THE NUTRITIONAL POTENTIAL OF THE FISH SLOUGH CAVE DIET

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ABSTRACT

Fish Slough Cave is situated in the rocky cliffs above the Fish Slough wetlands at the north end of Owens Valley, eastern California. This wetland environment, rich in riparian resources, sits in contrast to the surrounding xeric region. Excavation of the cave in 1988-89 resulted in recovery of over 300 human coprolites preserved in excellent condition. Analysis indicates that wetland taxa (e.g., fish, *Catostomus* sp.; plants, *Typha* sp. and *Rosa* sp.; and shellfish, *Anodonta* sp.) dominate the contents of the coprolites. The nutritional status of wetland diets is variably interpreted as either good or bad. The Fish Slough coprolite data point to the latter, although not for the traditional reasons. It is in these terms that the nutritional potential of the Fish Slough diet is addressed.

INTRODUCTION

Studies of wetland adaptations usually focus on the lush riparian resources that remain relatively abundant throughout the year, that is, relative to other ecozones, such as drylands that display only a seasonal profusion of resources. There is perhaps no greater example of this in North America than the Great Basin, where seasonal resource shortages often pose a threat to survival. As such, Great Basin wetland environments are looked upon as veritable oases amidst the vast desert expanses. Current archaeological research in Great Basin wetlands center on how these unique systems fit within regional systems; that is, how they were used over time by the prehistoric hunter-gatherers who inhabited them (Madsen 1982; Janetski and Madsen 1990; Kelly 1990; Bettinger 1993).

These wetland environments have posed somewhat of a conundrum for Great Basin researchers. Based on availability and abundance of resources, these regions should be great places to reside; as such, the nutritional potential of Great Basin wetlands is often considered to be good (Madsen 1982:212). The archaeological record, however, does not always confirm this hypothesis; so conversely, wetland environments must be bad. That is, although wetland resources are highly reliable, they are costly to procure and their energy returns are low; thus the opposing hypothesis argues that wetland resources are backup resources and should only be exploited when the higher ranked dryland resources are unavailable (Raven and Elston 1988:12; Thomas 1985:20; Parmalee and Klippel 1974:433).

These kinds of arguments about prehistoric diets and how they relate to settlement/subsistence patterns are a natural outcome of Great Basin wetland studies. However, when such studies lead to assertions about the nutritional potential of prehistoric diets in general and wetland environments in particular they become problematic. The issues are: first due to the very nature of archaeological field research which places constraints on the method and accuracy of dietary data collection, and secondly, because they lack the employment

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of nutritional models that are specific to the kinds of questions archaeologists ask about prehistoric diets. That is, simply put, what were the prehistoric inhabitants eating and why? Or, to ask more complex questions, why do some resources or environments seem to be underexploited?

In general, studies of paleonutrition focus on the reconstruction of prehistoric diets, and, in turn, on determining the nutritional benefits of the dietary components. The nutritional data are most often used in conjunction with ecological or more specifically optimal foraging models to determine the likelihood of a resource's inclusion in the prehistoric diet based on overall calories or energy gain.

Prehistoric diets are usually reconstructed from indirect, or circumstantial evidence based on analysis of ground stone and chipped stone tools, as well as comparative behavioral studies of living and historic hunter-gatherers. Direct evidence includes cultural food debris (floral and faunal), although clear relationships of the remains to the deposit can be difficult to demonstrate. The most direct evidence of prehistoric diet comes from coprolite analysis (Reinhard and Bryant 1992). Because this is so, the Fish Slough Cave collection offers an excellent opportunity to examine paleodiets in general, and wetland adaptations in particular.

THE FISH SLOUGH CAVE EXAMPLE

Fish Slough Cave is situated in the rocky cliffs above the Fish Slough wetlands at the extreme north end of the Owens Valley, in eastern California (Figure 1.). This wetland environment, rich in riparian resources, sits in contrast to the surrounding dry volcanic tablelands. Excavations of the cave in 1988-89 produced more than 300 exceptionally well preserved human coprolites. Fish Slough Cave represents one of the few collections of coprolites in the Great Basin that can be directly related to well-dated and well-documented prehistoric regional subsistence settlement systems. The Fish Slough coprolites provide direct evidence of prehistoric diet. Since we can assume that dietary remains represented in the fecal material were consumed within 24 hours, we can roughly approximate the diversity of daily dietary intake (understanding, of course, that some foods don't leave a residue in the fecal material). Analysis of the coprolites' contents offers the opportunity to examine subsistence patterns from a detailed dietary perspective.

Following traditional paleonutrition studies, preliminary analysis focussed on identifying the main constituents of the coprolites. A representative sample of fecal remains was selected for rehydration and microscopic analysis. Results of those analyses indicate that wetland taxa dominate the contents of the fecal material. Those taxa from the wetland/riparian zone of Fish Slough include the following: *Rosa* sp. (rose hips); *Sporobolus* sp. (drop seed); *Anodonta* sp. (freshwater mussel); *Cyprinodon* sp. (Owens pupfish); *Catostomus* sp. (Owens sucker); and *Typha* sp. (cattail root).

From a nutritional standpoint many of the wetland taxa are high in water content yet low in carbohydrates, fats, and proteins, making them a suboptimal food resource. After comparing the available nutritional data we note that the resources from dryland and upland regions are higher both in calories and carbohydrates than are wetland species (Table 1). In short, we surmise that the Fish Slough diet does not provide a good source of energy, and a quick appraisal of the situation tells us that the smart hunter-gatherers will be spending most of their time in the drylands and uplands seeking higher ranked resources. In other words, the nutritional potential of the Fish Slough wetland diet is poor. However, there is more to know about the Fish Slough Cave diet to assess its nutritional potential.

APPROACHES TO DIET AND NUTRITION STUDIES

To properly assess the nutritional potential of

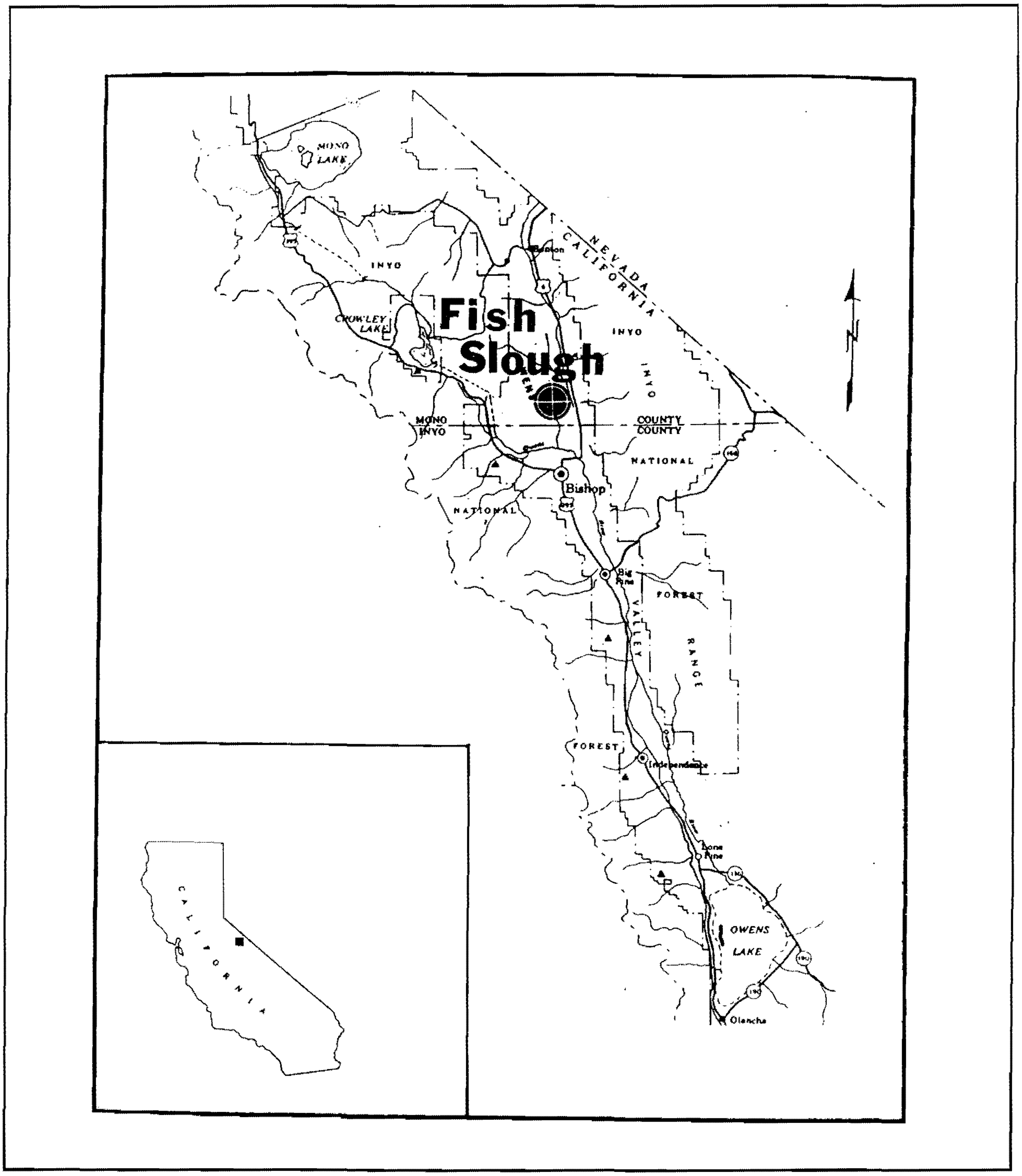

Figure 1. Location of Fish Slough (from B.L.M. 1985).

Table 1

Nutritional Content of Resources*						
Resources	Water (%)	Protein (%)	Fat (%)	Cho (%)	Ash (%)	Cal (kg.)
Wetland Species						
Typha[1] (shoots)	85.61	0.92	0.55	10.78	2.14	517
(roots)	85.51	0.71	0.38	11.63	1.72	528
(rhizomes)	93.78	0.45	0.28	3.25	2.23	173
Scirpus[2] (roots chewed into quids)	86.8	0.1	0.3	12.5	0.5	510
Rosa[1] (hips)	59.9	2.67	3.14	33.25	1.03	600
Mytilus[1] (boiled mussel)	72.0	18.9	2.2	5.0	1.9	115
Dryland Species						
Atriplex[2]	6.9	3.9	0.01	67.9	21.3	2790
Oryzopsis[2]	3.6	15.2	0.1	53.9	27.2	2740
Upland Species						
Pinus monophylla[1]	7.5	7.8	24.0	58.4	2.2	4810

*Resources are not necessarily Great Basin species. [1] Gilliland (1985), [2] Simms (1985).

any diet, we must be cognizant of the kinds of things that concern nutritional anthropologists. Not unlike those of paleonutrition, the goals of nutritional anthropology are to describe and analyze food practices and the nutritional consequences of human behavior. However, dietary studies from a nutritional perspective suggest an inquiry into all the processes involved; i.e., resource procurement, preparation, ingestion, digestion, absorption and transport of nutrients, synthesis of tissue components, and liberation of energy. Ecological models of diet are mainly concerned with ingestion and the liberation of energy, and are fundamentally not about nutrition and nutritional status of prehistoric diets. They speak to the nutritive benefits of a single resource in comparison to other individual resources. These benefits are most often addressed in terms of caloric gain, not vitamin or nutrient gain. Both nutritional and ecological approaches have their place in paleonutrition, but rarely have these both been combined in the same dietary study (cf. Keene 1985).

It is best to approach dietary studies with a basic understanding of how nutrients function and interact; however, since such an understanding is beyond the scope of this paper, a brief summary must suffice. In short, there are six classes of nutrients: carbohydrates, which are the main energy source; proteins, which promote growth and the maintenance and repair of tissue; fats, which are energy in storage form; vitamins, which serve a regulatory function; minerals, that are both structural and regulatory (for blood, bones, and hormones); and water, which functions both as a solvent and in temperature regulation and is perhaps the most significant nutrient (Malina 1987:174-5). It is important to emphasize that nutrients are components of food, and for the most part people eat food not nutrients. In other words, foods that are eaten are most often regulated by social behavior -- behavior that includes culturally prescribed methods of procurement, processing, and ingesting.

PROCESSING AND NUTRITION

Prehistoric hunter-gatherers used many different resources to meet their nutritional needs. They developed processing and preservation techniques to sustain, improve, and in some cases decrease nutritional benefit (Bender 1966:287; Messner and Kuhnlein 1986:74; Stahl 1987:184). To properly assess a diet we must have some notion about how the ingested foods were processed. We need to address the nutritional changes that occur in food before consumption; these are the chemical changes that occur as a result of processing.

Although cooking usually renders food more palatable or digestible, occasionally the effects are negative. A case in point is vita-mins, which are the most delicate of the nutrients and are particularly susceptible to nutritive loss during cooking (Bender 1966:262; Mess-ner and Kuhnlein 1986:69; Stahl 1987:182). For example rose hips, which are a major component of the Fish Slough wetland diet, are considered to be a good source of vitamin C; however, if they were processed by boiling, some nutrient loss might have occurred.

Proteins suffer nutritive damage only when they are extremely overcooked or when stored for extended periods of time (Bender 1966:262). Leaching (i.e., water processing) can lead to losses in carbohydrates and mineral salts, but the deficit is considered slight and unimportant (Bender 1966:262). Although nutrient losses from processing may be minimal, they must be considered before a case is made for the nutritional benefit of a particular resource.

CASE AGAINST HIGH FIBER DIETS

Dirt, grit, and fiber constituted a large part of prehistoric diets, quite often as a result of processing (Garn and Leonard 1989:337). Most prehistoric diets, however, were naturally high in fiber, resulting from a heavy reliance on grains and tubers (Garn and Leonard 1989:344). Over 50% of the Fish Slough coprolites contain fiber, suggesting a heavy dependence on roots. Considering that high fiber foods exit more quickly through the digestive processes, many nutrients may pass through the digestive system unabsorbed. Therefore, a high intake of fiber has negative effects to calcium availability, protein utilization, and iron absorption (Garn and Leonard 1989:344; Stahl 1987:173).

Processing fibrous plants may slow their movement through the digestive system, thereby allowing nutrients to be better absorbed. Pounding roots to break down the fiber is one way of processing prior to ingestion. In addition, chewing and expectorating the fiber or quids serves to aid in digestion (Stahl 1987:173). The large number of quids in the Fish Slough Cave collection suggests the employment of the latter technique.

Too much fiber, or bulk, in the diet could also result in an overall decrease in the volume of food consumed (Whitney and Hamilton 1984:71). In other words, highly fibrous foods may give one a false feeling of fullness, which can result in deficiencies in both nutrients and kilocalories. There is always the possibility that nutrient deficiencies can develop on high fiber diets (Whitney and Hamilton 1984:71).

DISCUSSION

Studies in paleonutrition rarely address the complex interactions among nutrients, and most do not take into account that foods are eaten together. Nutritional research indicates that most plant foods contain compounds known as anti-nutrients, which interfere with the digestive processes of metabolism and absorption of nutrients which can result in nutritional stress (Harris 1962:149). For example, calcium absorption is hindered by excess fat, phosphate, oxalate, and phytate, all elements that are found in most seed resources. In a very diverse diet, it may be of little importance if any one resource suffers nutrient damage, unless that one food is the main source of a nutrient (Bender 1966:262).When we assess wetland diets and make arguments about the importance of a single resource based on incomplete nutritional data we are ignoring important factors. For example, a recent Great Basin study suggests that fish provide a good source for necessary nutrients (i.e., they were high in protein, fat, and other minerals) and were probably used more than the archaeological record indicates (Lindstrom 1992:300). Taken as a single resource this is probably true; however, if the fish is eaten with other wetland resources, like highly fibrous cattail roots, one may not get the nutrient value of the fish because the fiber may reduce the bioavailability of some nutrients.

I am not suggesting that ecological models are bad for reconstructing prehistoric diet and settlement/subsistence patterns. On the contrary, they are among the best we have. However, caution needs to be taken when these models are used to infer nutritional status. Nutritional potential cannot be addressed one resource at a time, for it is the combination of resources (i.e., the combination of nutrients and their subsequent interactions), that determine the nutritional potential of a diet. Although settlement patterns are probably not based on nutritional needs, the dietary habits of people who have survived under adverse resource conditions must have included choices of nutritional consideration (Harris 1962:149). A population's survival is always contingent on the nutritional adequacy of their diet (Gilliland 1985: 7).

Taking the Fish Slough cave diet as an example, each meal represented by a coprolite may include from as few as four resources to a mixture of a dozen different resources, which, taken in combination, could be considered either good or bad. A very diverse diet is usually considered to be good, as nutrients that are lacking in some may be present in others. Similarly, concern that some resources are of lower nutritive value than others is unnecessary if the population is otherwise well-nourished (Bender 1966:287). In other words, an occasional foray to the slough for fish, mussels and cattail roots should pose no eminent health threat. However, if a high fiber diet becomes the norm then there is a good possibility that the fiber will reduce the absorption of important nutrients. Therefore, the high fiber wetland diet is not the optimal choice for long term survival, and wetland environments, exploited even as a backup strategy, may pose more of a paradox than we initially considered.

CONCLUSIONS

The Fish Slough diet inferred from the coprolite analysis can be argued to be potentially "bad", in the traditional sense, because many of the resources, wetland taxa in particular, have high procurement costs relative to low caloric/ energy returns. I would take this argument a step further and suggest that the diet is "bad" in nutritional terms because the high fiber diet may reduce the bioavailabilty of some important nutrients. Furthermore, it appears that inefficient food processing may have reduced the nutrient gain from some resources. In conclusion, it is tempting to suggest, based on results of the preliminary analysis, that the diet inferred from the coprolite data represents a starvation diet. In other words, the prehistoric inhabitants were not necessarily going to the slough to reap the benefits of a diverse diet, but because it was the only food available at the time. The preliminary analysis of the Fish Slough Cave diet, however, falls victim to the same inadequacies as other analyses; i.e., it fails to fully incorporate and reflect the necessary nutritional data.

Although archaeological remains can never completely express the true extent of the complexity of prehistoric diets, nutrition is so basic to human existence that attempts must be made to understand the role of nutrition in prehistoric settlement/subsistence systems. Studies of prehistoric diet by design should be of ecological, cultural, and nutritional significance. By addressing future research in these terms, analysis of the Fish Slough Cave coprolites promises to take a more comprehensive approach to the study of prehistoric Great Basin wetland settlement/subsistence systems.

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