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Social status and diet. Reconstruction of diet of individuals buried in some early medieval chamber graves from Poland by carbon and nitrogen stable isotopes analysis

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ABSTRACT

The study presents results of the investigations of diet based on carbon and nitrogen stable isotope ratios ($\delta^{13}C$ and $\delta^{15}N$) of the bone collagen of individuals buried in medieval elite chamber graves from the territory of the state of the first Piasts, Poland (the second half of the 10th and the first half of the 11th century). The aim of the research was to determine the diet of individuals buried in such funerary structures, to compare this with commoners buried in ordinary graves, and investigate any sex-related patterns. Rib bone samples were taken from individuals buried in chamber graves at Bodzia, Dziekanowice, Pień and Sowinki. Results indicate that the elite male diet was based on C_3 plants with possible contribution of some C_4 plants (millet) and substantial consumption of animal proteins including fish. The bone collagen $\delta^{13}C$ and $\delta^{15}N$ of male chamber burials suggested consumption of higher trophic level foodstuffs (meat and fish) whilst the female diet, and that of the juveniles, was similar to the commoners in the rest of the population.

1. Introduction

Access and entitlement to nutrition is often closely linked to social status within a population and can be determined by various factors. These include the location of residence which can determine the availability and seasonal variations of a given type of food as well as the effect of cultural customs, religious orders and prohibitions, sex and age, social status and a specific way of life, e.g. monastic brethren. The relationship between diet and social status is based primarily on the fact that certain types of food, such as for example meat and other animal products, are more nutritious and more valued than others, and access to them is not equal for everyone in a given society (Mays, 2010; Sen, 1981). Where artefactual, historical and archaeological evidence exists for the availability of foodstuffs, the direct evidence from the tissues of the individuals who lived in a particular period, place and population group can enrich our understanding of the dietary choices they made (Lee-Thorp, 2008).

The purpose of the study was to investigate diet of individuals buried in chamber graves, which are considered to contain representatives of the social elite from the area of the state of the First Piasts, from which the contemporary Polish state arose. The research aimed to determine what foods were consumed by individuals buried in this type of elite grave, how this compared with the diet of other groups in the population and if there were any sex-related differences. We also aimed to establish whether, due to the influence of Christianity, fish were an important component of the diet of these individuals. To obtain information about the diet, we used the analysis of stable isotopes of carbon and nitrogen in bone collagen.

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1.1. The early Piast state and the burial customs

The early Piast monarchy covers the period from the second half of the 10th century until the 30 s of the 11th, when the state experienced crisis and collapse. These rulers were Mieszko I, Boleslaus the Brave and Mieszko II (Bubczyk, 2011; Wyrozumski, 1999). The Piasts, ruling originally over the tribe of Polanie living on the middle Warta river in Greater Poland region, managed to extend their power to neighbouring territories by conquest and marriage alliances. Generally, the power of the Piasts extended to the lands located in the basin of the Oder and Vistula rivers (comprising such regions as Greater Poland, Lesser Poland, Kuyavia, Masovia, Silesia, Eastern Pomerania and temporarily Western Pomerania), although it changed over time (Fig. 1). It is commonly agreed that the Piasts were a ruling dynasty of local, Slavic origin. There have been also suggestions that the Piast dynasty and Mieszko I came from Scandinavia, however, there is no convincing evidence for this (Buko, 2008).

The consolidation of the Piast state is marked by the construction of characteristic strongholds with ramparts built of logs, stones and earth in a grate construction, additionally strengthened with hooks. The oldest forts of this type, based on dendrochronological dating, were built in the third and fourth decade of the 10th century in Greater Poland (e.g. Grzybowo 915–922, Ostrów Lednicki 930–940, Poznań after 940, Gniezno 940), (Urbańczyk, 2012). The Piasts accumulated the funds needed for creating a state organization and building central administrative strongholds probably from robberies and the fur and slave trade. In 966, Mieszko I was baptized, married the Bohemian princess Dobrawa (Dubravka) and began the Christian conversion of the country. His son, Boleslaus the Brave was crowned in 1025 and became the first king of Poland. Boleslaus strove to incorporate more territories by undertaking military campaigns to the neighbouring lands, fighting several wars with the Germanic Holy Roman Empire, Bohemia and Kievan Rus'. He was succeeded by one of his sons, Mieszko II Lambert, who initially continued his father's policy. However, the early state was not able to bear such a huge organizational and military effort. Therefore, during his reign, there were power struggles, the fall of the monarchy (in 1031 Mieszko II was driven out from the country), invasion by neighbouring states and a pagan reaction to Christianity, in the third decade of the 11th century. Mieszko's son, Casimir the Restorer, with the support of the rulers of Germany (Henry II) and Kievan Rus' (Yaroslav the Wise), was brought to power in 1039 and was able to rebuild state structures from scratch (Bubczyk, 2011; Buko, 2008; Wyrozumski, 1999).

In the pre-Christian period, cremation was the dominant burial rite in the Polish lands where the Piast state was later established. The dead were burned at the stake, their remains put into an urn and buried in the ground or placed on top of small earthen mounds. Sometimes grave goods were deposited with the deceased, mostly in the form of ornaments and everyday items, such as knives. With the adoption of Christianity, inhumation began to spread in the second half of the 10th century. The dead were interred in an upright position with arms stretched alongside the body and were buried in pit graves dug in the earth. The burials were mostly arranged in rows and oriented east–west. At the beginning of the functioning of row cemeteries in the Polish lands, men were buried with their faces turned towards west, and women to east. In addition, the deceased were equipped with numerous and rich funeral goods in the form of ornaments, everyday objects, weapons, and clay and wooden vessels. With time, all the deceased, regardless of sex, were placed with their faces in the eastern direction, which was regarded as sacred to Christians, and grave goods became rare. Around the middle of the 12th century, cemeteries previously located in the fields away from settlements began to be located near churches to create graveyards (Buko, 2008). With the beginning of Christianity,

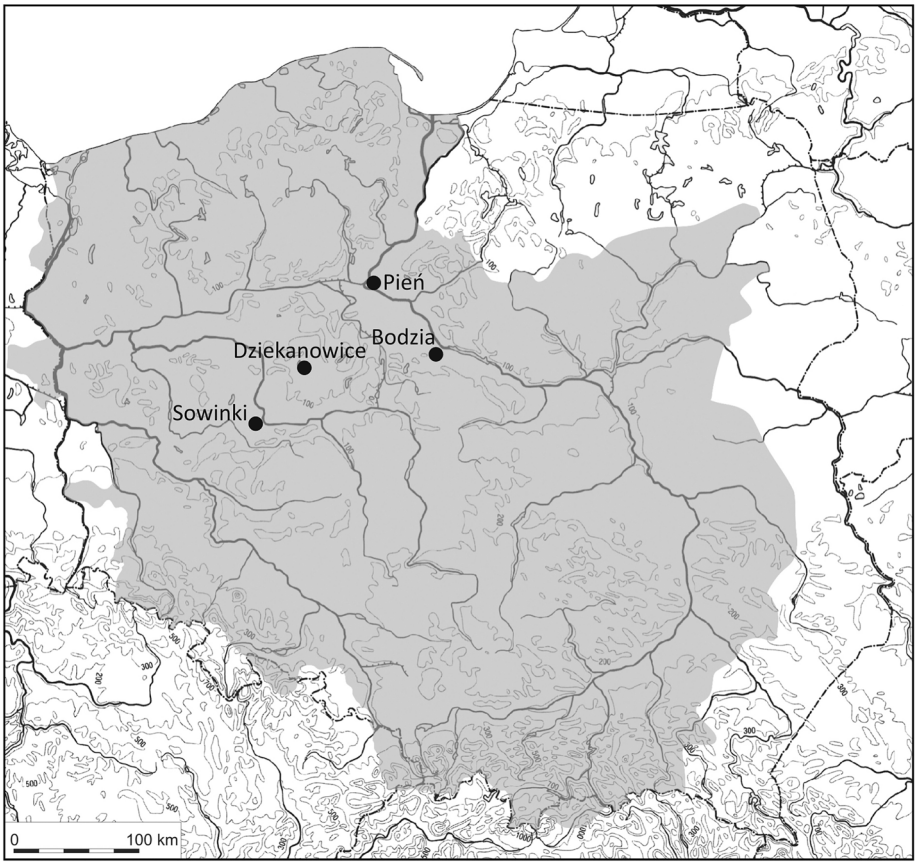

Fig. 1. The location of cemeteries with chamber graves in the area of the state of the first Piasts from the 10th–11th centuries analyzed in the text (map after Bajka, Florek, Kotowicz, 2016, compiled by B. Bednarczyk).

representatives of the Piast dynasty began to be buried within the first churches. Some burials in stone tombs have been identified: e.g. from the stronghold church in Ostrów Lednicki and the palace chapel and cathedral in Poznań (alleged burials of the first historical Piast rulers, prince Mieszko I and his son, king Boleslaus the Brave), (Górecki, 2001; Kara, 2015; Kurnatowska and Wyrwa, 2016).

In early medieval cemeteries were also present graves with a specific structure known as chamber graves. They consisted of a timber construction having walls, a roof and a floor, covered with earthen barrows or wooden "houses of the dead" (Błaszczyk, 2017; Janowski, 2015; Müller-Wille, 2015). In addition to the imposing grave structure made of wood, they were often characterized by rich funerary furnishings with luxury items, often made of valuable materials. The individuals buried within them were accompanied by silver jewellery such as temple rings, earrings, rings, necklaces made of glass, carnelian and rock crystal beads, everyday objects such as iron knives in leather sheaths (often decorated with stylized images of a viper or a dragon) and weapons such as swords, as well as clay vessels, wooden buckets often covered with decorated metal sheets, and bronze bowls. In some cases, burials in such graves were placed in wooden coffins with metal tape-shaped fittings (Błaszczyk, 2016; 2017; Janowski, 2011; 2015; see also Biermann, 2008).

Until recently, early medieval chamber graves discovered in the area of Polish lands were interpreted by many researchers as burials of Scandinavians – warriors, members of the prince's retinue of the first Piasts as well as merchants and their families (e.g. Chudziak, 2001; 2002; 2003). Currently, based on newer investigations and interpretations, it is assumed that they were mostly the burials of local, Slavic state elites of the Piast monarchy (Błaszczyk, 2016; 2017; Gardeła, 2014; 2016; Janowski, 2011; 2015; Sikora, 2010; 2013). Some information about individuals buried in early medieval cemeteries in ordinary pit as well as timber chamber graves has been provided by recent DNA and stable strontium isotope analyses. So far, they have been carried out for the cemeteries at Bodzia (Bogdanowicz et al., 2015; Price and Frei, 2015), Ciepłe (Bełka et al., 2019; Doan et al., 2019), Kałdus (Płoszaj et al., 2020) and Pień (Błaszczyk, 2020c; Płoszaj et al., 2017). Showing that part of them represented local, Slavic population, sometimes also moving between regions, and some could be possibly newcomers, such as the three men buried in chamber graves in the cemetery at Ciepłe, who probably came from Scandinavia, more specifically from Denmark (about the diet of these individuals see Reitsema and Błaszczyk, 2019).

1.2. Diet in medieval Poland

Research based primarily on plant and animal remains concluded that the basic foodstuffs of people living in the Polish lands during the early Middle Ages were cereals, vegetables, fruit and various animal products. Among the cereals grown were wheat, rye, barley and millet consumed in the form of bread, porridge, groats, soups and beer. The consumption of millet was common, especially in the earlier periods of the early Middle Ages (the 10th–11th centuries and earlier), which is confirmed by archaeological finds (grains of millet, chaff, prints on clay pots), written texts (especially by Arab authors) and published isotopic analysis of human bone collagen (Reitsema, 2012; Reitsema et al., 2010). In contrast, in early medieval Western Europe (e.g. Britain, Germany, Netherlands) as well as Scandinavia, millet was absent from the human diet (Randsborg, 1985; Richards et al., 2006; Schutkowski et al., 1999). A range of fruits and vegetables were grown and consumed, for example peas, broad beans, lentils, carrots, beets, swedes, cucumbers, radishes, onions, cabbages as well as cherries, apples, plums, pears and peaches (Dembińska, 1999; Lityńska-Zając and Nalepka, 2008). The remains of pigs dominate the archaeological midden contexts, but cattle, sheep, goats and horses were also bred. Eggs, milk and dairy products such as cheese were consumed (Dembińska, 1999; Iwaszczuk, 2014). In addition to remains of domesticated animals at archaeological sites from the period the remains of wild animals and fish are also found, although their frequency is relatively small. These non-domestic remains were more common in the strongholds inhabited by elite members than in settlements peopled by commoners (Grężak and Kurach, 1996; Makowiecki, 2003). Bones of wild animals recovered from medieval sites include elk, hare, aurochs, bear, red and roe deer (Reitsema, 2012; see also Makowiecki 2006). Bird bones account for 0.5 – 8.0% of total archaeozoological remains in early medieval Polish sites. Of these, 85% are domestic birds - hens, ducks and geese (Reitsema, 2012).

Historical and archaeological sources show that the fish species which were eaten included herring, cod fish, salmon, trout, sea trout, whitefish, perch, pike, catfish, carp, bream, roach, tench, eel, sturgeon and crayfish (Dembińska, 1999; Makowiecki, 2001). Some species were more available for members of higher social strata than for lower ones, e.g. sturgeon, eel, pike, zander and catfish (Dembińska, 1999). Presence of fish in the diet is also confirmed by the results of published human bone collagen isotopic studies (Reitsema, 2012; Reitsema et al., 2010; Reitsema and Błaszczyk, 2019). Water, beer and mead were commonly consumed and elites had access to wine. Beer was made from cereals including barley, wheat and millet (Dembińska, 1999; Reitsema et al., 2015).

During the Middle Ages, the diet was subject to some changes related to the wider distribution of some crops and the breeding of domestic animals as well as development of new methods of agriculture and food processing. The cuisine was varied and differed between the higher and lower social strata. One of the most prestigious and valued foods was meat. Ordinary people ate mainly meat from domesticated animals, while the consumption of venison and fish was widespread among the elites. An important factor influencing the diet in the early Middle Ages were the numerous fasting days imposed by Christianity, limiting the type of food consumed (in Poland after 966 CE). On fast days animal products were prohibited, including meat, eggs and dairy products, but excluding fish (Dembińska, 1999; Reitsema et al., 2015).

1.3. Dietary reconstruction using collagen $\delta^{13}C$ and $\delta^{15}N$

Indirect methods for estimating the diet of a population are based on archaeological data (plant and animal remains unearthed during excavations) and written historical records. Information obtained from these data determine the nutritional potential rather than the actual diet of individual people and groups. There are many studies which demonstrate that bone and dentine collagen contains amino acids incorporated from the protein element of the diet of an individual during growth of the tissues. The stable isotope carbon and nitrogen ratios ($\delta^{13}C$ and $\delta^{15}N$) of the food sources are reflected in the newly-formed collagen with a trophic level shift from food consumed. Thus, the analyses of stable isotope ratios present in the bone and dentine collagen of animals and humans are a direct method of determining the main sources of protein consumed (Ambrose and Norr, 1993; Lee-Thorp, Sealy and van der Merwe, 1989; Tieszen and Fagre, 1993). This change in $\delta^{13}C$ and $\delta^{15}N$ has been employed as a means for estimating the trophic level and type of food ingested by humans especially where faunal bone is available, and can successfully distinguish between marine and terrestrial protein, as well as discriminating between plants with different photosynthetic pathways (C_3, C_4 and CAM type plants). For a review of the development of the isotopic dietary evidence, see Lee-Thorp (2008). This can help to illuminate such features of life-history as migration (Beaumont et al., 2013), access to famine relief foods (Beaumont and Montgomery, 2016), and entitlement to a diet rich in high-status foods (Müldner and Hedges, 2007). Recent publications have shown that there may be an effect on $\delta^{15}N$ (and to a lesser extent $\delta^{13}C$) from chronic nutritional distress (Beaumont and Montgomery, 2016; Redfern et al., 2019), which will be also considered in this study.

2. The sites

For this study bone samples were taken from individuals buried in chamber graves in cemeteries at Bodzia, Dziekanowice, Pień and Sowinki. These cemeteries were located in the core of the state of the first Piasts (Dziekanowice and Sowinki) and along the Vistula river which played a role of a main communication and transport route (Bodzia and Pień), (Fig. 1). The chronology of cemeteries and chamber graves was established based on the typology of artefacts, coins and radiocarbon dates.

Dziekanowice are situated in the Greater Poland region on the eastern shore of the Lake Lednica. During the early Middle Ages, a stronghold with an open settlement existed on the island of the lake connected to land by two wooden bridges. A residential complex consisted of, among other buildings, a stone palace connected with a round chapel, and a rectangular church with a stone or wood on stone foundation (Górecki, 2001; Kurnatowska and Wyrwa, 2016). On the bank of the lake, near one of the bridges, a large inhumation cemetery (site 22) was in use from the second half of the 10th century to the beginning of the 13th century (Wrzesiński, 2012; Wrzesińska and Wrzesiński, 2016). As a result of conducted excavations a total of 1,665 graves with 1,730 burials were identified (Wrzesiński, 2016). Among them 6 chamber graves were recorded (graves number I, II, 20, 60, 61, 62) containing the remains of 1 child, 2 adult females and 3 adult males (Fig. 2). Based primarily on radiocarbon dating and on funerary furnishings, these graves can be dated to the second half of the 10th century and the first half of the 11th century (Wrzesińska and Wrzesiński, 2016). The burials had timber chambers built in log construction surrounded by rectangular ditches with the deceased deposited in wooden coffins with iron band ferrules. Among grave goods were found iron knives in leather sheaths, a phyllite whetstone, a necklace consisting of kaptorgas (capsule amulets) and a cross-shaped pendant of the Hiddensee type as well as a coin of Otton and Adelaide (around 1020 CE), (Wrzesińska and Wrzesiński, 2016).

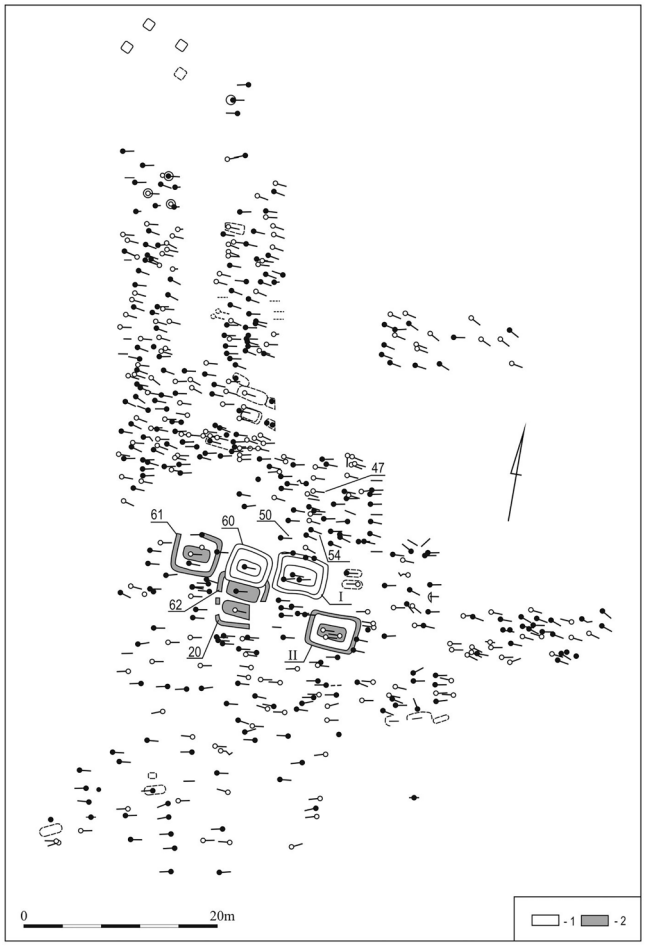

Fig. 2. The plan of the north-eastern part of the cemetery in Dzekanowice, site 22 (the Graeter Poland region): 1 – not sampled graves, 2 – sampled graves (II, 20, 61, 62), (after Wrzesińska and Wrzesiński, 2016 with modifications, prepared by B. Bednarczyk).

Also located in the Greater Poland region on the Warta river are Sowinki (site 23A), (Krzyszowski, 1992; 1995). During the excavations 150 inhumation graves with 158 interments were excavated, two of which were certain chamber graves (graves no. 148 and 151) and one can be regarded as a probable chamber grave (grave no. 70). All of them contained probably the remains of adult males, (Fig. 3). The period of use of the cemetery at Sowinki was determined to be from the second half of the 10th to the first half of the 12th century, whereby chamber graves, taking into consideration their grave goods and ^{14}C dates, can be dated to the second half of the 10th to the first half of the 11th century (Krzyszowski and Błaszczyk, 2016; Michalska and Krzyszowski, 2017). Chamber graves at Sowinki were built of timber in log construction and equipped with numerous and rich funerary grave goods, including among others iron knives in leather sheaths, a whetstone, stave buckets, iron spurs, an iron spearhead and a silver Arabic dirham of the Samanid dynasty (about 950–976), (Krzyszowski, 1992; 1995; 1997).

Bodzia (site 1) is located in the Kuyavia region about 9 km from the modern left bank of the Vistula river (Buko et al., 2013; Buko, 2015). As a result of the excavations, 52 graves containing 55 burials were discovered, most of which have a form of a chamber grave (Fig. 4). Based on the typology of items found in graves, coins and radiocarbon dates the period of use of this cemetery was determined from the second half of the 10th century to the end of the 11th or first half of the 12th century (Krąpiec, 2015; Buko and Kara, 2015; Goslar, 2015). Grave D162 contained skeletal remains of a male and grave E864/II of a female. Both graves can be dated to the end of the 10th or the beginning of the 11th century. Chamber graves at Bodzia were also probably built in log construction and surrounded by rectangular ditches. A man buried in grave D162 was accompanied by an iron knife and two silver coins. A woman from grave E864/II was provided, among others, with necklace of glass and silver beads, two fingerings, a stave bucket and fourteen coins (Buko et al., 2013; Buko, 2015).

Further north on the Vistula River, in Eastern Pomerania, in a region called the Chełmno land was located a settlement complex in Pień consisting of a stronghold, several open settlements and a cemetery (site 9) functioning from the middle of the 10th to the 12th century (Poliński, 2020). The cemetery was partially excavated and yielded 61 modern inhumation graves, 10 early medieval chamber graves (graves 15, 32, 37, 38, 39, 40, 49, 57, 69, 71) and a grave of a horse (grave 70), (Fig. 5). They contained interments of 1 adult male, 2 adult females and 7 children buried, according to the typology of grave goods and radiocarbon dates, in the second half of the 10th and the first half of the 11th century (Błaszczyk, 2020a). All graves were built of timber in log construction and one of them (grave no. 40) was surrounded by a rectangular ditch. Among others they were furnished with an decorated axe, a whetstone, iron knives, jewellery (temple rings and necklaces of beads and kaptorgas), silk textiles as well as ceramic vessels and stave buckets (Błaszczyk, 2020b; Janowski, 2013).

3. Materials and methods

Rib samples were taken from 18 individuals buried in early medieval chamber graves from the territory of the state of the first Piasts dynasty, representing 4 adult males, 4 adult females, 7 children and 3 individuals of undetermined sex but taking into account grave goods, they were

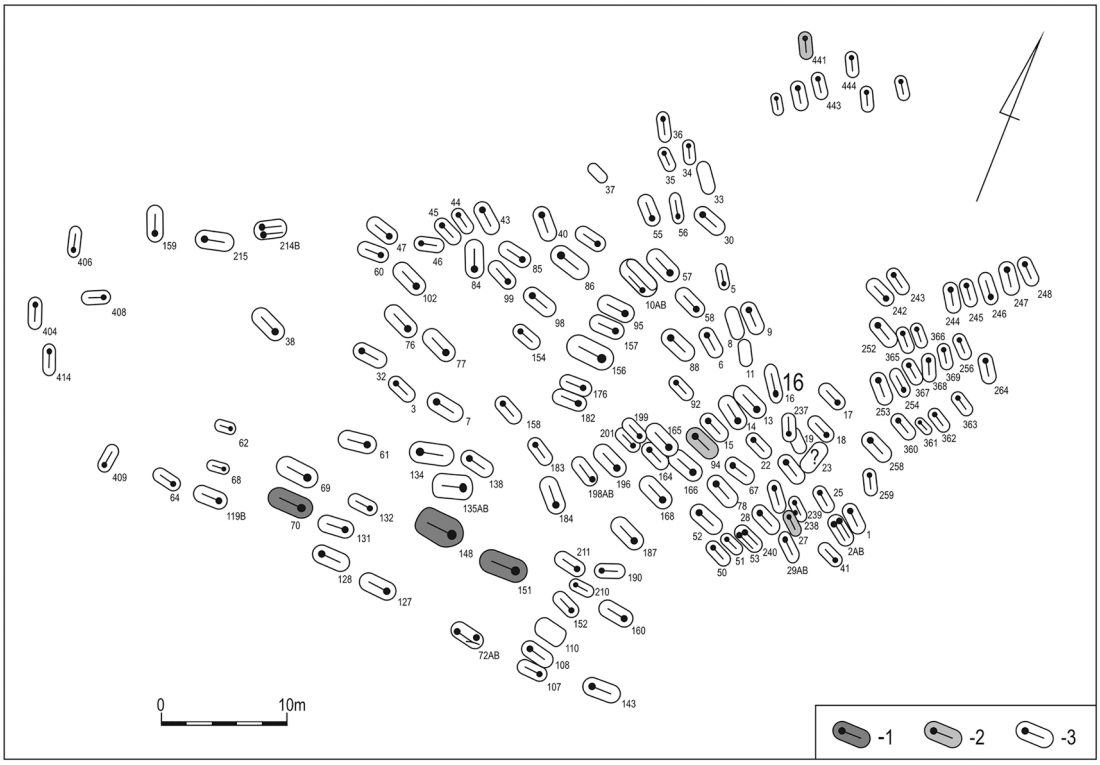

Fig. 3. The plan of the cemetery in Sowinki, site 23A (the Graeter Poland region): 1- sampled chamber graves (70, 148 and 151), 2 – sampled ordinary graves, 3 – other not sampled graves (after Krzyszowski, 1995 with modifications, prepared by B. Bednarczyk).

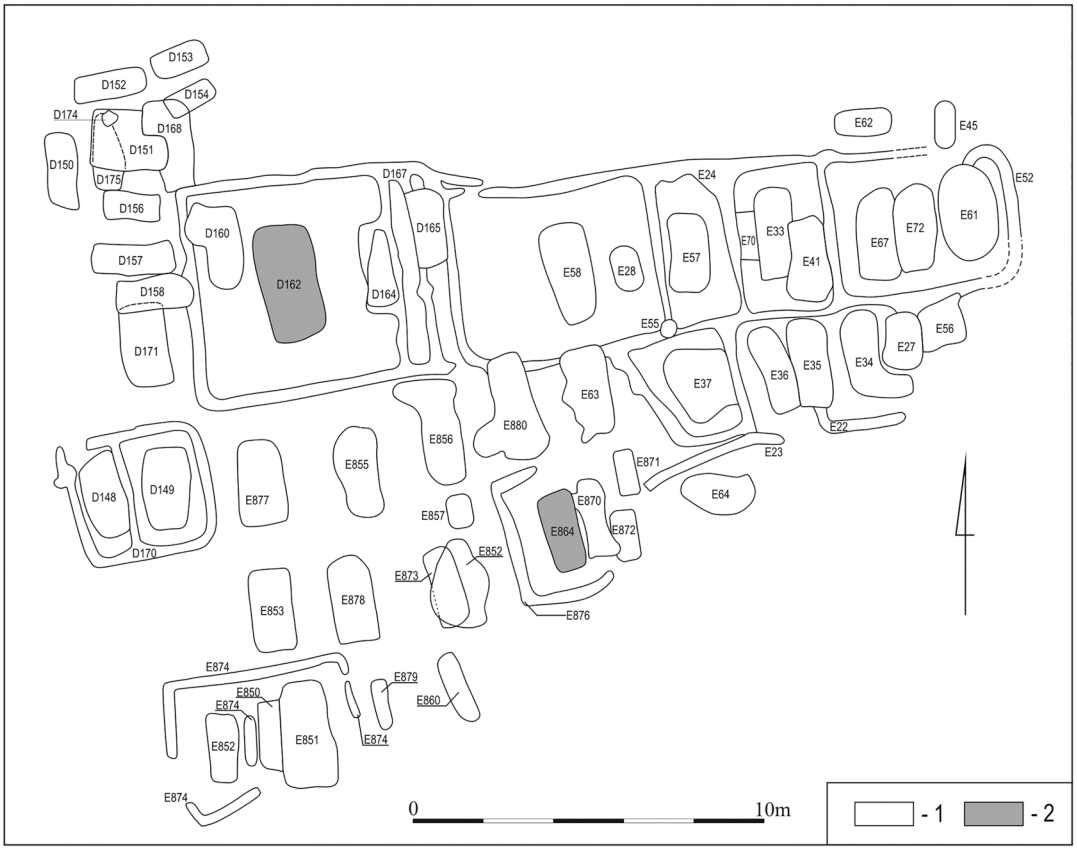

Fig. 4. The plan of the cemetery in Bodzia, site 1 (the Kuyavia region): 1 – not sampled graves, 2 – sampled chamber graves (D162 and E864/II), (after Müller-Wille, 2015 with modifications, prepared by B. Bednarczyk).

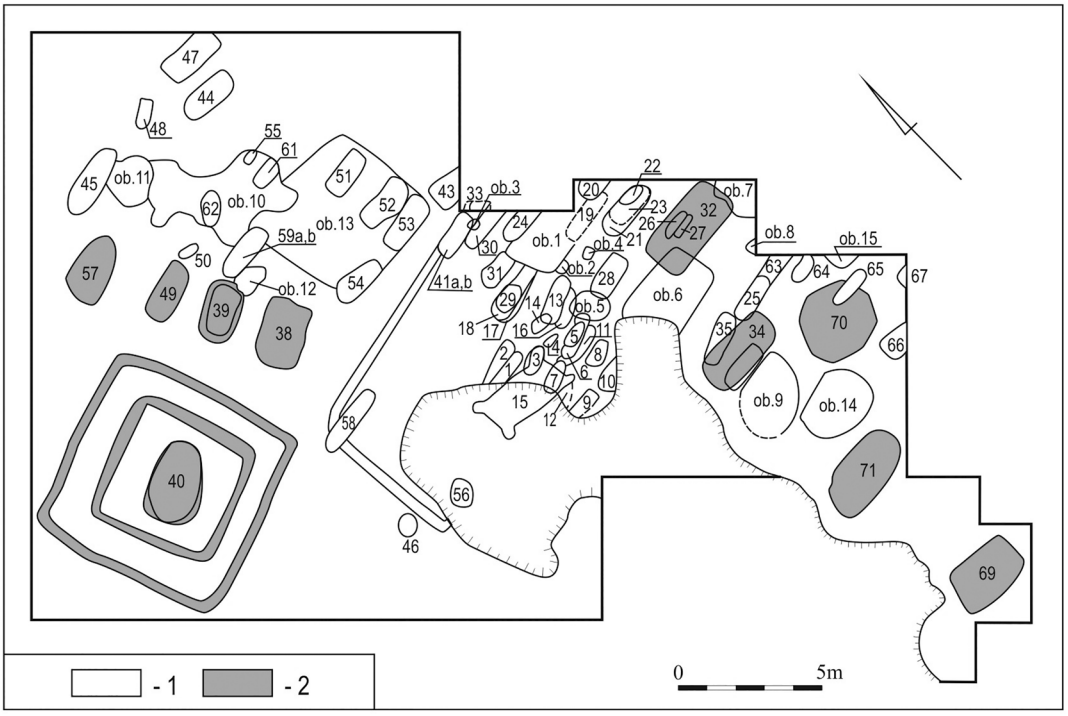

Fig. 5. The plan of the cemetery in Pień, site 9 (the Chełmno land region): 1 - not sampled graves, 2 – sampled chamber graves (32, 37, 38, 39, 40, 49, 57, 69, 70, 71), (after Poliński, ed. 2020 with modifications, prepared by B. Bednarczyk).

probably men (Table 2). The samples were taken from the remains unearthed at the cemeteries at Bodzia, Dziekanowice,Pień and Sowinki (Fig. 1, Table 2).[1] Sampled individuals belonged to age categories from *infans I* to *maturus* (*infans I* 0–6 years – 6 individuals, *infans II* 7–14 years – 1 individual, *juvenis* 15–22 years – 3 individuals, *adultus* 23–35 years – 4 individuals, *maturus* 35–55 years – 4 individuals; according to Malinowski, 1989). Additionally, samples were taken from skeletons of 6 individuals buried in ordinary pit graves at Dziekanowice (3 individuals – 2 males and 1 female) and Sowinki (3 individuals – 2 males, 1 – undetermined sex) dated to the 11th and 12th centuries (Table 3).

$\delta^{13}C$ and $\delta^{15}N$ values were also measured in bone collagen of 9 animals and 2 fish (a scale and a bone) discovered at the sites in Bodzia (3 samples – pig, sheep/goat, cattle), Dziekanowice (4 samples – cattle, pig and 2 unspecified species of freshwater fish), Pień (2 samples – pig, horse) and Mosina located near Sowinki (2 samples – pig, hen), (Table 4). The animal bones were excavated from features dated to the early medieval period in Bodzia, Dziekanowice, Pień (the 10th – 13th century) and in Mosina from the late medieval period (the 14th – 15th century)[2].

As a comparative material from the Polish lands were used the results of bone collagen $\delta^{15}N$ and $\delta^{13}C$ from early Middle Ages from Giecz site 4, 11^{th} – 12^{th} centuries (Reitsema, 2012; Reitsema et al., 2010), Kałdus site 4, 10^{th} – 11^{th} centuries (Reitsema, 2012; Reitsema and Kozłowski, 2010; Reitsema et al., 2017), Kałdus site 1, 12^{th} – 13^{th} centuries (Reitsema, 2012; Reitsema et al., 2017) and Gruczno site 1, 12^{th} century (Reitsema, 2012; Reitsema et al., 2017) as well as the late Middle Ages from Gruczno site 2, 13^{th} – 14^{th} centuries (Reitsema, 2012; Reitsema et al., 2017). Moreover, data from the elites of the Polish-Lithuanian Commonwealth, 17^{th} – 18^{th} centuries (Reitsema et al., 2015) as well as from Viking Age Birka, Sweden (Linderholm et al., 2008) and early Iron Age cemetery in Magdalenska Gora, Slovenia (Murray and Schoeninger, 1988) were used for reference (Table 1).

Individuals buried in the cemeteries from the older phases of the early Middle Ages in Kałdus site 4 and Giecz consumed C_3 plants with the share of C_4 plants and animal products with a certain contribution of anadromous or marine fish in the case of Kałdus site 4 and freshwater in relation to Giecz. The diet of people buried in the cemeteries from the younger phases of the early Middle Ages and from the late Middle Ages

Table 1
Values of $\delta^{15}N$ and $\delta^{13}C$ in bone collagen of selected comparative human populations.

Site	Samples	$\delta^{13}C_{VPDB}$ (‰)	Mean ‰	$\delta^{15}N_{AIR}$ (‰)	Mean ‰
Giecz, site 4	24	−18.0 – −19.4	−18.9 ± 0.4	7.9 – 10.0	9.2 ± 0.6
Kałdus, site 4	33	−20.3 –−16.3	−18.6 ± 0.9	8.7 – 11.9	10.1 ± 0.7
Kałdus, site 1	30	−20.5 – −18.7	−19.5 ± 0.4	8.7 – 11.6	10.2 ± 0.7
Gruczno, site 1	34	−20.0 – −18.9	−19.8 ± 0.4	8.1 – 11.2	9.4 ± 0.7
Gruczno, site 2	32	−20.8 – −19.5	−20.1 ± 0.4	7.6 – 10.7	9.3 ± 0.7
Birka	22	−21.1 – −19.0	−20.0 ± 1.1	11.5 – 16.5	13.6 ± 1.1
Magdalenska Gora	19	−20.0 – −13.0	−14.7 ± 1.6	5.4 – 10.6	9.4 ± 1.1
Poland elits	14	−19.8 – −18.9	−19.5 ± 0.3	12.3 – 14.2	13.6 ± 0.6
Lithuania elits	35	−20.4 – −19.2	−19.9 ± 0.2	9.5 – 11.5	11.7 ± 0.7

Source: Linderholm et al. 2008; Murray and Schoeninger, 1988; Reitsema, 2012; Reitsema et al., 2010; Reitsema and Kozłowski, 2010; Reitsema et al., 2015, 2017.

[1] Materials from Bodzia are stored at the State Archaeological Museum in Warsaw, from Dziekanowice at Museum of the First Piasts at Lednica, from Pień at the Institute of Archaeology, Nicolaus Copernicus University in Toruń and from Sowinki at Archaeological Museum in Poznań.

[2] Animal remains are stored in the same museums as human remains. The bones of the animals from Mosina were provided by the Archaeological and Conservation Workshop from Zielona Góra.

of the $12^{th} - 14^{th}$ centuries discovered in Kałdus site 1 and Gruczno sites 1 and 2 was predominantly based on C_3 plants (cereals, vegetables and fruit) with a greater or lesser share of animal products (meat, milk and eggs). People buried in the graveyard in the Magdalenska Gora consumed C_4 plants (millet) and animal products. The inhabitants of Birka ate primarily C_3 plants and freshwater fish. The diet of Polish and Lithuanian elites was based on C_3 plants and animal products as well as freshwater fish. Most of them had elevated δ15N and their diet significantly differed from commoners indicating high social status of those individuals as shown by their greater access to higher trophic level foods.

Collagen was prepared using the modified Longin method (1971). For each sample, approximately 3 g of bone was demineralised in 0.5 M hydrochloric acid (HCl) at 4 °C. The samples were rinsed with deionised water then gelatinised by heating in a solution of HCl (pH 3). The temperature and duration of heating was carefully controlled to maximise the yield but avoid degrading the protein. The samples were heated at 70ºC for 48 h and the solution then filtered to remove residues. The samples were frozen and then freeze-dried. The resulting collagen was measured, in duplicate, into tin capsules, each approximately 0.5 mg. Then, samples were combusted in a Thermo Flash EA 1112 and the separated N_2 and CO_2 was introduced to a Delta plus XL via a Conflo III interface.

Despite its durability, collagen, like any organic substance, can be contaminated and degraded into non-collagen proteins. In order to determine if the collagen is suitable for analysis, the ratio of carbon to nitrogen (C/N) and the content of carbon (% C) and nitrogen (% N) in the collagen should be checked. For the bone material from the excavations to be suitable for analysis, the C/N ratio should be in the range of 2.9–3.6, while the percentage of carbon in the collagen should be above 10%, and nitrogen over 4% (DeNiro, 1985; van Klinken, 1999).

Obtained results have been presented as a delta (δ) parameter, expressed in permilles (‰), which illustrates the deviation of the isotopic ratio of the sample in relation to the isotopic composition of international standards. For carbon isotopes, the standard is the isotopic composition of carbonate in belemnites, the VPDB (*Vienna Pee Dee Belemnite*), and for nitrogen AIR (*Ambient Inhalable Reservoir*). Samples were compared with laboratory and international standards that were interspersed throughout each analytical run. The international standards were: IAEA 600, CH6, CH7, N1 and N2. The laboratory standard, fish gelatin, was calibrated against the international standards. The analytical error was determined at ± 0.2‰ (1 s.d.) or better.

The values of $\delta^{13}C$ and $\delta^{15}N$ obtained for individuals buried in chamber graves express a normal distribution (Shapiro-Wilk test: $W = 0.934$, $p = 0.455$; $W = 0.952$, $p = 0.670$). In the case of the comparative populations - Giecz, Gruczno, Kałdus as well as Dziekanowice and Sowinki, the values of $\delta^{15}N$ express a normal distribution (Shapiro-Wilk test: $W = 0.990$, $p = 0.380$), and the values of $\delta^{13}C$ did not have a normal distribution (Shapiro-Wilk test: $W = 0.944$, $p < 0.001$). Therefore, to compare between individuals buried in chamber graves and reference populations for the $\delta^{15}N$ values was used a parametric t-Welch test and for the $\delta^{13}C$ values a non-parametric Mann-Whitney test. To compare the $\delta^{13}C$ and $\delta^{15}N$ values for men and women buried in chamber graves, the Mann-Whitney test was used due to the small sample size. Statistical tests confirmed the existence of significant differences in the diet among people belonging to the social elites buried in chamber graves and commoners buried in ordinary graves, but did not confirmed the existence of such statistically significant differences between males and females buried in chamber graves.

4. Results

The results of carbon and nitrogen stable isotopes analyses of human and animal remains are summarized in Tables 2–4. Collagen in the analysed samples was well-preserved. Among humans C/N ratios were between 3.2 and 3.5, %C 25.9 – 52.5 and %N 8.8 – 19.3 (Tables 2 and 3).

Table 2
The rib bone collagen $\delta^{15}N$ and $\delta^{13}C$ for individuals buried in chamber graves from the area of the early Piasts state with quality parameters.

Site/ Grave	Sex	Age	%C	%N	CN	$\delta^{13}C_{VPDB}$ (‰)	$\delta^{15}N_{AIR}$ (‰)
Bodzia							
D162	M	*maturus*	43.7	15.9	3.2	−18.9	9.4
E864/ II	F	*adultus*	43.3	16.0	3.2	−18.1	10.0
Dziekanowice							
20	M	*maturus*	42.0	15.1	3.2	−19.0	10.3
61	M	*juvenis*	31.8	11.4	3.2	−19.0	10.1
62	F	*adultus*	52.5	19.3	3.2	−17.6	10.1
II	M	*maturus*	25.9	8.8	3.4	−17.4	11.6
Pień							
32	F	*maturus*	42.7	15.5	3.2	−17.2	10.1
37	C	*infans I*	42.4	15.5	3.2	−17.1	9.2
38	C	*infans I*	41.6	15.3	3.2	−18.4	10.8
39	C	*infans I*	40.9	14.6	3.3	−18.0	9.7
40	C	*infans I*	42.2	15.2	3.2	−18.1	11.8
49	C	*infans I*	41.7	15.1	3.2	−18.1	9.8
57	C	*infans I*	43.2	15.7	3.2	−18.3	8.4
69	F	*adultus*	42.2	15.4	3.2	−17.7	9.8
71	C	*infans II*	40.8	14.7	3.2	−17.6	10.1
Sowinki							
148	N	*juvenis?*	42.2	15.3	3.2	−17.3	11.1
151	N	*juvenis?*	43.7	15.9	3.2	−16.5	10.8
70	N	*adultus*	44.9	16.4	3.2	−17.1	10.3
Mean			***41.5 ± 5.4***	***15.0 ± 2.1***	***3.2 ± 0.1***	***−17.8 ± 0.7***	***10.3 ± 0.9***

Source: Analyses carried out in the Stable Light Isotope Laboratory, University of Bradford. F – female, M – male, C – child, N – indeterminate.

Table 3
The rib bone collagen $\delta^{15}N$ and $\delta^{13}C$ for individuals buried in ordinary graves from Dziekanowice and Sowiki.

Site/ Grave	Sex	Age	%C	%N	CN	$\delta^{13}C_{VPDB}$ (‰)	$\delta^{15}N_{AIR}$ (‰)
Dziekanowice							
47	M	*adultus*	31.7	10.5	3.5	−19.2	10.0
50	F	*adultus*	41.4	14.4	3.4	−19.8	9.4
54	M	*maturus*	37.7	12.8	3.4	−19.7	9.7
Sowinki							
27	M	*maturus*	41.5	14.4	3.4	−19.8	10.0
94	N	*juvenis*	44.4	16.1	3.2	−17.1	9.6
441	M	adult	40.8	14.1	3.4	−20.0	10.2
Mean			***39.6 ± 4.4***	***13.7 ± 1.9***	***3.4 ± 0.1***	***−19.3 ± 1.1***	***9.8 ± 0.3***

Source: Analyses carried out in the Stable Light Isotope Laboratory, University of Bradford. F – female, M – male, C – child, N – indeterminate.

In turn, collagen in animal samples contained %C between 31.2 and 41.5, %N 11.2 – 15.6 and C/N ratios 3.2 – 3.3 (Table 4).

The faunal isotopic background of terrestrial animals exhibited a range in $\delta^{15}N$ between 5.7 to 9.9 ‰ and $\delta^{13}C$ −21,9 to −17.6 ‰. Domesticated herbivores (a sheep/goat, cattle, a horse) had values of $\delta^{15}N$ between 5.1 to 6.9 and values of $\delta^{13}C$ between −21.9 to −20.7, indicated that their diet was based on local plants. Domesticated omnivores (pigs and hen) had similar ratios of $\delta^{13}C$ to herbivores between −21.5 to −17.6 but higher ratios of $\delta^{15}N$ between 6.4 to 9.9. Some pigs showed lower and some higher $\delta^{15}N$ values. This indicates that some of them probably consumed a plant-based diet while others consumed some animal proteins. The pig from Mosina which has the highest $\delta^{15}N$ value (9.7‰) was probably fed refuse containing animal proteins. In turn, the high $\delta^{13}C$ of the pig from the Pień (−17.6‰) indicates that it fodder included millet. The $\delta^{13}C$ of a domestic hen from Mosina (−20.7‰) from the late Middle Ages indicates that it was fed with cereals, and its high $\delta^{15}N$ (9.9) showed that it consumed proteins possibly

Table 4
Results of $\delta^{15}N$ and $\delta^{13}C$ of faunal bone samples from Bodzia, Dziekanowice, Mosina and Pień with quality parameters.

Sample	Species	%C	%N	CN	$\delta^{13}C_{VPDB}$ (‰)	$\delta^{15}N_{AIR}$ (‰)
Bodzia						
pig	*Sus scrofa f. domestica*	40.4	14.3	3.3	−20.6	6.4
sheep/ goat	*Ovis aries/Capra hircus*	41.3	14.4	3.3	−21.0	5.1
cattle	*Bos taurus taurus*	41.3	14.8	3.3	−21.0	6.6
Dziekanowice						
cattle	*Bos taurus taurus*	37.8	13.5	3.3	−20.7	6.9
pig	*Sus scrofa f. domestica*	43.4	15.6	3.2	−21.5	7.3
fish	unspecified species	31.2	11.2	3.2	−24.6	5.2
fish	unspecified species	40.8	15.0	3.2	−20.2	5.9
Mosina						
pig	*Sus scrofa f. domestica*	41.1	14.9	3.2	−21.1	9.7
hen	*Gallus gallus domesticus*	41.5	15.0	3.2	−20.7	9.9
Pień						
pig	*Sus scrofa f. domestica*	41.3	14.9	3.2	−17.6	7.9
Horse	*Equus caballus*	38.6	14.13	3.2	−21.9	5.7

Source: Analyses carried out in the Stable Light Isotope Laboratory, University of Bradford.

from eating small invertebrates and on human trash and waste. Two fish have $\delta^{15}N$ values of 5.2 to 5.9 and $\delta^{13}C$ of −24.6 to −20.2 indicating that they belonged to some freshwater species (Fig. 3).

All individuals (male, female and juveniles) buried in the chamber graves have a mean $\delta^{13}C$ of −17.8 ± 0.7‰ and a mean of $\delta^{15}N$ 10.3 ± 0.9‰ (Table 2). Males have a mean $\delta^{13}C$ of −17.8 ± 0.9‰, a mean $\delta^{15}N$ value 10.7 ± 0.8‰; females have a mean $\delta^{13}C$ of −17.9 ± 0.5‰, a mean $\delta^{15}N$ of 10.0 ± 0.2‰ and juveniles have a mean $\delta^{13}C$ of −17.9 ± 0.5‰, a mean $\delta^{15}N$ of 10.0 ± 1.0‰ (Table 5). Individuals buried in ordinary graves (n = 6) have a mean $\delta^{13}C$ of −19.3 ± 1.1‰ and a mean $\delta^{15}N$ value of 9.8 ± 0.3‰ (Table 3). Those buried at Dziekanowice (n = 3) have $\delta^{13}C$ from −19.8 to −19.2‰ and $\delta^{15}N$ from 9.4 to 10.00‰ indicating that their diet was based on the consumption of C_3 type plants with probably a small share of millet (C_4 type plant) and animal proteins. Among individuals from Sowinki (n = 3) $\delta^{13}C$ values were from −20.0 to −17.1‰ and $\delta^{15}N$ from 9.6 to 10.2‰. One of these individuals (grave no. 441) from the later phase of the use of the cemetery had a diet based on C_3 plants without millet (-20.0‰). In turn, the other individual (grave no. 94) buried in the earlier period of functioning of the cemetery consumed significant amounts of millet (-17.1‰).

5. Discussion

The diet of individuals buried in sampled chamber graves from the territory of the state of the first Piasts was chiefly based on terrestrial food. It contained C_3 plants (cereals, vegetables, fruit) and animal products (meat, cheese, eggs). High $\delta^{15}N$ corresponding to faunal omnivore diet indicate that it was rich in animal proteins. Their mean $\delta^{15}N$ (10.3 ± 0.9) is higher than in samples from individuals buried in ordinary graves at Dziekanowice and Sowinki (9.8 ± 0.3) and comparative populations of commoners form the early and late Middle Ages in Poland, indicating a high consumption of animal proteins, but lower than the $\delta^{15}N$ of elites of the Polish-Lithuanian Commonwealth from the 17th – 18th centuries and Viking Age Birka. It suggests a much higher presence of freshwater fish in the diet of the Polish-Lithuanian elites and inhabitants of Birka. In turn, the relatively high mean $\delta^{13}C$ of samples from chamber graves (-17.8‰) indicate that diet of individuals buried in them also included C_4 plants (millet) probably consumed in the form of groats and beer. The mean $\delta^{13}C$ of individuals from chamber graves is higher than in most of the reference populations. It is only lower comparing to the early Iron Age population from Magdalenska Gora whose diet was based mostly on millet consumption (-14.7‰). Correlating high values of $\delta^{15}N$ and $\delta^{13}C$ for some individuals (Dziekanowice graves II and 61, Sowinki graves 148,151 and possibly 70) suggest that their diet included anadromous or marine fish (Fig. 7). It also cannot be excluded that these individuals consumed meat of millet-fed animals (e.g. pigs and hens) (Fig. 6).

The analyses of $\delta^{15}N$ and $\delta^{13}C$ in bone collagen showed that the diet of adults buried in the chamber graves analysed in this study (Bodzia, Dziekanowice, Pień, Sowinki) significantly differed from the rest of society in early medieval Poland as compared to individuals buried in ordinary graves at Dziekanowice and Sowinki as well as reference populations from the early and late medieval periods from Giecz, Gruczno and Kałdus. Generally, in contrast with people from contemporary non-chamber graves (n = 153), individuals with high social status buried in chamber graves have 1.7‰ higher $\delta^{13}C$ (Mann-Whitney test U = 201.5, $p < 0.001$) and 0.8‰ higher $\delta^{15}N$ (t-Welch test = -2.80, df = 20.35, p = 0.011). The differences suggest preferential access by these elites to food containing more animal proteins including meat and certain fish species as sturgeon, eel, etc. as well as food and drinks made from millet, e.g. beer. However, the diet among the elite people was not uniform and varied between individuals. It has to be noted that the bone collagen from the chamber grave burials includes a wide range of $\delta^{15}N$ and $\delta^{13}C$ suggesting that some individuals consumed foods similar to the rest of the population, while others had a much more varied diet (Fig. 7).

Most males buried in chamber graves (Dziekanowice graves II and 61, Sowinki graves 148, 151 and 70) had different diets from the rest of the population. Their diet was based on the consumption of C_3 plants probably with significant contribution of C_4 plant (millet), as indicated by high $\delta^{13}C$ values (-18.2 – −16.5‰). High $\delta^{15}N$ values (10.3 – 11.6‰) indicate that their diet was rich in animal proteins derived from meat of terrestrial animals. At the same time, correlation of high of both $\delta^{15}N$ and $\delta^{13}C$ values suggests that they probably consumed also anadromous fish such as sturgeon (*Acipenser sturio*) and/or marine fish (Figs. 7, 8). Laurie Reitsem's analysis of sturgeon remains from the early medieval site in Kałdus (n = 3) showed δ15N values from 9.9‰ to 11.3‰ and δ13C values between −17.1‰ and −15.6‰ (Reitsema, 2012; Reitsema et al., 2017). Sturgeon was a fish valued in the Middle Ages, and its consumption in this period is supported by archaeological finds (e.g. in Kałdus, Napole, Gniezno, Grzybowo, Giecz, and Ostrów Lednicki; Makowiecki, 2003). In the Middle Ages, this species occurred in the coastal waters of the Baltic Sea and larger rivers escaping into the sea. As a result of excessive fishing, it began to disappear from the late Middle Ages, until its total disappearance in modern times. As shown by Makowiecki's research, there was a diversification of consumption of individual fish species depending on the social status, which is evident in the diverse presence of their remains depending on the type of settlement and the inhabiting population. In strongholds the remains of sturgeon, pike, catfish, cyprinids were the main species represented with smaller amounts of other fish including perch. In turn, in the settlements the most numerous were the remains of cyprinids, and only then the pike, perch, catfish, sturgeon and other species (Makowiecki, 2003). For example, in the case of the settlement complex at Ostrów Lednicki (Dziekanowice), the share of sturgeon remains in the fish materials from the stronghold was 50%, and in the adjacent settlement 35% (Makowiecki, 2001). The consumption of fish was probably connected with their perceived high value, and indeed fish were included in the high status dishes. However, fish consumption could be related to compliance with the fasts observed by the church and state elites. In medieval Europe there were many fast days. Christians fasted on Wednesday, Friday and Saturday as well as during Lent (Makowiecki 2001). It can therefore be assumed that consumption of selected fish species, including sturgeons, was indicative of the higher social status of consumers, who could afford to eat fish on days when animal products were

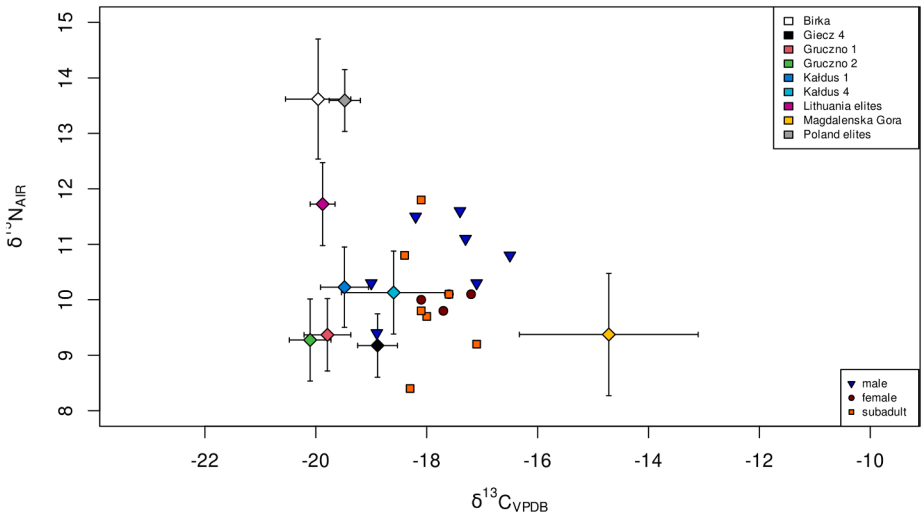

Fig. 6. Values of $\delta^{13}C$ and $\delta^{15}N$ in bone collagen of individuals buried in chamber graves in the area of the state of the first Piasts compared with other populations: chamber graves - males (Bodzia D162, Dziekanowice II, 20, 61, Sowinki 70, 148, 151), females (Bodzia E864/II, Dziekanowice 62, Pień 32, 69), juvenilles (Pień 37, 38, 39, 40, 49, 57, 71); reference populations – Giecz site 4 (n = 24), Kałdus site 4 (n = 33), Kałdus site 1 (n = 30), Gruczno site 1 (n = 34), Gruczno site 2 (n = 32), Polish and Lithuanian elites of the Polish-Lithuanian Commonwealth (Poland n = 14, Lithuania n = 35), Birka (n = 22), Magdalenska Gora (n = 19), (prepared by R. Fetner).

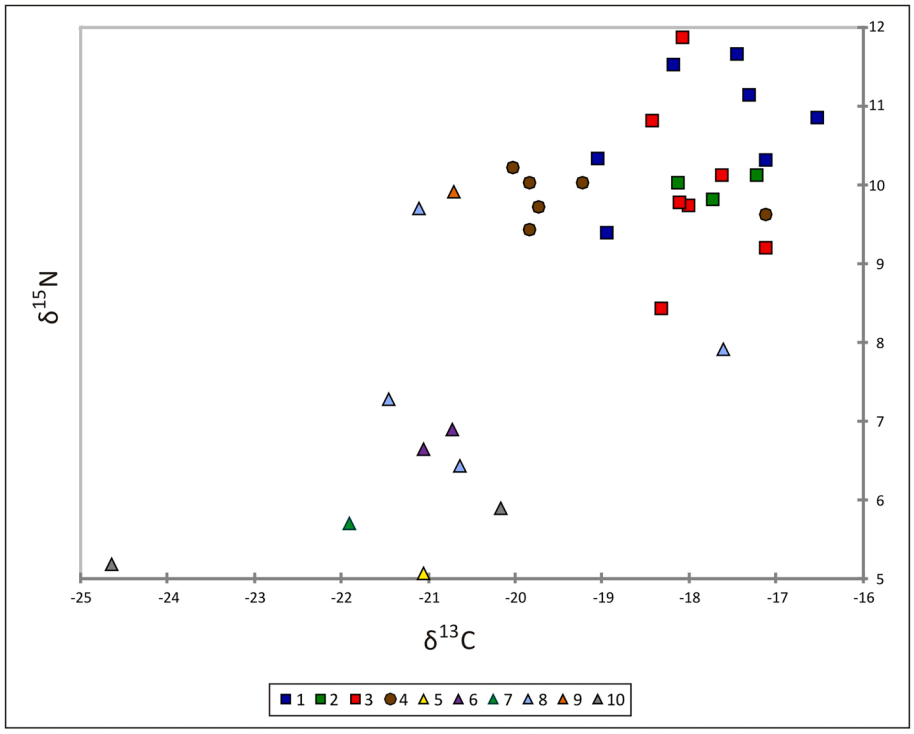

Fig. 7. Values $\delta^{13}C$ and $\delta^{15}N$ in bone collagen of individuals buried in chamber graves, reference ordinary graves and animals: 1 – males buried in chamber graves (Bodzia D162, Dziekanowice II, 20, 61, Sowinki 70, 148, 151), 2 – females buried in chamber graves (Bodzia E864/II, Dziekanowice 62, Pień 32, 69), 3 – juveniles buried in chamber graves (Pień 37, 38, 39, 40, 49, 57, 71), 4 – individuals buried in ordinary pit graves (Dziekanowice and Sowinki), 5 – sheep/goat, 6 – cattle, 7 – horse, 8 – pig, 9 – hen, 10 – fish (prepared by B. Błaszczyk and B. Bednarczyk).

prohibited. Interestingly, the diet of the medieval elite of the early Piasts' state differed in this regard from the diet of early modern elites of the Polish-Lithuanian Commonwealth, because although it also contained an important component in the form of fish, they were different species and mostly derived from freshwater sources (Fig. 6).

Two men were different from the rest – an individual from a grave D162 at Bodzia and from a grave 20 at Dziekanowice. They had a diet more similar to the rest of the society based on terrestrial organisms, primarily plants of the C_3 cycle (cereals, vegetables and fruit) with the share of animal products including meat. Their diet did not contain significant amounts of fish. The male from Dziekanowice, with a 0.9‰ higher $\delta^{15}N$ compared to the man buried in grave D162 from Bodzia, most likely consumed a diet richer in terrestrial animal proteins. In general, the diet of both men did not differ significantly from people from the early medieval reference populations of Polish territories buried in ordinary graves. The diet of the man from the grave no. D162 was close to the population from Giecz, while the man from the grave no. 20 to population from Kałdus and a man buried in an ordinary grave no. 47 at the same cemetery (Figs. 7, 8).

Although the values of $\delta^{13}C$ (Mann-Whitney test U = 14, p = 1) and $\delta^{15}N$ (Mann-Whitney test U = 24, p = 0.0713) among men and women does not show statistically significant differences (probably due to the small sample size), the diet consumed by women seems not as reach in proteins as that of men (Fig. 9, Table 5). The female diet was based on the consumption of C_3 and C_4 (millet) plants with some animal products. Females appear to have consumed less terrestrial animal proteins or fish than contemporary males, indicative of differential access to these foods ($\delta^{15}N$ was 0.7‰ higher in males). Interestingly, a female from grave 62 in Dziekanowice had an identical diet as the juvenile *infans II*, perhaps a girl, from grave 71 in Pień (Figs. 8, 9).

The diet of seven juveniles from the chamber graves (Pień graves 37, 38, 39, 40, 49, 57 and 71) is generally closer to the diet of the females

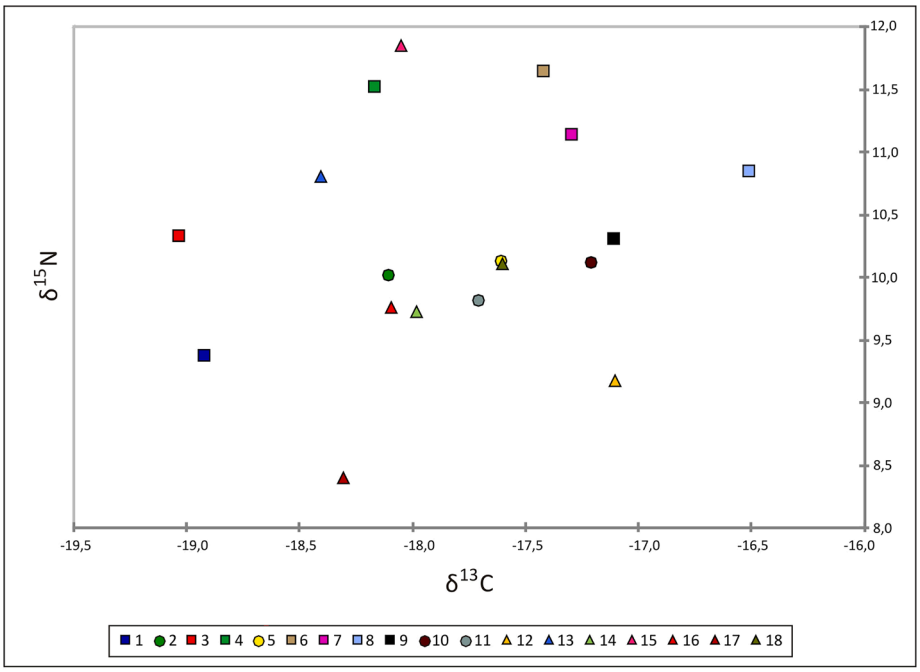

Fig. 8. Values of $\delta^{13}C$ and $\delta^{15}N$ in bone collagen of individuals buried in chamber graves: 1 – 1 – Bodzia D162, 2 – Bodzia E864/II, 3 – Dziekanowice 20, 4 – Dziekanowice 61, 5 – Dziekanowice 62, 6 – Dziekanowic II, 7 – Sowinki 148, 8 – Sowinki 151, 9 – Sowinki 70, 10 – Pień 32, 11 – Pień 69, 12 – Pień 37, 13 – Pień 38, 14 – Pień 39, 15 – Pień 40, 16 – Pień 49, 17 – Pień 57, 18 – Pień 71 (prepared by B. Błaszczyk and B. Bednarczyk).

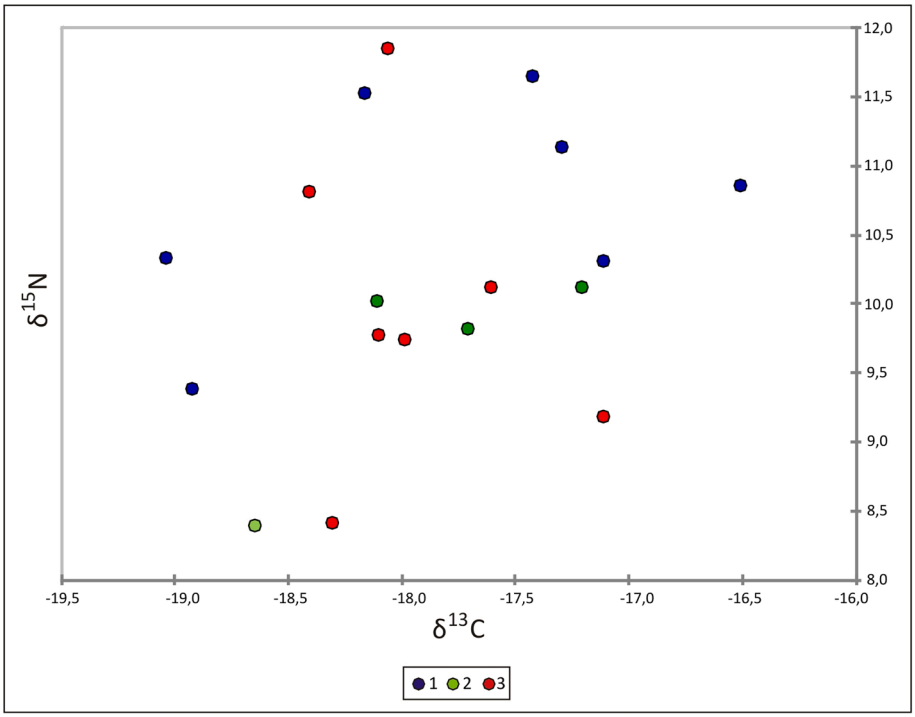

Fig. 9. Values of $\delta^{13}C$ and $\delta^{15}N$ in bone collagen of men, women and juveniles buried in chamber graves: 1 – men (Bodzia D162, Dziekanowice II, 20, 61, Sowinki 70, 148, 151), 2 – women (Bodzia E864/II, Dziekanowice 62, Pień 32, 69), 3 – juveniles (Pień 37, 38, 39, 40, 49, 57, 71), (prepared by B. Błaszczyk and B. Bednarczyk).

(Figs. 6, 8, 9) with the juvenile range for $\delta^{15}N$ greater than adults. This suggests that children were consuming a diet similar to the females, with the higher $\delta^{15}N$ measured in two individuals possibly reflecting continuing consumption of breast milk, although the effect of nutritional stress on those dying in infancy must also be considered. For example the two-year-old child from the grave 40 in Pień with the highest $\delta^{15}N$ value (11.8‰) and the three-year-old child from the grave 38 ($\delta^{15}N$ 10.8‰) may have still had some dietary input from breast milk. These higher $\delta^{15}N$ values in juveniles who have died at an early age could also reflect nutritional stress and the effect of catabolism and the recycling of body tissues which mimic a trophic level rise (Beaumont et al., 2018). Other juveniles (37, 39, 49, 57, 71) aged from 4 to 13 years had a similar diet to the adults ($\delta^{15}N$ between 9.2 and 10.1‰, $\delta^{13}C$ between −17.1 – −18.4‰), while the diet of the four-year-old child from grave 57 ($\delta^{15}N$

Table 5
Results of bone collagen $\delta^{15}N$ and $\delta^{13}C$ of individuals buried in chamber graves (Bodzia, Dziekanowice, Pień, Sowinki).

Sex and age	Samples	$\delta^{13}C_{VPDB}$ (‰)	Mean ‰	$\delta^{15}N_{AIR}$ (‰)	Mean ‰
adults	11	−19.0 – −16.5	−17.7 ± 0.8	9.4 – 11.6	10.5 ± 0.7
males	7	−19.0 – −16.5	−17.8 ± 0.9	9.4 – 11.6	10.7 ± 0.8
females	4	−18.1 – −17.2	−17.7 ± 0.4	9.8 – 10.1	10.0 ± 0.2
juvenals	7	−18.4 – −17.1	−17.9 ± 0.5	8.4 – 11.8	10.0 ± 1.0

Source: Analyses carried out in the Stable Light Isotope Laboratory, University of Bradford.

8.4‰) may represent a lower trophic level diet.

6. Conclusions

Although these are small numbers of individuals from each site, the measurement of $\delta^{13}C$ and $\delta^{15}N$ of bone collagen of individuals buried in chamber graves has shown that the representatives of the early medieval elite buried in chamber graves from the territory of the state of the first Piasts had access to better food than contemporary commoners. In particular, there is evidence that the they consumed a diet richer in animal proteins (including fish). This could be related to both their high social status and the observance of the fasts associated with the introduction of Christianity. Christianization in the Piast state, similarly to other medieval states, took place “from the top to the bottom”, i.e. the social elites were the first to adopt the new religion, which over time imposed it on the rest of society. In their diet millet was also present, consumed in different forms, e.g. beer. However, the two males buried in chamber graves from the cemetery in Bodzia and Dziekanowice had similar diets to the surrounding population. It is apparent that the diet of members of the early medieval elite (the 10th – 11th centuries) differed from the representatives of the elites of the early modern Polish-Lithuanian Commonwealth (the 17th – 18th century). Females buried in chamber graves consumed a diet similar to the rest of the population and which was similar to the diet of the early medieval population from the cemetery at Kałdus. It was not as rich in animal proteins as the males and contained more plant products, including millet. The children (between 2 and 13 years) had a diet similar to the elite women, with the exception of the two youngest who could have still been in the weaning process, or suffering nutritional deprivation.

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