Gilbert, Charles H., and Barton W. Evermann
1894 A Report Upon Investigations in the Columbia River Basin with Description of Four New Species of Fishes. Washington, D.C.: Bulletin of the U.S. Fish Commission (14):169-207.

LaRivers, Ira, and T. J. Trelease
1952 An Annotated Check List of the Fishes of Nevada. California Fish and Game 38(3): 226-240.

Pavesic, Max G.
1978 Ethnohistory as Cultural Ecology: A Case Study of Shoshonean Salmon Fishing. Paper Presented at the 31st Annual Northwest Anthropological Association Meetings, Pullman, Washington.

Plew, Mark G.
n.d.*a* Recent Data from Nahas Cave: A Further Note on the Origins of the Bow and Arrow in the Northern Great Basin. The Masterkey (in press).

n.d.*b* Nahas Cave: An Archaic Hunting Camp in the Owyhee Uplands, Idaho. Paper in preparation.

Shellbach, Louis
1967 The Excavation of Cave No. 1, Southwestern Idaho. Tebiwa 10(2):63-72. (Foreword by Earl H. Swanson, Jr.).

Steward, Julian H.
1938 Basin-Plateau Aboriginal Socio-Political Groups. Washington, D.C.: Bureau of American Ethnology Bulletin No. 120.

Swanson, Earl H., Jr.
1965 Archaeological Explorations in Southwestern Idaho. American Antiquity 31(1): 24-37.

A Reassessment of the Nutritional Value of *Pinus monophylla*

GLENN J. FARRIS

Researchers in the ethnology and archaeology of the Great Basin and the Transverse Ranges of California have dealt at length with the importance of single-leaf piñon (*Pinus monophylla*) nuts[1] in the diet of the Native Americans residing in these areas (cf. Barrows 1900); Bettinger 1976; Dutcher 1893; Steward 1934; Stewart 1942; Thomas 1973; Voegelin 1938; Zigmond 1941). Although this food item is most often dealt with quantitatively (volumetric portion of the diet; amount of nuts obtainable), some have discussed its quality as a nutritional item.

Maurice Zigmond, in his ethnobotanical study of the Great Basin and California Shoshoneans, states:

> The outstanding feature of the analysis [of pine nuts] is the indication of the high fat content which, in turn, accounts for the high food value. In the body, both fats and carbohydrates supply energy, but the former constitutes a much more concentrated form of fuel than the latter [Zigmond 1941:30-31].

In this comment he is specifically referring to the standard and most often quoted analysis of *P. monophylla* published by Woods and Merrill in 1899. It indeed shows a remarkably high fat percentage (see Table 1) and so seems comparable to other pine nuts, particularly the New Mexico piñon (*P. edulis*) (see Table 2). The Woods and Merrill error has been perpetuated in recent literature (e.g., Bean 1972:40; Bean and Saubel 1972:104).

Glenn J. Farris, Dept. of Anthropology, Univ. of California, Davis, CA 95616.

Woods and Merrill give a caloric value of 3327 calories per pound of edible portion of *P. monophylla* (1899:83). In computing caloric value, fat content is an important quality when one considers the multipliers used. A standard means of determining the caloric value for a pound of food is: "18.6 [% of protein + % total carbohydrates (nitrogen-free extract[2] + fiber)] + 42.2 (% fat)" (Woodroof 1967:78).

The data obtained by Woods and Merrill became the standard reference, being simultaneously published by the U.S. Department of Agriculture (Atwater and Bryant 1899:75). However, subsequent analyses performed over the years have differed radically from that published by Woods and Merrill (cf. Adams and Holmes 1913; Little 1938; Botkin and Shires 1948). Unfortunately, these published figures have appeared in journals not often referred to be the majority of anthropologists. No one seems to have explicitly set the record straight, although Elbert Little, Jr., (1938:1) did publish the Woods and Merrill figures side by side with the Adams and Holmes figures but, he unfortunately, did not comment on the differing results. In fact, since Little then quotes the fuel value from Woods and Merrill, he would appear to accept their figures (Little 1938:2).

Recently, an analysis on the seeds of *P. monophylla* was made by Dr. Victor Rendig and Mr. T. Steven Inouye of the University of California, Davis, on seed obtained by Mr. Jack Carpenter of the U.S. Genetics Experiment Station in Placerville, California. Carpenter collected the seed in Alpine County, California. The analysis done by Rendig and Inouye clearly is in consonance with those of Adams and Holmes, and Botkin and Shires, thus casting further doubt on the Woods and Merrill figures (Table 1).

It would appear that *P. monophylla* differs from most other pine species used by Native Americans in the western United States (Table 2). In particular, the fat content is less than half that of any of the other pine nut species except *P. quadrifolia*. The protein content is relatively low, under 10%, again most comparable with *P. quadrifolia*. Finally, the carbohydrate figure is remarkably high, being three times as high as other pine nut species with the exception once more, of *P. quadrifolia*.

However, a comparison with data on acorn meal shows a notable similarity. Computed fuel values of the pine nuts and acorn meal show *P. monophylla* falling closer to acorn meal (Table 2) than to other pine nut species. Without knowing the quality of the carbohydrates and proteins, and particularly the amino acid constituents of acorns and pine nuts, it would be a mistake at this time to place too much emphasis on the apparent similarities. Research on amino acid constituents of pine nuts is soon to be initiated at the University of California, Davis.

On the quantitative side too, the picture of *P. monophylla* needs to be corrected. The Woods and Merrill data show that the percentage of *P. monophylla* seed which is classi-

Table 1
FOUR NUTRITIONAL ANALYSES OF *PINUS MONOPHYLLA*

(kernels only—percentages by weight)

Researchers	Water	Protein	Fat	Fiber	Carbohydrates	Ash
Woods and Merrill	3.8	6.5	60.7	- - - - - - -	26.2	2.8
Adams and Holmes	7.9	8.9	22.8	0.7	57.2	2.6
Botkin and Shires	10.2	9.5	23.0	1.1	53.8	2.4
Rendig and Inouye	4.9	8.5	30.0	- - - - - - -	56.6	- - - - - - -

Table 2
NUTRITIONAL VALUES OF SOME PINE NUTS AND ACORN MEAL

(kernels only—percentages by weight)

Species	Water	Protein	Fat	Crude Fiber	Carbo-hydrate	Ash	Fuel value (cal.)[d] per lb.	per 100 gm.
Pinus sabiniana (Digger Pine)[a]	3.6	29.5	49.4	-----	17.4	-----	2959	652
P. lambertiana (Sugar Pine)[a]	3.3	25.2	53.6	-----	17.9	-----	3064	675
P. edulis (New Mexico Piñon)[b]	3.0	14.3	60.9	1.1	18.1	2.7	3241	714
P. quadrifolia (Parry Piñon)[b]	4.9	10.8	37.2	1.1	43.5	2.4	2647	583
P. monophylla (Single-leaf Piñon)[b]	10.2	9.5	23.0	1.1	53.8	2.4	2213	488
Quercus californica (=*Q. kelloggii*, California Black Oak)[c]	11.3	4.5	19.8	2.1	62.0	0.3	2117	466
Q. lobata (California White Oak)[c]	8.7	5.7	18.6	-----	65.0	2.0	2137	471

[a]Rendig and Inouye. Unpublished analyses done at the University of California, Davis, March 1980. Fiber and ash are contained in the carbohydrate figure. Samples of *P. lambertiana* were obtained from the U.S. Forest Service Genetics Laboratory, Placerville, California. The *P. sabiniana* sample was obtained by the author at Lake Berryessa in the southern North Coast Ranges of California.

[b]Botkin and Shires 1948:9.

[c]Merriam 1918:136-137.

[d]Caloric figures were computed by the author.

fied as waste is 41.7% (see Table 3). As in the case of the nutritional values, this figure has been perpetuated. However, Botkin and Shires report a very different figure, an average of 28.9% waste (Table 3). This increases the proportion of edible fraction of this nut by nearly 13%. Again, in comparison to other pine nut species, *P. monophylla* is only approximated by *P. quadrifolia.* My own experiences in weighing samples of *P. monophylla* bears out the figures obtained by Botkin and Shires (Table 3).

Table 3
COMPARISON OF WASTE TO KERNEL IN PINE NUTS

(by percentage)

Species	Waste	Edible
P. sabiniana[a]	77.0	23.0
P. lambertiana[a]	41.0	59.0
P. edulis[b]	41.5	58.5
P. quadrifolia[b]	32.8	67.2
P. monophylla		
(Woods and Merrill)	41.7	58.3
(Botkin and Shires)	28.9	71.1
(by Author)	27.9	72.1

Sources: [a]Author.
[b]Botkin and Shires 1948.

To exemplify the problem of using this erroneous shell-to-kernel figure, we have a discussion of the relative food values of acorns and pine nuts to ten Paiute and Washo families. Sherburne F. Cook calculated that these families used an annual average of 1 sack (100 lbs.) of acorns and an equal amount of pine nuts. After subtracting shell waste and water loss in drying for the acorns, the remaining useable meat amounted to 50 lbs. Cook then says, "pine nuts are structurally quite similar, and the same weight estimates will hold" (Cook 1941:55). Although he does not say what figures he bases this judgment on, it would be quite consistent with the then-extant data. Subsequent figures on the shell-to-kernel ratio would suggest that the 100 lbs. of pine nuts would represent 71 or 72 lbs. of edible portion rather than the 50 lbs. determined by Cook.

As regards caloric value, Cook calculates a rate of 2180 calories per pound for acorns and "pine nuts at probably the same order of magnitude" (Cook 1941:56). As we see in Table 2, this statement is reasonably accurate, although Cook gives us no evidence that it is based on anything more than a guess. In all, Cook's calculations for the food value available in the 100 lbs. of pine nuts would be substantially increased by using the correct figures.

The growing field of paleo-nutrition calls for ever more precise data. Whereas *P. monophylla* has been accepted as an important vegetal food for the Great Basin peoples, the nutritional data show it to be an even more remarkable food item than it appeared to be based on the earlier and more commonly used analytic report. In particular, the former emphasis on the exceedingly high fat content must be reconsidered. The importance of this high carbohydrate food item in the Great Basin may well lie in the lack of such food products as acorns (as in California) or corn (as in New Mexico and Arizona). To each of these food items, by contrast, the nutritional qualities of the dominant pine nuts in each area would seem quite complementary. Further nutritional research will shed greater light on the accuracy of this conclusion.

ACKNOWLEDGEMENTS

I very much appreciate the contributions to this paper made by Mr. Jack Carpenter, Dr. William Critchfield, and Dr. James Griffin of the U.S. Forest Service, Dr. Martin Baumhoff, Mr. Alan Garfinkel, Dr. Louis Grivetti, Mr. Richard Hughes, and Dr. D. L. True of the University of California, Davis, and, particularly, Dr. Victor Rendig and Mr. T. Steven Inouye of the Department of Land, Air, and Water Resources, University of California, Davis, for doing nutritional analyses. Any errors or omissions are mine.

NOTES

1. Properly, pine "nuts" are really seeds. In common speech, however, the two terms are both used. Such usage is reflected in this paper.

2. The term "nitrogen-free extract" refers to the fact that in using the Kjeldahl technique of analysis for nutritional factors, protein is determined by measuring the nitrogen present in the dried, de-fatted sample. This figure is then multiplied by a standard figure of 6.25 on the belief that the nitrogen forms 16% of the protein. Carbohydrates and ash are then considered to make up the remainder of the sample. It should be noted that the 6.25 multiplier is disputed since it is used for all foods. D. Breese Jones (1931) suggests a multiplier of 5.3 be used for nuts. This would act to lower the protein figure and raise that for carbohydrates. However, for the sake of comparability, the standard figure of 6.25 will be retained in the calculations presented here.

REFERENCES

Adams, Maxwell, and August Holmes
1913 Pine Nut Oil. Journal of Industrial and Engineering Chemistry 5(4):285-287.

Atwater, W. O., and A. P. Bryant
1899 American Food Materials. U.S. Department of Agriculture Office of Experiment Station Bulletin 28.

Barrows, Davis Prescott
1900 Ethno-botany of the Coahuilla Indians of Southern California. Chicago: University of Chicago Press.

Bean, Lowell John
1972 Mukat's People: The Cahuilla Indians of Southern California. Berkeley: University of California Press.

Bean, Lowell John, and Katherine Siva Saubel
1972 Temalpakh: Cahuilla Indian Knowledge and Usage of Plants. Banning, California: Malki Museum Press.

Bettinger, Robert L.
1976 The Development of Pinyon Exploitation in Central Eastern California. Journal of California Anthropology 3(2): 81-95.

Botkin, C. W., and L. B. Shires
1948 The Composition and Value of Piñon Nuts. New Mexico Agricultural Experiment Station Bulletin 344.

Cook, Sherburne F.
1941 The Mechanism and Extent of Dietary Adaptation among Certain Groups of California and Nevada Indians. Ibero-Americana 18.

Dutcher, B. H.
1893 Piñon Gathering among the Panamint Indians. American Anthropologist, o.s., 6:377-380.

Jones, D. Breese
1931 Factors for Converting Percentages of Nitrogen in Foods and Feeds into Percentages of Proteins. Department of Agriculture Circular No. 183.

Little, Elbert L., Jr.
1938 Food Analyses of Piñon Nuts. Southwestern Forest and Range Experiment Station Research Note No. 48.

Merriam, C. Hart
1918 The Acorn, a possibly neglected source of food. National Geographic 34(2): 129-137.

Steward, Julian H.
1933 Ethnography of the Owens Valley Paiute. University of California Publications in American Archaeology and Ethnology 33(3):233-350.

Stewart, Omer C.
1942 Culture Element Distributions: XVIII, Ute-Southern Paiute. University of California Anthropological Records 6(4): 231-354.

Thomas, David Hurst
1973 An Empirical Test of Steward's Model of Great Basin Settlement Patterns. American Antiquity 39:155-176.

Voegelin, Erminie W.
1938 Tubatulabal Ethnography. University of California Anthropological Records 2(1).

Woodroof, Jasper Guy
1967 Tree Nuts. Westport: Avi Publishing Co.

Woods, Charles D. and L. H. Merrill
1899 Nuts as Food. Maine Agricultural Experiment Station Bulletin 54:71-92.

Zigmond, Maurice Louis
1941 Ethnobotanical Studies among California and Great Basin Shoshoneans. Ph.D. dissertation, Yale University.