Megaliths, Agriculture, and Social Complexity: A Diet Study of Two Swedish Megalith Populations

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This paper tests the relationship between the erection of megaliths and agriculture in Neolithic Scandinavia. A dietary change in two Swedish megalith populations was tested by analyses of stable carbon and nitrogen isotopes extracted from human bone collagen. Carbon isotopes show that marine resources still were utilized in the coastal area and nitrogen isotope indicates that the major part of the protein came from a high trophic level, i.e., animals. It is concluded that a change in diet, and hence subsistence, took place from a hunter-gatherer-based subsistence toward one based on pastoralism, not horticulturalism. The prerequisite for social complexity is discussed and the author favors sedentism as the major determinant. © 1995 Academic Press, Inc.

INTRODUCTION

Megaliths are generally considered as indicators of a new complex social organization (Renfrew 1973; Hodder 1984). The appearance of megalithic tombs and development toward a greater social complexity in Scandinavia during the Early Neolithic period have been linked with a change in subsistence (Childe 1957; Sherratt 1990; Hodder 1990). This change comprises the transition from a hunting–gathering subsistence to one based mainly on agriculture, i.e., the transition from the Mesolithic to the Neolithic. However, the terms Mesolithic and Neolithic can have different definitions (Werbart 1994), e.g., specific time periods, specific subsistence (hunter–gatherers, pastoralists, horticulturalists), or different material cultures. In this paper the term Neolithic is used to refer to subsistence, and I will discuss what a change in subsistence implies.

It is argued that greater social complexity has its origins in the introduction of agriculture (Sherratt 1990). However, there are other views on the connection between social complexity and agriculture (Donahue 1992; Price and Gebauer 1992). Sherratt (1990:149) though stresses that “the requirements of cereal cultivation would have necessitated a more radical social organization of hunting and foraging communities than the keeping of small quantities of livestock.” He, thus, considers the erection of the megaliths as a new form of expression, linked with the greater degree of social complexity which was a prerequisite for agriculture. Some authors regard the megaliths as “a surrogate for the living village” (Sherratt 1990:149). This idea supports the link between megaliths and an agricultural subsistence since “many archaeologists assume a direct and positive correlation between cultivation strategies and village performance” and “state that Early Neolithic villagers practiced permanent field agriculture” (Gregg 1988:30).

Other evidence for a change in social complexity, in addition to the erection of megaliths during the Early Neolithic, are causewayed enclosures (Madsen 1978; Andersen 1980) and high status objects such as large polished flint axes (Nielsen 1987). These changes together with finds of domesticated animals (Madsen 1982) and cereal imprints in pottery (Hjelmquist 1979, 1955; Schiemann 1958; Larsson 1984), as well as cereal pollen in pollen diagrams (Welinder 1974; Göransson 1977), indicate
that the transition toward a greater social complexity was related to, and partly contemporary with, the introduction of agriculture. The term agriculture is used here to refer to "the theory and practice of cultivating and producing crops from the soil and of raising livestock" (The Penguin English Dictionary 1992:19). However, it is important to make a distinction between pastoralists and horticulturalists, which are both incorporated under the term agriculture. The transition from the Mesolithic to the Neolithic can, in Scandinavia, be seen as the appearance of a new culture which is distinguished by its ceramics, i.e., the Funnel Beaker Culture. It is within this culture we find imprints of cereals in the ceramic (Larsson 1984). Further, it is here we find bones of domesticated animals (Madsen 1982; Nielsen 1987) and Funnel Beaker ceramics are later found in the megalith context (Strömberg 1971).

The change in subsistence that the Funnel Beaker Culture and, hence, the megalith builders caused should also be reflected in a change in diet. The remains of domesticated animals and cereal imprints in ceramic, etc., certainly indicate such a change in diet. I would, however, like to stress the difference between diet and subsistence. By diet I mean the food that an individual actually consumed and by subsistence I mean "the acquisition of those materials that are necessary for the physiological well-being of a community (e.g., food and fuel) and the technologies needed to obtain them" (Dennell 1979:122).

I propose to test the rather generalized view that a change in diet toward an agriculturally (horticulturalism) based diet coincided with the erection of megalithic tombs (Childe 1957; Sherratt 1990; Hodder 1990). One way of studying the diet of prehistoric populations is by chemical analyses on skeletal remains. In this paper I will use analyses of stable carbon and nitrogen isotopes, extracted from bone collagen, to reveal dietary patterns. I will compare two different megalith populations, one inland in Västergötland and one coastal on the island of Öland.

Stable carbon isotope values have, in previous palaeodiary studies, been used to determine the amount of marine protein input (Chisholm et al. 1981, 1982, 1983; Tauber 1981, 1982; Botton 1984; Hobson and Collier 1984; Lovell et al. 1986; Jørgensen et al. 1986; Walker and DeNigo 1986; Sealy and van der Merwe 1988; Clutton-Brock and Noe-Nygaard 1990; Lidén and Nelson 1994; Lubell et al. 1994; Tuross et al. 1994), or C4-plant protein such as maize (Bender et al. 1981; Bumsted 1984; Ericsson et al. 1989; Tuross et al. 1994), in the diet.

The application of nitrogen as a dietary tracer, on the other hand, is based on a number of studies where it is shown that 15N is enriched (by approximately 3‰) up a food chain, terrestrial or marine (Wada 1980; Minagawa and Wada 1984; Schoeninger and DeNigo 1984; Peterson and Fry 1987; Shollo-Douglas et al. 1991; Tuross et al. 1994). This means that organisms belonging to the lowest level in a food chain (i.e., photosynthesising plants) have a δ15N value of approximately 3‰ as compared to that of air that is 0‰, while those organisms living entirely on plants will have a δ15N of approximately 6‰, i.e., approximately 3‰ higher than the previous level. What must be kept in mind here is that marine food chains are much longer than terrestrial food chains, which confers an "end-value" in a marine food chain which is much higher than the corresponding terrestrial value. This means that a top predator in a marine environment will get a δ15N value of approximately 18‰ as, e.g., seals or 20‰ as Greenland eskimos (Schoeninger et al. 1984; Schoeninger and DeNigo 1984), whereas a top predator in a terrestrial environment will get a δ15N value of approximately 10‰ as, e.g., bobcat (Schoeninger and DeNigo 1984). By simultaneously examining carbon and nitrogen
isotopes it is possible to identify the source of major protein.

**MATERIALS AND METHOD**

The two skeletal populations in this analysis originate from the megalith graves in Mysinge, Resmo parish, Öland and Rössberga, Vältorp parish, Västergötland in Sweden (Fig. 1). The passage grave from Rössberga was excavated in 1962 by C. Cullberg (Cullberg 1963). The chamber of the passage grave was oblong (9 × 2 m) and contained at least 17 compartments. The passage (Fig. 2) was oriented to the east and had a length of 8 m. Human skeletal remains, all disarticulated, were found both in the chamber and the passage. A preliminary osteological analysis revealed 16 males, 17 females, and 5 subadults buried in the grave (Cullberg 1963). The number of burials is underestimated and will probably increase upon reexamination of the material (Ahlström 1990). The passage grave in Rössberga has been dated by accelerator mass spectrometry (AMS) (Table 1), and the dates vary between 4590 ± 120 to 2440 ± 120 B.P. (Hedges et al. 1992). All skeletal samples used in the analyses originate from the compartments in the chamber and only skull fragments that could be identified as originating from different individuals were used.

The passage grave in Resmo is one of four graves gathered together on the southern part of Öland (Fig. 1). It was excavated in 1908 by T. J. Arne and proved to contain bones from approximately 30 individuals, among which at least 5 are children (Arne
### TABLE 1

Radiocarbon Dates and Stable Carbon Isotope Values of Human Bone Collagen from the Passage Grave Rössberga, Valtorp Parish, Västergötland, Sweden (Hedges et al. 1992)

| Lab. no. | Bone no., burial | $\delta^{13}$C‰ | $\delta^{13}$C dates B.P. |
|----------|-----------------|----------------||--------------------------|
| OxA-2706 | 1, Be 17        | $-21.1$        | $2440 \pm 120$          |
| OxA-2707 | 3, Be 3         | $-22.4$        | $4460 \pm 150$          |
| OxA-2708 | 4, Be 17        | $-22.5$        | $4590 \pm 120$          |
| OxA-2709 | 5, Be 16        | $-22.5$        | $3580 \pm 130$          |
| OxA-2710 | 6, Be 2         | $-21.9$        | $4400 \pm 130$          |
| OxA-2711 | 7, Be 2         | $-22.1$        | $4420 \pm 150$          |
| OxA-2712 | 8, Be 11        | $-22.1$        | $2920 \pm 120$          |
| OxA-2713 | 9, Be 11        | $-22.1$        | $4400 \pm 110$          |
| OxA-2714 | 10, Be 11       | $-22.3$        | $4440 \pm 120$          |
| OxA-2715 | 11, Be 9        | $-20.4$        | $4080 \pm 110$          |
| OxA-2716 | 12, Be 7        | $-22.2$        | $4080 \pm 110$          |
| OxA-2717 | 13, Be 5        | $-21.9$        | $4450 \pm 110$          |
| OxA-2718 | 14, Be 1        | $-21.9$        | $4090 \pm 110$          |
| OxA-2719 | 15, Be 1        | $-21.9$        | $3990 \pm 110$          |
| OxA-2720 | 16, Be 5        | $-22.1$        | $4290 \pm 110$          |
| OxA-2763 | 2, Be 4         | $-21.1$        | $4360 \pm 70$           |

1909, Fürst 1912). Its oval chamber (Fig. 3) is approximately 3 x 1 m, and the length of the passage is ca. 6 m (Blomqvist 1989a). The passage grave has been dated to approximately 3350-2850 B.P. by Bergensstråhle (1986:35), using a debatable construction model put forward by Blomqvist (1989a). All skeletal samples originate from the bottom layer (human bones), which was separated from the mixed top layer (animal and human bones) by a layer of gravel and sand. I used only skull fragments that could be identified as originating from different individuals.

Bone collagen for isotope measurements was extracted according to Brown et al. (1988), where high molecular remnants are selected for. The collagen was lipid extracted using a modified method by Kates (1986), as proposed by Lidén et al. (1995), to exclude the risk of lipid contamination since lipids have a different isotopic value from bone collagen by as much as 7‰ (Smith and Epstein 1971; De Niro and Epstein 1978; Vogel 1978; Lidén et al. 1995). The isotopes were measured using a VG Prism mass spectrometer with a precision of <0.1‰, and are given as $\delta^{13}$C = ($R_u/R_s - 1) \times 1000$ ‰, where $R_u$ and $R_s$ are the respective $^{13}$C/$^{12}$C ratios for the unknown and the standard limestone fossil (PDB), and $\delta^{15}$N = ($R_u/R_s - 1) \times 1000$ ‰, where $R_u$ and $R_s$ are the respective $^{15}$N/$^{14}$N ratios of the unknown and the air standard. Carbon isotopic end-values, i.e., the isotopic value for an individual living entirely on marine or, alternatively, terrestrial proteins, are from Lidén and Nelson (1994).

Although the atmosphere is well mixed it has been shown that terrestrial end-values vary slightly with latitude and longitude (Van Klinken et al. 1994). However, this variation can be disregarded in this study since the analyzed samples are from sites situated close to each other. Additionally, the marine end-value, which is highly correlated to salinity, differs more radically in the Baltic (−14 to −15‰) from that of the big oceans (−11 to −12‰) due to the brackish conditions in the Baltic (Lidén and Nelson 1994). The expected isotopic end-value for bone collagen for a population living entirely on terrestrial protein in Scandinavia would for bone collagen be approximately −20 to −21‰.

![Fig. 3. The passage grave at Mysinge, Resmo parish, Öland.](image-url)
RESULTS

The collagen quality is good in all samples, as shown by the stipulated C/N range 2.9–3.4 (De Niro 1985; De Niro et al. 1985), although the samples from Rössberga deviate slightly from the stipulated range. However, collagen quality can also be tested by the proportion of carbon and nitrogen in the collagen, where collagen that has carbon values higher than 13.0% and nitrogen values higher than 4.8% should be accepted as good quality (Ambrose 1990). The proportion of carbon (44.3–52.0%) and nitrogen (15.9–18.4%) in bone collagen reported for the Rössberga samples (Table 2) were all higher than the stipulated values and were hence accepted as good quality. In addition, the low variation in proportion of carbon and nitrogen within the Rössberga samples indicate that the bones had very similar preservation conditions.

The $\delta^{13}$C value from the Rössberga population ($\bar{x} = -20.8\%$, SD = 0.2) (Table 2) is in total accordance with the expected end-value for a population living entirely on terrestrial protein. Consequently, there appears to have been no marine contribution to the diet in the Rössberga population. The $\delta^{13}$C value from Resmo on the other hand, differs from the above terrestrial end-value by as much as 1–2% ($\bar{x} = -18.8\%$, SD = 0.6) (Table 3).

By using the approximated marine end-value for the Baltic of $-14\%$ and the terrestrial end value of $-21\%$, we can calculate the proportion of marine (brackish) and terrestrial protein input in the diet of the Resmo population. Thus, there seems to have been a 20% input of protein from the Baltic in the Resmo population.

Since there are no sex or age effects regarding the isotope values (Lovell et al. 1986), it has been suggested that a population living off the same resources and having the same diet has a standard deviation in the carbon isotopic value of $<0.3\%$ (Nelson et al. 1985; Lovell et al. 1986b). From this we can conclude that the population from Rössberga had a very homogeneous terrestrial-based diet with no marine input. The population from Resmo on the other hand had included marine resources, as shown by the higher variation (Rössberga SD = 0.2, Resmo SD = 0.6). The nitrogen values, which provide information about which trophic level the consumed protein is derived from, basically supports the in-

| TABLE 2 |
| Stable Carbon and Nitrogen Isotopic Values and Percentage Carbon (C) and Nitrogen (N) of Bone Collagen from Human Skull Bones from the Passage Grave Rössberga, Valtorp Parish, Västergötland, Sweden |

<table>
<thead>
<tr>
<th>Sample</th>
<th>$\delta^{13}$C%o</th>
<th>$\delta^{15}$N%o</th>
<th>C%</th>
<th>N%</th>
<th>C/N</th>
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<tbody>
<tr>
<td>K-15</td>
<td>-20.9</td>
<td>10.4</td>
<td>52.0</td>
<td>18.4</td>
<td>2.8</td>
</tr>
<tr>
<td>K-44</td>
<td>-21.0</td>
<td>9.7</td>
<td>40.2</td>
<td>14.4</td>
<td>2.8</td>
</tr>
<tr>
<td>K-50</td>
<td>-20.8</td>
<td>9.8</td>
<td>44.9</td>
<td>16.3</td>
<td>2.8</td>
</tr>
<tr>
<td>K-69</td>
<td>-21.1</td>
<td>10.0</td>
<td>44.3</td>
<td>15.9</td>
<td>2.8</td>
</tr>
<tr>
<td>K-94</td>
<td>-20.9</td>
<td>10.9</td>
<td>46.5</td>
<td>17.0</td>
<td>2.7</td>
</tr>
<tr>
<td>K-104</td>
<td>-20.8</td>
<td>9.9</td>
<td>45.0</td>
<td>16.1</td>
<td>2.8</td>
</tr>
<tr>
<td>K-109</td>
<td>-21.0</td>
<td>9.4</td>
<td>44.6</td>
<td>16.2</td>
<td>2.8</td>
</tr>
<tr>
<td>K-110</td>
<td>-20.3</td>
<td>11.5</td>
<td>44.0</td>
<td>15.7</td>
<td>2.8</td>
</tr>
<tr>
<td>$\bar{x}$</td>
<td>-20.8</td>
<td>10.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SD</td>
<td>0.2</td>
<td>0.7</td>
<td></td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Sample</th>
<th>$\delta^{13}$C%o</th>
<th>$\delta^{15}$N%o</th>
<th>C/N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resmo 6</td>
<td>-18.5</td>
<td>12.6</td>
<td>3.1</td>
</tr>
<tr>
<td>Resmo 8</td>
<td>-18.0</td>
<td>13.6</td>
<td>3.4</td>
</tr>
<tr>
<td>Resmo 9</td>
<td>-18.1</td>
<td>12.9</td>
<td>3.0</td>
</tr>
<tr>
<td>Resmo 10</td>
<td>-18.9</td>
<td>11.5</td>
<td>3.1</td>
</tr>
<tr>
<td>Resmo 11</td>
<td>-19.5</td>
<td>12.2</td>
<td>3.0</td>
</tr>
<tr>
<td>Resmo 12</td>
<td>-18.4</td>
<td>13.0</td>
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<td>Resmo 17</td>
<td>-18.2</td>
<td>13.4</td>
<td>3.0</td>
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<tr>
<td>Resmo 18</td>
<td>-18.6</td>
<td>12.6</td>
<td>3.0</td>
</tr>
<tr>
<td>Resmo 20</td>
<td>-19.7</td>
<td>10.7</td>
<td>3.0</td>
</tr>
<tr>
<td>$\bar{x}$</td>
<td>-18.8</td>
<td>12.4</td>
<td></td>
</tr>
<tr>
<td>SD</td>
<td>0.6</td>
<td>0.8</td>
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</tbody>
</table>
terpretation of the carbon isotopic values. Since marine food chains are longer than terrestrial, a marine protein contribution to a terrestrial consumer results in a higher \( \delta^{15}N \) value. The population from Rössberga has nitrogen isotopic values \((\bar{\delta} = 10.2\%, SD = 0.7)\) (Table 2) indicative of a population living mainly of meat and/or milk from terrestrial herbivores, e.g., sheep and cattle. The population from Resmo, on the other hand, has slightly higher nitrogen isotopic values \((\bar{\delta} = 12.4\%, SD = 0.8)\) (Table 3), which is totally in accordance with the marine input in this population’s diet. This can be illustrated clearly in a graph where carbon isotopic values are plotted against nitrogen isotopic values (Fig. 4, Table 4): the larger the input of marine protein the higher the nitrogen isotopic values (see, e.g., Tuross et al. 1994).

Thus, there is an exceptionally low variation in the carbon values of the Rössberga population. However, the variation in their nitrogen values is slightly higher than that in the population from Resmo. The high variation in nitrogen values in the Resmo population can be explained by the varying amount of marine protein input in the diet. This cannot, however, explain the variation in nitrogen values in the Rössberga population. Therefore, it is argued that since the variation in nitrogen is approximately the same for both populations (Rössberga SD = 0.7, Resmo SD = 0.6), the Rössberga population must have had a varying diet in regard to the trophic level from which the digested protein was derived (i.e., animals versus plants).

**DISCUSSION AND CONCLUSION**

The purpose of this work was to test the hypothesis that the introduction of megaliths, and hence a greater social complexity, coincided with a change in subsistence, from one based mainly on hunting–gather-

![Fig. 4. Result of the isotope analyses of human bone collagen from the passage graves at Resmo (crosses) and Rössberga (squares), and expected values for coastal and inland Mesolithic and Neolithic populations in the Baltic area (boxes). C/M denotes a coastal Mesolithic population living mainly on marine protein from the highest trophic level. I/M denotes an inland Mesolithic population living mainly of terrestrial protein from the highest trophic level. N denotes both an inland and a coastal Neolithic population living mainly of terrestrial protein of a low trophic level. The boxes’ sizes illustrate the isotopic mean value of the above populations plus and minus one standard deviation for each isotope (carbon 0.5%, nitrogen 0.7%).](image-url)
TABLE 4
Mesolithic and Expected Neolithic Stable Isotope Values of Human Bone Collagen from Coastal and Inland Settlements in Scandinavia

| Site         | Mesolithic | | | | Neolithic |
|--------------|------------|--------------|-----------------|------------|---|---|
|              | $\delta^{13}$C | $\delta^{15}$N | $\delta^{13}$C | $\delta^{15}$N |
| Coastal      | -15.4%$^a$ | 17.5%$^c$ | -21.0%$^c$ | 7%$^c$ |
| Inland       | -21.5%$^b$ | 10.0%$^c$ | -21.0%$^c$ | 7%$^c$ |

Neolithic megaliths

<table>
<thead>
<tr>
<th>Site</th>
<th>$\delta^{13}$C (SD)</th>
<th>$\delta^{15}$N (SD)</th>
<th>Subsistence</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Rössberga (Inland)</td>
<td>-20.8% (SD = 0.2)</td>
<td>10.2% (SD = 0.7)</td>
<td>No marine protein, minor plant protein</td>
<td></td>
</tr>
<tr>
<td>Resmo (Coast)</td>
<td>-18.8% (SD = 0.6)</td>
<td>12.4% (SD = 0.8)</td>
<td>Mixed marine and terrestrial protein, minor plant protein</td>
<td></td>
</tr>
</tbody>
</table>

$^a$ Königsson et al. 1993.
$^c$ Based on data from terrestrial and marine top predators, and terrestrial herbivores (Schoeninger et al. 1984; Schoeninger and DeNiro 1984).

...ing toward a subsistence based mainly on agricultural products. The primary methodology used to test this hypothesis was stable isotope analyses of skeletal populations from two Swedish megalithic communities, one coastal and one inland. To verify the hypothesis I would expect to find that the isotopic values for both populations indicate a diet consisting of terrestrial protein, originating from mixed trophic levels, i.e., consisting of both animals and plants.

The supposition that the Mesolithic people on Öland (and Resmo) had a diet consisting mainly of marine protein from a high trophic level was supported by the excavation results from the coastal Alby site, SE Öland (Königsson et al. 1993). Both the bone artifacts and the single carbon isotope value (~15.4%) from a Mesolithic man indicate that the people who lived there had a diet consisting mainly of marine protein, i.e., seal and fish. The expected change in diet should thus be seen in the analysis of the isotopes where a coastal Mesolithic population by the Baltic, living mainly on marine resources, would have low negative carbon values that should shift toward more terrestrial (more negative) values and high nitrogen values that would shift toward lower values (more plant protein) during the Neolithic.

The distribution of late Mesolithic settlements in inland western Sweden (Västergötland), i.e., near eutrophic lakes and areas with patchy soils, provides some information of ecologically “rich” sites with access to a wide variety of resources (Kindgren 1991). The expected change then in diet from an inland Mesolithic, hunter-gatherer-based diet toward one based on agriculture should thus be one where there is no change in the carbon values but a shift toward lower nitrogen values reflecting a greater dependence on cereals as a protein source, just as the megalithic subsistence in Denmark, which is supposed to have been based on a mixed terrestrial economy, was dominated by wheat production (Kristiansen 1984).

However, what we see in the carbon isotope values is an increased dependence on terrestrial protein in the coastal area, i.e., a dietary shift in terrestrial protein from 10–20% to approximately 80%. The same shift cannot, of course, be seen in the inland area where we do not expect any marine input...
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from either time period. In the inland area a diet based on cereal production would instead confer a shift in nitrogen isotopic values from high to low, i.e., from 10–11‰ to 7–8‰. However, the nitrogen isotopic values remain high. These results can only be interpreted as if these two populations, Resmo and Rössberga, were pastoralists. Both communities kept cattle and sheep/goat (as represented in the faunal remains), yet the inland community still practiced hunting and fishing (freshwater), although to what extent we cannot determine, and the coastal areas still utilized marine resources. The utilization of marine resources in megalith populations living by the coast is further shown in the stable carbon isotope results, Tables 5 and 6, from southern Sweden and Denmark (Blomqvist 1989b).

I would argue that the evidence we have for cereal cultivation, pollen diagrams (cereal pollen and clear cuttings), imprints in ceramics, kern stones, etc., does not alone imply a high dietary reliance on cereals. This evidence is only qualitative, not quantitative, as discussed by Kaelas (1991). Clark (1977) suggests that at least the Swedish west coast megaliths should have had a subsistence based on marine resources, like the megaliths on the west coast of Scotland and Ireland. Kaelas (1991) also questions the assumption of an overall high dependence on domesticated animals and plants in the megalith society. We cannot, however, disregard the evidence of cereals, but we can argue against its importance in the diet. I would consider cereals as luxury or ritual products in the form of bread, beverages, or just as kernals rather than as an important dietary resource. The idea that cereals and domesticates have evolved as prestigious and/or productive gifts has been put forward by Hayden (1990, 1992) and Jennbert (1984). The reason for the introduction of cereals and domesticates has been under discussion for decades. The most recent ideas are well summarized in Transitions to agriculture in prehistory, edited by Gebauer and Price (1992).

Having concluded that cereals played a minor part in the diet of the megalith populations, we must then question the statement that the greater degree of social complexity, which is expressed in the erection of megaliths, has its origins in cereal production (e.g., Sherratt 1990). While I am not arguing against the hypothesis that megaliths were an expression of a high social complexity, I think there is a need to look for other explanations for the increasing degree of social complexity. Alternative explanations for the emergence of social com-

### Table 6

<table>
<thead>
<tr>
<th>Site</th>
<th>Lab. no.</th>
<th>δ¹³C‰</th>
<th>¹⁴C dates B.P.</th>
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<td>Kellered</td>
<td>K-3515</td>
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<td>3490 ± 65</td>
</tr>
<tr>
<td>y</td>
<td></td>
<td>-19.1</td>
<td>3250</td>
</tr>
<tr>
<td>SD</td>
<td></td>
<td>0.6</td>
<td></td>
</tr>
</tbody>
</table>

### Table 5

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<tr>
<th>Site</th>
<th>Lab. no.</th>
<th>δ¹³C‰</th>
<th>¹⁴C dates B.P.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carlshögen</td>
<td>Lu-253</td>
<td>-19.5</td>
<td>4230 ± 65</td>
</tr>
<tr>
<td>Carlshögen</td>
<td>Lu-255</td>
<td>-19.1</td>
<td>4230 ± 80</td>
</tr>
<tr>
<td>Carlshögen</td>
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<td>4210 ± 65</td>
</tr>
<tr>
<td>Carlshögen</td>
<td>Lu-282</td>
<td>-18.8</td>
<td>3380 ± 60</td>
</tr>
<tr>
<td>Ramshög</td>
<td>Lu-257</td>
<td>-17.5</td>
<td>4540 ± 90</td>
</tr>
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<td>Ramshög</td>
<td>Lu-275</td>
<td>-18.2</td>
<td>4330 ± 65</td>
</tr>
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<td>Lu-276</td>
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<td>4520 ± 65</td>
</tr>
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<td>Ramshög</td>
<td>Lu-278</td>
<td>-18.8</td>
<td>4480 ± 65</td>
</tr>
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<td>Lu-472</td>
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<td>Tågarp</td>
<td>Lu-436</td>
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<td>y</td>
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<td></td>
</tr>
<tr>
<td>SD</td>
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plexity have been discussed by several authors (e.g., Gregg 1988; Kent 1989). Kent (1989:3) argues that “sedentary hunter-gatherers tend to share a more similar degree of socio-political, technological complexity and other features with sedentary horticulturalists than they do with mobile but fellow hunters (that is, groups with different mobility patterns but with same subsistence strategies are at different levels of complexity, such as nomadic Basarwa or “Bushmen” hunter-gatherers and sedentary Northwest hunter-gatherers). Similarities do not exist among groups with similar subsistence strategies but do exist among groups with similar mobility strategies.” Northwest coast Native American societies provide an example of hunter-gatherers that are more sedentary than nomadic and that have a high social organization with institutionalized power and hereditary rank and yet do not rely on cereal agriculture (Kent 1989). Kent is not arguing that sedentism and mobility are the only influencing factors determining the degree of social complexity but rather that they are primary factors (Kent 1989). Jennbert (1985:197) also discusses sedentism and permanent settlements as prerequisites for a high social complexity and suggests “that there need not be any major differences with regard to social structure between Late Ertebölle [i.e., sedentary Mesolithic] and the Early Neolithic periods.” It is possible to analyze dietary differences on the individual level using stable isotopes (Angerbjörn et al. 1994). From our material we can conclude that the population from Resmo show a varied marine protein intake and the Rössberga population seems to have had a varied diet regarding trophic level, which could be signs of a dietary hierarchical stratification. We cannot, however, draw any conclusion regarding this possible hierarchy or social stratification, since this analysis is based on cranial fragments and we do not have any sex or age determinations on the different individuals.

Accepting that sedentism is one of the major factors for developing a high social complexity, I would argue that the erection of megaliths took place in areas where there already existed a certain degree of high complexity. Northern Europe is, for instance, given as an example of an area where Neolithic tribally organized sedentary hunter–gatherer populations effectively managed to exclude farmers from their “territories” (Gregg 1988). Also, Price (1985) argues for the existence of an increased social complexity in Late Mesolithic Scandinavia, although he asserts that it might have been prevented from reaching an even higher complexity by the introduction of agriculture. Sherratt (1990:150), argues that “the advantages of having this form of organisation [i.e., a high social complexity] were not limited to the cultivation of cereals but once established also could be applied to other modes of subsistence (such as marine fishing) where the recruitment of a more extensive labour force gave a competitive advantage.” Conversely, in areas with high social complexity (e.g., sedentary fishermen) this mode could easily be applied to a subsistence based on agriculture (pastoralism and horticulture).

I would argue that the already existing sedentism was based on a relatively predictable resource (in coastal areas large marine mammals or salmon runs) and that by the time of the erection of megaliths, there is a need to manifest the exclusive right to this predictable resource or territory. The hypothesis that megaliths are territory markings has been discussed by several authors (Renfrew 1973; Härdh 1982; Sjögren 1986; Strömberg 1990). The problem with many of the above applications are that they divide the areas between and around the megaliths into a specific domain, which belongs to the megalith. This is defined as the actual territory. Territories are not always so easily detectable and do not have to be equally spaced around a megalith, but can also vary in size over time depending
on a number of factors (Davies and Houston 1984). Territory markings for exclusionary use-rights of a resource (geographical landmarks, topographical features, megaliths) are also a way of solving the problem of overexploitation of resources that might occur for a sedentary population (Gregg 1988:25). However, "exclusionary use-rights should not be equated with the exclusive ownership of or right-of-way through specific properties or territories. Moreover, use-rights need not be physically defended" (Gregg 1988:25).

Finally, we do see a change in diet from the Mesolithic to the megalithic Neolithic, at least in the coastal area of Öland. The Resmo population seems to be dependent mainly on terrestrial protein from a high trophic level, i.e., in this case herbivores (sheep/goat, cattle), with the contribution by marine animals of approximately 20%. This is compared with the mesolithic diet, which consisted of approximately 80–90% marine protein. However, it is difficult to identify a change in diet in the inland population at Rössberga. The postulated dependence on agricultural products such as cereals cannot be demonstrated, whereas stock herding seems to be the most reasonable dietary base. Although, the isotope analysis cannot differ between domesticated and wild animals, the increase of light demanding herbs as seen in pollen diagrams (Digerfeldt 1977; Digerfeldt and Welinder 1978), makes it most likely that the dietary base was domesticated animals. Hence the hypothesis that the megaliths brought about a change in diet toward agricultural, pastoralist, products can be verified, although the extent of pastoralist products differs in different areas. The agricultural products seem to have consisted mainly of domesticated animals, sheep/goat and cattle, whereas cereal production seems to have been of minor importance for the protein contribution. The postulated link then between cereal production and the erection of megaliths (Sherratt 1990) is not present in the Swedish material. If we, however, accept that the erection of megalith tombs took place in a society with a "high" degree of social complexity there is a need for an alternative explanation to the evolution of social complexity. The evidence for sedentism in the Mesolithic northern Europe together with the evidence of social complexity then supports Kent's (1989) theory about the connection of sedentism and complexity rather than economy and complexity.

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