IDAHO ARCHAEOLOGIST

ISSN 0893-2271

Volume 18, Number 2

Volume 18, Number 2
Fall 1995

IDAHO ARCHAEOLOGIST

The ***IDAHO ARCHAEOLOGIST*** is published semi-annually by the Idaho Archaeological Society in cooperation with the College of Social Science and Public Affairs, Boise State University. The ***IDAHO ARCHAEOLOGIST*** is the journal of the Idaho Archaeological Society, a non-profit association of professional and amateur archaeologists, organized under the laws of the State of Idaho. Subscriptions are $12.00 per year and may be obtained by writing the ***IDAHO ARCHAEOLOGIST***, Department of Anthropology, Boise State University, 1910 University Drive, Boise, Idaho 83725.

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Mark G. Plew, Editor
IDAHO ARCHAEOLOGIST
Department of Anthropology
Boise State University
1910 University Drive
Boise, Idaho 83725

Cover: Snake River Canyon below Swan Falls.

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ARTICLES AND REPORTS

FUNGAL CONTAMINATION OF STORED SEEDS: IMPLICATIONS[1] FOR ABORIGINAL CACHING STRATEGIES

by Michael T. Dunn
Boise State University

INTRODUCTION

The prehistoric residents of southwestern Idaho are known to have lived in small groups and were generally engaged in transhumant pattern of seasonal use of resources (Steward, 1938, 1941; Stewart, 1941). Storage of surplus resources is reported (Steward, 1941), yet the data on this is sparse, as ethnographic data are derived from informants many generations removed from their pre-contact lifestyles (Kehoe, 1992; Wheat, 1976) and the archaeological record is presently inconclusive. This lack of solid evidence concerning the economic strategies of the aboriginal occupants of this region has led to generalizations concerning the lifestyles of these peoples, and it manifested in two interpretations of the recent past.

A traditional view follows the reported ethnographic record for the Great Basin (Steward, 1938) which for some implies a collector strategy as outlined by Binford (1980). This is a pattern of strategically organized collection forays from more or less permanent, seasonally occupied camps. A more recent interpretation based upon archaeological data posits groups of foragers responding to the variability of the environment, using resources seasonally, but on an irregular and unpredictable annual cycle. In this model, after Binford's foragers, resource patches are "mapped into" through experience and those foods are consumed as encountered, with storage restricted to small scale, short term caches (Gould and Plew, 1994). Binford sums up this hypothetical concept as "Foragers move consumers to goods...while collectors move goods to consumers."

These different economic strategies would suggest different foraging and settlement patterns. If resource use is regular and predictable, travel is 'out and back' and storage from season to season may be feasible even when the time, energy, and storage losses are considered. If groups move in response to changing conditions, with daily movement based on local patch variability and seasonal movement is only as predictable as high in summer and low in winter, return to a specific site would not be guaranteed. Caching the excess harvest could be a form of insurance against starvation but with little time or energy investment, little would be lost if it went unrecovered.

Without extensive ethnographic or archaeological data to draw from, some have employed models from traditional animal ecology. Simms (1987) for example, used traditional methods to harvest indigenous resources of the Great Basin and ranked them in Kcal/hr according to the *Optimality* model (MaCarthur and Pianka, 1966). This allows foods to be ranked by their net energy value after procurement cost and says that all things being equal, a forager should choose a higher valued food over one of lower value. When Simms ranked seeds by this formula (Table 1) he found a low or even negative rate of return even though the archaeological record documents widespread use of this food item (Simms, 1987; Steward, 1938, 1941; Stewart, 1941).

There are many possible reasons for the inclusion of low ranked resources in a diet. Foodstuffs encountered while in pursuit of more lucrative items may be harvested at little or no cost and vital vitamins or minerals may be found in food of low caloric value. Storage may also change the ranking of a food item as shown by the value of nuts in the Saginaw Valley of Michigan (Keene, 1981). Some aboriginal storage is indicated in the Great Basin (Steward, 1938; Stewart, 1941), yet little is known about what may have been stored, for how long, and what impact storage would have on the value of a foodstuff.

If seeds were harvested for their storability, the value of this foodstuff should be maintained in storage from harvest until needed. Presently world-wide as much as 40 percent of cereal grains are lost post harvest from a variety of agents such as insects, rodents, and bacteria, yet fungi have the greatest potential for causing this loss (Meronuck, 1978). In India and parts of Africa and South America for example, the seed and grain crop loss due to fungi is estimated to approach 30 percent (Neergaard, 1977).

[1]Paper presented at the 37th annual meeting of the Idaho Academy of Science. Nampa, Idaho, April 1995.

This project experimentally stored seeds and analyzed them for fungal contamination to explore the limits this contaminant may place on storage time. Although this study takes place on the Snake River plane of southwestern Idaho, the outcome will presumably be applicable to the entire Great Basin culture area.

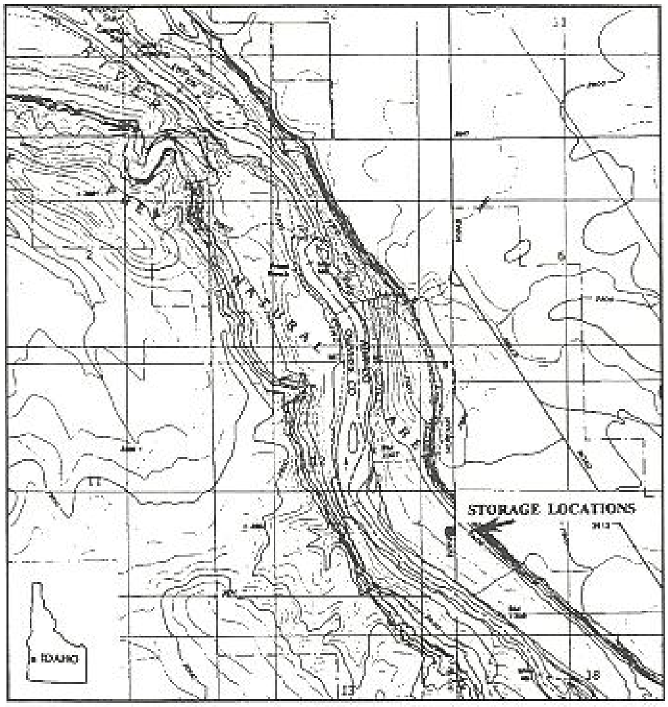

Figure 1. Map Showing the General Location of Storage Pits.

METHODOLOGY

The study site is within the Snake River canyon on the north side of the river downstream from Swan Falls dam (see Figure 1). Within the flood plain, near the talus slope at the base of the cliff wall, two pits were excavated. These pits were easily excavated with hand tools in the hard packed, well sorted, clay soil. As the definitive Hunter-gatherer pit model is undetermined for the Great Basin, a California example was loosely followed for size and shape. Seeds were known to be stored in pits (Steward, 1941) and pit size was variable, but could be up to a meter wide and deep (Wilke and McDonald, 1989). For this experiment a simple pear shaped pit was excavated at a size of approximately 0.5 meters wide and deep. To facilitate seed recovery, the pit bottoms were lined with flat rocks (basalt), that were common to the site.

Pits lined with grass, bark, or clay are known from the archaeological record (Wilke and McDonald, 1989; Yohe, 1995) but the reported linings raise questions that are beyond the scope of this paper. Besides increasing handling time each of the linings in evidence could potentially increase or decrease storability. Grass lining, for example, could introduce epiphytous fungus or wick away fungus-inducing moisture. Clay lined pits could repel soil fungi but hold existing and introduced moisture and therefore incubate fungal growth. These variables and others should be pursued in future experiments which will allow for comparison of a range of storage facilities.

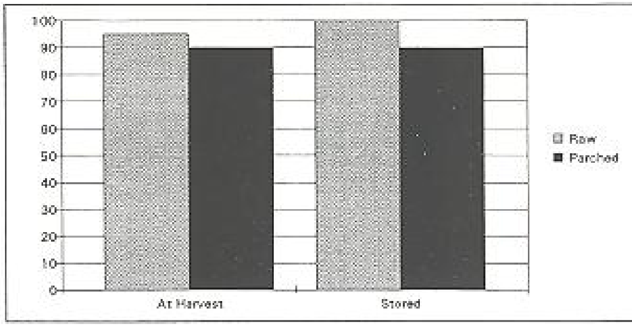

Figure 2. Chart Showing the Percentage of Raw and Parched Seeds Stored and at Harvest.

Generally, there is a wide range of seeds available for harvest (Simms, 1987), but due to the extremely dry summer in 1994 many of the potential candidates produced yields reduced in quality and/or quantity. One of the few plants that yielded seeds in harvestable numbers was *Atriplex canesens* (Shadscale/fourwing saltbush). Even though the Caloric ranking of *Atriplex* seeds in general is relatively high and some species may absorb toxins from the soil (Simms, 1985), these seeds were harvested for this experiment.

On 13 November, 1994, approximately 12 liters of seeds were harvested by hand in the immediate vicinity of the previously excavated pits. One half of the seeds (six liters) were parched on site using a Coleman stove and an aluminum pan. No attempt was made to duplicate the traditional hot rock and wicker basket parching method described in the ethnographic literature (Powell, 1987; Stewart, 1941). Parching was done in the most convenient and thorough method available to compare the storability of raw versus parched seeds. A random sample was taken from each treatment for lab analysis and the remainder were placed loose, in separate pits, which were covered by flat rocks. In March, a second sample was recovered from each pit, and analyzed by the same method as the November sample to determine the viability of storage over winter.

Recovered seeds from each of the pits and the control were tested for fungal infestation in two ways. A first group of seeds was surface washed with a 1 percent detergent solution and then rinsed five times with sterile distilled water. A second group of seeds was surface sterilized with a 20 percent chlorox solution (bleach) and then rinsed five times with sterile distilled water. Washing removes surface contaminates but not all surface organisms. Sterilization removes all surface organisms leaving only those organisms that have infested within the seed. This will allow for analysis of the degree or intensity of infestation.

Seeds were plated, five seeds to a petri dish, on V-8 Juice Agar. For each of the pits and both treatments ten plates were cultured for a total of 40 plates for each analysis. After five to seven days, growing colonies were isolated onto CM+ Agar for identification to Genus by this researcher with the assistance of Dr. Marcia Wickow-Howard of Boise State University.

RESULTS AND DISCUSSION

Seed parching is well documented in the ethnographic record (Powell, 1987; Steward, 1938; Stewart, 1941) and

TABLE 1
SEED RESOURCE RANKING

Resource	Pursuit (hrs./kg.)	Processing (hrs./kg.)	Return Rate (Cals./hr.)
Descurainia pinnata Tansymustard	2	0.8	1307
Elymus salinas Salina Wild Rye	1	1.2	921-1,238
Atriplex nutalli Nutall Shadscale	0.9	1.6	1200
Scirpus sp. Bullrush	1.1-6.6	0.6-3.5	302-1.6999
Echinocholoa crusgalli Barnyard Grass	4.2	0.8	702
Lepidium fremontii Peppergrass	1.0-2.1	1.7-4.9	537
Poa sp. Bluegrass	3.0-5.7	1.1-5.0	418-491
Elymus cinereus Great Bin Wild Rye	4.0-7.1	1.9-3.4	266-473
Oryzopsis hymenoides Indian Rice Grass	4.0-5.7	1.8-3.5	301-392
Muhlenbergia asperifolia Scratchgrass	6.5-12.5	1.4-2.9	162-294
Hordeum jubatum Foxtail Barley	2.5-11.1	8.7-11.1	138-273
Sitanion hystrix Squirreltail Grass	19.2	11.8	91

(after Simms, 1985)

proved to be useful for three reasons; removing chaff, increasing storage space, and reducing fungal contamination.

By removing the husk from the harvested seeds their volume was reduced by two-thirds. As the construction of storage pits was fast and simple in this location, volume is probably not a major concern for caching. On the other hand, if transportation is required minimizing space would be beneficial (see Jones and Madsen, 1989, for transportation cost of *Atriplex* seeds).

A breakdown of the fungal analysis can be seen in Table 2. At harvest 50 of the raw/washed seeds molded, many with a variety of fungi that made isolation difficult. Forty-six of the 50 raw/sterilized seed molded with many of them monocultures that allowed for simple isolations. Parched washed seeds showed only three molded seeds and the parched sterilized group had only one as yet unidentified fungus. Of the 136 isolates from the 200 seeds, 132 were from raw seeds and only 4 from the parched group.

Of the recovered, stored seeds, only nine of the parched/sterilized seeds remained mold free and only that treatment had any seeds with fungal monocultures. All parched/washed seeds as well as seeds from both raw treatments were fully involved with mold. Although 40 cultures remain as yet to be identified, 287 isolates revealed 13 Genera.

Comparison between the washing and sterilizing laboratory treatments uncovered some interesting data on degree of infestation, competition, and habitat of the fungal

TABLE 2
ISOLATED FUNGI

AT HARVEST - 136 Isolates from 200 Seeds

Raw Washed		Raw Sterilized		Parched Washed		Parched Sterilized	
Alternaria	39	*Alternaria*	40	*Aureobasidium*	1	Unknown	1
Epicoccum	18	*Epicoccum*	7	*Cladosporium*	1		
Ulocladium	5	*Camarosporium*	5	*Ulocladium*	1		
Cladosporium	3	*Cladosporium*	4	**Total**	**3**		
Fusarium	2	*Aspergillus*	1				
Aspergillus	1	*Chaetomium*	1				
Camarosporium	1	*Diplopoda*	1				
Unknown	1	*Pyrenochaeta*	1				
Total	**70**	*Stemphylium*	1				
		Tricothecium	1				
		Total	**62**				
RAW TOTAL	**132**			**PARCHED TOTAL**	**4**		

AFTER STORAGE - 287 Isolates from 200 Seeds

Raw Washed		Raw Sterilized		Parched Washed		Parched Sterilized	
Alternaria	59	*Alternaria*	36	*Alternaria*	13	*Cladosporium*	9
Ulocladium	12	*Cladosporium*	9	*Penicillium*	10	*Phoma*	5
Penicillium	9	*Penicillium*	9	*Ulocladium*	10	*Epicoccum*	4
Cladosporium	8	*Ulocladium*	7	*Epicoccum*	8	*Alternaria*	3
Camarosporium	3	*Camarosporium*	6	*Cladosporium*	3	*Ulocladium*	3
Epicoccum	3	*Epicoccum*	4	*Phoma*	2	*Penicillium*	2
Oidiodendron	3	*Chaetomium*	2	*Fusarium*	1	Unknown	18
Diplopoda	1	Unknown	7	Unknown	14	**Total**	**44**
Stemphylium	1	**Total**	**80**	**Total**	**61**		
Unknown	1						
Total	**102**						
RAW TOTAL	**182**			**PARCHED TOTAL**	**105**		

Genera that will be discussed fully in a later paper. The pertinent comparison for this paper is between the raw and parched seeds.

This experiment demonstrated that seed parching is an excellent fungicide in the short term but its effectiveness is greatly reduced over time. As shown in Figure 2, immediately after treatment parching reduced fungal contamination by 96 percent but after four months of storage only 9 percent of tested seeds remained mold free. Therefore if seeds are harvested for their storability, and parched first as the record indicates, this experiment suggests that effective storage is limited to short caches, and so by implication, points toward the forager end of Binford's continuum model as the economic strategy of the prehistoric inhabitants of southwestern Idaho and Great Basin.

CONCLUSION

This work is intended to provide future researchers empirical data on fungal contamination of stored foodstuffs in this region. In view of a lack of archaeological data on food storage it is hoped that the information provided here will assist in the application of Optimal foraging and Diet Breadth models. With the potential for variability not only in climate (as seen in the limited variety of seeds available in this year for this test) but also in habitat, seasonality and cultural choices, many questions remain unanswered. One can hope that in time experiments such as this may address many of these questions.

In the continuing discussion of where aboriginal Great Basin groups fall on the collector-forager continuum, the role of food storage is a crucial point of contention. If, as the diet breadth model suggests, seeds were harvested for their storability; empirical data on storage losses may provide valuable clues to predicting prehistoric economic strategies. Long term storability would make a collector pattern feasible, while large losses would make this pattern and its reduced mobility unprofitable.

Comparing parched versus unparched seeds demonstrated that this pre-storage treatment, so prevalent in the ethnographic record, does produce a dramatic, immediate reduction on the fungal infestation of seeds. While after four months of in ground storage, parched seeds were molded to a lesser degree than those stored raw, fungal growth at that time was still considerable and approached the infestation rate of raw, unstored seeds.

From this data set, it would appear that profitable seed storage in subterranean pits is limited to short term caching strategies; and that any long term storage model would need to take into account losses that may meet or exceed the present day figure of 30 percent loss to fungal contamination in developing nations. It is hoped that such Middle Range approaches will assist in connecting the seemingly contradictory evidence of seed use in the Optimal Foraging model and the archaeological evidence for highly mobile forager groups in the prehistoric Great Basin culture area.

ACKNOWLEDGEMENTS

I thank Dr. Marcia Wicklow-Howard for the use of her lab and Mycological expertise and Dr. Mark Plew for his assistance in preparing this manuscript.

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AUTHOR AND SUBJECT INDEXES TO IDAHO ARCHAEOLOGIST 1977 - 1995

Sharon R. Plager
Boise State University

The following author and subject indexes serve as reference tools to the literature that has been published in Idaho Archaeologist from Volume I in 1977 to Volume XVIII (1) in the spring of 1995. Its purpose is to guide research for the interested amateur archaeologist as well as professional scholars within and outside the state of Idaho.

Idaho Archaeologist is the journal of the Idaho Archaeological Society. The Great Basin Chapter, under the direction of Tom Moore and Bill Norquist, published its first volume in May, 1977. After Moore retired as co-editor, Norquist continued to edit the journal until his own retirement in 1983. Temporarily filled by co-editors Florence Schaertl and Kenneth Ames, the editorial position has been held by Mark Plew for the last ten years. Publication responsibility has also transferred to Boise State University. In 1990, a formal agreement was enacted which gained support from the College of Social Sciences and Public Affairs. This joint cooperation continues the tradition of dedication to preserve Idaho's past history.

The society's initial goal was to develop a quarterly periodical. It began with three issues of Volume I published in 1977 and two issues of Volume II, one published in 1978 and one in 1979. Volume III was comprised of three issues with the first two issues published in 1979 and the third issue published in 1980. Volume IV realized quarterly publication with July 1980, fall 1980, winter 1981 and spring 1981 issues. Volume V consisted of three issues: a fall issue, a combined winter and spring 1982 issue, and a summer 1982 issue. Volume VI consisted of two issues: a combined fall and winter 1982 and a winter 1983. Summer 1984 was the only issue of Volume VII. To maintain production schedules, the society decided to change the format to a semi-annual periodical starting with the 1985 spring and fall publications. To date, this goal has been achieved.

The journal format has undergone other significant changes. In appearance the journal has evolved from manually typed xeroxed pages to a typeset bound publication. American Antiquity's manuscript style was adopted in 1978 with minor modifications. Idaho Archaeologist now operates under an editorial advisory and an editorial review board. Papers are reviewed anonymously by members of the society and the professional community. Initially each issue of a volume was paginated separately; beginning with the spring 1985 issue, each volume was paginated consecutively.

The author index lists each author who has published in Idaho Archaeologist with the exception of those authors whose abstracts for the Idaho Archaeological Society Conference were published in the journal. Journals including conference abstracts are listed under Idaho Archaeological Society. Manuscripts published by more than one author are listed alphabetically by the senior author's name followed by the contributing author. Each junior author is also listed alphabetically with reference to the complete author listing.

The subject index is not comprehensive. Notes from the editors, president's messages, letters to the editors, archaeological updates, coming events and business meeting minutes are not included. Perusal does offer informative insight into the history and development of the Idaho Archaeological Society and details the tireless contributions of peoples and agencies that have made this research possible.

An attempt was made to choose those subject headings that would help the interested reader or researcher find additional information on a variety of topics and issues. After reviewing the articles, each was listed under the main focus of the paper and the geographic area cited. Some articles lend insights to several areas of interest and can be found under various subject headings. Excavated site reports and surveys are an exception; they are listed under their respective subjects and local and regional geographic areas. These reports often reveal pertinent information on material culture, subsistence strategies and a variety of issues; listing each site and survey report under its relevant subjects would have made the index more cumbersome than useful.

Book reviews have been listed under a separate heading as a quick reference for those desiring further information on a topic that relates to but may not directly involve Idaho archaeology. This also applies to the manuscripts listed under miscellaneous.

Consistent with the publication's adopted format, American Antiquity's bibliographic style was used. Plains Anthropologist was referred to for relevant subject headings and index format. The author index lists each author's articles chronologically. In the subject index, each article falling under a particular subject heading is listed alphabetically by the article title. Please note that in some instances this alphabetization has allowed the comments addressed toward a specific paper to be listed prior to the initial paper. The year of publication and the volume numbers should facilitate keeping the articles in proper sequence.

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SHORT CONTRIBUTIONS

A STONE PHALLUS FROM SOUTHWEST IDAHO

James L. Huntley
Idaho Archaeological Society
Dana Schuster
Boise State University

This note describes a ground stone phallus found at Succor Creek Canyon in Owyhee County, Idaho. Discovered by Edna Ballantyne in the late 1920's, the object is part of the Ballantyne family's private collection and has not been previously analyzed. Phallic type artifacts such as this are rare in the archaeology of Idaho. Few references can be found in the literature for phallus representations in ground stone, rock art, or any other medium. This raises the question of whether the artifact represents a trade item from the Columbia Plateau, where similar objects are more common (Butler, 1957; Carlson, 1982; Duff, 1975), or if it is of local manufacture. Unfortunately, the provenience and contextual information which would have helped answer this, is limited. Interviews with the finders established only that the specimen is a surface find which may have been associated with a possible bedrock mortar. No other artifacts were reportedly found in the immediate vicinity.

Made of light colored stone, the phallus is elliptical in cross section and measures 35.5 cm in length and 7.5 cm in width at the widest part of the base. About 4 cm from the wide end there is a shallow depression which extends for almost the entire circumference. Below this depression there is a rough exfoliated area, 2 cm in diameter, created by a shallow spawl. Due to a lack of polished areas or abrasions typical of use wear, it is assumed the spawling is due to natural weathering processes. Three deep narrow grooves appear in this exfoliated area. Three similar grooves appear on the opposite side which are not associated with an exfoliated area. While the grooves do appear to be fairly recent, analysis was unable to determine if they are manufactured or naturally occurring.

Although complete when found, the phallus was accidentally broken several years later. The break is apparent near the midpoint on the artifact and mended with white glue. Several unsuccessful attempts were made to dissolve the glue and reveal the broken edges. These involved soaking the artifact in water and applying acetone solution directly to the glue. More drastic measures were not considered since the possibility of damaging the artifact outweighed the potential for diagnostic information.

A narrow depression, which runs almost the entire length of the phallus, appears to be a seam or irregularity in the rock. Reddish flecking evident in the seam proved under magnification to be a ferrous constituent of the rock. Other than this, the artifact is relatively smooth with only a few small pits and scratches.

The narrow end, which exhibits the most carving, measures 5.2 cm in width. Two ridges or rings circumscribe the phallus connecting in a "V" shape on one side. The opposite side contains two ovoid depressions approximately 1 cm in diameter, 0.5 cm in depth, and about 1 cm apart. Two exfoliated areas also occur here, one partially obscuring one of the ovals and another smaller one between the ovals. Irregularities in the rock matrix are notable at these points and appear to have created a

weakness in the stone making them vulnerable to breakage.

The carving on the narrow end is very similar to ground stone phallic artifacts found throughout the Northwest Coast and Columbia Plateau regions (Carlson, 1982; Duff, 1975). The paired ovoid depressions and ridges set the artifact apart from more general phallic forms. Considered by some to represent a stylized face, it is a common Northwest Coast-Interior Plateau motif (Carlson, 1982). Examples of ground stone phallus and "face" combinations can be found in the Maryhill Museum of Art on the Columbia River Collection. Other similar examples come from Wakemap Mound located in The Dalles-Deschutes Region. A chronology, based on the Wakemap excavations, places phallic forms similar to this one in the Late Period (c.a. 1400-1800) (Butler, 1957:159).

Though typological similarities suggest the artifact could be a trade item, this is challenged by the findings of Dr. Carl Waag and Dr. Craig White, Department of Geology at Boise State University, who examined a thin section made from a small piece of the specimen which was removed from the broken edge. Their analysis revealed the rock type to be a well cemented sandstone consisting of fine sand sized grains of feldspar (mostly or entirely plagioclase) and quartz with lesser amounts of biotite, white mica, and fragments of fine-grained volcanic rock. Iron oxide and clay appear to comprise the cement between the sand sized grains. They determined an appropriate rock name for this sandstone would be fine-grained arkose (White, 1995).

White noted that this type of rock is common to the Owyhee Mountain Range as well as the Pacific Northwest. This fact bears directly on the issue of origin. While the analysis does not rule out the possibility that this phallic form is a trade item, there is also no reason to assume the artifact could not have been manufactured somewhere in the Owyhees.

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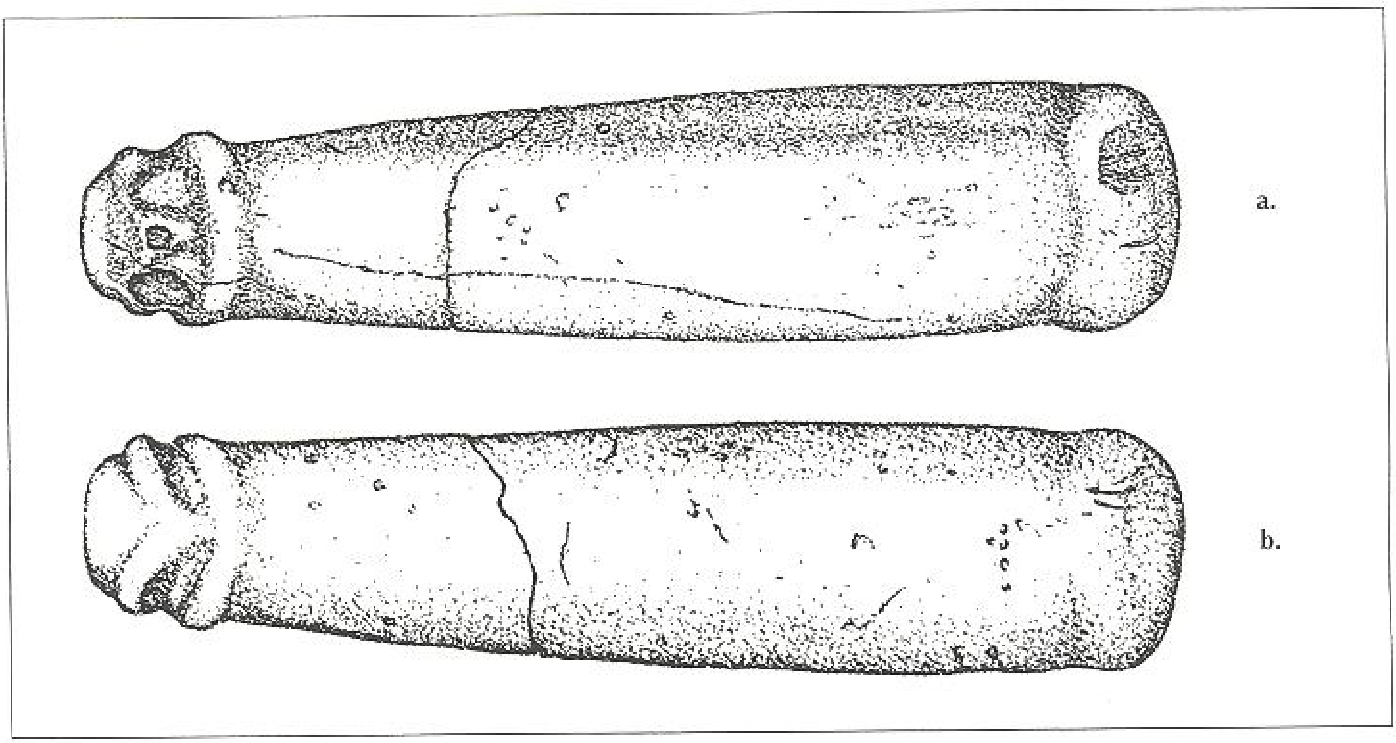

a. Dorsal Surface; b. Ventral Surface of stone phallus.

AN ADDITIONAL REFERENCE TO "METAL ARROWHEAD TYPES..." WHICH APPEARED IN VOLUME 15, NO. 2, OF THE IDAHO ARCHAEOLOGIST

by Donald R. Tuohy
Nevada State Museum

In a paper Amy Dansie gave for me on October 10, 1992 at the 23rd Great Basin Anthropological Conference held in Boise, Idaho entitled "Metal Arrowhead Types and Other Sharp-pointed Metal Objects, Hunting Knives, found in Nevada," I omitted one key reference, and that one was Robert F. Heizer and Alex D. Krieger's study "The Archaeology of Humboldt Cave, Churchill County, Nevada." In their publication published in 1956, they report on an "Iron Arrowpoint" on page 32. Heizer and Krieger (1956:32) say this about the point: "...Included in the contents of Cache I was a long, slender arrowpoint (42082) made of thin metal, probably a barrel hoop. It is shown in Figure 4."

Cache I was explained in their Appendix I (Heizer and Krieger 1956:91). It was clearly a cache which dated to the contact period between the "antique" or historic Paiute culture and the European-American culture of the latter half of the nineteenth century. Cache I contained the following:

"3 burlap sacks (2 close weave, 1 loose weave)
2 pairs trousers (1 military, 1 black pair split open)
1 canvas ore sack
5 strips of cloth or cloth fragments
1 Apocynum cord
1 fishline with bone hooks
1 chert blade
1 steel arrowpoint
1 bundle of eagle feathers"

Note that the bulk of the artifacts were of European-American manufacture. The steel or iron arrowpoint was wrapped in cloth strips of red flannel. It is shown in one of Heizer and Krieger's plates (1959:134-135, Plate 7a). They give no measurements for the steel point, but their point is shaped similar to the knife blade I reported found in Churchill County by Margaret Wheat, illustrated in Figure 6 in my *Idaho Archaeologist* article (Volume 15, No. 2, pp. 19-26).

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Tuohy, Donald R.
1992 Metal Arrowhead Types and Other Sharp-Pointed Metal Objects, Hunting Knives, found in Nevada. **Idaho Archaeologist**, 15(2): 19-26.

Boise State University
**College of Social Sciences
and Public Affairs**
1910 University Drive
Boise, Idaho 83725

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