The Archaeology of Food and Identity

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4. Human Excrement from a Prehistoric Salt Mine: A Window onto Daily Life

Nicole Boenke

Abstract: An Iron Age salt mine (ca. 500–300 B.C.) on the Dürrnberg Mountain in the northern Alps has yielded hundreds of samples of human feces. These samples, which reveal not merely what foods were available to the prehistoric community but what people actually ate, shed light on miners' culinary habits and social status as well as on community relations with other areas in Europe.

The Dürrnberg Mountain on the edge of the northern Alps offers unique insights into the nutritional habits of a prehistoric community. As a result of remarkable preservation conditions in an Iron Age salt mine (ca. 500–300 B.C.), more than 100 samples of human excrement (coprolites) survived to be analyzed. While standard archaeobotanical assemblages from settlements inform about prehistoric gathering or plant cultivation practices, human feces shed light on actual consumption patterns in the past. This chapter discusses how food consumption in this Iron Age community was interwoven with trade, import, and social contacts. Previous studies of grave goods from the Dürrnberg region have revealed that the local Iron Age salt traders were in contact with areas throughout much of Europe, from Bohemia in the north to the Mediterranean in the south and from southwestern Germany to the southeastern Alps (Moosleitner 1991; Pauli 1978, 1991; Stöllner 2002a; Zeller 2002). This study contextualizes the food evidence within broader patterns of extraregional contact as it examines how food consumption at Dürrnberg was influenced by external relations.

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Archaeological Site and Cultural Context

The Dürrnberg Mountain is located in the Northern Calcareous Alps, 15 km south of Salzburg in Austria (Figure 4-1). There is a long tradition of salt use in this region. In the Neolithic, salt was probably acquired from brine springs (Hell 1926); salt mining originated in the Iron Age, at the end of the sixth century B.C. (Stöllner 1999, 2002b, 2003). Salt exploitation halted during the first millennium A.D. but began again in the twelfth century A.D., when local production was controlled by the archbishops of Salzburg (Schatteiner 1995). Salt mining then continued uninterrupted until 1989. Many of the shafts produced by modern miners cut into the ancient mining shafts, providing access to them for archaeological research.

The enduring investment in salt production is rooted in the fact that salt (NaCl) is a widely useful and important resource. Both humans and animals require some salt intake for health (Heuberger 1994). In addition, through much of history salting was a key method of preserving foodstuffs. Salt was used historically in tanning as well, and it is still used for several industrial processes (Mackwitz 1994). It is thus small wonder that people have for millennia had a great interest in obtaining and trading salt.

There is evidence of salt production by brine boiling at several Iron Age sites throughout Europe (Fries-Knoblach 2002), but there is evidence of salt mining at only two sites in the Austrian Alps. It appears that toward the end of the Iron Age, salt from brine springs and seawater replaced rock salt. In the early Iron Age, however, the mining sites at Hallstatt and Dürrnberg were prosperous settlements. The rich grave goods from Hallstatt are so impressive that in 1874 the Swedish archaeologist Hans Hildebrand dubbed the Early Iron Age (800–475 B.C.) the Hallstatt period (Riekhoff and Biel 2001). Rock salt mining at Hallstatt had been under way since the Late Bronze Age (Barth 1998) and copper mining in the Mitterberg region since centuries before that, so the people of the northeastern Alps had long experience in working below ground. Therefore, when the Celts started salt mining at Dürrnberg in the late sixth century B.C., their mining technology was already quite developed (Stöllner 2003).

Historically, the Iron Age salt mine and settlement at Dürrnberg have received far less archaeological attention than have the area's outstandingly rich Iron Age graves. This situation began to be remedied in the 1990s, however, when an interdisciplinary project headed by the University of Marburg's Thomas Stöllner (now of the University of Bochum) began excavations and surface surveys in and around Dürrnberg with the aim of analyzing the whole economic system of the region (Stöllner 2003).

The geological situation of the northern part of the Hahnrainkopf mountain in the Dürrnberg region provides good conditions for salt mining: here the salt deposits extend from the surface to a depth of 30 to 40 m below ground. Brine springs probably showed ancient miners the locations of the salt (Stöllner 2003). To reach the salt deposits, the Celts cut diagonal shafts down from the surface. They then followed the deposits into the earth, opening mining galleries more than 30 m wide, 5 m high, and around 100 to 150 m long. Several small shoes

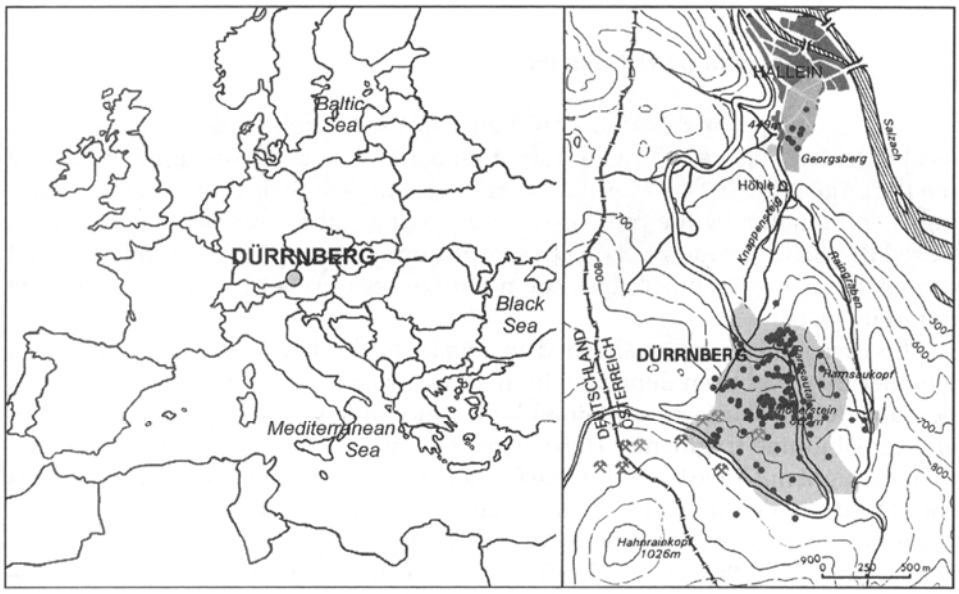

Figure 4-1. *Site location and the settlement area (light gray) according to Pauli (1995) and Stöllner (2002c) with mining entrances in the vicinity (according to Stöllner 2003). Dots represent the locations of graves and settlement features.*

found inside the mines tell us that children were present in the mines as well as adults. The children probably acted as carriers, removing rubble and transporting broken salt to the surface (Stöllner 2003). Children might also have helped the miners by bringing tools, timber, food, and wood (for illumination) into the mine. The extraction of the salt itself must have been done by adults because the heavy pickaxing would have required a great amount of strength.

The mines represented a sizable investment on the part of the local people. Considerable time and effort had to be invested in the mines before they became profitable (Stöllner 2003). For all of the mine workers, both adults and children, a permanent supply of food and raw material would have been needed. Clearly, this was not a poor region; indeed, its wealth is reflected in the rich grave goods found there, such as imports of amber from the Baltic Sea and metal vessels from the Mediterranean (Moosleitner 1991; Pauli 1978; Stöllner 2002a; Zeller 2002). These goods also demonstrate that the Dürrnberg region participated in a well-developed system of trade (Stöllner 2000, 2003).

The Dürrnberg settlement was inhabited not only by miners, their families, and possibly their masters. Excavations have provided evidence of fine metalworking, woodworking, tanning, and butchery (Lobisser et al. 2003; Stöllner 1991; Zeller 1984), indicating that numerous craftsmen and artisans were also part of the Dürrnberg community. The samples of excrement from the salt mine probably represent only the diet of the miners: how representative are they of the diet of the entire community?

Analysis of the Feces

To answer this question I turn to the coprolites themselves. These fecal samples (Figure 4-2) were found embedded in salty waste layers inside the Iron Age mine shafts. Most of the samples had lost their original shape, having been flattened by the pressure of the moving salt formation as over time it closed the ancient mine shafts. Each sample represents a portion of the intestinal contents of a single person; they are not mixtures of several feces, as would be found in a latrine.

The first issue to be established in regard to the Dürrnberg coprolites was whether they had been deposited by the miners or by animals (pack animals or perhaps dogs). The feces contained large amounts of roughage, including several cereal glume fragments. This suggested initially that the foods represented therein might not have been suitable for human consumption, but no conclusions could be drawn without closer examination of the feces' contents.

Fecal content analysis involved dissolving the samples of excrement in warm water and sieving them through a 0.25-mm screen (Boenke 2007). (Samples of the solvent water were taken so that microscopic information would not be lost.) The sieved botanical macroremains were then examined under the microscope at 8× to 40× magnification and identified morphologically. In some cases 40× to 100× magnification was used: this greater magnification was used to look at fibers, cell structures on fruit surface fragments, and cell patterns in cereal grain fragments.

The results of this analysis indicate that the Dürrnberg coprolites are unlikely to have come from animals. Nearly all of the plants represented in the coprolites are cultivated crops or wild fruits; there are no traces of hay or of other forms of animal fodder. This alone could not rule out the possibility that the feces were of animal origin, as pack animals in the mines might have been given unusually high-quality feed to increase their strength. However, more detailed consideration of the feces' contents refuted even this possibility. In addition to the plant material, bone fragments and muscle fibers were discovered in the feces, indicating that they had been produced by an omnivore. Only two nonhuman omnivores were present in the region: dogs and pigs. Dogs could not have produced the feces because the bone fragments in the Dürrnberg samples lacked the sharp broken edges characteristic of bones found in canine excrement (Kowalski et al. 1976), and pigs could not have done so because they would not have been present inside the salt mines. The coprolites discovered in the Dürrnberg mine must be of human origin.

This conclusion is further confirmed by parasitological analysis of the excrement samples (Aspöck 2003). The Dürrnberg feces were infested with eggs of five parasite species: whipworm (*Trichuris trichiura,* present in 98 of 104 samples), roundworm (*Ascaris lumbricoides,* in 47 samples), lancet fluke (*Dicrocoelium dendriticum,* in 5 samples), beef or pork tapeworm (*Taenia* sp., in 3 samples), and sheep liver fluke (*Fasciola hepatica,* in 1 sample). Nearly every combination of species was found in one or more samples. Only five of the 104 samples analyzed showed no signs of parasitic infestation (Aspöck et al. 2001). The parasites identi-

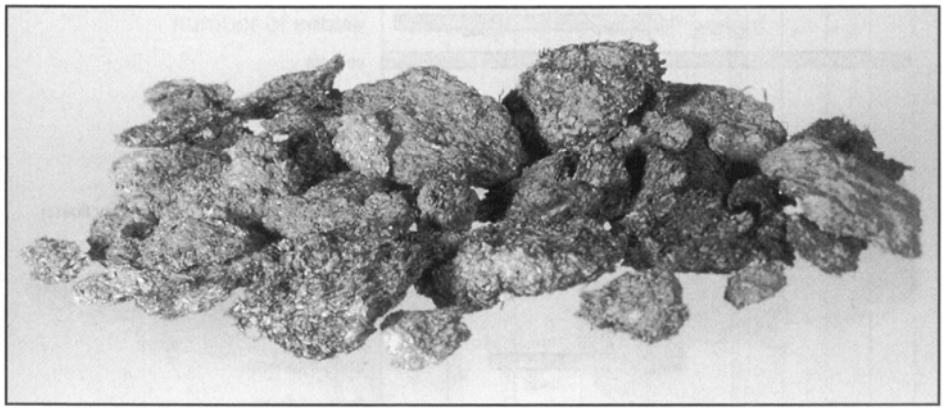

Figure 4-2. *Sample of human excrement.*

fied are not unique to humans: whipworm occurs in dogs and pigs, tapeworms infest cattle and pigs, and sheep liver fluke and lancet fluke primarily affect ruminants. Pigs also get a species of roundworm (*Ascaris suum*) that is very similar to the kind found in humans. No species other than humans is affected by all five of these parasites, however, so their presence in combination in the Dürrnberg samples indicates that the samples are human excrement (Aspöck et al. 2001; Boenke 2007). In sum, there can be no doubt that the feces retrieved from the Dürrnberg mine are human in origin.

Foods Represented in the Feces

The Dürrnberg feces contained thousands of botanical fragments that testify to a varied diet of cereals, legumes, and fruits (Figure 4-3). The staple cereals were hulled barley (*Hordeum vulgare*), broomcorn millet (*Panicum miliaceum*), and spelt (*Triticum spelta*). Horsebean (*Vicia faba*), pea (*Pisum sativum*), and lentil (*Lens culinaris*) were consumed as well, as were fruits such as sloe (*Prunus spinosa*), apple (*Malus sylvestris*), pear (*Pyrus pyraster*), blackberry (*Rubus fruticosus*), wayfaring tree (*Viburnum lantana*), and common hawthorn (*Crataegus monogyna* and *C. laevigata*). Differences in the proportions of these plant materials allow differentiation between certain kinds of dishes (Figure 4-4). In addition, microscopic analysis of the coprolites' contents revealed muscle fibers and little bone fragments in some samples, indicating that meat was also frequently consumed.

Dietary interpretation of the botanical samples cannot be based on the simple counting of plant remains, because human consumption is structured not by seed numbers but by the quantity of fruits or plants from which those seeds came. Different plants have different numbers of seeds in each edible unit (e.g., peaches have one seed per fruit, while blackberries have many). Seeds also vary in weight and size. Therefore, for this analysis the number of seeds in each sample was used to calculate the number of fruits represented in that sample. For example, one ce-

soups were probably the local culinary staple. As Barth (1992) noted, the same ingredients are still used to make *Ritschert*, a dish traditional in the southeastern Alps; this region is well represented in the artifacts found in the Dürrnberg Iron Age graves.

It is problematic to equate modern and ancient cooking practices, however, as our culinary standards may not be those of the past. Despite the high numbers of glume fragments in the Dürrnberg coprolites, the possibility therefore remains that the miners ate their cereals in the form of bread. This possibility is bolstered by a unique find of Iron Age bread from the Ipweger Moor, a bog in northern Germany (Behre 1991). This bread contained high numbers of glumes, especially those of broomcorn millet. Early Medieval bread finds from Sweden also contain numerous glume fragments (Hansson 1995, 1996).

Another issue involving the plants eaten at Dürrnberg is that of meat substitution: might the poorer members of this Iron Age society have relied on protein-rich legumes rather than meat? Analysis of the fecal material proved very interesting on this subject (Figure 4-5). Indications of meat consumption such as bone fragments and muscle fibers are not only very common in the Dürrnberg samples, they also occur in a higher frequency in those samples containing legumes than in those containing just cereals and fruits. Legumes were therefore not used as a substitute for meat. Rather, at Dürrnberg protein-rich foods were consumed together.

As noted previously, Dürrnberg's miners ate not only cereals and legumes but also a variety of fruits. Whereas the cereals and legumes were cultivated, the fruits were gathered from the wild. Fruit cultivation was not practiced in Europe north of the Alps prior to Roman times, several hundred years later (Jacomet and Kreuz 1999). Dürrnberg's fruits were probably gathered on the mountain itself. Wood analysis and soil science surveys indicate an open forest with hedges and bushes in the vicinity of the settlement (Boenke 2007; Stöllner 2003). The fruit species identified in the Dürrnberg coprolites would have flourished in such conditions.

Excrement samples with a high fruit content are dark in color, probably as a result of digested fruit pulp. In these samples, seeds, apple cores, stone cells, and surface fragments are embedded in a black matrix. Numerous such samples were found in the Dürrnberg salt mine, and they reveal that fruits were much more common in the local Iron Age diet than can be proven by archaeobotanical analysis of floral remains from settlements. The settlement assemblages are probably biased by the fact that fruits are less likely to have been charred and therefore preserved than are cereal grains.

It is interesting that Dürrnberg's inhabitants ate not only fruits such as berries and apples, which are widely recognized as delicious; they also frequently consumed the mealy small fruits of the common hawthorn or wayfaring tree, which are seldom found at other archaeological sites. Perhaps this was a matter of necessity. The bulk of Dürrnberg's food must have been acquired through trade, as although agriculture is possible on the Dürrnberg Mountain, there is not enough arable land to support a large community. Sufficient calories and protein could have been obtained by buying cultivated crops, but vitamins would have had to be procured from local sources. Dense human settlement and a limited supply of

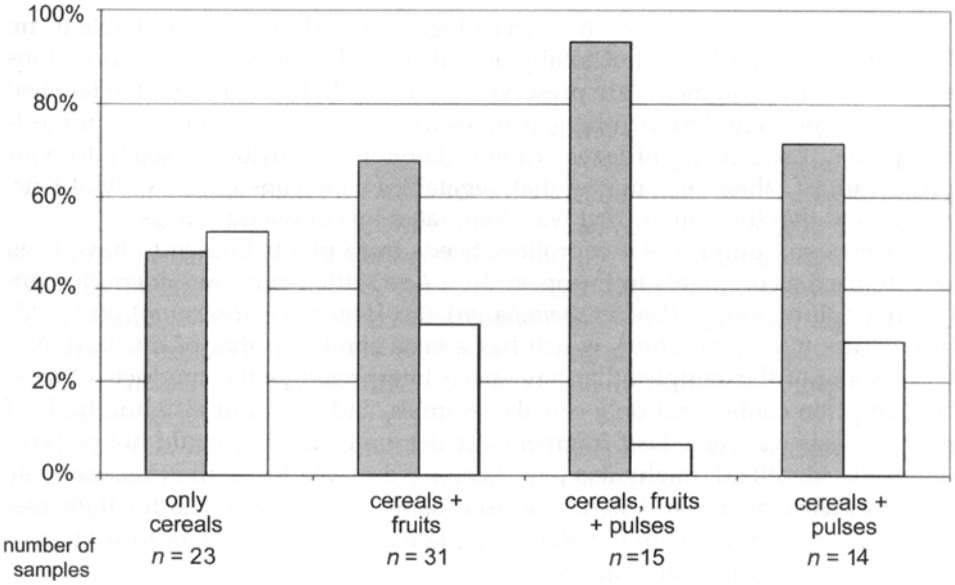

Figure 4-5. *Percentage of samples with indications of meat consumption (presence = gray; absence = white) among feces samples of varying contents.*

wild berries and apples meant that the Iron Age locals had to eat a wide range of fruits, including some that could not be considered conventionally delicious.

The fruit remains also do not support the idea that mining was strictly a cold-weather undertaking. Archaeologists working at Dürrnberg prior to the recent excavations have commonly argued that the ancient miners could have worked only in wintertime, because it is easier to guarantee a continuous air circulation in the deep shafts in cold weather (e.g., Pauli 1995). However, while fruits such as sloes could easily have been dried for year-round consumption, cherries and strawberries are relatively difficult to preserve and were probably eaten in the summer, when they ripened. They do not appear to have been conserved either by drying or by using fat, because they occur only occasionally in the feces, while fruit preservation typically involves larger quantities of material. Strawberries and cherries were therefore probably eaten in the summer, which suggests that the mines were open year-round.

The apparent dietary prominence of wild fruits and hazelnuts (the latter have been found in soil deposits in the mine but not in the feces) is also interesting because the feces contain no root fibers or leaf fragments that would indicate a comparable use of other gathered plants. A common topos in archaeological food studies is that prehistoric cuisines are likely to have included not only cultivated cereals and legumes, which char and therefore preserve well, but also a wide variety of plants that do not char, do not preserve, and therefore cannot be seen archaeologically, such as fruits and vegetables. This might be true elsewhere, but the Dürrnberg feces contain no evidence of vegetables. One explanation could be that leaf fragments and root fibers, especially when they are cooked, are easy

to digest and so do not enter the archaeological record in any identifiable form. However, these parts are not totally absent from the record: on rare occasions even fragile leaf fragments are preserved (Figure 4-3). Furthermore, the few leaf fragments found in the Dürrnberg samples were not unusually large or indigestible pieces. The scarcity of leaves cannot therefore be attributed solely to poor preservation. I therefore suggest that vegetables were consumed rarely at Dürrnberg and that the miners' diet was dominated by cultivated cereals.

Spices were found in the coprolites. Seeds from plants known to have been widely used as oil plants in European Iron Age settlements were identified, including opium poppy (*Papaver somniferum*), flax (*Linum usitatissimum*), and gold-of-pleasure (*Camelina sativa*), which has a taste similar to that of mustard. Notably, some of the samples that have been interpreted as the products of stew consumption contain not only cereals, legumes, and meat but also hundreds of gold-of-pleasure seeds. Leaf fragments, which unfortunately could not be taxonomically identified, might also have been used to add flavor. It is also possible that the Celtic people of Dürrnberg used some leaves and fruits for their medicinal properties; many of the identified plants combat diseases of the digestive system caused by intestinal parasites.

Traces of meat consumption in the coprolites, such as bone fragments and muscle fibers, appear frequently but in small amounts. The low numbers of bone fragments in the feces as well as in other mine deposits appear initially to conflict with the existence of a large faunal assemblage associated with the Dürrnberg settlement, but on further consideration the data present no interpretive difficulty.

Zooarchaeological analysis of the settlement faunal assemblage has demonstrated that cattle were driven up the Dürrnberg Mountain to the village to be slaughtered and that the villagers processed large amounts of beef. The contrast between these data and the scarcity of meat in the coprolites suggests that while cattle were indeed present and butchered on the Dürrnberg, most of the beef (including the best cuts) was probably preserved with salt and traded away. Offcuts might have been all that was usually left for the miners (Pucher 2003; Stöllner 2003).

These meat scraps may well have been cooked in soups. Stewed meat is the easiest form of cooked meat to digest, which is probably why macroscopic finds of muscle fibers are rare. If the miners were eating roasted meat there should have been greater numbers of visible muscle fibers in the samples.

Other archaeological evidence also supports the idea that roasted meat was not a dietary staple. More or less whole bones such as those commonly left after the consumption of roasted meat are rare finds in the Dürrnberg mines. In addition, spits for roasting occur primarily in the same context as do luxury goods, including drinking vessels for imported wine: in graves. Consumption of roasted meat appears to have been reserved for special occasions such as funerals or social situations when it might be used as a sign of wealth.

Since small pieces of crushed bone and microscopic muscle fibers do occur frequently in the Dürrnberg feces (Figures 4-3 and 4-5), we know that the miners did not lack for animal protein. They ate meat regularly, but roasts were probably reserved for trading or for special occasions.

Social Implications

The contrast between the hard work that would have been required of miners and the extremely rich graves in the surrounding area has led to considerable debate about the nature of Iron Age social organization in the Dürrnberg region. Several models have been proposed, ranging from slavery to a romantic picture of a wealthy community of equals (Pauli 1978; Schauberger 1968; Stöllner 1996, 2002a, 2002c). Analysis of the miners' feces sheds light on their socioeconomic status as reflected in their food habits. Socioeconomic position and legal standing are linked but not necessarily congruent, so fecal analysis cannot prove what the miners' legal rights were, although it can hint strongly at their probable place in society.

The mine workers were undoubtedly skilled laborers, rich in technical mining knowledge. The idea that the miners were downtrodden slaves does not accord with the results of analysis of their excrement. Comparison of the Dürrnberg data with contemporaneous archaeobotanical data from other areas in Europe indicates that the miners had access to all of the foods that were common in Iron Age Central Europe (Boenke 2005); they lacked for neither plant foods nor for meat. While their diet might appear tedious to modern eyes, by Iron Age standards they were well fed.

Yet this does not mean that the Dürrnberg miners were particularly wealthy or high-status individuals (cf. Pauli 1978). The individuals buried in the region's opulent Iron Age graves were probably not those who spent their lives hauling salt in the mines. Rich people clearly had access to bronze vessels, weapons, and precious jewelry; they probably had access to luxury foodstuffs as well. Mediterranean imports such as figs and grapes are known from other Celtic settlements (Kreuz and Boenke 2001; Stika 1999), but these fruits do not appear to have been imported to Dürrnberg even for the local elites. Excavators have thus far found only a single grape (*Vitis vinifera* ssp. *sylvestris*) seed at the Dürrnberg settlement, probably from a locally gathered fruit (Swidrak and Schmidl 2002). However, local elites might well have eaten expensive cuts of roasted meat, whereas the miners generally did not. As noted previously, ample quantities of meat were produced at the settlement, but bones associated with high-value (meaty) cuts do not appear inside of the mine, and the miner's feces do not suggest consumption of roasted meat.

The Dürrnberg miners thus were at neither the zenith nor the nadir of Celtic society. Of course, in any complex society there are numerous social positions intermediate between the upper and the lower ends of the social scale. Unfortunately, our knowledge of the possibilities is limited by the fact that there are no indigenous written sources for early Celtic society. Archaeological data in association with contemporary ethnographic accounts by Greek and Roman authors are used to trace the development of Celtic sociopolitical organization from monarchy in the Hallstatt period (800–475 B.C.) to oligarchy and a system of followers, or clients, during the subsequent La Tène period (475–15 B.C.; Dobesch

1996, 2002). The relationship between chieftains and clients was one of interdependence: a chieftain distributed his wealth to clients, and in return clients supported their chieftain in war and in work, stabilizing and increasing his wealth and influence (Dobesch 2002). Sadly, little is known about ordinary Celts, especially their individual rights or status, as the Greek and Roman sources focus on themes of political interest.

The Dürrnberg miners probably participated in this Celtic client system. The miners' work guaranteed the growing prosperity of the settlement, from which it is clear that political elites and/or traders profited. Meanwhile, miners, who could not produce their own food, were provisioned with food and probably furnished with other goods as well. The quality and variety of the foods provided were comparable to those known from other Iron Age settlements. The miners thus shared in the common wealth of the settlement.

Trade, Import, and Social Contacts

In archaeological contexts with limited variation in foodstuffs, it is difficult to assess levels of contact on the basis of food species. Prehistoric diets throughout central Europe were long based on a relatively small range of plant species: after the regional introduction of agriculture in the sixth millennium B.C., few new species appeared for thousands of years (Jacomet and Kreuz 1999). Indeed, apart from a short period of dietary innovation during the Roman era, there was little culinary change for most people in Europe north of the Alps from the Neolithic until medieval times. During the Iron Age, around 500 B.C., people north of the Alps relied mainly on eight cereal species, five kinds of legumes, and three or four kinds of oil plants. Not all of these were actually cultivated, so the number of farmed crops may have been even lower. (Oats, for instance, were morphologically domesticated yet still grew as weeds rather than as deliberately sown crops.) We therefore find very similar cultivated floral repertoires at most Iron Age sites and must seek patterns of regional similarity and difference in relative proportions of species rather than presence/absence lists.

The most common cereals in the Dürrnberg coprolites are barley and broomcorn millet. However, the miners shared a (slight) emphasis on spelt with areas in southwestern Germany (Boenke 2005, 2007): in Baden-Württemberg (Stika 1995, 1999), Rhineland-Palatine (Kroll 2001), and Hesse (Kreuz 1992/1993) spelt was an important crop at a variety of Iron Age settlements. It was rarer in regions nearer to Dürrnberg such as Bavaria (Küster 1995) and Austria. Links to southwestern Germany are further demonstrated by the presence of people from this area in the Dürrnberg graves (Pauli 1978; Stöllner 2002a). Perhaps these people brought their culinary traditions with them when they came to the Dürrnberg region.

The archaeobotanical evidence from the Dürrnberg feces thus confirms the importance of local contacts with southwestern Germany. Culture contact involved not only elites and luxury goods but also commoners and humdrum goods.

Conclusions

Archaeobotanical and parasitological analyses prove that feces found in Celtic salt mines at Dürrnberg are of human origin. Examination of the feces' contents enabled the first archaeological consideration of daily consumption habits at Dürrnberg. The diet of the Dürrnberg miners was based on cultivated plants, mainly cereals: the plants involved were those typical of Iron Age central European sites. The miners also ate fruits and meat. They had a well-balanced diet, but they did not consume luxury foods such as imported fruits or significant quantities of roasted meat. This suggests that the miners were neither slaves nor members of the sociopolitical elite. Long-distance trade did not have a strong influence on the cuisine of ordinary people, but some simple cooking traditions suggest cultural links with particular foreign regions. Finally, the salt miners were kept well supplied with an assortment of foods. This indicates that the local economy involved not only salt mining at Dürrnberg but also agriculture in the surrounding areas and trade at the local as well as the regional scale.

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