). In the same context, another worked wooden object was found: a thick board with two sloping grooves (a few cm wide and 1-2 cm deep) on one of its sides (Fig. 6: no 25). The large dimensions, general shape and other particulars of the object suggest that it is a large fragment of a dug-out boat (cf. Christensen 1990: Figs. 2-15; Grøn & Skaarup 1993: Fig. 11).

In the lagoon sediments B6 of trench III, the excavation uncovered a strange cluster of seven wooden sticks (Fig. 6: no 26), very similar in length and diameter (10-15 x 2-3 cm). They were barked and perhaps rounded at the tips. The purpose of this assemblage is unknown, but the sticks were no doubt intentionally put down close together or one over another. Perhaps such sticks were used for kindling a fire by rotary friction, but they do not exhibit traces of singeing.

At the higher part of the island bank in layer B5 of trench III, a small pit (ca. 30 cm in diameter) was discovered (Fig. 9), in which an antler axe or hoe was found (Fiedorczuk 1995: Fig. 4e). About 10 cm north of the pit, but already in the B5-layer, a flint microlith point (arrowhead?) occurs (Fiedorczuk 1995: Fig. 2: 25). The tongue of the point was oriented towards the pit; this suggests that originally the axe and the arrow sharpened by flint formed one assemblage. Similar cache or votive deposits are known from Mesolithic sites in southern Scandinavia (Larsson 1990b: 286).

5c. BURIAL(S)

In trench III (14-15E 66-67N), layer B6a, remains of a human burial was uncovered (Fig. 6: nos 10-17). Within an area of 40 cm in diameter, three human teeth

occurred (nos 10-12): the first premolar (P1) of the maxilla and the first two molars (M1 and M2) of the jaw, all teeth from the left side, of an adult estimated at about 28 years old individual (D.M. S. Ślarzyński, Prof. Dr. A. Malinowski and Dr. M. Pyżuk, pers. comm.). Among them, a digit bone of a middle size mustelid (no 13), a beaver vertebra (no 15), a fragmentary red deer rib (no 16), a pike bone (no 17) as well as a very carefully worked amber ornament, originally probably a pendant (no 14; Fiedorczuk 1995a: Fig. 5d) have been excavated. There were no visible traces of a pit, an organic container or red ochre. The assemblage lies very close to the SW-border of the lagoon outflow (14-15E 66N) and only 25 cm away from an erosional bench due to wave action. Thus, it would seem that the SE-part of the burial has been destroyed by natural causes. Towards the south-west, other finds could originate from the same grave: a red deer tooth (Fig. 6: no 18), a red deer rib (no 19) very close to a grinder-hammerstone (no 20), a piece of a grinder slab (no 21) together with a rib of a young dog (no 22) of small/medium sized breed (see chapter 4c). A few medium sized stones were found around and among this second assemblage, mostly towards the south-west and north-east (Fig. 6).

Another human bone, a skull fragment of an adult (Dr. M. Pyżuk, pers. comm.) was found (14E 69N) in the extension of the same layer (B6a), 2.3 m away of the burial, towards the NNE (Fig. 6: no 9). Similarly, a fang of a medium/large dog was found within 70 cm distance of the skull fragment (Fig. 6: no 8; see chapter 4c). Both bones, human and dog, lay between two outflows of the lagoon (belt of 68N and 69-70N) and could be the remains of a second burial that was also badly eroded. Some stones are visible within a radius of ca. 70 cm at the same locus; apparently these elements suffered less displacement as a result of erosion.

Taking into account the location of the stone groups, the distance between the bones, and the presence of no doubt two dogs, we may be dealing with two separate human burials, each accompanied by a dog. The burials seem to have been destroyed by outflows from the lagoon, but the more quiet water of the lagoon might also have disturbed the original arrangement of the grave, i.e. skeleton, grave goods, and also eventually the pit or organic container (cf. Grøn & Skaarup 1993: 47). Anyhow, it is difficult to ascertain whether the Dudka burials originally partial or complete inhumations of humans and dogs.

Two charcoal samples collected from layer B6a between both burials gave the following C¹⁴-values: 6270±120 BC and 4530±150 BC. In the light of the stratigraphy and other C¹⁴-determinations, only the first

date is correct (see chapter 2b; Tables 1 and 2). It fits best with the first burial (14-15E 66-67N), because the C¹⁴-sample was taken from the same lower part of layer B6a. The doubtful, second date was obtained on charcoal collected from the top of layer B6a. But even if one takes this into account, it is much too young. Anyhow, both Dudka burials are among the oldest from Poland and the adjacent Central European Lowland area, where Boreal burials are much less frequent than Atlantic ones (cf. Marciniak 1993a: 11; 1993b: 9; Bag-niewski 1990: 36, 167; Kannegaard Nielsen & Brinch Petersen 1993: 76; Larsson 1990b: 284; Butrimas 1989: 10; 1992:9; Głósik 1969: 202; Sulgostowska 1990a: 51, 56; 1990b: 2; 1991: 10; Więckowska 1985: 73-75; Wysoczański-Minkowicz 1985: 169; Wiercińska & Szlachetko 1977: 190; Szlachetko *et al.* 1964: 48-54).

The most of animal bones associated with the first burial (Fig. 6: nos 15-17), a beaver vertebra, a red deer rib and a bone of pike, may represent animal food supplied to the deceased. Adding a last meal of fish to the grave was a rather common custom in the Mesolithic (Jonsson 1986: 62, 71). The beaver and the pike suggest that death and burial took place most probably in early spring (see chapter 4e). One of mammalian bone, however, a digit bone of a fur-bearing carnivore (Fig. 6: no 13) might have been a remain of a pelt used as a wrapper or clothes (see chapter 4c; cf. Brinch Petersen, Alexandersen & Meiklejohn 1993: 69, Figs. 3, 4; Kannegaard Nielsen & Brinch Petersen 1993: 78-79).

Amber have been found elsewhere as a Mesolithic grave good but not in the form of a worked piece (Marciniak 1993a: 11; 1993b: 9; Kannegaard Nielsen & Brinch Petersen 1993: 80). The shape of a carefully worked amber ornament from Dudka grave is unique, particularly in such an early period (Fig. 6: no 14; Fiedorczuk 1995a: Fig. 5d). Presumably, it was originally a perforated pendant, similarly to another simple amber pendant also dated to the late Boreal (Fiedorczuk 1995a: Fig. 5e); it suggest that the first burial concerns perhaps a woman (cf. Marciniak 1993a: 9; 1993b: 9; Kannegaard Nielsen & Brinch Petersen 1993: 80-81; Larsson 1990b: 284). The amber was most likely of a local origin and not imported from the Baltic coast. Most of Masuria is very rich in amber, particularly along river valleys where it is easily accessible in the banks or simply found on the surface (Mazurowski

1983: 21-22, Fig. 1). Moreover, the recovery of amber may have become quite easy during the late Boreal, when lake-shores and riverbanks eroded (see chapter 2d). Symptomatically, the second Mesolithic amber dates also to the late Boreal, while all other amber ornaments from Dudka are dated not before the early Subboreal. This was again a period of more intense erosional activity, caused by partial deforestation and undergrowth destruction combined with increasing humidity and rising water levels (see chapter 2d and 3).

The place chosen for the burials is significant. Already in the late Boreal, people were apparently buried on Dudka island, within the encampment zone (see chapter 5a) and at the same time in the direct vicinity of the lake's water. Such locations are typical for Mesolithic graves of the circum-Baltic area and are interpreted as manifestations of territorial attachment (Larsson 1983-1984: 34). The burial marked the territory, Dudka island and Lake Staświny, as belonging to a specific group because their ancestry had been buried there. Such manifestations could be an initial condition for the development of more marked territorial systems for settlement (network) and restricted catchment exploitation during the late Mesolithic. A restricted territorial system with shorter distance expeditions to hunt and obtain particular raw materials, might be the cause of the absence at Dudka of bison/aurochs and beaver (see chapter 4c), as well as amber, during the Atlantic.

Perhaps it is not a coincidence, that people put two large stones over the first and apparently richest burial (Fig. 6g). Very thin peaty layers, L9 and L8, have been distinguished below these stones. They were pressed down by the stones and stratigraphically the stones should date to the early Atlantic (see chapter 2c). It is not excluded that people intended the stones to mark the grave of an (important) ancestor. Such locations may have been remembered for many generations, especially since the grave was originally delimited or marked by smaller stones. With time, this well marked grave, several generations old, could become a token to lay claim on Dudka island and Lake Staświny. In the circum-Baltic area, graves marked by stones appear in the late Mesolithic at many localities suitable for camping and subsistence (Kannegaard Nielsen & Brinch Petersen 1993: 77).

6. PALAEOENVIRONMENT AND PALAEOHISTORY

6A. ENVIRONMENTAL EXPLOITATION

The lake and island originated on ground moraine sediments of the Pomeranian phase of the Vistulian glaciation. From the late Pleistocene, probably at end of

the Older Dryas (Dryas II) (Ralska-Jasiewiczowa & Starkel 1988: 106), the melting ice-sheet created an extensive, shallow lake with a large, flat island in the centre. The island was formed of boulder clay, covered

by limestone gravel and sand or fine calcareous silt in some places.

Till the beginning of late Preboreal, the lake was poor and oligotrophic, with the lowest recorded, slightly fluctuating water level. During the warmer oscillation of the Allerød and, later, of the Friesland, the lake level rose as much as 0.4 m, probably due to dead-ice melting. In this period, only birch and pine grew in the forests. In between, during a cooler period, the not yet developed soils, sparsely forested patches with juniper bushes and some open areas with limited vegetation as well as strong winds from the north and the north-west allowed erosion and transport of sands from the island interior to the banks and littoral. Calcareous gyttja with large bivalves accumulated in the cold and oligotrophic lake.

During the last colder oscillation, most probably in the Youngest Dryas (Dryas IV) of the early Preboreal, some pine trees grew on the island. At that time, the first typical ungulates of the Holocene woodland appeared, as evidenced by a find of red deer. However, the landscape as a whole still resembled rather a park-tundra with extensive patches of birch-pine forest. The lake shores were placed with wide, open sandy beaches.

Probably man's first visits to the island date from the colder oscillation assigned to the Youngest Dryas (Dryas IV), but his cultural identity cannot be established directly: the corresponding deposits yielded only a rib of red deer and some charcoal but no flint artifacts. However, three flints redeposited in Neolithic layers can be assigned to the Late Palaeolithic of the Tanged Point cultural complex (Fiedorczuk 1995a: Fig. 3). In the extensive lowland area of Central Europe and southern Scandinavia, sites dated to the early Preboreal (first two centuries of the eighth millennium BC) represent still Late Palaeolithic cultures; shortly thereafter, at the beginning of the Late Preboreal, the earliest Mesolithic emerges (cf. Schild 1989: 94; Gramsch 1987: 115; Gramsch & Kloss 1989: 316; Bokelmann 1981; 1991: 86; Willkomm 1981: 39; Fischer & Tauber 1986: 9, 11; Larsson 1990b: 273; 1993: 216; Brinch Petersen 1993: 47). Presumably something similar can be said about Dudka and all what precedes the late Preboreal can be assigned to the Late Palaeolithic. We can thus assume that Late Palaeolithic hunters caught up successfully typical forest game, as red deer, and visited the island, bringing with them parts of carcasses, perhaps in spring to fish for pike and perch as did later visitors.

The most important and rapid changes of environment occurred in the beginning of the late Preboreal, about 7750 years BC, in connection with a significant warming of the climate. The shallow and rich in lime on its bedding Lake Staświny warmed up and became

richer in organic content. On the island, dense pine forest developed with birch, soon followed by other deciduous trees, mainly hazel and elm. Along the shore, the first narrow patches of reeds appeared. All this was conducive to the accumulation of duff and peat in depressions, the increase of the biomass and fishfauna of the lake, the colonization by waterbirds, the appearance of typical game of Holocene wooded land and particular thermophilous species (tortoise, weasels). At this time, horse still dwelt in some remaining patches of open land and roe deer in coppices and clearings in not fully developed forest yet in the region around the lake.

From the very beginning of the late Preboreal, Mesolithic man appears: forest hunters and fishers pitched their camps on the SE-side of the south cape of the island, i.e. not far from trench I. The main purposes of encampment on the Dudka island were fishing, fowling and perhaps collecting bird eggs, as well as catching tortoises. All this took place from the early spring till the beginning of summer, taking advantage of the reproductive seasons of particular species. The tool kit for catching fish near shore, comprised wooden(?) and antler clubbing tools, wooden and bone(?) spears and perhaps baskets, but no trace of such contraptions were found. Simultaneously, some of the Dudka people hunted for big game on the mainland in distinctly various biotopes. From the very beginning of the Mesolithic, pike was most commonly fished and red deer the most frequently shot mammalian game.

In the beginning of the Boreal, soon after 7000 years BC, environmental conditions changed. The climate became cooler and more humid and the average summer temperature lowered to 18°C. Winds turned more to the west. Torrential rains or spring thaw washed sands and gravels down the littoral. The water level rose by about 0.3 m. However, the deterioration of the climate did not hold back pedological and eutrophication processes. Some part of the littoral were invaded by reeds, others by algae. The pine forest grew into a more variable forest with many deciduous trees, shrubs of hazel and alder groves along the water. Former areas of poor vegetation were changed into tall grasslands, partly thanks to beaver activity. The game fauna underwent adequate changes: horse disappeared and roe deer lost considerably in importance. Elk took over and to a lesser degree also aurochs; both species would be well adapted to Boreal conditions.

People also adapted to the new conditions and they moved their camps to the more protected and quiet bay in the middle of the south-eastern shore. After fishing and fowling in early and middle spring, they left the island in late spring, because weasels and tortoise became rare. After the summer gap, they returned to Dudka in

September to gather hazel nuts and other plant products and perhaps to hunt migratory birds.

The late Boreal and the beginning of the early Atlantic (6500-5700 years BC) were marked by the strongest water activity. The water level often fluctuated and rose on again, average by half of meter. Storms caused formation of lagoons, which were ruptured by later storms and heavy floods. In quieter times, lagoons filled with sands and organic matter. Floods also washed duff and sands from the interior to the littoral zone. The lake became fully eutrophic, with algae, a muddy bottom; the bay along the SE-shore, was protected by reeds, in which coarser plant material could slowly settle. This bay provided excellent conditions for tench and rudd. Beaver appeared in the vicinity and may have played a role in the hydrology of the region. The most common ungulates in the surrounding forest and shaggy land were red deer and elk.

The most important change in human behaviour during late Boreal was the care taken for deceased members of the group. They were buried with precious ornaments (amber pendant), food reserve and possibly wrapped in a pelt. Graves were located within the encampment area very close to the lake. These burials may have included dogs. The role of dog came into prominence, considering their indispensability in tracking game in becoming dense deciduous thicket.

Already after the first half of the early Atlantic, from ca. 5700 years BC, climate conditions seems to have been more steady, warm and dry. The water-level stabilized and lowered slightly perhaps accelerating growth of reeds and algae. Shrubs and trees grew close to the shore-line. Washed duff as well as fallen sticks and branches covered the water in the sheltered bay. Forest became more extensive and dense with new and more various deciduous tree species, but pine was still frequent. In this period, human influence on the local vegetation becomes visible for the first time. People cleared forest by burning to make open spaces and perhaps to attract elk. Ruderal plants began to grow close to the camps pitched constantly at the same place. Red deer and wild boar thrived in more shaded broad-leaved primeval forest, which was much less suitable for roe deer and bison or aurochs, and soon after, also for elk. Thermophilous fauna, wels and tortoise, came back to Lake Staświny and proliferated.

The new environmental conditions, particularly the more dense primeval forest, with all possible sorts of plants, as well as changes in the game spectrum, influenced human activity. Long distance expeditions to hunt (aurochs?, beaver?) and to search for raw materials such as amber ceased. Man changed his camps more often, but within more restricted area, coming thus back more

often to the same localities and creating a denser network of paths, attracting new ruderal plants. Human attachment to particular territories may have grown and was perhaps expressed by the marking of a grave of an important ancestor by large stones. A similar symbolic action, claiming Dudka island could be the possible weapon depot of an antler axe and an arrow buried in a small pit.

The greater mobility of humans, within smaller territory, can be linked with a broader spectrum of food resources. Now habitation on the island was scheduled at thoroughly considered aims and took place three times in the year round. The first visit on the island happened in the early spring for pike fishing, after that red deer shed antlers were collected on the mainland. This raw material must have been of great value, because during the whole Mesolithic and even later in the Zedmar culture, flint and ground stone axes seem to have been rarely used or unknown by the Dudka people. The second period of visit took place at the turn of spring/beginning of summer, when wels and tortoise were caught. The summer was spent on the mainland again, more likely to gather ripening plant products and to hunt. Finally, in late summer/early autumn, the third visit to Dudka island aimed at gathering hazel nuts and maybe hunting migratory birds.

The short visits to the island, each time no longer than two months, and the fact that they occurred during the warmer half of the year, could be the main reason for the lack of clear hearths or dwelling structures. Nevertheless, new kind of equipment appeared caused by new conditions. Rough stages reached out over the unpleasant and possibly even dangerous littoral water, full of algae, organic debris and thick silty bottom. At the same time, fast dug-out boats became common, what is attested by the find of a transom and maybe a piece of a dug-out trunk, may have rendered travel and open water fishing more efficient. The main fishing techniques remained the same as in the Preboreal, but the appearance of more various and smaller fish species as well as to kind of wooden floats (ring and peg-like) indicate the use of nets and angles.

During the late Atlantic, some of environmental and cultural conditions changed distinctly. A drier period and the lowering of the water level caused a sudden peat increase both on the island bank as well as on the former littoral zone. Marshy alder woods grew along the lake shores. The island became less accessible and the lake overgrew progressively. The conditions were now better for tortoise and birds and for beaver as well. Economical activity markedly intensifies in exploitation various aquatic resources of subsistence : a broader spectrum of fishing, fowling, tortoisening and even bea-

ver hunting attained their Holocene maxima (Gumiński 1995a: Table 3, 4). Fishing from the vast open water as well as by nets may have been practised more often and explains the presence of zander and the highest share of cyprinids in the ichthyofauna. Unlike hazel nuts, which gathering and preparing dried fruits seem to have lost its former importance. One of the reason could be the application of pottery, which revolutionized the preservation and preparation of foods. The renewal of far distance expeditions and intensification of cultural contacts are confirmed by the introduction of pottery, T-shaped antler axes and soon later the attempts at husbandry.

The turn of the late Atlantic was marked by progressive deforestation, what occasioned the increase or appearance of particular game species (hare, horse, roe deer, aurochs). Human population seem to have proliferated and settlement on the island became longer : from the beginning of spring probably till the middle of autumn. Wooded parts with alder, elm, hazel and oak, in which swine feeds may have been exploited by keeping herds of pigs on the island, resulting in the degradation of the vegetation (especially tree species) and ending this form of husbandry. The first newcomers, of the typical Neolithic cultures, the Funnel Beaker following by the Globular Amphora culture, began to visit Dudka and influenced the native Zedmar culture (Gumiński 1995c).

6B. CULTURAL RELATIONS

The set of Mesolithic implements, particularly those made of flint, is small and it is hard to demonstrate its cultural connections with the accepted taxonomies (Fiedorczuk 1995a). This is common for many wetland sites, because each of the recovered assemblages come from a very restricted section of time (Gumiński 1993: 452). Anyhow, it seems that from the Early to the Late Mesolithic, we are dealing with the same culture, most similar to the Komornica, but with some specific artifact types (long triangles, trapezes) commonly appearing in later Mesolithic. The late Mesolithic culture of Dudka can be placed within the Maglemosian or the North-Western Mesolithic culture complex. The foregoing conclusion is different from the previously held opinion that the Masurian Lakes District was connected with the Kunda complex, the North-Eastern Mesolithic culture complex. It was also assumed, that Late Palaeolithic people of the Świderian culture were present till the beginning of the Boreal and that during the Boreal, their culture transformed through the Post-Świderian into the Kudlaevka and Neman cultures of the Atlantic period (Kozłowski 1986: 36-42; 1989: 18-23, 119, 165; cf. Więckowska 1975: 393-398, Fig. 91). Such affilia-

tions have been suggested on the basis of stray finds and a few unstratified, undoubtedly mixed, sandy sites in different regions of NE-Poland. At the same time, some isolated stray finds resembling Late Palaeolithic artifacts or/and made of reindeer bone and antler were palynological dated to the Holocene. These finds seem to confirm the thesis exposed above. However, palynological dating of single samples taken from the vicinity of an artefact should be given up. The latest C¹⁴-re-examination of similar pollen-dated stray finds from southern Sweden show them usually to be completely unreliable and that the former palynological attributions need to be revised (Ekström *et al.* 1989: 14, 17, 20). In any case, at Dudka during the whole Mesolithic (from the late Preboreal till the late Atlantic), there are no artifacts of flint, antler or bone, wood or even amber that are not typical for the Maglemosian and that could indicate relations with the Kunda complex (cf. Fiedorczuk 1995a).

The introduction of pottery, probably simultaneously with T-shaped antler axes, took place in the middle of the late Atlantic ca. 3600 BC (Gumiński & Fiedorczuk 1990: 64; Gumiński 1995d). At the same time, both these typical markers of the neolithisation process appeared in the Ertebølle culture, the related post-Maglemosian counterpart in southern Scandinavia (Andersen 1975: 100, Fig. 57-59; 1985: 58; 1991: 15, 29, Fig. 14; 1993a: 83, 85; Andersen & Johansen 1987: 52; Andersen & Malmros 1985: 93; Vang Petersen 1984: 11). Distances of two to three hundred kilometres to the nearest settlements of the Neolithic Band Pottery (Danubian) culture can be estimated in both Masuria and southern Scandinavia.

This first Neolithic influence on both, pure Mesolithic communities (pre-ceramic Ertebølle; the direct ancestors of the Zedmar) was not followed by any significant or abrupt changes in economy, settlement, material culture or social structure (cf. Gumiński 1995a: Fig. 2, 3, 4, 5; Andersen 1991: 22; 1993a: 61, 64, 68, 73, 79, 89; 1993b: 66; Andersen & Johansen 1987: 50; Fischer 1993: 62-63; Larsson 1989a: 369-370, 374). In other regions of the (post-) Maglemosian (North European Plain), the first appearance of pottery in Mesolithic groups occurred at quite different times, spanning a period of one thousand years (cf. de Roever 1979: 23; Price 1981: 95, 102; Zvelebil & Rowley-Conwy 1986: 77; Schwabedissen 1981a: 50; 1981b: 136, 140; Fischer 1993: 63; Galiński 1992: 87-90; Ilkiewicz 1989: 39). This was caused by several factors, such as different distances to the main neolithisation centra (the Atlantic, the Danubian, and the Eastern European?), ethnic divisions, differences in communication and trade exchange networks, occupations on the sea-coast or exclusively in-

land, and different access to areas still abounding in food resources.

Hunters-gatherers of the Ertebølle and the Zedmar lived in a different environment. The Ertebølle people had easy access to prime quality flint and marine food resources. The Zedmar culture had the same prospects for obtaining appreciable surpluses from several food resources. Most importantly was the possibility to take full advantage of whichever kind of nourishment on a year-round basis (cf. Madsen 1987: 231-233; Nielsen 1987: 240; Larsson 1990b: 279, 291; Andersen 1993b: 66-68). Such circumstances resulted in rendering the lean seasons, particularly spring, less stressing. This security could be attained only by groups which kept and defended their access to particular water reservoirs and the adjacent territories. How real and vital territorial rights may have been, can be deduced from such Scandinavian data as the repeated wounding by hunters for the same individual of red deer, evidence of human violence, the presence of an uninhabited fjord acting probably as a buffer between two intensively inhabited regions which exhibit minor differences in material culture (Noe-Nygaard 1974: 246; Madsen 1986: 232; Kannegaard Nielsen & Brinch Petersen 1993: 81; Brinch Petersen, Alexandersen & Meiklejohn 1993: 69, Fig. 8, 9; Andersen 1993a: 91).

These Mesolithic or Paraneolithic pottery groups, including the Eastern European one, are in general similar to each other (Gumiński & Fiedorczuk 1988: Fig. 18). Significantly, the Zedmar type pottery is mostly of «Central European» style: flat bottomed, S-like or funnel-like profiles, very scanty ornamentation and a virtual absence of comb-like imprints, holes below the rim, oval bowls («lamps») (Gumiński 1995d; Gumiński & Fiedorczuk 1988: Fig. 18; 1990: Fig. 3, 4:1, 3, 6; Timofeev 1991: 23). As the Ertebølle sites, the Zedmar ones are also within the range of the Danubian style T-shaped axes made of antler (Gross 1939: Fig. 12; Timofeev 1981: Fig. 1, 2; 1991: 19; Gumiński & Fiedorczuk 1990: 58, 69, Fig. 9: 1, 4) and delimit their most north-eastern extension in Europe. Most numerous in the Zedmar culture are microliths in the form of obliquely truncated microblade pieces (Gumiński & Fiedorczuk 1988: 141, Fig. 14: a-n; 1990: 67, Fig. 6: 11-20; Fiedorczuk 1995b: Fig. 2: 33-40; Timofeev 1991: Fig. 5: 19-24). They resemble the obliquely truncated points, typical for the Komornica and other Maglemosian groups. The Narva culture of the East Baltic Countries, farther towards the north-east, has a completely different flint industry, including arrow-head points. (Gumiński & Fiedorczuk 1988: 143; 1990: 67; Timofeev 1991: 25).

To conclude, the pure Mesolithic and early Zedmar culture at Dudka represent the same cultural tradition:

Maglemosian. This is a different proposition than the commonly held idea that the whole Mesolithic and Zedmar culture are connected with the Kunda circle tradition of the Eastern Baltic Countries, as are the Narva and the Neman cultures (cf. Kempisty 1981: 16-22; 1986: 201-205; Kozłowski 1989: 179; Rimantiene 1992: 116).

From a geographical point of view, the Masurian lakes are nowadays included to the Eastern Baltic Lakes Districts and the Eastern European Lowland (Fig. 1; Kondracki 1978: 332; 1991: 565, 574, 601-602; Matuszkiewicz 1991: 493, Fig. 302, 305, 311, 312). It can be suggested that during the Mesolithic, the Great Masurian Lakeland (the central Masuria) was still much more connected with the North European Plain, which is itself part of Western Europe. This connection concerns not only cultural relationships but probable the general landscape as well. It seems, that one of the most important landscape attributes, separating the Central European Lowland from the Eastern European Lowland was the frequent occurrence of spruce. This coniferous tree, even in a mixed forest, affects the landscape markedly, giving much shade and less passage. Pollen diagrams from Masuria, contrary to those of the north-east territory of the East-Baltic Countries show distinct differences. Till the end of the Atlantic, spruce was practically absent in the Great Masurian Lakes and a western Masuria areas, but represents from 10 to 25 % of AP in Lithuania and Latvia respectively (see Table 3; cf. Nalepka 1995: Fig. 3; Ralska-Jasiewiczowa 1983: 139-141; 1989: Fig. 1, 2; Pawlikowski *et al.* 1982: 109, Fig. 7; Starkel 1977: 181-182; Gudelis 1973: 196, 201, Fig. 67, 69; Girininkas 1990: Fig. 4; Kuskas 1985: 26, 28, 63, Fig. 2, 4; Kuskas & Butrimas 1985: Fig. 8; Levkovskaja 1987: 47, Fig. 4, 22; Loze 1988: 108-112). Also some of game species indicate differences in biotope conditions between the Great Masurian Lakeland and the Eastern Baltic regions (including the Prussian Lowland). In the latter regions, elk and/or aurochs continue to play the most important role in the late Atlantic instead of red deer, with comparatively high values of brown bear and beaver. Also noticeable is the lack of thermophilous tortoise, a low frequency of wels and the presence of mountain hare (cf. Timofeev 1991: 22; Rimantiene 1992: 108; Zagorska 1993: Table 1, 2; Loze 1993: Table 2, 4). These differences suggest that the environmental border between the Central and Eastern European Lowlands ran north-east of the Great Masurian Lakeland during the Atlantic. It is also suggestive that the three late Atlantic/early Subboreal sites of the Zedmar culture, Dudka, Zedmar A and Utinoe Boloto, reveal gradual changes in the hunted game in accordance with their increasing north-eastern

location. Utinoe Boloto is situated farthest to the north-east already beyond Masuria, in the Prussian Lowland; here aurochs is most prominent, with red deer on the third place, far behind wild boar. Elk is not very significant but occurs as frequently as brown bear (cf. Timofeev 1991: 22). Similar tendencies are present at the sites of the counterpart Narva culture in the Lithuanian Lake District. There elk occupies the second place (after red deer) and aurochs, brown bear, and beaver play an important role, but red deer is still dominant; also tortoise is not absent (Girininkas 1990: 28-29, Table 1).

A «western type» landscape with its distinct vegetation and fauna covered the region of the Great Masurian Lakes probably till the end of the early Subboreal. However, isolation from the rest of Central Europe began from the late Mesolithic on. This combined with the frontier situation, thick primeval deciduous forest, a close network of large lakes and human attachment restricted territories to isolate the region. The first and early Neolithic (Band Pottery) Danubian colonisation missed the Great Masurian Lakeland. The second neolithisation wave, ca. 3600 BC, brought flat bottomed pottery and T-shaped antler axes to it; in this process, the increased activity of the Danubians as well as the post-Maglemosian hunter-gatherers played a role. The third neolithisation wave ca. 3100-3000 BC manifested itself by the spread of the Funnel Beaker culture within the former Maglemosian province, except Masuria.

Why was this region left out? It seems, that apart of the above mentioned partial isolation, the Masurian Lakeland still abounded with food resources, even if there also population had increased and despite of a global environmental deterioration. Factors as partial deforestation, spread of heathlands, elm decline, reduction or even disappearance of some important game species (aurochs, elk, brown bear, beaver), the Littorina Sea transgression causing changes in water conditions of fjords and lagoons and the disappearance of the oyster, influenced the late Ertebølle communities in southern Scandinavia (Aaby 1993: 26; Aaris-Sørensen 1980b: 131-136; 1993: 30; Bratlund 1993: 104; Iregren 1988: 298, 300; Christensen 1993: 22; Gaillard *et al.* 1988: Fig. 1). There, the Funnel Beaker culture way of life, since food producing became «independent of capricious nature» and had to be adopted to survive. This was apparently not the case in the early Zedmar community in the Masurian Lakeland, where all aquatic food resources, fish, waterbirds and tortoise, reached their Holocene maxima (cf. Gumiński 1995a: Fig. 4) and where the partially overgrowing of some of the lakes could result in increase of birds and tortoises. Also, partially deforestation does not necessarily entail a decrease of available ungulate game; on the contrary, game may become easier to track. Summing up, there was no fundamental reason for people of Dudka and relating territories to change their cultural behaviour.

7. CONCLUDING REMARKS

The foregoing paper should be regarded as a hypothesis, one of the possible scenarios to explain the finds done at Dudka. I am conscious of the fact that some (many?) of the advanced explanations and attempts to fit data into the puzzle are rather weakly supported. However and as already said in the introduction, it is worthwhile and certainly stimulating to make an attempt towards simultaneously interpreting both archaeological and scientific data, even when these are rather incomplete and not always clear.

Dudka shows us Mesolithic man as a fisherman (especially big predatory fish), a hunter (forest ungulates, waterbirds) and a collector (plants, tortoise, bird eggs). His economical activity apparently went on in a rational

and opportunistic way, adapting smoothly to changes in the environment and the availability of its resources. So, he adequately adjusted his scheduling and the timing in annual round to obtain the most sought and abounding goods; relative sedentary or increasing in mobility were stimulated accordingly to thin or dense forests; new subsistence activity, tool kit and equipment were employed properly to new conditions. Notwithstanding this flexibility, several practices related to subsistence but also to other activities (location of camps, burials) remained almost the same throughout the whole Mesolithic, no doubt because the basic conditions of access to many resources did not change fundamentally.

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„AcPb” – „Acta Palaeobotanica”

„AP” – „Archeologia Polski”

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„JDA” – „Journal of Danish Archaeology”

„JAS” – „Journal of Archaeological Science”

„LA” – „Lietuvos Archeologija”

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