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RECOGNIZING WOMEN IN THE ARCHAEOLOGICAL RECORD*

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Primary sexual characteristics are usually absent in the archaeological record. The recovered secondary sex markers in bone morphology or mortuary context reflect the lifelong integrated biocultural experience of the individual man or woman. Internal patterns of variability within and between sexes can be recognized but are too frequently masked by traditional descriptive and univariate analyses. Fortunately, a more detailed picture of life experience is gained by analyzing chemical composition (isotopic and elemental) of hard tissues using an analytical anthropology approach and by examining the variation in novel ways.

For example, men and women from an AD 14th century farming village are indistinguishable in their central tendencies for stable carbon isotope distribution. Yet the dispersion of the sexes is quite distinct, revealing different patterns of distribution of the same foods. Univariate or bivariate studies of elements such as strontium or iron and aluminum cannot distinguish species among the herbivores nor separate men from women. Using the combined isotopic, multielement, and multivariate analysis reveals that women group strongly apart from men and that women are more like each other as a group than men are as a group. Curiously, women are closely identified ecologically with the animal species of greatest cultural significance.

Within-society patterns of sex differential resource procurement and use have also been identified by Katzenberg in her diachronic studies of southern Canada economic change. Grupe used a multielement analysis to determine sexual reproductive patterns among women in Medieval Germany.

With separate recognition of women in the archaeological record one can begin to ask innovative questions of their role in social evolution.

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FIGURE 1

Ordinarily, sex is recognized by the presence or absence of a Y chromosome or by identifying the resulting primary morphological sex characteristics associated with reproduction (the internal and external genitalia and organs). But, ordinarily these identifiers are not preserved in the archaeological record. However, one can recover from the archaeological record the secondary sex markers of the skeletal morphology or of the mortuary context. Whether physical or cultural, distinctions based on secondary sex characteristics are enhanced as the result of puberty. The archaeological record is therefore most often concerned with adult biological and cultural sex roles.

The sex markers of the archaeological record reflect the lifelong integrated biocultural experience of the individual man or woman. Consequently, internal patterns of variability, within or between sexes, are frequently masked by the usual descriptive or univariate analyses. A more detailed picture of life experience is gained by analyzing chemical composition (isotopic and elemental) of hard tissues and evaluating the patterns of chemical variation within an anthropological context that integrates biological, archaeological, and ecological perspectives. We'll see how such an analytical anthropology approach and its results might be used with a case study from North America.

Bone samples from 54 adults were examined for stable carbon isotopic abundance in collaboration with the University of Massachusetts, Baylor College of Medicine, and the University of Arizona. Nine middle-aged individuals were also examined for 14 additional elements in a pilot study. The adults all came from a single community in the US Middle West economically based on subsistence farming. Cultivated foods included maize, squash, and beans supplemented by gathered fruits, greens, and game animals such as deer and antelope, rabbit, and waterfowl. Culturally, bison were the most important animal resource. Villagers numbered approximately 500, and shared the same living environment and archaeological history. **FIGURE 2** This affords a rare opportunity to examine natural levels of chemical, biological, and dietary variation among modern humans with control over genetic, environmental, socio-economic, and chronological variables.

Carbon isotope analysis can be used to group plants into two distinct classes of human food. Most leafy vegetables, trees, tuber and root crops like potatoes, and most cereals such as wheat and rice are classified as C_3-like foods. "Warm-weather" grasses such as maize and sorghum, are classified as C_4-like foods. The plant food groups are isotopically distinct and so are an animal's tissues when subsisting on one or the other group of plants. **FIGURE 3** But humans tend to eat like our friend Mary demonstrates, who with her blinds pulled, had three helpings of corn, two baked potatoes, extra bread, and a little lamb.

REMOVE FIGURE

Recognizing diet, let alone sex, from such a natural world may seem formidable but can be successful. Stable isotope abundances do not change after death. Our research has demonstrated that purified samples of bone protein from archaeological populations have the same isotope value as the tissue when living. A true picture of the food patterns can be interpreted for the once living population from an analysis of human, plant, and animal tissues.

In an earlier study, we analyzed 17 women and 15 men (as well as antelope, bison, dog, and maize) for stable carbon isotopic composition. We found statistically significant differences between the sexes in average composition and in the variability in composition. FIGURE 4 However, when an additional 19 adults were analyzed, increased variability among the men overwhelmed the statistical differences.

While carbon values for men and women cluster identically, individual values are distributed in quite different patterns between men and women. It is possible that variability of carbon isotope values is physiologically restricted among women but not among men. Among the published studies which listed sex as well as isotope value, we could detect no differences between average diets of men and women in populations with a maize diet base. In a control group of Hopewell C_3-eaters (non-maize diet), men and women are statistically different in average isotope values, but here it is the women who are more variable than the men.

A more likely explanation for sex-differentiated food patterns in this group of farmers is based upon access to the 'menu' of available foods. Any woman is more like another in her isotope value. This is not true among men. Any individual man seems to have more restriction in his choice of meal components. Consequently, any one woman is more representative of the entire social group than is any man. We find the women's diets overall tend towards more meat and less C_3 vegetal foods than the men's. Perhaps women prepared the meals which would allow tasting of items that might then be distributed differently between women and men as consumers. But then, again, there are those leftovers....

FIGURE 5

To further explore the association of sex and diet with chemical tracers, we analyzed five of the women and four of the men for 14 elements, including strontium and calcium, often used to apportion vegetable foods in prehistoric diets. A bison and three antelope were also analyzed but their sex could not be determined morphologically.

The carbon isotope values identify three classes of diets: bison, antelope, and human. The bison diet had about 20% more of the C_4 grasses than the antelope diet. This accords well with what is known of feeding ecologies of contemporary Plains antelope and bison. The humans in the pilot study sample were getting approximately 80% of their carbon from maize and another 20% from meat (the aforementioned bison and antelope) and other plant foods. This diet pattern compares to the contemporary American pattern which has 15% of the carbon derived directly from maize and sugarcane and 21% derived indirectly from 'corn-fed' meat, egg, and dairy products.

FIGURE 6

None of the elements could correctly classify the three major feeding individual cases were incorrectly placed. Only the average herbivore could be distinguished from the average human on a single-element basis. For example, the strontium data indicated the bison was eating as much meat as the humans. The ratio of strontium to calcium identified two humans as more herbivorous than all but 1 antelope. Women and men could not be recognized. These are disappointing results from the usual model of paleodietary research which examines variables in isolation of their anthropological and ecological contexts.

The most significant element differences between humans and herbivores were zinc and three measures known to correlate with protein preservation. Zinc, manganese, and iron do separate the herbivore class from the omnivore class. Zinc content is 1 and 3/4 times higher in humans than in the herbivores. The manganese and iron content of the humans is nearly 30 times greater than that of the herbivores. If on this basis you wish to apportion meat between the diets of men and women, please note that the men are higher in manganese but lower in iron than women.

Even considering all the elemental data (but not the isotope value) in a multivariate analysis, men and women can only be recognized when the elemental data are corrected for slight differences in bone development between the four classes of animals. The herbivores were segregated as a class but still the different diets of the bison and antelope could not be detected.

FIGURE 7

A satisfactory discrimination of all four classes is obtained only when the carbon isotopic value is combined with the elemental values. The best 3-variable model of discrimination is the carbon isotope and the elements nitrogen and magnesium. These represent in order of power functions of diet, burial, and sex.

Nevertheless, the greater the number of variables examined, the greater the separation of the sex and dietary classes. When the entire multinuclide series is used, the isotope value, representing diet, accounts for 1/3 of the variability among the individuals. The element nitrogen accounts for another 20%. As Oakley pointed out, nitrogen content is a measure of protein preservation . Samples deposited immediately into garbage pits (the antelope) can be separated from all the rest of the samples (human and bison) which had been exposed to the sun prior to burial. It should be noted from our tests that the cultural differences in burial at this site do not contaminate the bone samples for purposes of our analysis. However, this may not be true of other populations.

The next four elements representing physiological and additional dietary factors account for 30% of the difference between all four classes of animals and humans. None of the measures are correlated with each other with the exception of the seventh, the element carbon which accounts for less than 1% of the variability.

FIGURE 8

The next step is to [illegible]

canonical variable is principally a dietary and preservation variable. As expected, the isotope value strongly identifies the three major patterns of C_4 plant utilization, antelope (the least), bison, and human (directly as maize and indirectly as meat). The elements nitrogen and carbon act to group the antelope separately as a consequence of their burial circumstances.

MaGNEsium acts to separate the women very slightly further and to reinforce the antelope isolation. We cannot exclude a weal preservation factor that may isolate the antelope. But notice that in the 3-variable model maGNEsium also had a sex recognition function. Why this is so cannot be explained simply by recourse to dietary input, levels of estrogen, or any other single cause. Foods rich in maGNEsium include cereals, which would tend to separate the antelope from the bison and humans. MaGNEsium is also a major constituent of bone and subject to hormonal regulation. The women deviate twice as strongly as the men do from the standardized average value.

<u>TURN FIGURE SIDEWAYS</u>

It is the second canonical variable, based primarily on the strength of the MANganese content, which clearly and strongly groups the women separately from the men. In a preliminary study of hair from a wild baboon population, we were able to discriminate males from females on the basis of MANganese, zinc, and maGNEsium. Yet MANganese content alone fails to distinguish among these farmers. Plant foods are given in the trace element diet literature as the richest source of dietary MANganese yet the lowest values are among the herbivores. Curiously, the antelope is intermediate between men and women. It is the bison which is most closely identified with these Plains women in both dimensions.

Sadly, the state of basic anthropological and clinical research into fundamental human variation in chemical composition is inadequate to decide how much of the canonical variable demonstrates distinctions of physiology, primarily sex, and how much demonstrates the cultural recognition of sexual differences, that is, gender, in food distribution.

<u>END VIEWGRAPHS</u>

Internal patterns of diet and sex variability have been isolated in studies from Canadian and German researchers.

Anne Katzenberg examined multinuclide variation diachronically among southern Ontario populations. She noted a change in subsistence patterns from a generalist subsistence economy to one focusing on maize cultivation. Archaeologists have usually assumed that this economic shift requires a decrease in hunting activities and meat consumption. Katzenberg instead demonstrates a change <u>within</u> the dietary patterns. Rather than a decreased importance of meat, there is a shift within the variety of plant foods consumed. Katzenberg recognizes a change in the subsistence activities of Middle-Late Woodland women, from an emphasis on gathering to one on growing food, while the tasks of men change little. Her demonstration is possible only because of her broader perspective and use of an integrated multicomponent study.

In an equally innovative, cross-sectional study of a Medieval German population, Gisela Grupe examined multinuclide variation. By controlling for dietary factors, Grupe was able to recognize the physiological state of women and could begin to assess the biological and cultural factors affecting that status. The strontium/calcium ratios of women indicate a reproductive period in this particular population that was nearly identical to the physiological span of fertility, from late juvenile age to about age 40. Zinc composition of women, commonly depleted in pregnancy and lactation, was also lower for individuals in this age span. But, weaning occurred before age two, earlier than historical records had suggested.

Comprehensive and creative analytical anthropology studies can assist in identifying the biological and cultural experiences of women in the archaeological record. Carbon isotope values are the best single discriminator of diet, demonstrated in the biogeochemical sense as well as in the statistical sphere. When properly prepared, samples are not affected by contamination nor by the quality of skeletal preservation. Dietary patterns account for about 80% of the signal from isotope markers; physiological patterns, such as age and health status within individuals are responsible for most of the rest of the signal.

Because the elemental analysis should be of the total bone tissue (mineral as well as protein) all elements have at least a weak association with preservation. Only a multielement analysis can control for these. For example, calcium and phosphorus signal bone structural integrity in clinical and archaeological populations. Elemental abundances of carbon, nitrogen, and hydrogen are related primarily to protein and lipid content.

MANganese in our study has a stronger sex factor than diet while maGNEsium has a stronger diet factor. We cannot tell if such sexual factors are based on metabolic and physiological consequences of primary sex differences or on the physiological and cultural differences of gender. Our results presented here, although from a small study, are well controlled and give good direction for extended study. With separate recognition of women in the archaeological record one can begin to ask innovative questions of their role in social evolution.

Recognition of Diet and Sex by S ngle Variables

	Herbivore vs *Omnivore*		
most significant	$\delta^{13}C$		$p < 2.24 * 10^{-7}$
	C H N Zn		
	Sr Fe		
	Na Mn		
least significant	Mg		p 0.02

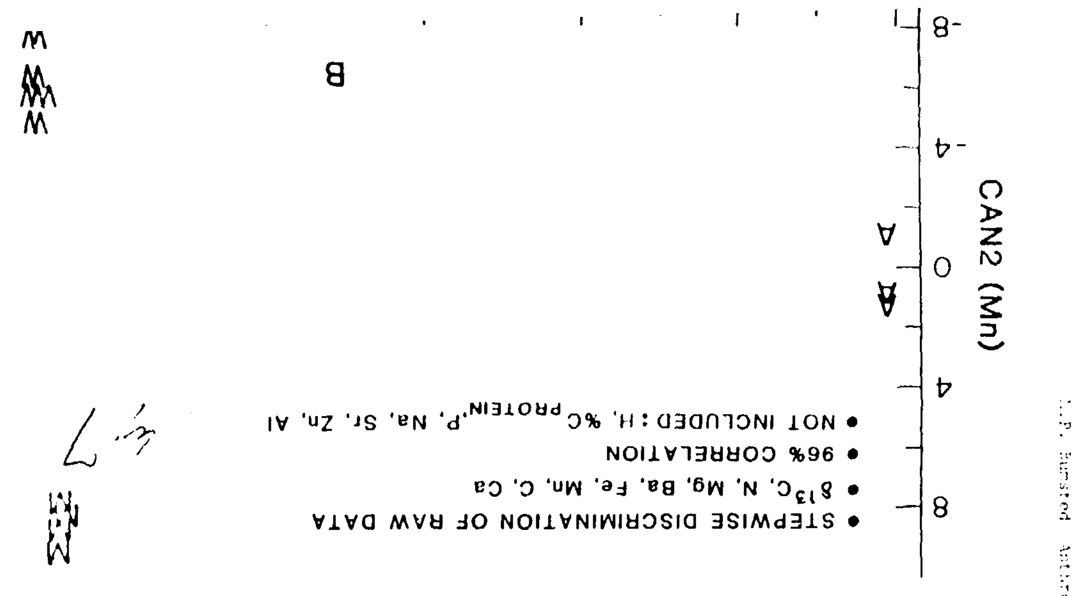
Women vs *Men*

NONE

PLOT OF CANONICAL DISCRIMINANT FUNCTIONS

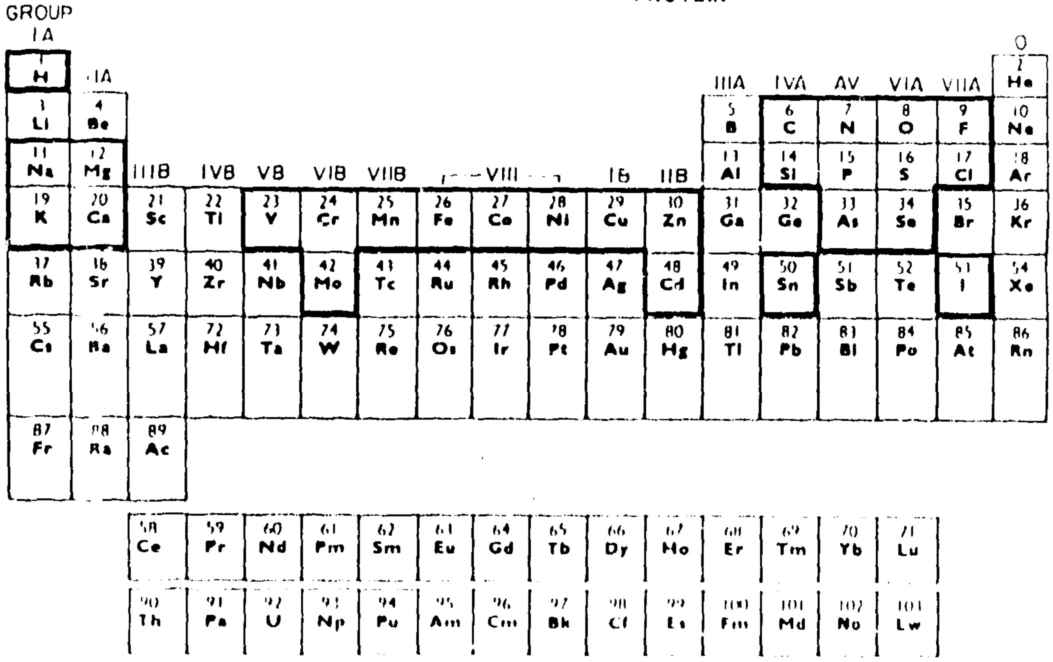
SYMBOL IS VALUE OF ANIMAL

A=ANTELOPE, B=BISON, M=MEN, W=WOMEN

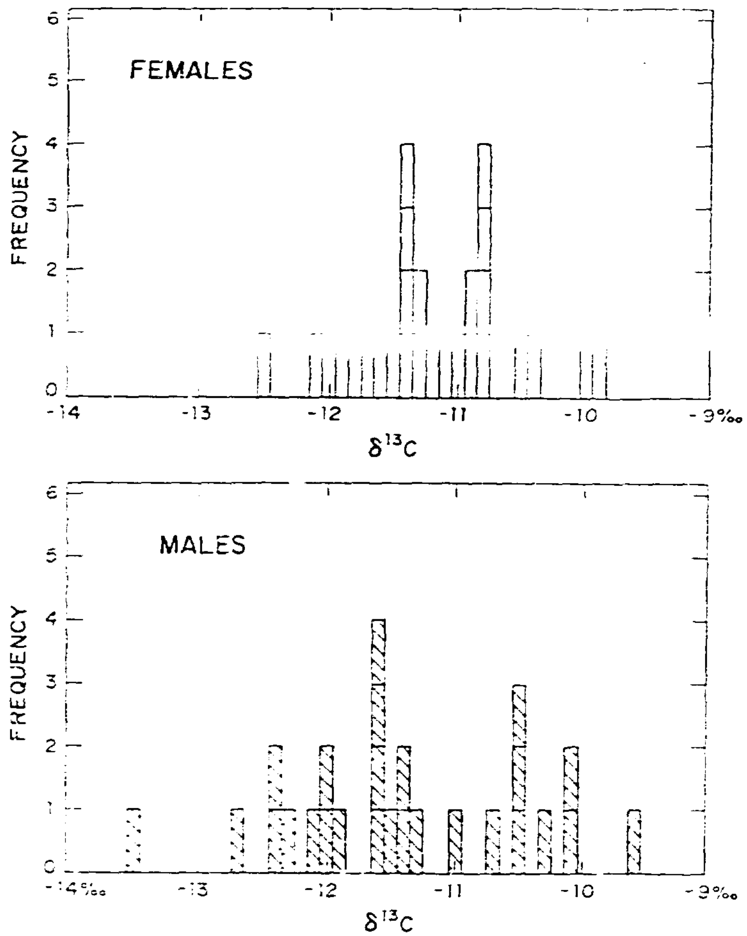


13 ELEMENTS UNDER EXAMINATION IN PILOT PROJECT

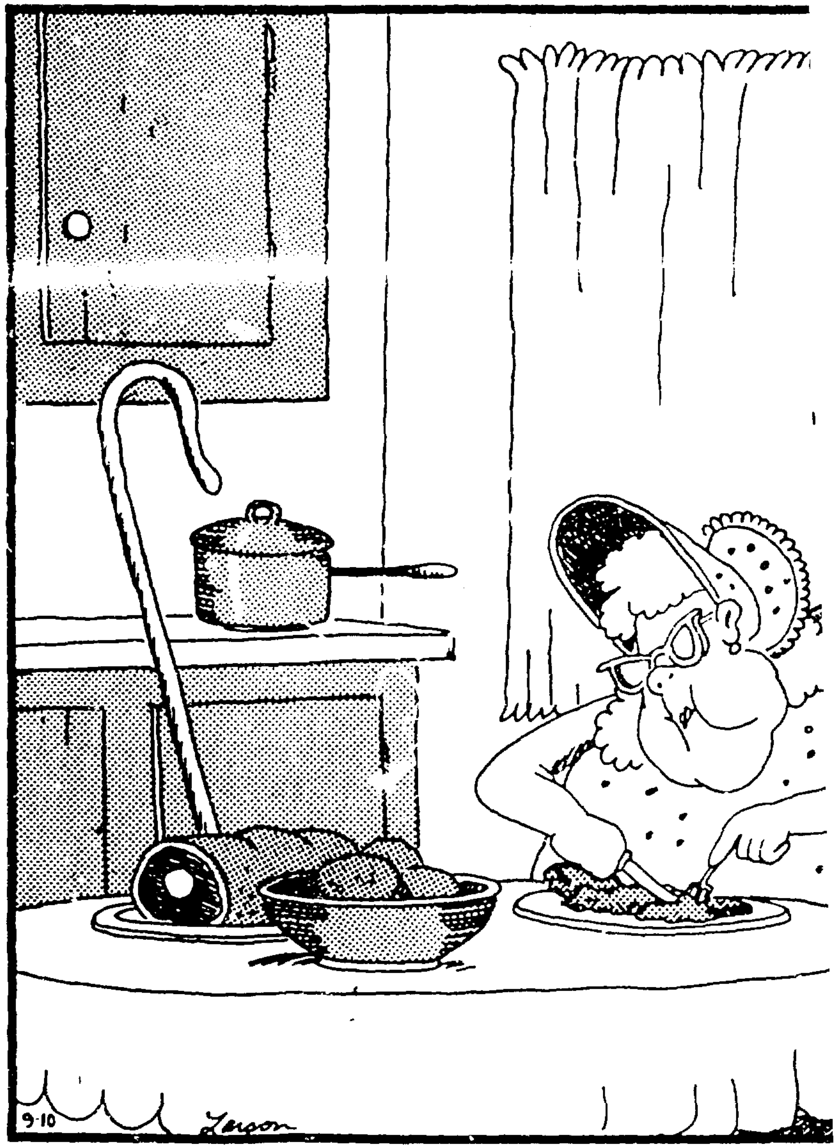
PLUS $\delta^{13}C$, $\%C_{PROTEIN}$



ESSENTIAL ELEMENTS



THE FAR SIDE By GARY LA



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