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ORIGINAL ARTICLE

Environmental context and the role of plants at the early medieval artificial island in the lake Paklicko Wielkie, Nowy Dworek, western Poland

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Abstract
This paper reports the archaeobotanical investigation of the early medieval lake site near Nowy Dworek, in the west of Poland, focussing on the role of plants on and around the site. The construction of a small, artificial island in a lake similar to Irish crannogs, traces of awooden bridge and archaeological artefacts all indicate that the site was a special place for the local Slav community in the 9th–10th centuries AD. Plant macroremains and pollen also demonstrate the uniqueness of the place. A large number of the cultivated and wild plant taxa are connected with the local environment and reveal an interest in plants as an element of beliefs. Pollen from dung pellets provides information about plants used as fodder and complements the picture of plant communities on the land around the island.

Keywords Island · Plant macroremains · Pollen · Dung pellets (coprolites) · Use of plants · Early Middle Ages

Introduction

Lake dwelling settlements are very characteristic of the circum-Alpine region in Europe. They were built near lakeshores or in marshy areas and were in use between the Neolithic and the Bronze Age (Schibler et al. 2004; Tolar et al. 2011). Most houses were constructed with the use of wooden piles to stabilize the buildings and protect them against flooding. The island at Nowy Dworek in a lake, Paklicko Wielkie, western Poland, represents a special type of dwelling site, different from those known from the Alpine region. It was built much later, in the early Middle Ages, over standing water and it was connected to land by a bridge. The phenomenon of settlements on islands in lakes is common in western Slav territories. The islands with bridges, used as defensive settlements (ramparts), are especially well known from northern Germany. They may have been designed to provide refuge for people in times of need (Bleile 2010). However, the construction of Nowy Dworek is also similar to crannogs, which are well-known in the north of Europe, in Ireland, Scotland and Wales, and date from the late Bronze and Iron Age to the 17th century AD. Crannogs were located at some distance out from the edge of the lake and were enclosed by piles, thus forming artificial islands (Morrison 1985). Throughout their long history crannogs served as farming homesteads, refuges in times of trouble, fishing platforms and even residences for the upper classes. These places might also have had a religious function (O'Sullivan 2000, 2005; Fredengren 2002). Their exceptional importance could, among other things, be connected with a belief in the special role of water, where the island itself was perceived as the pre-land, the first earth to emerge from the waters of the proto-ocean (Chudziak 2010).

It is also known that in early medieval times the natural environment was of special importance to the people and plants played an important role in all aspects of life. They were not only a source of food, but also the background of all events, as well as part of religious rites (De Cleene and Lejeune 2003; Kujawska et al. 2016). Many myths

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connected with water, an island as the centre of the world and plants as an element of beliefs are characteristic of the western Slavs in Poland. Historical knowledge about this area as well as its specific landform features, with numerous lakes and small islands with evidence of connections with the land, has motivated archaeologists to conduct a detailed study. General explorations show that the islands were artificially built and probably functioned as settlements. One of the first lake islands to be studied in detail in this part of Poland was Żółte in the lake Jezioro Zarańskie (Chudziak and Kaźmierczak 2014). Significantly, systematic archaeobotanical and palynological analyses were conducted on site (Noryśkiewicz 2014; Pińska and Latałowa 2014). The numerous well preserved plant remains allowed detailed mapping of certain activities on the island. Charred remains from the features in the inner part of the site suggested repetitive rituals in which rye bread or cakes were chiefly used. Finds of plants on the Żółte site supported the archaeological description that the island functioned as an important local or regional settlement centre in the early Middle Ages.

The next site selected for investigation is unusually interesting. It is a very small, artificial island at Nowy Dworek, also dating back to the early Middle Ages. Assessments to date are that this site was a multi-functional socio-cultural centre, including a mythical or even magical role (Chudziak et al. 2012). Considering the excellently preserved plant remains and dung pellets, in the current archaeobotanical research we have sought to answer two main questions: (1) does plant material from such a site show the character of the past environment in the vicinity of the island? (2) do plant remains confirm the important function of the site in the past and provide information about ritual practices?

Site description

The Nowy Dworek site exists today as a small island in a lake, Paklicko Wielkie, in western Poland (Fig. 1). It is located in Ziemia Lubuska (Lubusz land), between Pomorze (Pomerania) to the north, Śląsk (Silesia) to the south, Wielkopolska (Greater Poland) to the east and Brandenburg to the west. Archaeologists describe the vicinity of the site as a quite densely settled area (Chudziak et al. 2012). Near the lake, remains of a supposed 7th–8th century stronghold and a 8th–11th century village were uncovered. The inhumation cemetery located in nearby Jordanowo is probably connected with these sites (Hensel and Hilczer-Kurnatowska 1972; Kurnatowska and Łosińska 1996; Łosiński 1998; Felis 2010).

The island today has a surface area of about 0.01 ha, a round outline with a diameter of 12 m and it protrudes 0.4 m above the present water level, but during the medieval period the island was larger, as the lake level was then about 1 m lower. The site was built in a shallow part of the lake basin. The early functioning of the place in the late 9th and 10th centuries AD is connected with wooden structures, which covered the entire area of the island and were used as reinforcement for the earth embankment. As a result of rising water level, new elements were successively added to the island in the 10th–11th centuries in the form of a grid. Probably at that time, a wooden trackway supported by oak piles encircled the island. Since no traces of structures in the form of houses were found on the island, we may assume that the place was some kind of platform, 40 m in diameter. The connection with the mainland was provided by a wooden bridge ca. 80 m long, which has been dendrochronologically dated to the 9th–10th centuries AD (Phase I AD 837–875, Phase II 928–943, Phase III 956–965; dendrochronological analysis by M. Krąpiec). During the archaeological work on land and underwater contexts, artefacts connected with weaving or leathercraft were discovered. There was also early medieval pottery, typical of local western Slav tribes. Around the island deer skeletons together with cattle skulls were found; on the island mainly separate deer bones were noted, while remains of farm animals were almost absent (unpublished archaeozoological data by M. Makowiecka and D. Makowiecki).

Materials and methods

Material for the archaeobotanical analysis was collected from two trenches located on the central part of the island and from the shallows (Fig. 1). Twelve individual samples represent a succession of levels associated with the construction of the island (Table 1). All samples contained well preserved waterlogged plant remains with a small admixture of charred plant remains and sand. In samples collected from trench 4–5/13, dung pellets of goats or sheep were recorded (Table 1; ESM 1). The level with the finds was well isolated from the present-day surface. From each sample, 300 cm^3 sediments were selected. The materials were soaked for 24 h in weak KOH solution and sieved with 2.0, 0.5 and 0.2 mm meshes. The remaining material was wet-sieved only with the coarse sieve in order to obtain large remains, which are normally underrepresented in the base sample. Plant names have been used after Mirek et al. (2002). The plants are arranged into seven socioecological groups according to their habitat requirements (Table 2; ESM 2). The eighth group (unspecified plants), includes taxa of unknown ecological affiliation, and was excluded from the analyses and graphical representations. Dung pellets of goat/sheep found in samples from trench 4–5/13 were analysed for pollen. Each of the finds was dried, cleaned and weighed (Table 3). The samples were prepared with the use of HCl, KOH and Erdtman's acetolysis (Berglund and Ralska-Jasiewiczowa 1986). Spores of *Lycopodium* were

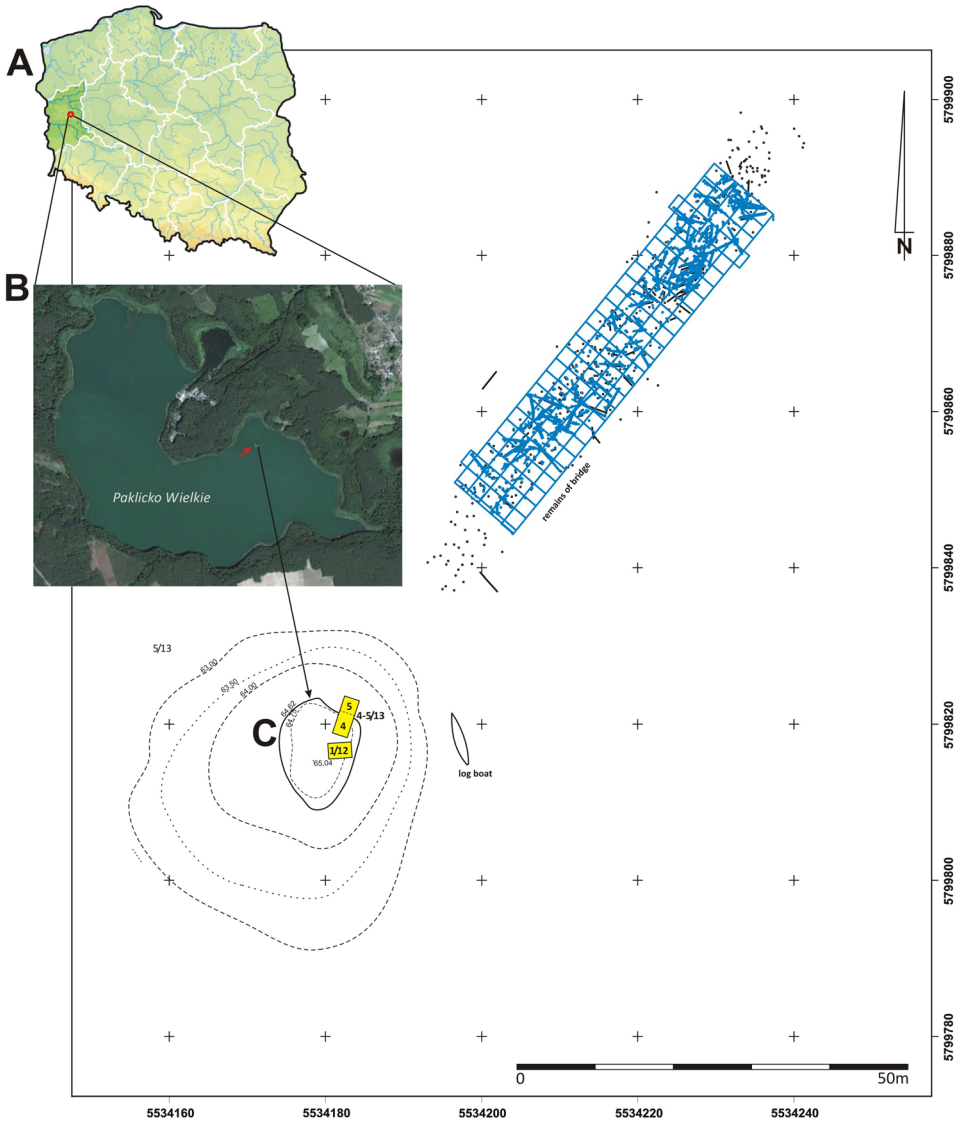

Fig. 1 Nowy Dworek. *A, B*-site location; *C*-island plan with archaeological trenches (*yellow*) (drawing by Kowalewska, Grabiec, Kaźmierczak; modified); 64.52—water level in 2013

added at the beginning of sample preparation in order to allow the calculation of pollen concentrations (Stockmarr 1971). Modern comparative material was obtained from pollen analysis of the dung pellets of primitive breeds of goat and sheep at a farm run by the Archaeological Museum in Biskupin. Monitoring of fodder elements was made possible by the mapping of the vegetation growing in the pen enclosing the livestock and from the information on the fodder which was provided during the winter.

Results and discussion

Elements of the natural environment

The archaeobotanical samples contained more than 21,850 plant remains representing 219 taxa. Among them, 165 were identified to species level (Table 2). Such rich plant representation was a key to the reconstruction of the elements of the natural conditions (Behre and Jacomet 1991), which existed in the vicinity of the island in the early Middle Ages.

In the results, the most prominent group are plants from ruderal habitats and arable land (ESM 3). Most of them have a broad syntaxonomic identity, or habitat requirement, and may grow in different plant communities (Matuszkiewicz 2008). The predominance of plants associated with root-crop weed floras, gardens and ruderal habitats is connected with a considerable number of remains of nitrophilous plants such as *Chenopodium* spp., *Atriplex* spp., *Polygonum persicaria, P. lapathifolium* or *Solanum nigrum*. It is difficult to describe a single reason for this situation. These plants are typical of open ground, small garden plots, places alongside well-trodden paths and refuse dumps. However the archaeological results indicate that the small island at Nowy Dworek was

Table 1 Nowy Dworek. Archaeological description of archaeobotanical samples; *Bw* below wooden structure

Sample	Trench	Depth (m a.s.l.)	Level of wooden elements	Archaeological/dendro-chronological dating	Dung pellets
3/12	1/12	63.19	5	1st half of the 10th c	–
4/12	1/12	63.55	5	1st half of the 10th c	–
7/12	1/12	63.24	6	2nd half of the 9th c	–
8/12	1/12	63.14	bw	2nd half of the 9th c	–
11/12	1/12	62.95	bw	2nd half of the 9th c	–
2/13	4/13	63.7	2	1st half of the 10th c	–
3/13	4/13	63.65	4	1st half of the 10th c	+
4/13	4/13	63.45	5	1st half of the 10th c (AD 933)	–
5/13	5/13	63.36	2	1st half of the 10th c	–
6/13	4–5/13	63.15	6	2nd half of the 9th c	–
7/13	4–5/13	62.9	6–7	2nd half of the 9th c, AD 875 (−7/+8), AD 878 (−1/+6), AD 889	+
8/13	4–5/13	62.7	bw	2nd half of the 9th c	+

a kind of wooden platform without the right conditions for such plants, such as ground or earth. A possible explanation of the presence of these plants in the samples is that the plant parts were brought to the island from a village near the lake shore, together with the sediment used to strengthen the structure. We cannot exclude either that some ruderal plants, which prefer moist eutrophic conditions, actually grew on the island or were brought across the water from the lake shore. The high proportion of remains of ruderal plants is characteristic even of the oldest site occupation horizon.

The botanical results from Nowy Dworek indicate the presence of arable land in the vicinity of the island. Numerous remains of *Panicum miliaceum* found in the samples demonstrate the great importance of millet growing for the local people. However, weeds typical of millet such as *Echinochloa crus-galli, Erysimum cheiranthoides, Setaria pumila* or *S. viridis/verticillata* were very rare. Remains of flax field weeds were not common either, represented by single remains of *Cuscuta epilinum, Galium spurium, Silene gallica* and *Spergula arvensis* ssp. *maxima*. Weed communities typical of winter cereal crop cultivation are represented by a few *Fallopia convolvulus* fruits and single remains of *Agrostemma githago* and *Centaurea cyanus*. The latter is the most characteristic weed of rye, but it is not a frequently recorded species on early medieval sites in Poland (Latałowa 1999). It may suggest that rye cultivation was not well developed in the early Middle Ages (Pińska and Latałowa 2014), also in the vicinity of Nowy Dworek. Ecological indicators, used to describe growing conditions, show that in most cases damp, mesotrophic or eutrophic, sandy clayey soil, rich in humus and organic matter was used for cultivation (Zarzycki et al. 2002). *Galium spurium, G.* cf. *tricornutum, Silene gallica* or *Aethusa cynapium* indicate areas with warm and calcareous soil. Two types of millet glumes (long and brown versus round and yellow) may indicate various soil conditions in arable land rather than a taphonomic process.

Among numerous taxa identified in the samples, those from meadows and pastures of different habitats were found. Their occurrence is also indicated by the pollen results from the dung pellets as well as from the Paklicko Wielkie lake sediments, of which analyses are in progress. Macrofossils of these plants usually show that the area surrounding the site was used for keeping livestock (Latałowa et al. 2003). Bearing in mind the finds of goat/sheep dung pellets, we may assume that animal fodder, both fresh and dry, could have been brought to the island. Although some species from this group such as *Lythrum salicaria, Prunella vulgaris* and *Origanum vulgare* are not well tolerated by animals (Rutkowska 1984), they could have been collected not as fodder but as decorative elements or herbs.

Woodland areas in the early Middle Ages were a source of food, herbs and building materials (Dembińska and Podwińska 1978). Although woodland and scrub are represented mostly by collected taxa on the plant list from Nowy Dworek, they provide information about the character of the woodland communities which grew around the site. *Alnus glutinosa* was in alder carr near the lake shore. *Fagus sylvatica, Quercus* sp., *Carpinus betulus* or *Corylus avellana* formed meso- and eutrophic oak-beech woods. *Fragaria vesca, Rubus* spp., *Prunus spinosa* and *Betula* sect. *albae* signify exploitation of woodland margins, clearings and glades. Plants growing in pine woods were rare, both in taxa and in remains.

In view of the site location, the presence of aquatic and wetland plants in the samples is not surprising. Seeds of these plants often float on a lake surface, and are driven off the shore by waves. We may suppose that isolated remains

Table 2 Nowy Dworek. List of taxa with numbers of macrofossils. Complete version with composition of separate samples in ESM 2. *Asterisk* denotes cultivated or collected

Taxa	Remains (*n*)
Cultivated plants (I)	
Cereals	
Panicum miliaceum	1,766.5
Hordeum vulgare	1
Secale cereale	3
Triticum sp.	0.5
Vegetables	
Brassica nigra	8
Brassica rapa	20.5
Daucus carota *	17
Pastinaca sativa	13.5
Oil / fibre plants	
Cannabis sativa	2
*Humulus lupulus**	3
Linum usitatissimum, seed / fruit	90 / 10
Papaver somniferum	56
Fruits	
Cerasus avium / vulgaris	1 / 6.5
Cerasus avium / vulgaris	200
Malus sp.	20.5
Malus sp. / *Pyrus* sp.*	4.5
Prunus domestica	3
Pyrus sp.*	28
Weeds of winter crops and flax (II)	
Aethusa cynapium	3.5
Agrostemma githago	22.5
Anagallis arvensis	8
Capsella bursa-pastoris	10
Centaurea cyanus	1
Cirsium arvense	8
Cuscuta epilinum	7.5
Galeopsis tetrahit	9.5
Galium aparine	2
Galium spurium	13.5
Galium cf. *tricornutum*	1
Fallopia convolvulus / cf.	147.5 / 19.5
Papaver argemone L.	31
Rhinanthus serotinus ssp. *apterus*	1
Rumex acetosella	250
Scleranthus annuus	1
Silene gallica	5.5
Spergula arvensis ssp. *maxima*	0.5
Viola arvensis / *tricolor* L.	10.5
Weeds of root crops, gardens and ruderal habitats (III)	
Acinos arvensis	59
Anthriscus sylvestris	2
Arctium lappa / tomentosum	40 / 1
Arctium lappa / *tomentosum*	3
Atriplex patula	27
Atriplex prostrata ssp. *prostrata* / cf.	15 / 2
Atriplex nitens	1
Atriplex sp. / *Chenopodium* sp.	2,826
Atriplex sp.	78
Berteroa incana	8
Carex hirta	15
Chaenorhinum minus	4
Chenopodium album	3,062.5
Chenopodium glaucum	1
Chenopodium hybridum	96.5
Chenopodium polyspermum	50
Chenopodium sp.	1,892.5
Cichorium intybus	10
Cirsium lanceolatum	2
Conium maculatum	2
Cuscuta europaea / cf.	7 / 0.5
Descurainia sophia	11
Echinochloa crus-galli	2
Euphorbia helioscopia / cf.	4.5 / 0.5
Erysimum cheiranthoides	13
Lapsana communis	9
Lamium album	10
Linaria vulgaris	8.5
Malva sylvestris	2
Melandrium album	15.5
Mentha arvensis	4
Myosotis arvensis	1
Nepeta cataria	2
Plantago major	39
Polygonum aviculare	48
Polygonum hydropiper	1.5
Polygonum lapathifolium	106
Polygonum persicaria / cf.	71 / 2
Potentilla norvegica	1
Potentilla reptans / cf.	10 / 1
Rumex crispus	22.5
Setaria pumila	32
Setaria viridis / *verticillata*	3.5
Silene vulgaris	18
Sisymbrium officinale	1
Sonchus arvensis	2
Stachys annua	2
Solanum nigrum	136
Sonchus asper / cf.	3.5 / 1
Spergula arvensis ssp. *vulgaris* / s.l.	3.5 / 0.5
Stellaria media	79
Thlaspi arvense	3.5
Urtica dioica	857.5
Urtica urens	2
Verbena officinalis	12.5
Plants from semi-natural and natural meadows and pastures in fresh and most habitats (IV)	
Angelica sylvestris	1
Caltha palustris	2
Centaurea jacea	3
Centaurea cf. *jacea*	6
Cerastium holosteoides	41.5
Linum catharticum	12
Lythrum salicaria	1,290
Potentilla erecta	29
Prunella vulgaris	70.5
Ranunculus acris	27.5
Rhinanthus serotinus	1
Stellaria graminea	11
Thalictrum flavum	1
Thalictrum lucidum	6
Trifolium pratense, petals	4
Valeriana officinalis	45
Plants from dry meadows, grasslands and heath (V)	
Agrimonia eupathoria	1
Anthemis tinctoria	16
Arabis hirsuta	1
Arenaria serpyllifolia	133
Calluna vulgaris	1
Campanula glomerata	4
Centaurea scabiosa	4
Centaurea cf. *scabiosa*	1
Dianthus deltoides	6
Hypericum perforatum	32
Knautia arvensis	4
Luzula multiflora / *campestris*	3.5
Origanum vulgare	294.5
Petrorhagia prolifera	22.5
Picris hieracioides	2
cf. *Pimpinella saxifraga*	1
Potentilla argentea	48
Stachys recta	1
Thalictrum minus	4
Thalictrum cf. *simplex*	1
Viola canina s. str.	1
Plants from forests and forest edges (VI)	
Ajuga pyramidalis	2
Ajuga reptans	1.5
Alnus glutinosa, fruit / ament	4 / 4
Betula sect. *albae*, fruit / scale	70 / 2
Campanula rapunculoides	5
Carex spicata	2
Carpinus betulus	1
Corylus avellana	11.5
Fagus sylvatica / cf.	3 / 1
Fragaria vesca	561.5
Moehringia trinervia	1
Pinus sp.	2
Prunus spinosa	3
Pteridium aquilinum	6.5
Quercus sp.	8.5
Rubus caesius	123
Rubus idaeus / sp.	136.5 / 36
Sambucus nigra	4.5
Solanum dulcamara	2
Stellaria nemorum	1
Vaccinium myrtillus / sp.	35.5 / 1
Viburnum opulus	4.5
Wetland and aquatic plants (VII)	
Bidens tripartita	1
Carex elata	15
Carex elata / *nigra*	2
Carex nigra	7
Carex panicea	1
Carex paniculata	11
Chara sp.	1,287
Cladium mariscus	2
Eleocharis palustris / *uniglumis*	7
Eupatorium cannabinum	1
Fallopia dumetorum	0.5
Filipendula ulmaria	20
Galium palustre	1
Juncus sp.	1,030
Lycopus europaeus	22
Mentha aquatica	9
Myosoton aquaticum	93
Najas marina	10
Nuphar lutea	1
Nymphaea alba / cf.	3 / 1
Polygonum mite	22
Ranunculus repens	55
Ranunculus sceleratus	47.5
Schoenoplectus lacustris	47
Sch. lacustris / *tabernaemontani*	17
Sch. tabernaemontani	3
Scirpus sylvaticus	279
Stachys palustris	2
Stellaria palustris	1
Torilis japonica	1
Typha sp.	1,947
Unspecified plants	
Apiaceae indet.	7.5
Asteraceae indet., fruit / perianth	10 / 2
Brassicaceae indet.	26
Campanula sp.	3
Carex sp. bicarp. / tricarp.	17 / 92
Carex flava / *viridula*	3
Centaurea jacea / *scabiosa*	2
Centaurea sp.	4.5
Cerastium sp.	15
Cirsium sp.	5
Ericaceae indet.	2
Fabaceae indet., seed / perianth	2.5 / 3
Galeopsis sp.	1
Galium sp.	6
Hypericum sp.	2
Lamiaceae indet.	18.5
Linaria sp.	2
Luzula sp.	1
Malvaceae indet.	1
Melandrium sp.	2
Melandrium sp. / *Silene* sp.	117.5
Mentha aquatic / *arvensis*	3
Papaver sp.	9.5
Poaceae indet.	659.5
Polygonum sp. / Polygonaceae	7.5 / 1
Potentilla sp.	65.5
Prunus sp.	1
Ranunculus sp.	6
Rosaceae indet.	4
Rumex sp.	5
Salvia sp.	1
Scrophularia sp.	1
Solanum sp.	3
Stachys sp.	4
Stellaria graminea / *palustris*	1
Stellaria sp.	23.5
Thalictrum sp.	3
Valeriana sp. / *Valerianella* sp.	1 / 1
Valerianaceae indet.	3
Veronica sp.	1
Viola sp.	3
Varia	37

Table 3 List of dung pellets from Nowy Dworek studied by pollen analysis

Sample ID	Pellet number on pollen diagram	Weight (g)	AP + NAP
7/13	1	0.2049	615
	2	0.1421	536
	3	0.1808	264
	4	0.1847	242
	5	0.2089	506
	6	0.1689	319
	7	0.2241	241
	8	0.1675	306
	9	0.1698	321
	10	0.1741	291
	11	0.1678	503
	12	0.1419	313
	13	0.2118	353
	14	0.1769	503
	15	0.1931	139
	16	0.1369	677
	17	0.1443	556
	18	0.1194	159
	19	0.1833	594
3/13	20	0.1026	529
	21	0.0967	454
	22	0.0660	535
	23	0.0796	426
	24	0.0377	504
	25	0.0642	318
	26	0.0094	38
	45	0.0500	521
8/13	27	0.2049	174
	28	0.1565	343
	29	0.1493	311
	30	0.1418	322
	31	0.1551	512
	32	0.0970	582
	33	0.0614	273
	34	0.1073	261
	35	0.0604	202
	36	0.1125	650
	37	0.0819	1062
	38	0.0726	418
	39	0.1063	394
	40	0.0523	617
	41	0.0964	507
	42	0.1072	627
	43	0.0574	549
	44	0.0273	521

of *Schoenoplectus lacustris, S. tabernaemontani, Cladium mariscus, Typha* sp., *Juncus* sp. or *Carex* spp. could have come from the lake shore, where there were patches of rushes. Their sparse presence in the samples may corroborate the theory that the island was well protected from water. In some of the lowermost samples, numerous oospores of *Chara* sp. as well as single fruits of *Najas marin*a were found (ESM 2). They probably came from aquatic habitats in the shallows of the lake where the island was built. The same situation was observed in lake shore settlements in the Zürich region, Switzerland (Behre and Jacomet 1991).

Cultural context: the role of plants

On the island at Nowy Dworek, remains of useful plants were recorded in all the levels. They are an important element in the discussion of the function of the site. Most of the 17 taxa represent cultivated plants and show the development of agriculture (ESM 2). Uncultivated plants which may have been gathered were also found, which in classic interpretation represent a supplementary source of food or medication (van Zeist 1991; Łuczaj and Szymański 2007). However, the important feature about our findings is that the island was recognized as an exceptional place for local people, leading us to search for botanical traces of potential spiritual aspects.

The most significant fact is the presence of numerous fruit stones of *Cerasus avium, C. vulgaris* and glumes of *Panicum miliaceum* (millet). In the early Middle Ages, millet was widely cultivated in Poland (Wasylikowa et al. 1991) as well as in the Ziemia Lubuska area (Koszałka 2012). Unfortunately, archaeobotanical data from this area are very scarce and it is difficult to compare the results from Nowy Dworek with those from nearby dry land sites. The situation such as in Nowy Dworek was also observed in the results from Żółte, where apart from charred remains of cereals, numerous waterlogged millet glumes were found (Pińska and Latałowa 2014). It is worth noting that millet was an important element of farming rituals, which were supposed to ensure a good harvest (Gieysztor 2006). Finds of cherries are quite common from other sites in Poland, but such a concentration of stones is rare. It confirms that various fruits of plants must have been deliberately brought to the island. We cannot exclude that they might have been used as food, but in the past, cherries were also used in fortune-telling (Ziółkowska 1983).

In the early Middle Ages, *Linum usitatissimum* provided food, medicines, textiles and also played an important role in the spiritual life of women, who used flax in courtship rituals (Wojciechowska 2000). Seeds and capsules of flax were found in the Nowy Dworek samples, as well as in those from Żółte (Pińska and Latałowa 2014), which suggests that whole plants were brought to the island. *Papaver*

somniferum, Cannabis sativa, Pastinaca sativa, Malus sp. and *Pyrus* sp. could also have served as kinds of offerings. The question is whether the apples or pears came from orchards or were collected from the wild.

During this period, folk medicine spread to folk magic (Skarżyński 1991). On the island, among the remains of wild plants, some taxa which were used for healing and with special significance in folk magic were also identified (Grieve 1971). An interesting one is *Origanum vulgare*, which was used for treating colds, indigestion or stomach upsets. However, the Slavs believed that the plant provided special protection to women and defended them against witches (Kluk 1808; Wijaczka 2007). *Agrimonia eupatoria, Calluna vulgaris, Centaurea scabiosa, Dianthus deltoides* and *Hypericum perforatum* were also brought to the island from dry land habitats, mostly pastures. They could have been used not only as medicine or sacrifice, but also as ornaments. Therefore, as remains of the perianths of common agrimony and heather were found in the samples, it is possible that—as in the case of flax—whole plants were gathered and brought to the island.

Each of the samples contained *Fragaria vesca* and *Rubus idaeus*. Frequent and numerous fruitstones of *R. caesius* were also noted. It seems that these plants were more widely available to local people than *Vaccinium myrtillus*, for example. All of them, including *Sambucus nigra* or *Corylus avellana*, are known as plants important to Slav people, and could have been gathered from local woods.

Livestock on the island

In the samples from trench 4–5/13, dung pellets of goats or sheep were found, and all 45, which were analysed, contained very well preserved pollen. A total of more than 80 taxa have been identified and the pollen concentration was between 8×10^4 and 55×10^5/g (Fig. 2). In the pollen spectra, a few prevailing taxa were found (*Alnus, Corylus avellana, Pinus sylvestris*, Apiaceae, Cichorioideae, *Artemisia, Urtica*, Cerealia) which amounted to 50–90% of total AP + NAP (AP—arboreal pollen, NAP—non arboreal pollen). A significantly higher percentage and concentration of a specific pollen type in pollen spectra from dung may result from the eating by the livestock of pollen-rich material such as floral parts. Apart from the predominant taxa, a wide variety of other pollen types was also found in small amounts. Most pollen spectra from dung pellets with a lower pollen concentration seem to show a wider taxonomic variety, as already indicated by Reinhard et al. (2006).

In our material, relatively abundant pollen of *Alnus, C. avellana* and *P. sylvestris* was found (Fig. 3, ESM 4). Hazel and alder start flowering very early in the year, even in February, and as they produce large amounts of pollen, this may be accidentally consumed by animals. However, their catkins are used as a direct source of food during periods when the overall amount of fresh food is scarce (Akeret et al. 1999). Therefore, they may have been part of animal fodder, especially as the presence of alder in the vicinity of the island has been confirmed by analysis of macroscopic remains. *P. sylvestris* is non-dietary type and its presence may be deemed accidental (Reinhard et al. 2006). Pine is an anemophilous tree producing very large amounts of pollen. During its flowering period in May, its pollen lands on various surfaces (grass, water, etc.), even far away from the origin tree. However, such high percentages of pollen grains (max 47–81%) in dung pellets from the island cannot be linked with animal food in the form of pine inflorescences. As indicated by the results of comparative studies from the modern farm at Biskupin, high occurrence of pine pollen, both its percentage and concentration, is a result of its abundant pollen dispersal on the day the dung was collected and the day before. Therefore, in the case of the Nowy Dworek dung pellets, the source of pine pollen may have been water, air or other plants covered with it rather than the eating of pine inflorescences by the livestock.

The occurrence of *Tilia* pollen in fossil dung pellets from Nowy Dworek is scarce (max 0.4%). As the comparative results from Biskupin indicate, lime, which is insect-pollinated, is also scarcely present in animal dung, despite the numerous trees close to the examined area. The greatest abundance in those materials was found in November (2.4%), but not in July (0–0.4%) when lime was flowering heavily. An abundant presence of lime pollen would be possible if livestock were fed with the dry leaves (Akeret et al. 1999). In Biskupin, therefore, the lime pollen is likely to have been accidentally brought in with fodder from the area when lime was in flower. The same could have taken place in Nowy Dworek in the Middle Ages.

Most herbaceous plants flower in summer and autumn and they could have been deliberately consumed by animals as they grazed or given to them in the form of fodder (Apiaceae, Cichorioideae, *Artemisia, Urtica*, Brassicaceae, *Filipendula*, Poaceae, Chenopodiaceae). In the dung pellets with an absolute predominance of *Artemisia* or *Corylus*, apart from pollen grains typical of these taxa, pollen aggregates and pollen grains of varying degrees of ripeness were observed. This indicates that the livestock was fed with flowering twigs of *C. avellana* and with flowering *Artemisia* (Delhon et al. 2008).

In a few cases, pollen of plants characteristic of different seasons occurred together, as in the case mentioned above with *C. avellana* flowering in early spring found together with *Artemisia* which flowers in late summer and autumn (Fig. 3). This may be assumed to result from the feeding of livestock with dry fodder in periods when fresh food was scarce or unavailable, such as at the end of winter and the beginning of spring. But we must remember that catkins

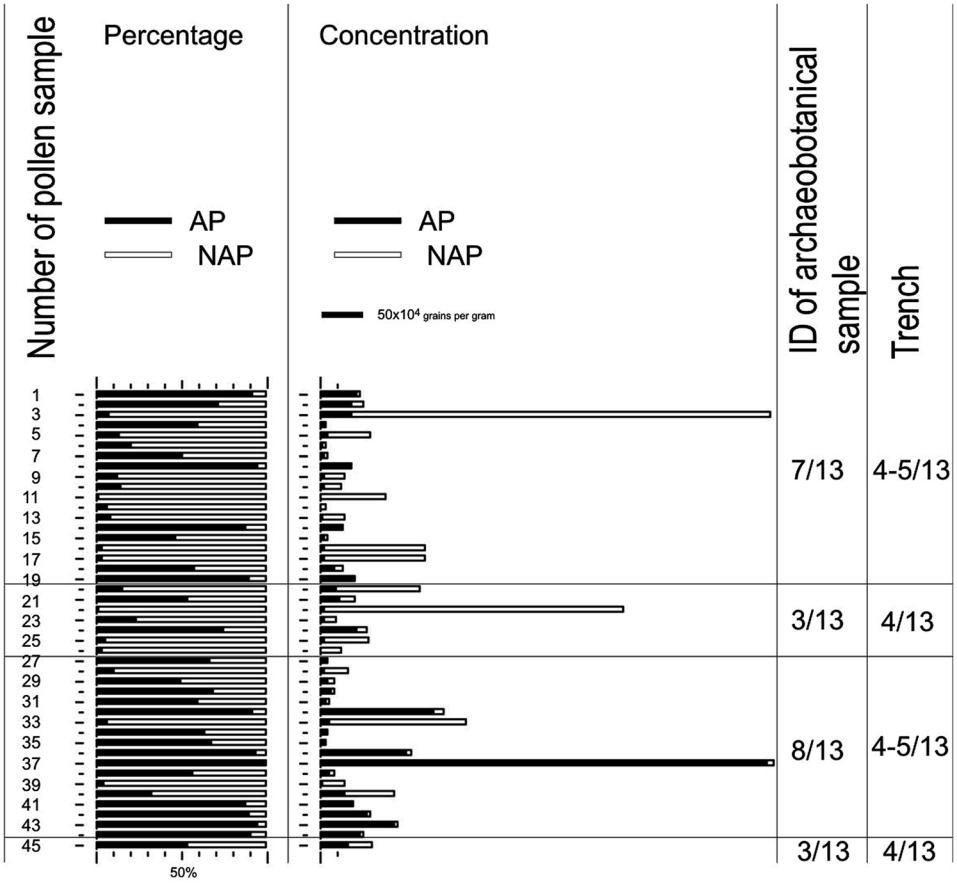

Fig. 2 Nowy Dworek. Pollen percentage and concentration summary diagrams

containing pollen occur as early as autumn (Akeret et al. 1999).

The presence of *Urtica* in dung is interesting. Nettle pollen was found both in fossil materials from Nowy Dworek and present-day animal dung pellets from Biskupin. In a few samples their percentage was from 10 to 87% (Fig. 3). This plant is a valuable source of food, but because of its rough leaves with stinging hairs, it is generally avoided by grazing animals when growing. It is eagerly consumed, but in a processed form like hay and silage, as well as after wilting or freezing (Hejcman et al. 2013). Therefore, the nettle pollen in the dung pellets from Nowy Dworek could have been delivered with dry fodder. Analysis of macroscopic remains indicates that nettle was locally available.

Among the macroscopic remains in the samples in which dung pellets were found, apart from traces of meadow plants which might have been part of fodder, fragments of *Fagus sylvatica, Quercus* sp. fruits and *Pteridium aquilinum* leaves were found. The first two might have been used as fodder, although fruits of beech and oak were more often fed to pigs. The presence of bracken, a fern rather avoided by animals, might be connected with a type of animal bedding, although in some situations, shredded dried leaves mixed with straw or hay were given to horses during winter. It is worth remembering that this fern was and still is thought to have magical qualities (Cunningham 1985; Madeja et al. 2009). All three taxa also appear in the pollen and spore spectra of the dung pellets, but their occurrence is low (Fig. 3).

Summary and conclusions

The small, artificial island in the lake Paklicko Wielkie, Nowy Dworek, has been defined by archaeological studies to be a Slavic socio-cultural centre, with a number of functions, religious ones included. This is supported by the site location, the island's unique construction and traces of animal offerings around the site, among other evidence. The bridge connection from the island to the settlement is also important. Although the archaeobotanical examination described here covers only the small, central part of the island, the results are quite surprising, with large assemblages of plant remains preserved in organic deposits. The set of plant remains from each of the archaeological levels had a complex origin and represents various habitats in the vicinity of the island (ESM 3, ESM 4 sum). The analysis revealed a significant concentration of both cultivated and collected plants which had been brought to the island

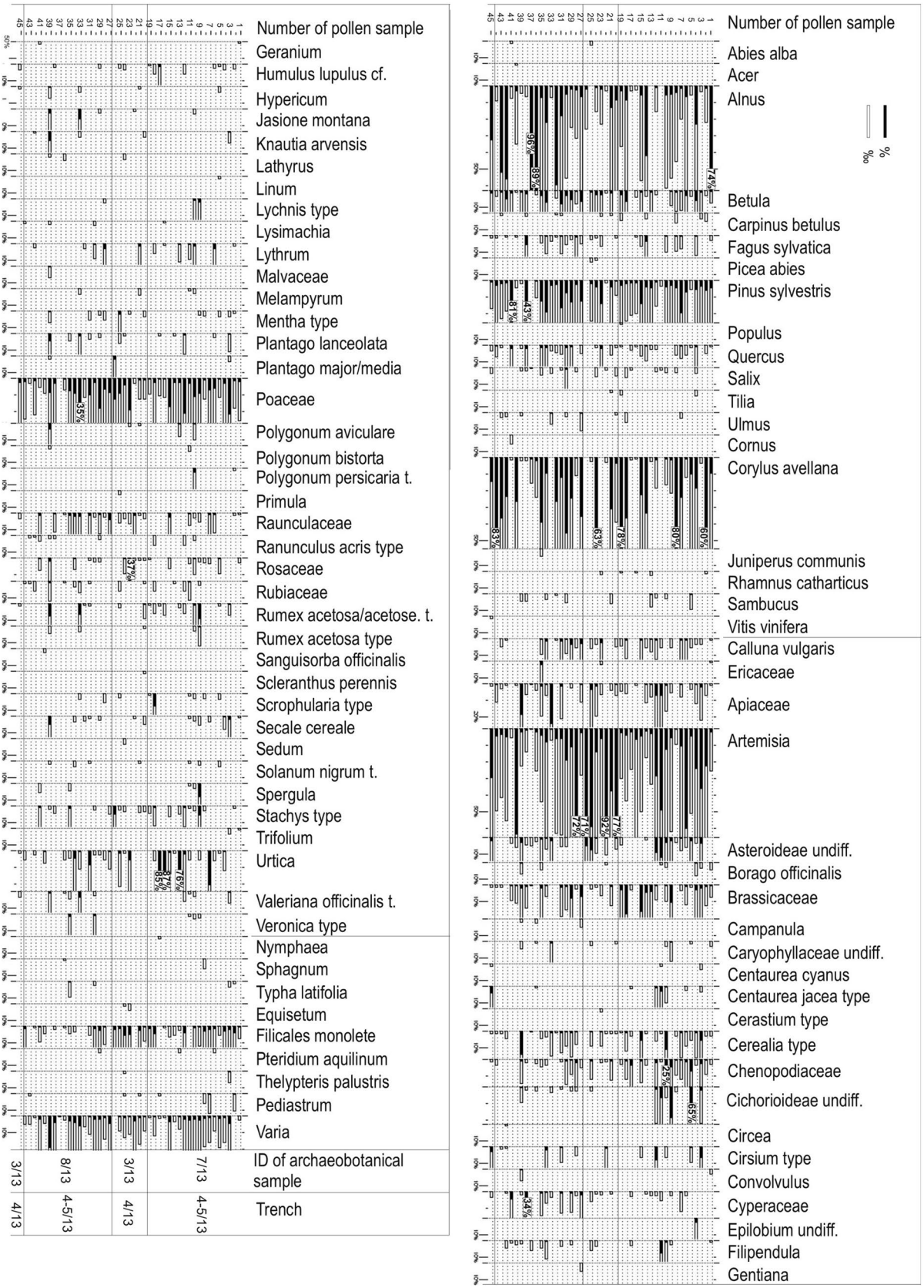

Fig. 3 Nowy Dworek. Complete pollen percentage diagram

deliberately. The archaeobotanical data presented in this paper allow us to draw certain conclusions.

- In the 9th and 10th centuries AD, the local vegetation around the lake developed under strong human influence. Most of the remains are from ruderal plants, which colonized the disturbed areas. Plants in this group may have formed communities in and around the settlement located on the lake shore. As a result of human activity, cleared areas rich in nutrients may have developed around the site. Sediments from these places were used to build and strengthen the island. This suggests that local people were ingenious and practical. The island must have been something important to them. The structure was prepared with great care, well protected from water, as remains of aquatic or wetland plants were scarce.
- The presence of crops and their segetal weeds suggests the importance of agriculture for local people. The basic cereal was millet, but rye or wheat may also have been grown, since pollen of *Secale cereale* and Cerealia-type is recorded in the pollen diagram from the lake sediments and also from the dung pellets. Flax cultivation near Nowy Dworek is certain.
- Local woodland provided building materials as well as food and medicines. We may assume that the woodland was reduced by clearance and the newly open land cultivated or used as pastures.
- The magical aspect of the island is corroborated by the presence of groups of plants formerly used in folk medicine and religious rituals such as farming ceremonies. Cherries, millet, flax as well as gathered fruits or herbs could have been brought to the island as offerings. Not only seeds or fruits were used, but also the whole plants.
- Animals were definitely present on the island in Nowy Dworek. Our results indicate that the dung pellets are from various vegetative seasons. This is proved by the presence of predominant pollen taxa from plants which flower at different times of the year. It seems that the main fresh or dry fodder ingredient was herbaceous plants, perhaps with leaves and flowering twigs from trees as well. It may be assumed that fodder ingredients depended on the season during which the animals stayed on the island.
- On the basis of our results to date, it is difficult to estimate how long the animals stayed on the island. Was it a short stay, perhaps as part of a cult which may have involved animal offerings? Or were the animals brought to the island to be protected and fed? The former seems more likely, because their prolonged stay on the island would have left clearer traces. The nearly complete absence of livestock bones on the island suggests that the animals, once killed, could have been eaten somewhere else, away from the island.

The conclusions above validate archaeobotanical results, both from pollen and macro remains, as a good tool to support archaeological interpretations concerning a special site like this early medieval lake island. Although the plant composition from the island at Nowy Dworek results from selected human activities in the past, archaeobotanical data can express the nature of plant communities which developed around the site. The selective group of plants with magical importance give us certainty that the island in Nowy Dworek was a special place for the local population. The kind(s) of ritual practices remain an open question, but they may have been connected with farming or protection.

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