tribe and polity in late prehistoric europe

demography, production, and exchange in the evolution of complex social systems

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plenum press • new york and london
Tribe and polity in late prehistoric Europe: demography, production, and exchange in the evolution of complex social systems / edited by Michael N. Geselowitz and D. Blair Gibson.

Based on the proceedings of a symposium held at the 52nd Annual Meeting of the Society for American Archaeology in Toronto, May 9, 1987.

Includes bibliographies and index.

ISBN 0-306-42913-6


Based on the Proceedings of a Society for American Archaeology symposium on Demography, Production, and Exchange in the Evolution of Complex Social Organization in Late Prehistoric Europe, held May 9, 1987, in Toronto, Canada

A Division of Plenum Publishing Corporation
233 Spring Street, New York, N.Y. 10013

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Printed in the United States of America
DIET, STATUS, AND COMPLEX SOCIAL STRUCTURE IN IRON AGE CENTRAL EUROPE:

SOME CONTRIBUTIONS OF BONE CHEMISTRY

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Science, like the course of civilization itself, advances at an accelerating pace. So also does the application of science to the task of unfolding the unwritten history of man’s changing relation to his environment, his advance towards a more complete and rational exploitation of natural resources in the interests of a fuller and more complex social life.
(Clarke 1970:20)

These words by Graham Clark introduced the second edition of a volume exploring the increasing role of interdisciplinary research on archaeological problems, particularly the evolution of complex forms of human behavior and organization. Since 1970, the applications of scientific methods in archaeology have continued to increase in number. In the past decade, methods based on bone composition, including carbon and nitrogen stable isotope ratios in bone collagen and trace element concentrations in bone mineral, have been applied to aspects of diet, subsistence and social structure (work summarized in van der Merwe 1982; Klempinger 1984; Price et al. 1985; DeNiro 1987).

In the continuing spirit of these interdisciplinary adventures, this paper presents the preliminary results of analyses of bone collagen from a small number of human skeletons recovered from the Early Iron Age (Hallstatt period) cemetery of Magdalenska gora in Slovenia, Yugoslavia. We propose that such results are useful in attempts to understand the nature of social structure in the early Iron Age. The number of samples analyzed is too small to address the evolution of the system in this paper, but in keeping with the diachronic and processual orientation of this volume suggestions are made concerning the applications of the method to a broader context. It is hoped that the promise of this endeavor will be apparent.

The Problem

The Early Iron Age (800-400 B.C.) in central Europe was characterized by the emergence of large defended commercial and industrial settlements associated with tumulus cemeteries of considerable complexity. Recent research has stressed the importance of the dynamics of subsistence and

Reconstructions of the social structure based on the traditional methods of archaeological mortuary analysis are varied. This is true in particular for southeastern central Europe and the earliest emerging Hallstatt period commercial and industrial centers. While certain similarities show that contact existed between the West and East Hallstatt period communities, differences in material culture and burial ritual distinguish the West (southern Germany, northern Switzerland and eastern France), and the East (alpine Austria, Bohemia, East Germany, Poland and Slovenia) Hallstatt culture areas. Recent research on the general Hallstatt phenomenon across central Europe has either stressed or deemphasized these differences.

Wells (1985) has stressed the differences in the presence of imports, burial placement within the tumuli, and inequalities in the quantities and kinds of burial offerings between the western and eastern Hallstatt culture areas. Based on these differences he suggested that positions of status in Slovenia were less clearly defined and structured than in the West. The "clan" or "family" tumuli of Slovenia (Gabrovček 1974) are characterized by a continuum of burial wealth. This has been interpreted as an expression of fairly equal access to goods (Wells 1981). Those few graves that contain diverse burial goods are found spread among all tumuli. Wells proposed a model of enterprising family heads of equivalent status who were able to use their personal abilities to organize and be catalysts to increased production for personal and community gain, but who differed little in status from their contemporaries (Wells 1981).

A contrary interpretation was proposed by Bintliff (1984) who emphasized certain similarities that exist in the burial structures of the West and East Hallstatt culture areas. For example, the Great Tumulus at Štična, Slovenia, one of the few such structures in the East excavated by modern methods, contained a circular pattern of burials surrounding a central core. Though the core at Štična was empty, Bintliff compared the circular interment pattern to that of the Magdalenenberg tumulus in southwest Germany, whose central burial, while plundered in antiquity, contained the remains of a wagon and horse trappings, considered to be high status burial goods. Based on this similarity, Bintliff suggested the existence of a strict hierarchy of status levels in Slovenia similar to that apparent in the burial structures of the West Hallstatt culture area.

Biba Teržan (1985) defined distinct status groups in a similar fashion in Slovene cemeteries. Based on the presence of weapons or iron knives as male burial goods, and rings or beads as female goods she identified several groupings at Magdalenska gora. The group of highest status and power according to Teržan was made up of warriors, who by the late Hallstatt period had fragmented into five distinct sub-groups identifiable by the combination of various weapons in the burials. The leading sub-group was characterized by a full complement of two spears and an axe, and was the group from which the leading high status individual, the "prince" and "patrisfamilius" emerged (following Teržan 1985: 100).

It is apparent that contrasting approaches to the burial data have produced differing interpretations of the social structure: either the status differences among community members were slight and informal, or the status differences were marked and formal. A method independent of traditional mortuary analysis is needed to test these inferences. As Ian Hodder (1982) has argued, the burial ritual should be seen as a transformation rather than as a clear mirror of the status and life of the
individual. It is perhaps useful in this context to look at evidence concerning the life of that individual rather than the death!

The Materials

As an independent test of the contrasting interpretations of early Iron Age social structure in Slovenia, a sample of human skeletons from Magdalenksa gora were selected for analysis of certain aspects of bone composition. Magdalenksa gora, a hillfort and associated tumulus cemetery, is located along the Sava River in the hilly pre-alpine region of north-western Yugoslavia. The settlement is as yet unexplored, however between 1908 and 1913 at least nine of the large tumuli were excavated with considerable enthusiasm by the Duchess Paul Friedrich of Mecklenburg. The Duchess, an ardent amateur archaeologist and wife of the Prussian duke, explored the prehistoric monuments on her ancestral lands of Carniola, modern day Slovenia. After her death the material eventually passed to an auction house in New York, and was finally purchased by the Peabody Museum in two stages, in 1934 and 1940. Most of the material, encompassing 359 burials, is preserved in the Mecklenburg Collection of the Peabody Museum at Harvard University (Hencken 1978).

The Duchess did not systematically collect the human remains from her investigations. Angel (1968) was able to determine the sex and general age group of only 32 individuals from Magdalenksa gora, 20 of which have secure grave contexts. These 20, comprising 5 females and 15 males from Tumuli IV, V, and X, were selected as the sample for analysis of stable carbon and nitrogen isotope ratios in bone collagen.

Regrettably, skeletal remains from the richest and most diverse burials of the cemetery, such as the "situla grave," Grave 6-7-7a in Tumulus V, and the "horse burial." Grave 29 in Tumulus X, are not preserved. Nevertheless, the 20 burials available have parameters that are potentially significant in studying the pattern of diet and status groups. These include sex, age, presence or absence of weapons, presence or absence of grave goods, and tumulus membership.

The burials range in date over a period of 400 years, but due to the small size of the sample all individuals are considered as a single cohort. The effect of this discrepancy is reduced by the fact that nearly all of the dateable burials (9 of 13) cluster in the latest phase (Negau, 450-300 B.C.) of the Slovene early Iron Age (Hencken 1978).

In order to reconstruct aspects of human diet it is necessary to know the items that constitute the daily subsistence of the community (Bumsted 1984). This includes the plant and animal resources exploited and their respective isotopic compositions. Such information from Magdalenksa gora and the surrounding area is not available. Few analyses of nitrogen and carbon stable isotope ratios in faunal bone collagen or in plant material have been performed on European material. In general, the few data have been restricted to the reconstruction of marine and terrestrial components of the diet of prehistoric coastal populations in Denmark (Albrechtsen & Brinch Petersen 1977; Tauber 1981).

Information gathered from other sites across Europe, however, indicates that the people of the European Iron Age exploited a wide range of domestic and wild species. Animal resources included cattle, sheep and goat, pig, dog and horse, red and roe deer, boar and various other small wild animals, fowl and small quantities of aquatic foods (Amschler 1939a, 1939b; Boessneck 1971; Boessneck & Stork 1972; Bökonyi 1974; Clason 1979; Benefit 1983; Bartosciwicz 1985). An assemblage of animal remains,
including cattle, sheep/goat, pig, horse, dog, feral pig, beaver and hare (identified by G.P. Greis, Harvard University), from the early Iron Age settlement of Altdorf, Bavaria, West Germany (Wells 1986) were analyzed in order to approximate the isotopic composition of the faunal contribution to the early Iron Age diet. These fauna are comparable to those we would expect to find at Magdalenka gora. Furthermore, the similarity of the two sites in terms of latitude and period of occupation support the assumption that fauna from Altdorf will have bone collagen stable isotope compositions representative of fauna exploited by the Magdalenka gora community.

Floral remains from early Iron Age contexts in central Europe include cultivated wheats, barleys and millet, supplemented by oats and rye, legumes and small amounts of collected wild fruits, nuts, grasses and leafy plants (H. Werneck 1961; Hofmann 1964; W. Werneck 1970; Knörzer 1971, 1980; van Zeist 1975; Körber-Grohne 1981; Quillian 1983). The isotopic compositions of European plant remains have yet to be studied systematically. Nearly all of the domesticated species, however, have been tested from other contexts (Bender 1968; Smith & Epstein 1971), and carbon isotope ratios for other species are available in the journal Radiocarbon. These published values are used to approximate the carbon stable isotope composition of the floral contribution to the early Iron Age diet. Nitrogen isotope ratios for European plants, however, have not been published. In order to reconstruct the nitrogen stable isotope composition of the plant diet it will be necessary to analyze these plants. This work is in progress in the Bone Chemistry Laboratory at Harvard University.

The Method

The method used to address the problem of social structure in burial contexts has two working bodies of method and theory: a body of mid-range anthropological theory concerning status and diet in complex society, and bone chemistry.

Explicit in the body of anthropological theory concerning the evolution of formalized status and rank groups in complex society are mechanisms of social differentiation, or sumptuary laws, which legitimate, regulate and differentiate the behavior of status groups (Childe 1951; Fried 1967; Service 1971, 1975). These mechanisms are often in the form of dietary privileges (Service 1971). Ethnographic and archaeological research from North America, Mexico and Africa (Oberg 1940; Spores 1965; Haviland 1967; Hatch & Willey 1974) has documented complex societies where status distinctions involved preferential access to foods of greater nutritional value, often including stock or hunting produce.

Such mechanisms of social differentiation through unequal access to subsistence products are implied for Iron Age Europe (Frankenstein & Rowlands 1978; Wells 1980), although direct archaeological evidence of these mechanisms is ambiguous. This may be due primarily to the paucity of well-excavated settlements with clearly defined elite structures and carefully recorded floral and faunal remains (for a discussion of this general problem in the West Hallstatt culture area see Härke 1979). A study of animal remains from Hallstatt period burials (Koreisl 1934) suggests that hunted animals may have been placed in the tombs of select individuals; perhaps this is a hint of the privileged access to game animals which was to become more pronounced by the early Middle Ages (for example Müller 1973). For a society with strict status distinctions dietary evidence of these mechanisms would be expected. Conversely, for a society where status distinctions were not formally maintained, evidence of a more homogeneous diet would be expected.
Bone stable isotope chemistry involves the analysis of stable isotope ratios of carbon and nitrogen in the organic portion of bone (collagen). These ratios are compared to standards and are expressed as delta values (delta 13C and delta 15N) in parts per thousand (o/oo) as shown below.

For a more detailed presentation of this method see Price et al. 1985: 429-431.

The underlying principle of stable isotope analysis is that the stable carbon and nitrogen isotopic composition, or signature, of the diet of an animal determines the carbon and nitrogen isotopic signature of that animal's bone collagen (DeNiro & Epstein 1978, 1981). In archaeological terms, what an animal consumed in life remains recorded in the bone collagen after death.

Significant food groups can be recognized by their isotopic composition (DeNiro and Epstein 1981; van der Merwe 1982). A variety of tropical grasses (referred to as "C4" plants), including important domesticated crops such as maize and millet, utilize CO2 during photosynthesis in a more efficient manner than do most plants (the so-called "C3" plants) (O'Leary 1981). This greater efficiency results in stable carbon isotope ratios which are more positive than those found in "C3" plants (Bender 1968; Smith & Epstein 1971; Downton 1975; Raghavendra & Das 1978; Burleigh et al. 1984). "C4" plants have an average delta 13C value of -12.5o/oo; the mean value of "C3" plants is about -27.0o/oo (Price et al. 1985). Numerous studies have taken advantage of this difference to test hypotheses about prehistoric human dependence on maize (Vogel & van der Merwe 1977; van der Merwe & Vogel 1978; Bender et al. 1981; DeNiro & Epstein 1981; Price & Kavanaugh 1982; Farnsworth et al. 1985; Schwarcz et al. 1985).

A compilation of plant stable carbon isotope ratios from the journal Radiocarbon shows that Europe is a largely homogenous "C3" plant regime with an average delta 13C value of -25.2o/oo (Burleigh et al. 1984). One plant found on Iron Age European sites is an exception. This is millet, a tropical grass which is present in small quantities on sites in central Europe by the late fifth millennium B.C. (Barker 1985). Bender's (1968) analyses of several millet species (Panicum sp. and Setaria sp.) yielded results with a mean delta 13C value of -14.3o/oo. Thus far, millet appears to be the only "C4" plant of any importance for human subsistence during the European Iron Age.

Certain food groups have similar isotopic signatures and thus are difficult to distinguish on the basis of stable isotope ratios. For example, marine plants and organisms have relatively positive stable carbon isotope ratios, and therefore 'mimic' the isotopic signatures of "C4" plants in the diet of their consumers (Tauber 1981; Chisholm & Nelson

\[
\text{delta 15N} = \left( \frac{\text{15N/14Nsample}}{\text{15N/14Nstandard}} \right) - 1 \times 1000 \text{ o/oo}
\]

\[
\text{delta 13C} = \left( \frac{\text{13C/12Csample}}{\text{13C/12Cstandard}} \right) - 1 \times 1000 \text{ o/oo}
\]

The standard for delta 13C measurements is the PeeDee belemnite (PDB) carbonate, while that for delta 15N measurements is atmospheric (AIR) nitrogen.
1982; Chisholm et al. 1983; Hobson & Collier 1984; Schoeninger & DeNiro 1984). The presence of these "rival" food groups must be carefully considered in dietary analysis.

Recent studies compiling nitrogen isotope ratios have suggested that these ratios may be used to discriminate between organisms in different trophic levels (Schoeninger & DeNiro 1984, Schoeninger 1985). One potential complication, however, is the fact that marine foods have stable nitrogen isotope ratios that are more positive, on average, than those ratios in terrestrial foods. For this reason marine foods can have stable nitrogen isotope ratios similar to those in terrestrial foods obtained from upper trophic levels. In the absence of marine components in the diet, however, nitrogen stable isotopes may be useful in indicating the relative consumption of animal products, such as meat, milk and blood.

Bone collagen was extracted from 20 humans and 9 animals using the procedure presented by Schoeninger & DeNiro (1984). The collagen was combusted using a modified version of the Stump and Frazer method (Northfelt et al. 1981). The carbon dioxide and nitrogen gases were purified and separated in a vacuum system using cryogenic distillation. The isotope ratios were then determined by mass spectrometry.

Results

The results of the stable isotope ratios of the fauna and human bone collagen are listed in Table 1 and are summarized in Figure 1. A distinct separation of the nitrogen isotope ratios from the human and animal sample populations is obvious, thereby illustrating the "trophic level effect" (Schoeninger 1985). The only meat eating animal sampled, the dog, falls within the range of the humans (delta 15N = +9.30/oo. This suggests that the nitrogen stable isotope ratios obtained may be helpful in reconstructing the relative quantities of animal products present in individual diets. Although we recognize that camp dogs are not complete carnivores, the difference in delta 15N values between the herbivorous faunal sample and that of the dog probably reflects the ingestion of animal products on the part of the dog. Among the human samples, the results cluster with the exception of one old aged male, who occurs within the range of the herbivorous fauna. This anomaly is discussed in more detail below.

<table>
<thead>
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<th>Table 1. Symbols</th>
</tr>
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<tr>
<td>#: $G =$ genus (for Altendorf)</td>
</tr>
<tr>
<td>#: $Gr =$ tumulus and grave (for Magalenska gora)</td>
</tr>
<tr>
<td>#: $col =$ Percent (by weight) collagen extracted from each sample</td>
</tr>
<tr>
<td>#: The values given represent averages of two determinations of the stable isotope ratios, with the exception of the delta 13 value given for sample #NS2627 which is the average of three determinations. Replication of the delta 13C values was achieved to within an average of 0.30/oo; replication of delta 15N values was within an average of 0.40/oo.</td>
</tr>
</tbody>
</table>

Key: $ & graves with weapons |
<p>| #: graves without goods |</p>
<table>
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<th>Sample</th>
<th>G/Gr</th>
<th>sex</th>
<th>age</th>
<th>%col</th>
<th>C/N</th>
<th>delta13Cδ</th>
<th>delta15Nδ</th>
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<td></td>
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</tr>
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<td>2611</td>
<td>Doe</td>
<td>5.3</td>
<td>2.7</td>
<td>-20.9±.029*</td>
<td>4.0±.020</td>
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<td>4.9±.038</td>
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<td>12.6</td>
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</table>

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Figure 1. Plot of the stable isotope ratios of carbon and nitrogen in bone collagen from faunal and human skeletons. The human samples were collected at the early Iron Age site of Magdalenka gora in Slovenia, Yugoslavia. The faunal samples were recovered from the site of Altdorf in Bavaria. As discussed in the text these animals should be representative, both isotopically and in adaptation, of the fauna exploited by Iron Age inhabitants of Magdalenka gora. Note especially the relatively positive delta 13C values of the human samples as compared with the fauna. The faunal values reflect the "C3" environment expected in Europe. The human values represent an ingestion of approximately 60% "C4" based food. Two faunal samples (hare with delta 13C = -16.60/o/oo and dog with delta 13C = -18.00/o/oo) also have relatively positive carbon isotope ratios. In terms of nitrogen isotope ratios the human sample has delta 15N values that are, on average, about 40/o/oo more positive than the fauna. The dog (at +9.30/o/oo) falls within the human range. A single old aged male with extremely low carbon and nitrogen stable isotope ratios (delta 13C = -20.00/o/oo, delta 15N = +5.40/o/oo) clusters with the herbivores. Levels of precision: delta 13C = ±0.1, delta 15N = ±0.3.

Because marine foods in the diet can 'mimic' the ingestion of animal products as discussed above, it is important to consider their potential contribution to the diet at Magdalenka gora. The site lies along the Sava River over 80 kilometers inland from the Adriatic Sea. For this reason alone, it is unlikely that marine resources would have been available to the early Iron Age community. Anadromous fish, such as the large European sturgeon (Acipenser sturio), are the only possible exception to this. Sturgeon were once common in the Danube and its tributaries during the spring (Clark 1948; Grzimek 1973). Even so, remains of sturgeon have not been reported among the fish species recovered from Iron Age sites on the Danube (for example Gornolava, Clason 1979). Thus, it appears unlikely that sturgeon were an important component of the prehistoric diet.

The nitrogen isotope composition of freshwater regimes has not been studied sufficiently (Price et al. 1985), but the few data available (Schoeninger & DeNiro 1984) suggest that their isotopic signatures are similar to other terrestrial fauna. The carbon isotope evidence from...
several studies in North America indicate that freshwater fish and mollusca may be characterized as "C3" food sources (van der Merwe & Vogel 1978; Bender et al. 1981; Chisholm & Nelson 1982). Perhaps more important for our study, though, is the recent analysis of faunal remains from the early Iron Age site of Most na Soči in Slovenia (Bartosiewicz 1985) which suggests that the swift rivers of the region were rarely exploited as food sources.

Discussion: Diet

The relatively positive carbon stable isotope ratios of the human samples are surprising. Delta 13C values recorded for human samples from Europe have an average of -19.50/oo with a range from -17.20/oo to -24.60/oo (Burleigh et al. 1984) which reflects a diet based on "C3" foods, as expected. The Magdalenska gora humans have bone collagen stable carbon isotope ratios that are considerably more positive. Since marine and aquatic resources were probably not significant contributors to the diet, the high carbon values should be due either to the consumption of "C4" plants or of animals consuming "C4" plants. The faunal sample set (excluding the dog and the hare) has an average delta 13C value of -21.20/oo and a range from -19.60/oo to -21.90/oo. These stable carbon isotope ratios show clearly that the animals were not feeding on "C4" plants. Since it is unlikely that dog and hare accounted for the major portion of human diet, the relatively positive delta 13C ratios of the humans are apparently due to a large proportion of "C4" plants in the vegetable diet. Broomcorn millet, Panicum miliaceum, is the only domesticated "C4" plant identified for Iron Age Europe. The less common Italian millet, Setaria italica, occurred probably only as a weed of cultivation (Renfrew 1973).

An approximation of the percentage of millet in the diet may be obtained by using a modification of the formula presented by Schwarzc et al. (1985). For this purpose a delta 13C value for millet of -14.30/oo has been used (based on Bender 1968). The mean of the values published by Bender (1968) for the "C3" European domesticates, including wheats, barleys and oats, was used as the average for the "C3" plant contribution to the diet. This value (-27.60/oo) is somewhat less positive than generalized values used in other studies (-26.50/oo, van der Merwe & Vogel 1978; -26.00/oo, Schwarzc et al. 1985). A fractionation, or enrichment, value of +50/oo between food and bone collagen of the consumer has been used based on van der Merwe & Vogel (1978). The average delta 13C value in the human sample (-14.70/oo) from Magdalenska gora requires approximately 60% "C4" plants in the vegetable diet, with a range among the human samples from a low of 20% (delta 13C measured in bone collagen = -20.00/oo) to a high of 72% (delta 13C = -13.00/oo). These estimations appear to contradict the traditional interpretation that the two most important cereal crops in Iron Age Central Europe were wheat and barley (e.g. Barker 1985).

As a hardy, small grained cereal with a very short growing season and high tolerance for poor soils and little water (Renfrew 1973), millet was

\[
\frac{X - \text{delta 13C} - r}{\text{delta 13C} - \text{delta 13C}}
\]

Where X= the measured delta 13C value, delta 13C= the value of the "C3" diet, delta 13C= the value of the "C4" diet, and r= the fractionation value. We have substituted a negative sign in front of 'r', where r= +50/oo (contra Schwarzc et al. 1985, who use r= -50/oo).
ideally suited to cultivation in central Europe as a spring crop (Barker 1985). The delta 13C values obtained in this study suggest that the productivity of this crop may have been great enough to make millet a staple crop for some communities. It is of interest to note that in the first century A.D., Pliny recorded that the Sarmatian tribes, who occupied what is now part of Poland and the Soviet Union, subsisted largely on a porridge made of millet (cited in Renfrew 1973). Similarly, the Greek geographer Strabo (63? B.C.- A.D. 21?) described the Iapodes of the rugged southeastern Alps as cultivators of spelt wheat and millet (Book VII, chapter V/4).

The clustering of the dog values with the humans is a phenomenon that has previously been noted for Northern Europe (Noe-Nygard 1986) and South America (Burleigh & Brothwell 1978). This is certainly a result of the symbiotic relationship between humans and dog in that the "site-bounded attachment of the dog" (Noe-Nygard n.d.) led it to share in the human diet.

The hare exhibits the highest delta 13C value of the faunal complement, well within the human range, and suggests that a large proportion of the hare's diet consisted of "C4" plants. Barring the presence of as yet unidentified "C4" grasses in Europe, it is tempting to see this as the result of the hare's nocturnal forays into the community's millet fields in the spring and early summer, whereupon it was finally captured and added to the "menu" of the early Iron Age community.

The anomalously low delta 13C (-20.0/o/oo) and delta 15N (5.4/o/oo) values of the individual from Tumulus IV, Grave 30, indicate that the old aged male's diet was similar to the Altdorf herbivores. On the basis of one individual it would be unwise to generalize about old age status and diet at Magdalenska gora. According to Angel (1968), the individual's teeth were in good condition and only moderately worn, so that dental health in this case should not have inhibited the intake of animal protein through meat consumption. It is more likely that the diet was related to certain cultural choices.

Discussion: Status and Diet

For the consideration of status and diet, the delta 13C and delta 15N values of the Magdalenska gora sample are compared to several basic sample parameters to ascertain the presence of any patterns among the stable isotope ratios that could be indicative of status differentiation. These parameters are sex, age, presence or absence of weapons in the male burials, presence or absence of grave goods in all burials, and tumulus membership.

The most obvious pattern in Figure 2 is the smaller range of variation among females for both stable carbon and nitrogen isotope ratios than is observed for the sample of males. Although the apparent difference may be attributable to the small size of the female sample, the pattern suggests that females may have had a more restricted and homogenous diet. Furthermore, the ranges of the delta 15N values suggest that the consumption of animal products was more variable among men, with certain males of the community consuming more than any females. The most positive delta 15N value among the males is +10.6/o/oo, a value nearly 1o/oo more positive than the highest value among the females (+9.7o/oo). At the low end of the range, there is little difference; the least positive value in a male is +8.6/o/oo while that in a female is +8.7/o/oo. The values in the male sample are more positive, on average, than those in the female sample (male \( \bar{x} = +9.7o/oo \), excluding Tumulus IV, Grave 30; female \( \bar{x} = +9.3o/oo \))
Figure 2. A comparison of bone collagen stable isotope ratios of carbon and nitrogen between males and females from Magdalenka gora. Note the group of six males who have more positive delta 15N values than any of the females. These values suggest greater ingestion of animal products on the part of these males relative to females. Furthermore, note the three males with relatively more negative delta 13C values signifying less "C6" foods in the diet than was true for most of the sample. The old aged male with anomalously low delta 13C (-20.00/oo) and delta 15N (+5.40/oo) values is not included in this graph. Levels of precision: delta 13C = ±0.1, delta 15N = ±0.3.

but these differences are not significant statistically (t = 1.33, df = 17, not significant at p < .05).

The difference in variability between males and females is even more extreme in the ranges of the delta 13C values. The range of stable carbon isotope ratios within the male sample, excluding the old aged male IV/30, is over 40/oo (-17.5 to -13.00/oo) whereas within the female sample it is less than 10/oo (-14.6 to -13.80/oo). It is interesting to note that the less positive delta 15N values (+8.7 to +9.70/oo) among males are associated with the complete range of delta 13C values. Whereas the more positive delta 15N values (>9.7 to +10.60/oo) are associated with delta 13C values more positive than -14.70/oo. These data suggest that those males who had access to more animal products (indicated by the more positive delta 15N values) also had more millet (indicated by the more positive delta 13C values). This is a difference of averages only, since there are males whose bone collagen delta 13C values are relatively positive, yet their delta 15N values are relatively negative. Among the female sample, the relatively positive delta 13C values (all above -14.70/oo) are associated with less positive delta 15N values (all below +9.70/oo). An explanation for this pattern is not obvious.

In Figure 3 the carbon and nitrogen stable isotope ratios are summarized by age and sex groups. All the females were young adults and for this reason determination of variability across age groups in the female sample is not possible. The single old aged male (delta 13C = -20.00/oo; delta 15N = +5.40/oo) is excluded from this graph. Among the other males there appears to be a pattern of less positive delta 13C and
Figure 3. A comparison of bone collagen stable carbon and nitrogen isotope ratios among groups defined by age and sex. Females (all young adults) fall in the lower end of the range of delta 15N values. There is some suggestion of a tendency toward more positive delta 15N values in young adult males (indicating more animal products in their diets) as compared with middle aged males. There is however considerable overlap, and the means are similar (young adult male $\bar{x} = +9.90^{\circ}/oo$; middle aged male $\bar{x} = +9.60^{\circ}/oo$). The old aged male with extremely low delta 13C ($-20.00^{\circ}/oo$) and delta 15N ($+5.40^{\circ}/oo$) values is not included in this graph. Levels of precision: delta 13C $\pm 0.1$, delta 15N $\pm 0.3$.

more positive delta 15N values for these young adult males relative to their middle aged seniors and the females. While not statistically, the differences of the averages for the young adult and middle aged males appear to suggest the consumption of more animal products by the young adult males. The old aged male apparently subsisted on a diet of grain and vegetables containing only a small percentage of "C4" plants.

For the remaining parameters, a comparison of carbon ratios fails to reveal any obvious patterns. Some males of both young adult and middle-age status were interred with weapons, including iron axes and spears, and in one instance a bronze helmet (Tumulus IV, Grave 3). A comparison of the nitrogen stable isotope values for "warriors" and "non-warriors" (Figure 4) indicates no significant differences between the two groups. Excluding the old aged male, IV/30, the respective delta 15N means are $+9.60^{\circ}/oo$ and $+9.80^{\circ}/oo$ ($t = 0.65$, df $= 12$, not significant at $p \leq .05$). The ranges of the values are also similar. This suggests that there were no diet distinctions between men interred with weapons and those buried without them. Among the "warriors" there is also no significant isotope difference correlating with weapon type or certain combinations of weapons.

3 Delta 13C: Young adult male $\bar{x} = -14.80^{\circ}/oo$; middle-aged male $\bar{x} = 14.30^{\circ}/oo$; female $\bar{x} = -14.20^{\circ}/oo$.

Delta 15N: Young adult male $\bar{x} = +9.90^{\circ}/oo$; middle-aged male $\bar{x} = +9.60^{\circ}/oo$; female $\bar{x} = +9.30^{\circ}/oo$.

4 delta 13C: $t = 0.83$, df $= 12$, not significant at $p \leq .05$; delta 15N: $t = 1.11$, df $= 12$, not significant at $p \leq .05$. 

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Figure 4. A plot of stable nitrogen isotope ratios in bone collagen from individuals identified as 'warriors' and 'non-warriors'. With the exception of the old aged male identified as a 'non-warrior' (not included in this graph, delta 15N = +5.40/oo), there appears to be no difference between the two groups. Level of precision: delta 15N = ±0.3.

A similar pattern (or lack of pattern) is present in Figure 5, which presents a comparison of the nitrogen stable isotope values of those individuals interred with grave goods and those buried without. This figure includes individuals of both sexes and age groups. The average delta 15N values of the two groups, excluding the old aged male, are nearly identical at +9.60/oo and +9.50/oo respectively, as are the range of values (c = 0.38, df = 17, not significant at p ≤ .05). Apparently there was no correlation between access to animal foods during the life of an individual and the placement of "wealth" in the form of burial goods upon that individual's death.

Figure 5. A plot of stable nitrogen isotope ratios in bone collagen from individuals buried with and without grave goods. With the exception of the old aged male who was buried with grave goods (not included in this graph, delta 15N = +5.40/oo), there appears to be no difference between the two groups. Level of precision: delta 15N = ±0.3.
So far, in considering the entire sample from all tumuli, tentative distinctions in diet between the sexes and age groups have appeared while little correlation has been found between diet and material culture in the burials. When the sample is divided by tumulus membership in Figure 6 a different pattern appears. All of the individuals with delta 15N values that are more positive than +9.70/oo were recovered from Tumulus X. There is also evidence of greater variability in diet (evidenced by a larger range of variation in both carbon and nitrogen isotope values) in Tumulus X relative to Tumulus IV. The difference between the means from Tumulus X (delta 13C = -14.30/oo, delta 15N = +9.70/oo) versus Tumulus IV (delta 13C = -14.90/oo, delta 15N = +9.40/oo, not including the old aged male) is not significant statistically either for the delta 15N values (t = 1.03, df = 16, not significant at p ≤ .05) or the delta 13C values (t = 1.05, df = 15, not significant at p ≤ .05). Even so, the average delta 15N values differ in the direction suggesting less intake of animal protein on the part of members of Tumulus IV.

There are no significant differences in the material culture between the tumulus burials: all time periods, each sex, and each age group are represented as well as "warriors" and "non-warriors," and "wealthy" and "poor" graves. Yet there is some indication that the males of the clan or familial group identified with Tumulus X had preferred access to and consumption of animal products relative to the members of Tumulus IV. The results reported above show that this access cannot be correlated with differences in material culture or the inferred roles of individuals on the "inter-tumulus" or "intra-tumuli" level, nor is it explained by the distribution of females or of age groups in the tumuli. It may be tentatively explained by suggesting that, separate from aspects of material culture in mortuary contexts, mechanisms of social status differentiation were at work involving dietary restrictions or rules that served to separate members of different clan or family groups. Whether this involved the differences in family herd size, land on which to hunt, or preferential treatment during feasting is not clear.

![Graph](image)

**Figure 6.** A plot comparing the nitrogen stable isotope ratios in bone collagen of Magdalenka gora inhabitants who were interred in different tumuli. Note that none of the individuals from Tumulus IV have delta 15N values as positive as a large proportion of the individuals from Tumulus X. The old aged male with the extremely low delta 15N value (+5.40/oo) from Tumulus IV is not included in this figure. Level of precision: delta 15N = ±0.3.
Summary and Discussion

The stable carbon isotope ratios in bone collagen from the Magdalenska gora sample indicate the presence of a high percentage of "C4" plants, probably millet, in the vegetable diet of people living in Slovenia during the Hallstatt Iron Age. Whether this was a local adaptation or a characteristic of all central European communities awaits future studies of other populations. A more thorough knowledge of the isotopic compositions of plants in Europe is necessary in order to verify the place of millet as the solitary "C4" plant. As part of this on-going study, a selection of modern plants from central Europe has been sampled (S. Gregg, pers. comm.) and awaits analysis in the Bone Chemistry Laboratory at Harvard University.

The nitrogen isotope analyses indicate that there was no correlation between grave wealth or individual function and meat consumption. This could be seen to support Peter Wells' interpretation that there was little status differentiation among members of the community. However, the apparent difference in the consumption of animal products between two tumuli at Magdalenska gora suggests that the second aspect of this model, that there were no status differences between family groups, may not be accurate. It appears possible that status recognition, at least in terms of access to the products of the hunt or herd, may have been a function of family or clan membership.

The interpretations presented here are preliminary and tentative. A sample of 20 individuals from a cemetery that may have contained around 1800 burials (Wells 1981) is too small to provide more than suggestions for future investigation. Sample bias may result from the absence within our sample of any burials traditionally interpreted as those of individuals of the highest status based on object counts and diversity of grave goods.

Furthermore, the assumptions made in the use of Bavarian material to approximate the isotopic composition of the faunal component of the diet need to be tested by the analysis of Slovene faunal remains. In addition, the results of the nitrogen stable isotope analyses will be compared to the results from trace element analyses of the Magdalenska gora sample to test the estimations of meat consumption. Recent studies have shown the utility of the analysis of strontium and related trace elements in human mineral bone in the reconstruction of the meat component of the human diet (Schoeninger 1979a, 1979b, 1981; Blakely & Beck 1981; Peebles & Schoeninger 1981; Price & Kavanaugh 1982).

The method presented here is ideal for sites with excavated floral and faunal remains and associated burials; it stresses the need to appreciate the importance of the recovery of these food remains. There is promise in the integration of recent scientific advances with a program of museum and field work concerning the building of a research design to investigate the social organization of early Iron Age communities in particular, and of complex societies in general. This method could be applied in a diachronic perspective to skeletal collections in which the temporal and spatial patterns and burial contexts of a large number of graves are precisely known. The site of Mauenhain in Baden-Württemberg, West Germany, discussed in the paper by Bettina Arnold (this volume) would be an excellent focus for research. The approach will be complemented by future developments in the building of a body of middle range theory concerning the interpretation of mortuary practices.
It is hoped that the method presented here will provoke discussion and further interdisciplinary research into unlocking the information latent in museum and field collections that may illuminate the nature and development of complex society. To return again to the words of Graham Clark (1970:19):

The knowledge to be won by investigating the physical remains of early man far transcends the biological level....in sometimes unexpected ways it throws light on economic, social and even spiritual aspects of life.

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