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Locals or Newcomers?

Isotopic methods can tell us much about the status, diet, and mobility of people in early-medieval Poland.

Fig. 1
A chamber grave from the cemetery in Bodzia, Kuyavia (10th–11th century), containing the burial of a 20–25-year-old woman (visible fragment of skull), over whom a 20–30-year-old man was later buried with a sword and other objects. In a later period, a 15–16-year-old girl was buried nearby. All three individuals were related, and strontium isotope values suggest they likely came from Scandinavia

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Remains from early Piast-era cemeteries show striking variation in both geographic origin and dietary patterns among elites – evidence of long-distance movement and cultural exchange.

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Among the primary sources for studying past societies – including the early Polish state – are burial sites and cemeteries. In pre-Christian times, the dead in Polish lands had been cremated, their ashes placed in clay vessels (urns), which were then buried atop earthen mounds. With the adoption and spread of Christianity in the second half of the tenth century, the rite of inhumation (burial) was introduced, as required by the new religion. Uncremated bodies were laid in pit graves arranged in rows – hence their archaeological classification as *row cemeteries*. Members of the highest state and ecclesiastical elites – rulers and their families, bishops, and abbots – were often buried inside the earliest churches. Other elite individuals were interred in cemeteries, often in particularly elaborate graves, including the so-called *chamber graves*, which featured wooden constructions (Fig. 1).

Archaeology offers many methods for studying past societies through the examination of cemeteries. One of these is known as *isotopic analysis*, which examines the ratios of different isotopes of various elements found in the bones and teeth of humans and animals – based on the principle: you are what you eat and drink. This method relies on the relationship between the isotopic composition of consumed food and the composition of body tissues – such as bioapatite in bones and tooth enamel, and collagen in bones. The technique involves measuring the ratios of specific isotopes (i.e. identifying *isotopic signatures*) in the tissues of examined individuals and comparing them with reference values typical for different types of food, ecosystems, or regions with distinct geological or climatic conditions. This allows researchers to determine, among other things, the origin and mobility of past populations and to reconstruct their diets.

To study people's origin and mobility – that is, to determine which individuals were local and which were newcomers, and from which region the latter may have come – researchers analyze the strontium isotope ratio ($^{87}Sr/^{86}Sr$) and the oxygen isotope ratio ($^{18}O/^{16}O$, or $\delta^{18}O$). The strontium isotope composition varies across different types of rock and depends on their geological origin and age. Some rocks, such as granites, have higher values, while others, such as basalts or limestones, have lower ones. Strontium is transferred from the soil into water, then into plants and the animals that consume them, and finally enters the human body through food and drinking water. Because strontium shares similar physicochemical properties with calcium, it is incorporated into the mineral component of bones and teeth (hydroxyapatite – crystalline calcium phosphate).

The oxygen isotope ratio, in turn, depends on climate and varies geographically. The amount of oxygen in body tissues reflects the local water's isotopic signature. Lower temperatures result in lower $\delta^{18}O$ values, while higher temperatures produce higher ones. Samples for such analysis are taken from tooth enamel, since it is highly durable and, once formed during childhood, does not change. As a result, the isotopic signature preserved in enamel reflects the strontium ratio of the region where a person was born. To determine the isotopic composition of the local natural environment, samples are taken from soil, water, plants, and animals. By comparing the strontium and oxygen isotope ratios in a person's tissues with those of the environment, researchers can determine whether the person was born in the area where their remains were found or whether they came from somewhere else.

However, this method has certain limitations. The range of $^{87}Sr/^{86}Sr$ values characteristic of specific rock types or sediments may be identical across geologically similar regions. Likewise, $\delta^{18}O$ values can be similar in areas with comparable climates and geographical locations. Additionally, such studies can only identify newcomers in the first generation – their children will already bear the isotopic signature of their parents' new place of residence.

What isotopes reveal about diet…

To reconstruct ancient diets, researchers analyze the ratios of carbon isotopes ($^{13}C/^{12}C$, or $\delta^{13}C$) and nitrogen isotopes ($^{15}N/^{14}N$, or $\delta^{15}N$). Carbon isotope analysis helps determine the type of ecosystem from which food was sourced – whether the diet was based on terrestrial organisms, aquatic organisms, or a combination of both. The ratio of stable carbon isotopes in plant tissues, which is linked to the type of photosynthesis, also allows researchers to identify the types of plant foods consumed. One type, known as C3 plants, grow primarily in temperate climates and include cereals (wheat, rye, barley, oats), legumes (peas, broad beans, lentils), vegetables (cabbage, carrots, beets, turnips, parsnips, cucumbers), most fruits, and herbs (mustard, coriander, juniper, horseradish, dill, garlic, caraway, vervain, angelica, marjoram). C4 plants, in turn, are typically found in tropical and subtropical climates and include, among others, millet, maize (corn), sorghum, and sugarcane.

Nitrogen isotope analysis, in turn, allows researchers to determine the trophic level of the individual (i.e., whether they were herbivorous, carnivorous, or omnivorous). This provides insight into whether a person consumed animal proteins, such as meat, eggs, milk, and dairy products. The higher the organism's position in the food chain, the higher the nitrogen isotope values in their tissues – hence these values are higher in carnivores than in herbivores. Samples for this type of analysis are taken from bone collagen, which is durable and resistant to postmortem isotopic changes. Since bone tissue undergoes continuous metabolic remodeling, the isotopic composition reflects the kind of food consumed over the last 10 years of life in adults, and roughly the last year in the case of children.

…and about migration

The isotopic research methods described above have been used to study the remains of elites from the early Piast state during the reigns of Mieszko I, Bolesław the Brave, and Mieszko II (latter half of the tenth to the first half of the eleventh century). These individuals were buried in chamber graves discovered at cemeteries in Bodzia (Kuyavia), Dziekanowice and Sowinki (Greater Poland), and Ciepłe, Pień, and Kałdus (Eastern Pomerania, Chełmno Land). Analysis of strontium isotope ratios ($^{87}Sr/^{86}Sr$) revealed some variation in terms of their origin and mobility (Fig. 2). Some of the individuals were born and spent their childhoods in the same areas where they were buried, as indicated by the close match between their isotopic signatures and those of the local environment. However, more than half originated from places other than where they were laid to rest, suggesting they had changed their place of residence during their lifetimes. Comparisons with regional isotopic signatures allowed researchers to determine that some individuals had moved within the territory of the early Piast state, while others had come from outside the borders of early-medieval Poland.

With just one exception, all the men, women, and children buried at the Vistula-adjacent cemeteries in Kałdus and Pień were found to be of local origin. In contrast, at Ciepłe, also located along the Vistula but further north, virtually all of the men exhibited very low strontium values in their teeth – typical of regions with carbonate rock subsoil (limestone). This suggests that these men came to Polish lands from southern Scandinavia, most likely from present-day Denmark. They were buried with rich grave goods, including weaponry (swords and spears), riding gear (such as spurs), as well as bronze bowls and wooden buckets with iron fittings. Low strontium values were also measured in a large portion of individuals buried at Bodzia, suggesting a northern origin as well. However, that cemetery also contained local individuals, including a man buried in the first and oldest grave, which took the form of a mausoleum – a wooden structure. His strontium values were high, consistent with the Greater Poland region. One of the men from Ciepłe and a woman from Kałdus may also have originated from there. At two cemeteries located in the central Piast realm – Sowinki near Poznań and Dziekanowice by Lake Lednica, where one of the major Piast residences stood on an island – nearly all of the individuals buried were of local origin. In the case of the deceased from Dziekanowice, the measured strontium

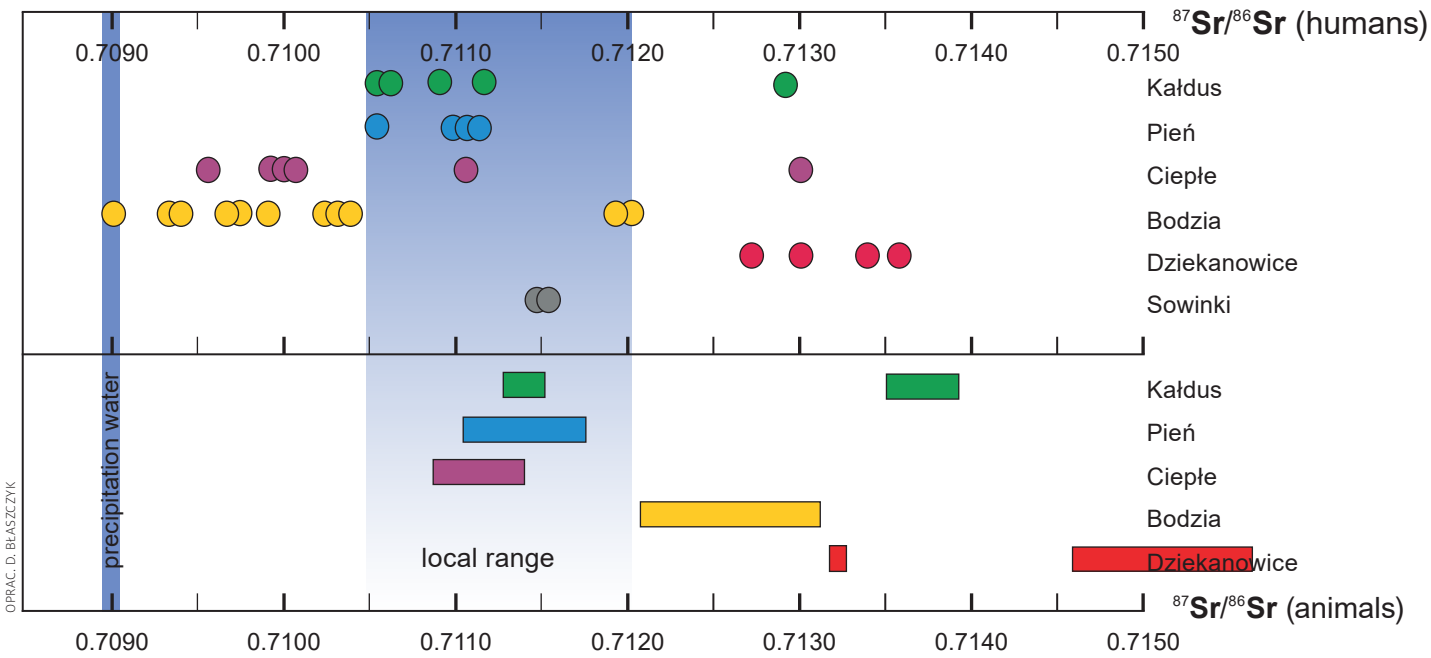

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Fig. 2
Strontium isotope ratios ($^{87}Sr/^{86}Sr$) in tooth enamel from individuals buried in chamber graves dating to the early Piast state (10th–11th century), shown alongside strontium values from animal remains recovered from excavations (e.g. pig, sheep/goat, cattle, horse, hare, wild boar, roe deer, red deer). The blue-shaded area marks the typical strontium range for northern Poland, shaped by postglacial deposits such as glacial tills, sands, and gravels

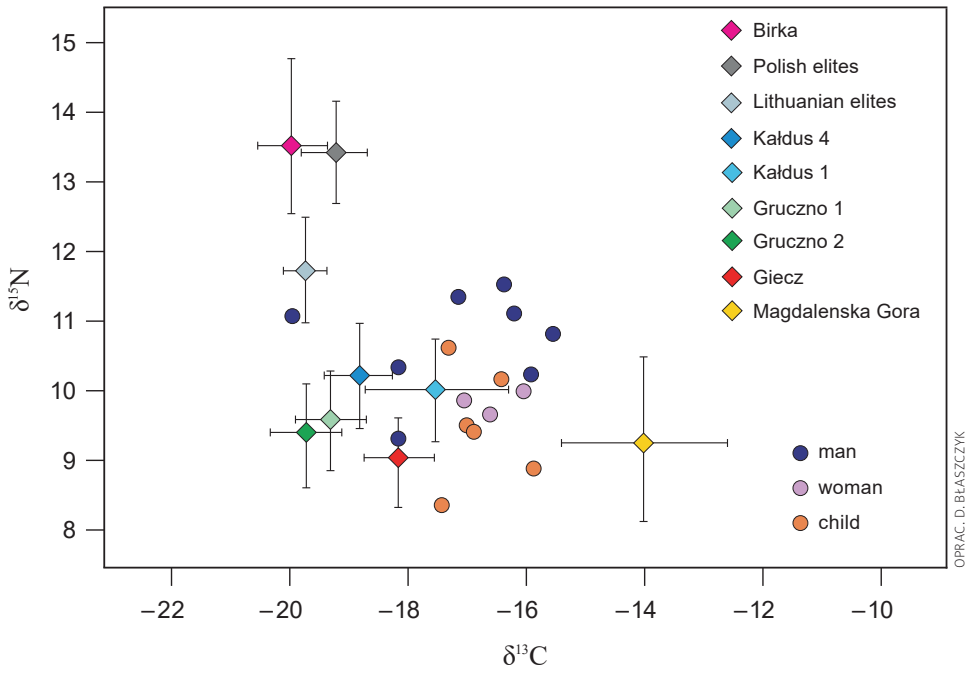

Fig. 3
Carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotope values in bone collagen of individuals buried in chamber graves within the early Piast state (10th–11th century) (Bodzia, Dziekanowice, Sowinki, Pień, Kałdus), compared to other populations with varied diets. Individuals buried at the Magdalenska Gora cemetery in Slovenia (6th–4th century BCE) consumed large quantities of millet. The diet of people from Polish lands during the early-medieval period (10th–11th century) (Kałdus 4, Giecz) was mixed and land-based, consisting of C_3 plants (wheat, rye, vegetables, fruits), with some millet and animal protein. In the later medieval period (12th–14th century) (Kałdus 1, Gruczno 1 and 2), the diet was based mostly on C_3 plants, with varying amounts of animal products (meat, milk, eggs). The diet of residents of Viking-era Birka (8th–11th century, Sweden) was rich in freshwater fish. The elites of the Polish–Lithuanian state (16th–18th century) consumed C_3 plants and animal protein, including significant amounts of freshwater fish, with Polish elites consuming considerably more meat, especially fish, than Lithuanian elites

ratios were very high – but this is characteristic of the local geology.

Interestingly, in double graves discovered at Kałdus and Ciepłe, each having a man and a woman buried together, strontium values showed that the men were local, while the women had come from elsewhere. This pattern is typical of patrilocal societies, which are most often also patrilineal: the woman leaves her native community and joins that of her husband, and inheritance is passed down the male line. Written sources confirm that this was indeed how communities in medieval Polish lands were organized.

Meat, fish, plants

Analyses of carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotopes showed that the diet of individuals buried in chamber graves – representatives of the elite – differed significantly from that of the broader population (Fig. 3). Most notably, it was rich in protein from terrestrial and aquatic animals, especially amphibious fish such as sturgeon and eel. This is indicated by a correlation between high nitrogen isotope values and low carbon isotope values. The consumption of such fish is also confirmed by archaeological finds. Zooarchaeological research has demonstrated that the type of fish consumed was dependent on social status. In fortified settlements that served as centers of administration and elite residence, remains of sturgeon, pike, and catfish were most commonly found. In contrast, materials from settlements and outer suburbs yielded mainly cyprinid fish remains, with smaller quantities of perch.

Carbon isotope values also indicate a significant presence of C_4 plants in the elite diet. In early Piast-era Poland, this primarily meant millet, consumed in various forms such as millet porridge and also used for brewing beer. The popularity of millet – observed since earlier medieval periods – was linked to slash-and-burn agriculture, which involved clearing forest by fire and using the ash-enriched soil for cultivation. By the early eleventh century, millet ceased to be a major dietary component, a change that is visible in the isotopic record. From that time onward, C_3 cereals such as wheat and rye became dominant.

Isotopic analyses also showed that the diet of the elites was not uniform and varied primarily by sex. Differences related to the presence of animal protein and the relative contribution of C_4 (millet) and C_3 (grains, vegetables, fruits) plants. While carbon isotope values were similar between men and women, nitrogen isotope values were lower in women, indicating that they consumed less animal protein, especially less fish. The diets of children also varied by age and were generally closer to those of women than men. High nitrogen isotope values suggest that children were breastfed until the age of three or four.

A particularly interesting case is that of a man buried in a chamber grave at Kałdus, whose nitrogen and carbon isotope ratios were completely different from those of other individuals buried in chamber graves at the same site and in similar graves elsewhere. His values indicated a diet based on C_3 plants and rich in animal protein, with a large proportion of freshwater fish. Interestingly, this diet closely resembled that of later (early modern) Lithuanian elites, suggesting that

Further reading:

Błaszczyk D., *Między niebem a ziemią: Groby komorowe na obszarze państwa pierwszych Piastów* [Between Heaven and Earth: Chamber Graves in the Territory of the Early Piast State], Warsaw 2017.

Błaszczyk D., Pochodzenie i dieta mężczyzny pochowanego w grobie D162 z cmentarzyska w Bodzi w świetle badań izotopowych [The Origin and Diet of the Man Buried in Grave D162 from the Bodzia Cemetery in Light of Isotopic Research], *Światowit*, vol. XIII–XIV (LIV–LV), 2018, pp. 133–157.

Wadyl S. (ed.), *Ciepłe: Elitarna nekropola wczesnośredniowieczna na Pomorzu Wschodnim* [Ciepłe: An Elite Early Medieval Necropolis in Eastern Pomerania], Gdańsk 2019.

this individual was either of foreign origin or had distinct culinary preferences.

Isotopic studies also included individuals from the early Piast state who were not part of the elite. Material for these studies came from cemeteries excavated in Mazovia and Podlasie. During the period in question, two types of cemeteries existed in these regions: row cemeteries, typically located near strongholds, where the dead were buried in graves arranged in rows, and cemeteries with stone structures, where graves were also arranged in rows, but surrounded by large standing stones and filled with smaller stones forming what are known as cobble grave constructions.

Strontium and oxygen isotope measurements indicate that a large portion of individuals buried in the Mazovian stone-structure cemeteries were of local origin. At the same time, many of the deceased had isotope values outside the local range, suggesting they were born elsewhere (Fig. 4). In contrast, in Podlasie, only a few individuals buried in such cemeteries were identified as immigrants (Fig. 5). These results suggest that rural communities in Mazovia, which used cemeteries with stone-structured graves, were more heterogeneous and mobile than their counterparts in Podlasie. A large share of individuals likely came from other regions of Poland. In contrast, Podlasie communities appear to have been more homogeneous, with very few immigrants.

Graves in Mazovia and Podlasie

The isotopic signatures obtained from individuals buried in row cemeteries in both Mazovia and Podlasie differed, with few exceptions, from those of people buried in cemeteries with stone constructions (Figs. 4 and 5). This indicates that each type of cemetery was used by a different population. However, the differences in strontium isotope ratios were likely the result of variations in diet (e.g. consumption of imported goods or high salt intake), rather than actual differences in geographic origin. At the same time, some individuals buried in row cemeteries displayed strontium values typical of cemeteries containing stone-covered graves – and vice versa: some buried in such graves had values characteristic of row cemetery populations. This suggests mutual contact and a degree of population movement between the two communities.

The isotopic data obtained so far from individuals buried in early Piast-period cemeteries show that the social and political elite of the time were composed primarily of local people of Slavic origin. However, this group also included foreigners, including individuals from Scandinavia. The diverse isotopic signatures within this elite group point to their high mobility, with individuals moving between different regions of the early Piast state – and even from abroad. In many regions of Poland, elite burials have been identified as belonging to newcomers from Greater Poland, the political heartland of the Piast realm. This may indicate that they formed marriage alliances with members of local elites.

What further set state elites apart from the general population was their diet – rich in animal protein, including likely large quantities of fish. They may also have consumed significant amounts of millet-based beer. In contrast, rural communities were composed mostly of locals, although some individuals of foreign origin were present. The proportion of immigrants varied by region and type of settlement. The most diverse populations were found in stronghold settlements, particularly those located along major rivers such as the Vistula, which at the time served as main routes for communication, transport, and trade. ■

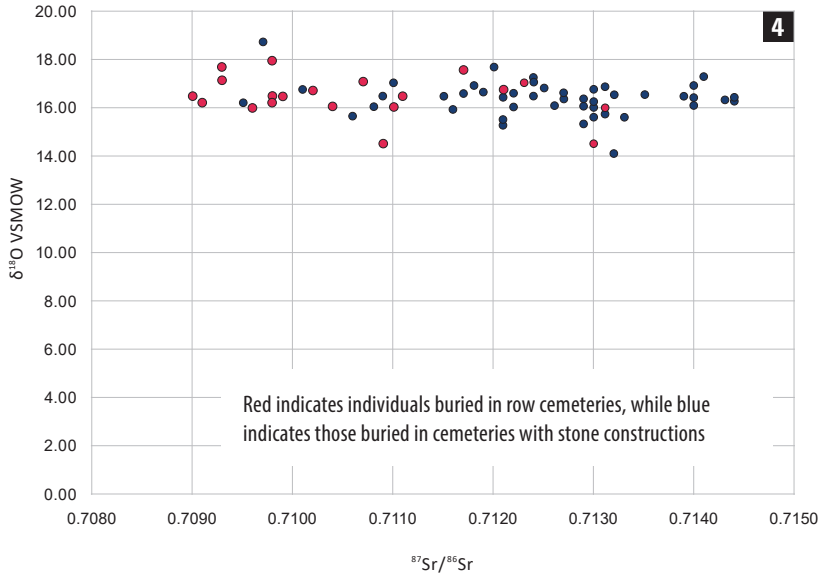

Fig. 4
Distribution of oxygen ($\delta^{18}O$) vs. strontium ($^{87}Sr/^{86}Sr$) isotope ratios in individuals buried at Mazovian cemeteries (10th–13th century)

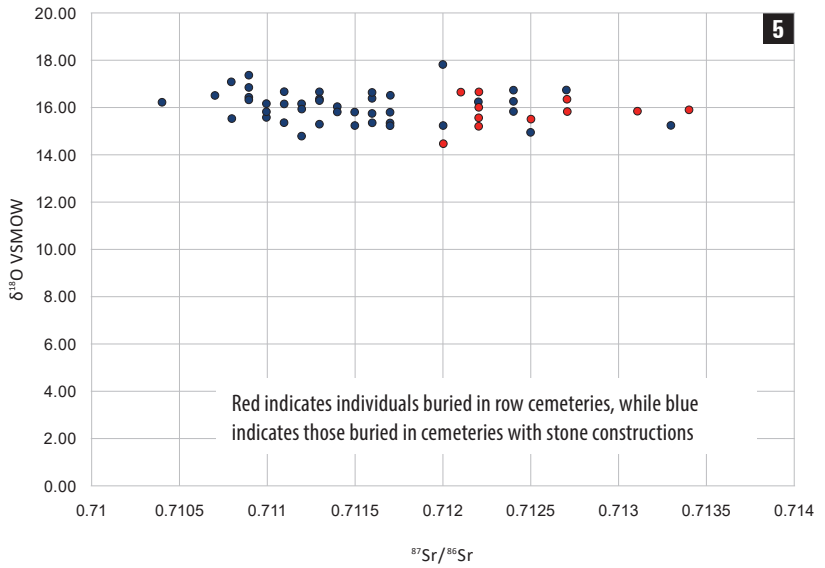

Fig. 5
Distribution of oxygen ($\delta^{18}O$) vs. strontium ($^{87}Sr/^{86}Sr$) isotope ratios in individuals buried at Podlasie cemeteries (11th–13th century)