# II.

# ANALYSIS OF HUMAN COPROLITES FROM ARCHAEOLOGICAL CONTEXTS, WITH PRIMARY REFERENCE TO LOVELOCK CAVE, NEVADA

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## Introduction

Archaeologists spend a good deal of time trying to determine the dietary regimes of the people who lived before the beginning of recorded history. A great variety of methods have been devised to collected information which will help to ascertain the economic basis of the society under study (Clark 1952, 1953; Heizer 1960; Gabel 1967). Direct evidence of hunting, fishing, collecting, cultivating, or herding may come from faunal remains, carbonized seeds, pollen grains, or from artifacts identifiable as having served as food collecting or food producing devices.

Under certain favorable conditions, organic materials such as the bog bodies of Europe (Glob 1954:419-430; 1969) and the desiccated or "mummified" human bodies found in cave sites or in very dry open air occupation sites--such as those in the coastal desert regions of Peru and in the Great Basin of the western United States--will be extraordinarily well preserved, and it is possible to study the stomach and intestinal contents of these individuals and learn a great deal about what they had eaten as a "last meal" (Helbaek 1950; 1951; 1958). These instances, however interesting they may be, are nonetheless only individual, isolated examples of the human diet of ancient times. To generalize on the basis of evidence representing only a few meals could lead to serious errors of interpretation about the subsistence basis of the prehistoric population.

When the archaeologist has available large numbers of naturally desiccated or intentionally mummified human bodies it may be possible to identify many of the dietary elements consumed by a large sample of a contemporaneous population. However, to our knowledge, no such studies have been carried out. Another possible means of obtaining information about the foods that were eaten by a group of prehistoric people is provided when human fecal pellets (coprolites) have survived in their original form as the result of preservation by desiccation. It is this approach to the study of ancient dietaries with which we are presently concerned.

One of the first such studies of the contents of human coprolites found in an American archaeological site was made in 1912 by Llewellyn L. Loud. Other examinations of coprolites or stomach contents of human bodies found in archaeological sites were made at about the same time in Egypt (Wood Jones 1910: 215-220), in England (Warren 1911:198-208), and in southeastern United States

(Young 1910). Loud examined several specimens of desiccated human excrement which he had collected in the course of his salvage excavations in Lovelock Cave, Nevada, carried out on behalf of the Museum of Anthropology, University of California, Berkeley. His unprecedented, if somewhat perfunctory inspection of Lovelock Cave coprolites was not reported upon until seventeen years later (Loud and Harrington 1929). The background of Loud's work at Lovelock Cave is given by Heizer and Napton (this volume). The history of subsequent investigation of archaeological and coprological remains from Lovelock Cave and other prehistoric occupation sites has been reviewed by Heizer (1967a: 1-20; 1967b:49-52; 1969b:244-250; see also Heizer and Napton 1969:563-568). Investigations at Lovelock Cave and other Great Basin archaeological sites were made between 1937 and the present date. This research may be briefly summarized as follows:

(1) [1937]: Heizer and Krieger (1956) excavated Humboldt Cave, Nevada, (NV-Ch-35) and found several dozen coprolites (ibid:33). They endeavored to have the contents of sample specimens studied and identified; however, this was one of the first attempts to enlist the aid of specialists in studying the food habits of American Indians by analysis of ancient excrement, and there was no precedent for this type of research. Samples of the desiccated human excrement found in the cave were sent, intact, to various botanists, but this largesse was apparently unappreciated, for the specimens were never studied nor returned.

(2) [1950-1967]: Norman L. Roust (1967:49-88) analyzed 51 Lovelock Cave coprolites which had been collected in 1950 at random from the surface of the cave midden and from the screened debris left by relic collectors. Needless to say, there was no way of determining the stratigraphic provenience or exact age of these coprolites, short of radiocarbon analysis of each specimen. However, the coprolites processed by Roust provided at least an indication of the types of foods that were eaten by members of the Lovelock population. Roust also dissected and examined 85 coprolites from Hidden Cave (NV-Ch-16), one specimen from Humboldt Cave (NV-Ch-35), and 12 coprolites from NV-Pe-8).

(3) [1966-1967]: Richard Ambro (1967:37-47) and R. Cowan (1967:21-35) analyzed 30 of several hundred human coprolites found in a crevice near the entrance of Lovelock Cave. A sample "Entrance" (ENT) coprolite gave a radiocarbon date of A.D. 1805 ± 80 (UCLA-1071-E). Another group of coprolites was found at the bottom of an abandoned cache pit located near the east wall inside the cave. Twenty of these coprolites were analyzed. One of the "Interior" coprolites produced a radiocarbon date of A.D. 756 ± 60 (UCLA-1071-F, see Tubbs and Berger 1967:89-92). These radiocarbon dates indicated that the "Interior" coprolites were approximately 1000 years older than the "Entrance" coprolites. However, these two groups of coprolites were essentially homogeneous in composition (Table 9).

The preliminary analysis of Lovelock Cave coprolites performed by Roust and the more detailed analysis of Lovelock Cave coprolites carried out by Ambro and Cowan provided evidence of the extensive use of lacustrine subsistence resources obtained from Humboldt Lake, the former shoreline of which was located less than two miles from Lovelock Cave. The late date of some of the ENT coprolites (A.D. 1805) indicated that the "lacustrine adaptation" persisted in this area until just before the discovery of the lake by Peter Skene Ogden in 1829 (Cline 1963). A modified version of the lacustrine subsistence adaptation is documented in the ethnographic literature (Hopkins 1883; Scott 1966; Heizer n.d.).

The late date of the "Entrance" coprolites and the discovery, in midden trash removed from the cave in 1911 by guano miners and discarded on the hillside in front of the cave, of several types of projectile points used during the Late Period in western Nevada (Clewlow 1968:89-101; Clewlow and Napton 1970) demonstrated that Lovelock Cave had been occupied much more recently than many investigators had supposed (see Loud and Harrington 1929; Grosscup 1960). Thus, coprolite studies helped not only to clarify the prehistoric subsistence economy, but also provided information about the protohistoric and terminal stages of Lovelock Cave occupation. Nevertheless, the approximate date of the beginning of human occupation of the site remained unknown.

The radiocarbon dates of the "Interior" coprolites (A.D. 756) suggested that the lacustrine-oriented "Lovelock" subsistence pattern might have begun at a fairly early date--perhaps during the pre-Christian era. This possibility seemed to be supported by the results of analysis of 74 coprolites found in the "Thirty-Two Inch Midden" in Hidden Cave, near Fallon, Nevada. These coprolites were examined and reported upon by Roust (1967:49-88). Vegetal material said to have been associated with this midden gave a radiocarbon date of 1094 B.C. $\pm$ 200 (L-289BB; Broecker and Kulp 1957).[1]

The oldest date of cultural material from Lovelock Cave (1218 B.C.; C-735) was obtained from basketry collected by Harrington in 1924 (see Cressman 1956: 311-312). A very early date of 4054 B.C. (C-278) was produced by solid carbon analysis of a sample of unburned bat guano taken from just above the base of the cultural strata in the cave. It was obvious, of course, that if the date of 1218 B.C. represented actual occupation of the cave, the lacustrine subsistence adaptation might have been in existence at that time, and, implicitly, at an even earlier date. On the other hand, the subsistence basis might have been much different during the earlier phases of cave occupation.

(4) [1967-1970]: In order to investigate some of these unknown aspects of the cave's prehistory, we made a brief visit to the site in May, 1968. Fortunately, the cave contained a few small remnants of undisturbed midden in crevices or under large rocks, and we decided to excavate some of these pockets of material, gambling on the possibility that we would find enough coprolites and vegetal material to provide information about the subsistence adaptation of the earliest inhabitants of the site.

We began work in the cave in September, 1968 (see Heizer and Napton, this volume). Excavations were completed in the spring of 1969. Widely separated parts of the cave deposit were tested by us in order to obtain a sufficiently extensive horizontal sampling of coprolites (fig. 2). When conditions permitted, we attempted to obtain samples of coprolites and vegetal materials from stratified contexts by means of deep test units extending from the existing surface of the cave midden to its base (fig. 3). Unfortunately, because of the extensive damage caused by the guano miners in 1911 and by the generations of relic collectors who have burrowed in the cave for more than a half-century, we were able to obtain coprolites from only a few contexts which could provide satisfactory stratigraphic control. The temporal position of coprolites found in the midden was determined by radiocarbon dating of associated vegetal material, and in many cases by radiocarbon dates obtained directly from individual coprolites (see Heizer and Napton, this volume, Table 4).

<u>Coprolite Analysis Procedures</u>: Analysis of human coprolites found in archaeological sites has become a very useful supplemental source of information about the dietary practices of extinct human populations. The coprolite analysis procedure currently in use at Berkeley subsumes four separate procedures, the first of which (collection of samples in the field) is discussed, with reference to Lovelock Cave, in the following section. The general problem of sample size in coprolite analyses is given further consideration at the conclusion of this article.

When the investigator has acquired a number of coprolites, it is of course necessary to be able to distinguish between the coprolites produced by the human inhabitants of the site and those produced by other mammals. At this writing, the most reliable and certainly the most expedient method of distinguishing between human and non-human coprolites is not by form, color, or size, but by the contents or constituents of the individual fecal specimens. The occurrence, in a single sample of excrement, of burned seeds, fish bone, bird feathers, charcoal, bulrush seeds and human hair obviates any question as to the species of mammal responsible for producing the fecal specimen. Only man would gather, prepare, and consume the unique assortment of foods found in most of the Lovelock Cave coprolites. This apparently obvious situation can be complicated, however, by the visual similarity between the feces of man and bears, and by the fact that some of the coprolites could have been produced by scavengers. Coyotes, for example, are known to consume food scraps, human cadavers, and even human feces. Domesticated dogs kept by the Indians would also have consumed food residue and other debris descarded in the cave.

Several methods for distinguishing between human and non-human coprolites have been applied in our study of the Lovelock Cave coprolites (Stross 1970: 47-48). Samples of human and non-human coprolites were processed by either extraction and chromatography to determine the cellulose content. Cellulose materials are not completely digested by humans (see Consolazio, Johnson, and Pecora 1963). The cellulose content of Lovelock Cave coprolites CR-1 and CR-2 (human coprolites) is much higher than that of coprolite X-3, which, on the basis of color, form, and composition, was believed to have been produced by a carnivore, probably a coyote (see Table 1):

Table 1

Cellulose and Inorganic content of Human and Non-human coprolites from Lovelock Cave, Nevada (NV-Ch-18), expressed as percentages

| Sample | Cellulose | Inorganic |
|---|---|---|
| CR-1 | 33.8 | 5.6 |
| CR-2 | 23.8 | 4.5 |
| X-3 | 11.3 | 33.6 |

The data presented in Table 1 suggest that variations in cellulose content can be used to distinguish between coprolites produced by various mammals; however, this assumption must be verified by processing additional samples.

Processing of samples: This general topic includes three sub-topics (A) Levels of analysis, (B) methods of dispersion and (C) methods of quantification. These are discussed in the following pages.

(A). Coprolite analysis: There are five major "levels of analysis" of coprolites from archaeological contexts.

Macroscopic: Large fragments of floral, faunal and inorganic materials recovered from the coprolite by sieving or manual segregation are identified (if possible to the species level) and are quantified by weight or volume. It is this fraction of the coprolite which provides the most useful date pertaining to food habits.

Microscopic: Small items (tiny seeds, pollen exines, fish bones, plant fibers, bird feathers, hairs, etc.), are examined on the microscope stage. Identification to the family or generic level is possible; however, quantification is extremely difficult. Usually, the "Ocular Proportional Tabulation and Identification Control method" is the only feasible means of quantifying this material if large numbers of specimens are to be processed.

Microchemical: The submicroscopic level of analysis. Various stains (eosin, "Lugol's," Pyronin and others) aid in distinguishing between meat and vegetal fractions of the detritus suspended in the trisodium phosphate solution. The results of examination or identification of coprolite components by stain techniques depend to a considerable extent upon the experience of the technician, and for this reason are not readily reproducible.

Chemical: Routine chemical analyses are often made of fresh human fecal material (Gradwohl 1956) but the method has received only minimal application in the field of coprolite analysis (see Heizer 1967a:1-20). Fry (personal communication, 1970) reports an unusually high sodium cloride content in some of the human coprolites from Danger Cave, Utah (see also Fry 1968). Lovelock Cave coprolites are now being processed for detection of fatty acids and lipids. An extensive study of the amino acids in the Lovelock human and non-human coprolites has been carried out at the University of California, Berkeley, by Edward Blake (personal communication, 1970), and cholic and lithocholic acids occurring in the Lovelock coprolites have been analyzed by Evans and Evans (personal communication, 1970).

Bacteriologic: Fry and Moore (1969:1620) and Moore, Fry and Englert (1969: 1324-1325) successfully demonstrated pinworm (*Enterobius vermicularus*) infection in ancient human coprolites from Danger Cave, Utah. Dr. F. L. Dunn, University of California Medical Center, San Francisco, examined 168 Lovelock Cave coprolites and found no evidence of endoparasites (see Dunn 1966:329-345; 1968:221-228; Dunn and Watkins, this volume; see also Radovsky, this volume). Dr. John M. Budinger, Consulting Pathologist for the Bronx Zoo and Director of Laboratories, Lawrence Hospital, Bronxville, New York, examined a large sample of Lovelock Cave coprolites, as well as the visceral contents of a mummified human body from the cave. No evidence of human parasites was found. Larval nematodes of the genus *Rhabditis* were found by Dr. Dunn in Lovelock Cave coprolites which he examined in 1966, indicating that helminths can be preserved in recognizable form in the Lovelock fecal pellets (see Heizer 1967a:1-20). For further information on parasitological studies of coprolites from archaeological sites see Grzywinski (1959/1960:195-199; 1962:548), Woodbury (1965), Samuels (1965:175-179), Pike and Riddle (1966:293-296), Pike (1967:184-188), and Hall (1969).

(B). Dispersion techniques: At least five different chemical solutions have been used in processing desiccated biological and botanical materials. Van Cleave and Ross (1947:318) used trisodium phosphate ($Na_3PO_4$) to reclaim dried tapeworms; Benninghoff (1947:325-326) dispersed peat in a 0.25 to 0.05 per cent aqueous trisodium phosphate. Barghoorn (1948:480-481) used sodium chlorite in similar paleobotanical investigations. Wilder (1904:1-17) discussed solutions used in restoring dessicated human tissue for histological examination. The first use of trisodium phosphate in rehydrating coprolites was by Callen and Cameron (1955:51; 1960:35-37; 39-40). Colyer and Osborne (1965:186-192) processed human coprolites from Wetherill Mesa, Colorado, in an 0.2 percent lye solution. Samuels (1965:175) processed Wetherill Mesa coprolites in an organic chelating solution consisting of 2.0 percent (w/v) sodium hydroxide with 0.5 percent (w/v) ethylenedinitrilotetraacetic acid disodium salt (EDTA, or Versene). Witenberg (1961:86) used Triton solution to rehydrate coprolites from archaeological sites in Palestine. The principal effect desired in rehydration of coprolites is to soften the desiccated fecal mass, reconstitute the vegetal and other organic matter, and disaggregate the individual components. Rehydration of the Lovelock Cave coprolites

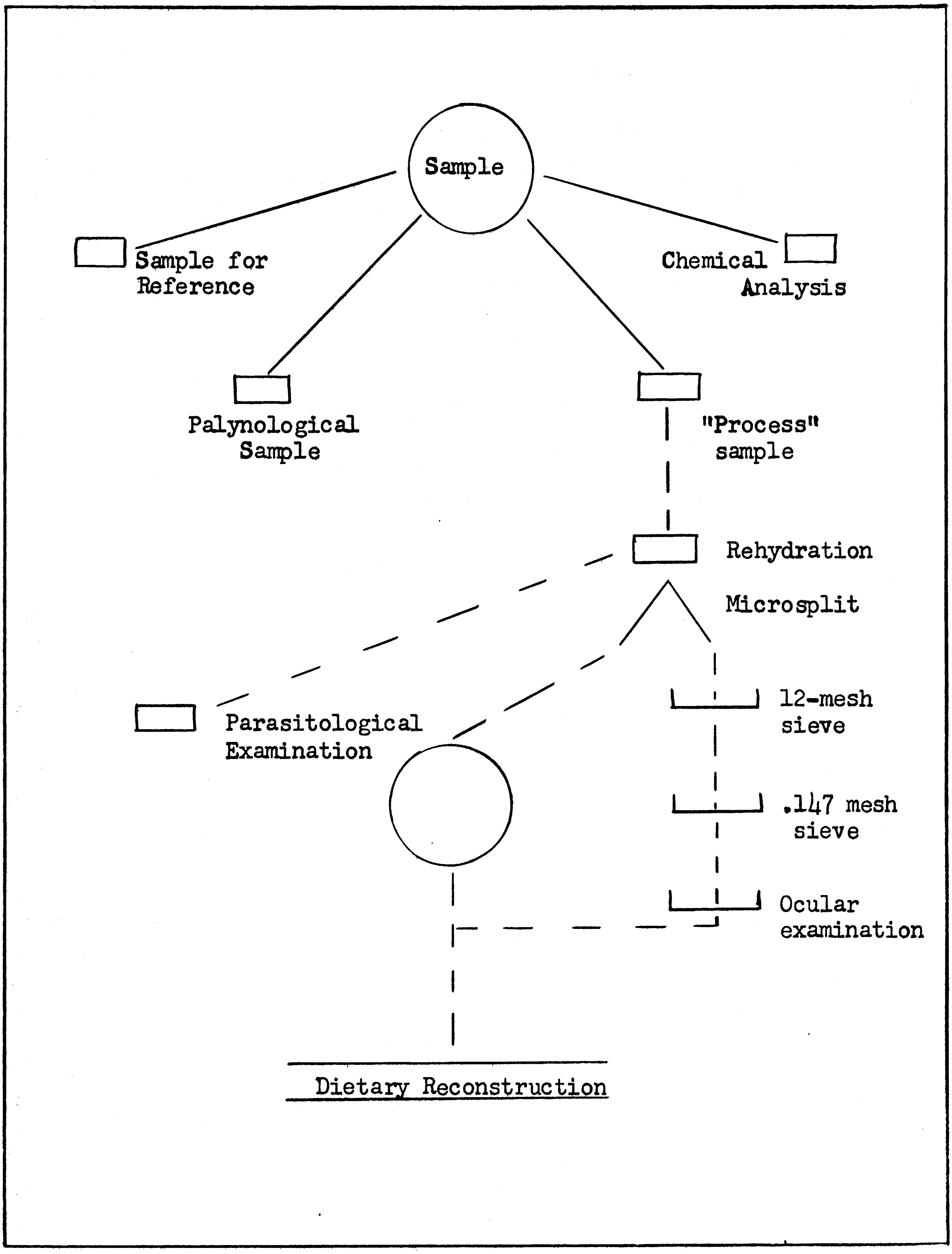


Figure 1. Diagram of coprolite analysis operations

was achieved by soaking each specimen for 48 to 72 hours in an 0.5 per cent solution of trisodium phosphate at room temperature. Disaggregation was expedited by occasional manual agitation of the container. The rehydrated coprolites were decanted into a series of progressively finer wire sieves (1.68 mm., Tyler Series No. 10; 500 my, Tyler Series No. 32; and 147 my, Tyler Series No. 100). Colyer and Osborne (cited supra), Fry (1968:27), Watson (1969:44) and others have used various combinations of graded sieves as an aid to segregation of coprolite components.

(C). At this writing there is no standard or uniform method of quantifying the components of coprolites. Ambro and Cowan attempted to quantify the components of the ENT and INT coprolites by weight; Roust (1967:49-88) used both weight and volume measurements. Watson (1969) and others have used systems of arbitrary indices or "values" such as "trace", "dominant", "scarce", "scanty", or "abundant". Gravimetric procedures were used in quantifying the manually segregated Lovelock Cave coprolites processed by us in 1968: food items having sufficient bulk to permit gravimetric quantification were weighed on an Ainsworth triple beam balance or on a Mettler Analytical balance (Model P120), and the data were recorded, of course, as weight in grams.

In 1968-9 we processed a total of 75 coprolites and midden samples using the basic trisodium phosphate method (see Callen and Cameron 1960:35-37; Callen 1963:186-194; Heizer 1967a:1-20; Heizer 1969b:563-568). We have retained for future analysis about one-half of each coprolite selected for processing. This was a departure from the earlier procedure used by Ambro and Cowan--the ENT and INT coprolites were processed in their entirety, except for microsamples averaging a gram or two in weight, which were reserved for future chemical and palynological analyses. We augmented this major change in procedure by adapting, from well-established techniques used in wildlife food habits studies, the "Ocular Proportional Tabulation and Identification Control" method. In the application of the "OPTIC" method, approximately three-fifths of each coprolite is processed in an aqueous solution of 0.5 percent trisodium phosphate. When dissaggregation is complete, the coprolite constituents are decanted into small sieves (147 my; Tyler No. 100) and are re-desiccated in a laboratory oven or under controlled constant temperature heat lamps. The entire processed sample is then scanned under 10X binocular dissecting microscopes by two or more experienced technicians, each of whom identify the major coprolite components and record the observed occurrences as an estimated volumetric percentage of the entire processed coprolite (see Martin and Korschgen 1963:320-329; Browning 1962: 91-107). The application of quantification procedures resembling the "OPTIC" method is discussed by Folk (1951:32-33), Terry and Chilingar (1955:229-234), Griffiths and Rosenfeld (1954:74-91), and Allen (1956:160-161).

The major advantage of the "OPTIC" method is of course the considerable saving of time when the method is employed to supplement the tedious manual segregation procedure. Coprolites processed by manual segregation are eventually reduced to an "irreducible minimum"--a residuum which often represents a significant fraction (by weight) of the processed coprolite. In the end one usually has no other recourse than to try to estimate the proportions of the various components of this residuum. In earlier phases of the Lovelock coprolite project, the composition of the residuum was estimated and the percentage was "adjusted" to represent a function of weight.

Experimental replicate estimates of the volumetric contents of sample coprolites tabulated by the "OPTIC" method were in close agreement. Using this method, the proportional composition of the various constituents is rapidly determined. Constituents are identified and quantified, and the occurrence of minor or adventitious constituents is suppressed. The method permits one to quickly access the contents of a large series of coprolites. The data obtained by application of the "OPTIC" system are expressed as volumetric percentages based on examination of the entire processed portion of each coprolite. However, these are at best only controlled approximations. When attempting to quantify feathers, for example. gravimetric data--even when carried to excesses of accuracy--has little meaning in terms of the actual amount of digestible food consumed.

We found that manual segregation of recognizable food items and visual estimates of proportions of the residuum was an effective procedure. The manually segregated coprolite components can be quantified by weight, volume, or frequency of occurrence, and thus can be adjusted to be comparable to the volumetric percentage estimates.

Identification and quantification may be achieved simultaneously; however, there are very few persons who are qualified to accomplish this rather specialized task. Human coprolites often contain extremely intricate combinations of fragmentary plant material, insects, fish, bird bone, feathers, skin, animal hair, and dozens of other kinds of organic and inorganic substances, all of which have been altered by maceration or by passage through the digestive tract, and have been stained by the fecal matrix and distorted by prolonged desiccation.

Early in 1968, enough was known of the general contents of the Lovelock coprolites (Roust 1967:49-88; Cowan 1967:21-35) that it was obvious that the prehistoric inhabitants of Lovelock Cave and adjacent cave sites in western Nevada subsisted on many types of "lacustrine" foods, such as cattail seeds and rootstalks, tui chub, mudhens and bulrush seed. A large number of these vegetal foods are eaten by contemporary waterfowl. Ducks (McAtee 1939) and geese (Dow 1943:3-18) thrive on the seeds of aquatic plants (Martin, Zim and Nelson 1951), a fact which assumes considerable significance in view of the importance of lacustrine food resources to the prehistoric human population of Lovelock Cave. It occurred to us that wildlife biologists would have occasion to examine vegetal materials similar to those found in the Lovelock coprolites. Accordingly, we made contact with Bruce Browning, Chief of the Food Habits Investigations Laboratory, California Department of Fish and Game, Sacramento, and arranged for examinations to be made of the total constituent suites (less chemical and pollen samples) of the fifty ENT and INT coprolites processed by Ambro and Cowan.

The coprolites were transferred to the Sacramento field laboratory in 1968, and analysis and identification of the coprolite constituents was made by means of the same techniques employed in wildlife food habits studies (see Errington 1932:75-86; Dusi 1949:295-298; Browning 1962:91-107; Martin and Korschgen 1963: 320-329). Identifications were made by scanning the constituents of each coprolite under wide field 9X ocular and 9.7X binocular microscopes. All major food items observed in the coprolites were identified and described by two independent analysts (B. Browning and W. Stienecker), each of whom estimated the volumetric percentage of the identifiable and unidentifiable coprolite constituents. Items estimated to occur in quantities of less than one percent by volume were recorded as trace amounts, following standard practice in the field. It was possible to identify a wide variety of materials by visual inspection of the entire constituent suite of each coprolite.

The results of the pilot examination of the entrance and interior coprolites, which apparently represented two separate intervals of cave occupation, were productive enough to encourage us to make further excavations in Lovelock Cave. Random samples of these coprolites were rehydrated, following the usual laboratory routine, and were segregated manually. This analytic procedure differed from previous analyses in the small but important detail that the contents of the coprolites were sorted in their entirety and the separated constituents were placed in one-dram shell vials. The superiority of this procedure over examination of coprolite components mounted on microscope slides lies in the fact that all components of each separate type were contained in individual vials and could be identified *en masse*. Identification of seeds, achenes, hairs, and other coprolite components was accelerated by this procedure. Fifteen coprolites from each excavation unit were processed, but the total sample of fifteen specimens transected the five stratigraphic units, so that the sample from each level consisted of only three individual specimens. Obviously, three coprolites from each level was not an adequate sample. It was necessary to expand the sample laterally, in order to provide a more adequate representation from each occupational horizon. Thus, in the case of the LX, WA, and WE coprolite sample series, the original sample of fifteen specimens (three specimens from each of five arbitrary levels) was augmented, insofar as possible, to comprise approximately fifteen specimens from each level (Table 3).

## Rationale of the Coprolite Sample

The Lovelock Cave coprolites were obtained from several locations in the cave (see figs. 2,3), in order to minimize the possibility that our interpretation of the prehistoric diet of the Lovelock population might have been skewed by too limited or selective sampling. Lovelock Cave is of sufficient size (50 by 160 feet) and is structured in such a way that different areas of the cave floor could have been occupied at different times. In fact, the interior of the cave and the exterior cave, or outer rockshelter, can be demonstrated to have been occupied at different times. There were obvious differences in the composition of coprolites obtained from the various test or excavation units. These differences are considered to be temporal, rather than strictly positional phenomena. That is, in our opinion the observed dietary differences are not due to alternating occupation of the site by different groups, but are interpreted as being a function of gradual changes in the various types of foods available in the vicinity of the cave at different times in the past. The sources of the various coprolite groups or samples from Lovelock Cave are indicated in Figure 2. Coprolites were obtained from the following units or "lots" (Table 2).

Table 2

Source Locations and Totals of all Lovelock Cave Coprolites Processed in 1967-1970

| Area | Code reference | Number |
|---|---|---|
| West Alcove | (WA) | 135 |
| West Crevice | (WC) | 20 |
| West End | (WE) | 49 |
| Lot AN | (AN) | 15 |
| Lot LX | (LX) | 52 |
| East End | (EE) | 10 |
| Entrance | (ENT) | 20 |
| Interior | (INT) | 30 |
| Nonhuman | (CS) | 10 |
| Roust group | (RG) | 51 |
| Medical Study (Dunn) | (PD) | 168 |
| Medical Study (Budinger) | (PB) | 15 |
| Other analyses | (RX) | 25 |
| TOTAL | | 600 |

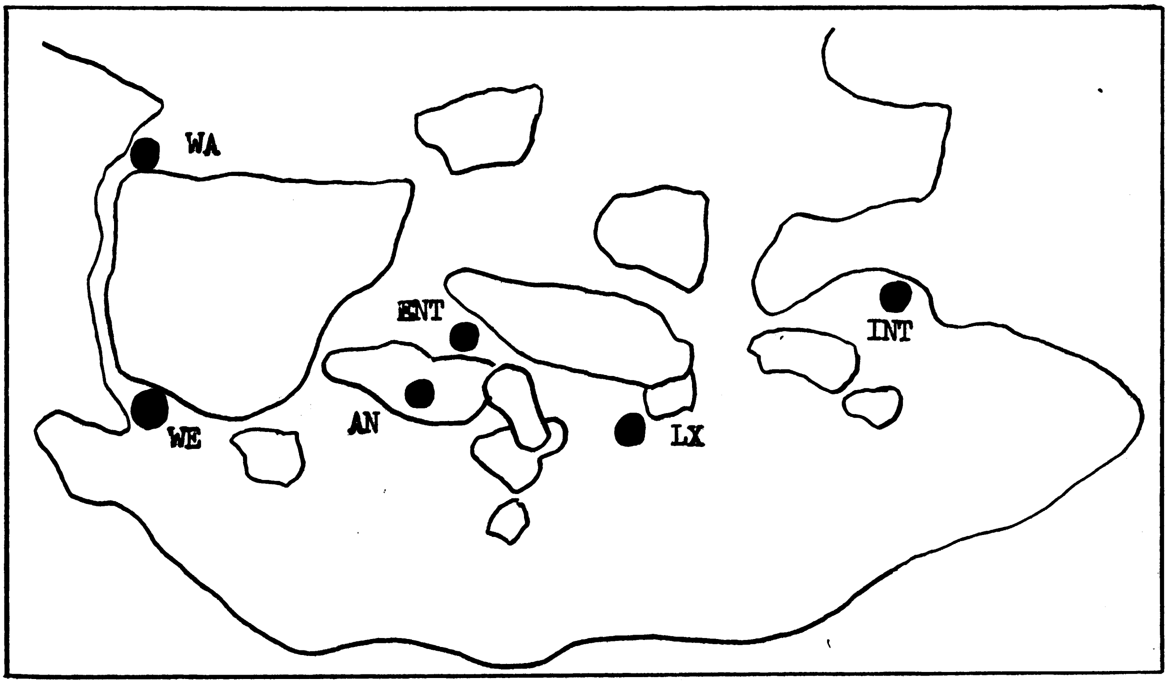


Figure 2. Horizontal provenience of coprolite samples collected and analyzed, 1967-1969.

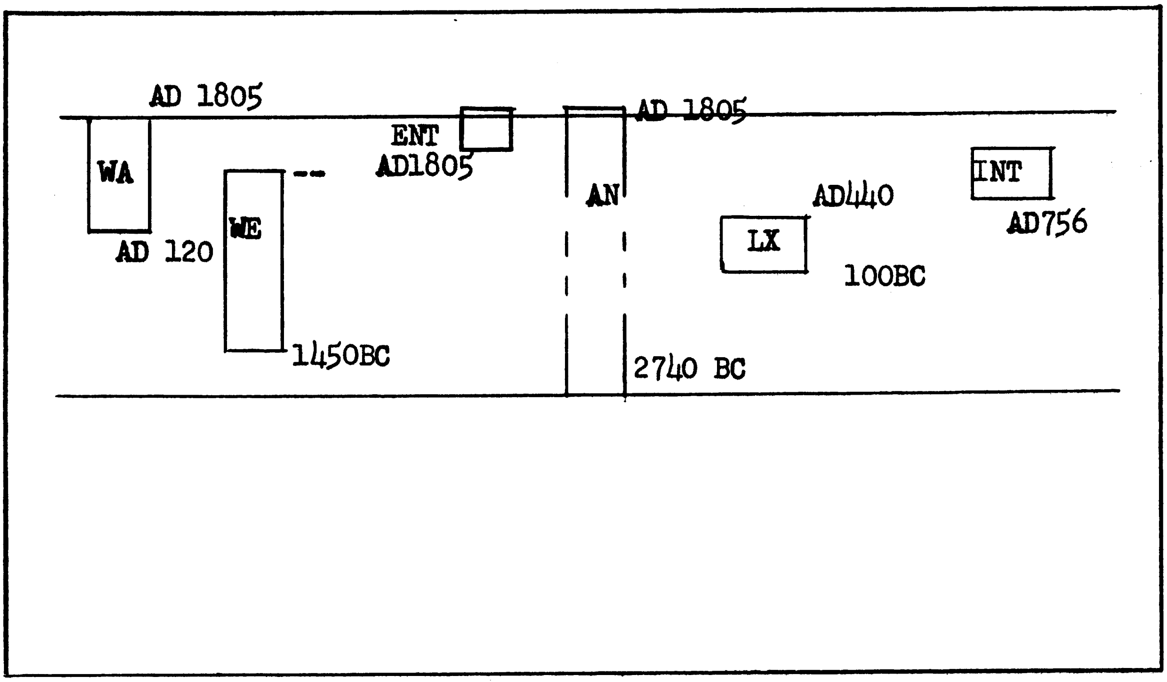


Figure 3. Lovelock Cave, Nevada. Schematic vertical relationship of coprolite samples collected 1968-69.

The "West Crevice" coprolites came from a sliding mass debris which had accumulated in a deep and narrow crevice between rock A and the west wall of the cave (see Heizer and Napton, this volume, figs. 10 and 23). The "East End" coprolites were found in spoil dirt in the deep east end of the cave. These specimens, which are entirely without stratigraphic or associational context, closely resemble the contents of the "Interior" coprolites, a well-controlled sample obtained in 1965 from a cache pit located near the east inside wall of the cave. The "West Crevice" and "East End" coprolites will not be reported upon in detail at this time.

## Lovelock Cave Coprolite Samples

West Alcove: The best set of coprolites, from the point of view of stratigraphic control, came from the "West Alcove" (WA). Here, in a previously undisturbed ante-chamber of the cave, we found a narrow crevice which was almost completely filled with occupational debris. More than 1000 coprolites were retrieved from this crevice. The entire available collection of West Alcove coprolites was examined by visual inspection in our laboratory and the major visible components were identified. On the basis of this preliminary examination, the coprolites were grouped by stratigraphic level and by approximate composition, and the process sample was selected at random from the total population. This was done in order to obtain a representative sample of the population collected from the WA area during the 1969 excavations. The same procedure was used in selecting all of the Lovelock Cave coprolites processed in 1968-1969. The 20 "ENT" and 30 "INT" coprolites processed in 1967 were selected by Ambro and Cowan from total populations of more than 200 coprolites each, which were recovered from the "Entrance" and "Interior" locations (fig. 2). Each group was considered to be a discrete sample representing a "point" occurrence. That is, these two samples do not span long periods of time, but instead represent relatively brief intervals of occupation, occurring *circa* A.D. 1805 and A.D. 756.

The West Alcove coprolites range in age from about A.D. 1800 (surface) to A.D. 300 (at 11 feet deep) and A.D. 120 (12 feet deep). The coprolites in the crevice were so abundant that it was possible to analyze a sample of 15 coprolites from each of eight stratigraphic levels. The 15 specimens were selected at random from an average total population, per level, of about 60 coprolites. We believe that the occurrence of large numbers of coprolites in this crevice is due to the fact that the occupants of the west alcove and outer rockshelter used the deep crevice as a latrine. The aggregate volumetric percentages of these specimens are expressed graphically in Table 6.

The principal difference within the West Alcove coprolite series is the presence in the upper level specimens of the seeds of *Typha*, *Najas*, and *Panicum*, and the relative scarcity of *Elymus* (wild rye), which occurs in the lower level

West Alcove coprolites. It is possible that use of Elymus in the past reflects exploitation of meadowland resources near Humboldt Lake, and the increased use of Typha, Najas, and Panicum in recent times could indicate intensification of lacustrine specialization. This is perhaps the most obvious interpretation that one might make of the shift from Elymus to primarily mesic and hydrophytic flora. There are, however, several other factors which could account for this phenomenon. The transition could be due to seasonal differences, although Elymus and the hydrophytes flower and seed at approximately the same time. The transition could be due to far more subtle factors, such as deliberate cultural choice, or perhaps to selection by personal preference. On a larger scale, the transition could be due to ecological alterations in the vicinity of Humboldt Lake. It is known, however, that stands of Elymus existed near the lake in 1840. The extensive Elymus crop was used as livestock forage by the Bidwell-Bartleson party in 1840 (Bidwell 1928). By 1849 the wildrye crop had been denuded by the emigrants. In 1864, the Blake brothers were able to obtain a good sample of wildrye grass from the sloughs near the present site of the town of Lovelock (USDA/NHRBSFP 1965). In view of the documented presence of Elymus in the lower reaches of the Humboldt River in the eighteenth century, we conclude that the transition from the use of Elymus to extensive exploitation of seeds of water-loving flora is probably due to "cultural factors"--perhaps to the gradual intensification of exploitation of lacustrine resources. This trend is also indicated by the fish bone found in the coprolites. Fish bone (mostly Gila [Siphateles] bicolor) is present in small amounts in the older WA coprolites. The cui-ui and Tahoe sucker (Catostomus tahoensis) occur in the upper level midden trash. An increase in fish bones is indicated by the contents of the INT and ENT coprolites, the LX coprolites, and the upper AN coprolites (see Follett, this volume). Bulrush seed (Scirpus sp.) occurs in almost all of the WA coprolites.

The older WA coprolites, dated by radiocarbon analysis of sample specimens, were deposited as early as the first century A.D., extending the demonstrated range of the lacustrine adaptation at Lovelock Cave back through time from A.D. 756 to the beginning of the Christian era.

West End coprolites (WE): The WE coprolites came from disturbed midden debris in the deep west end of the cave near the "Lot 15" area, excavated in 1924 by M. R. Harrington and L. L. Loud. An unknown amount of cultural material had been removed from the upper part of the midden deposit in the west end of the cave as part of Harrington's Lot 16. Thus, the sample begins well below the original surface of the midden. The test unit (S40/W85) was carried to the base of the midden deposit.

The age of the upper level WE coprolites (found 48 to 54 inches below the existing surface) is indicated by a date obtained from cultural material found in Level II of Lot 15 (A.D. 268; C-728,-729,-730). Basketry fragments from a lower level (Level IV of Harrington's Lot 15) provided the date of 1218 B.C. (C-735). Human remains collected by us in 1969 (see Morbeck, this volume) from the bottom of the West End deposit yielded a date of 1450 B.C. ± 80 (UCLA-1459-C). The human bones lay about six inches above the base of the west end deposit. The coprolites found superior to the bones are of course younger. Unfortunately, the available fund allocations did not permit radiocarbon determinations to be made of the deep WE coprolites. We would judge that the WE coprolites range in age from about A.D. 268 to _circa_ 1200 B.C.

The WE coprolites are very similar in composition to the deep WA coprolites. _Elymus_ is present; fish bone is present but is scarce compared to the copious amounts contained in the most recent Lovelock Cave coprolites. Seeds of _Scirpus_ cf. _acutus_ are unusually abundant in some of the WE coprolites. Bird feathers, bones and skin are present in very small amounts. There is an indication, which is not brought out by the volumetric tabulations, of extensive use of small mammals, especially of ground squirrels. This is revealed by the presence of numerous hairs of ground squirrels in some of the deep WE coprolites (O. Brunetti, personal communication, 1969). We do not have at hand sufficiently large samples of the osseous component of the Lovelock Cave midden to provide verification of the occurrence of ground squirrels during the time period represented by the older WA coprolites. The contents of 49 WE coprolites, grouped by levels, are detailed in Table 6.

_AN coprolites_: The AN coprolite sample constitutes a stratified series. The entire group came from midden debris found under a very large rock (Heizer and Napton, this volume, fig. 9, rock B), which was located near the entrance of the cave. The sloping mass of debris under the rock is situated in such a way that the uppermost, or surface coprolites, were derived from the "entrance" (ENT) coprolite crevice. Thus, many of the most recent AN fecal pellets probably date _circa_ A.D. 1805.

The older AN coprolites comprise two samples; a group of five (AN 7-10) from about 72 inches below the surface of the entrance deposit which were probably deposited _circa_ 1000 B.C., and a group of five from about 84 inches below the surface. The oldest sample of coprolites (AN 11-15), consisting of five specimens from a layer of bat guano and midden trash, probably dates _circa_ 1500-2000 B.C.--about the same period as the deepest WE coprolites (66"-72").

The AN coprolites number only five coprolites per level. Because of this deficiency, the possibility of sampling error is increased by a factor of ten. The upper level coprolites, however, are approximately the same age as the ENT coprolites. We obtained a larger sample of "recent" AN coprolites (about 75), all of which were inspected visually or by partial dry-dissection prior to selection of sample AN 1-5. The recent AN coprolites appear to be more homogeneous than the earlier specimens, but this impression might be due to the inadequate sample representing the older AN occupational levels.

As we observed in reference to the WA and WE coprolites, _Elymus_ is common in the older AN coprolites. Fish bones are scarce or absent in the older specimens (AN 10-15), but increase in the recent AN 1-5 specimens (see Follett, this volume). Coprolites of intermediate age are poorly represented in the AN unit due to the intrusion in the test unit of two large cache pits which originated from a recent occupation level in the upper midden deposit. These cache pits must have been constructed prior to A.D. 400, the approximate date of the fall of rocks B, C, and D.

Vegetal material found in association with coprolites AN 10-15, produced a radiocarbon date of 2740 B.C. ± 100 (I-3962). This matted vegetation, containing human hair, quids, fragments of twine or netting, and other cultural debris, is considered to represent the oldest presently known occupation of Lovelock Cave. Fish bones are relatively common in this level. There are several fragments of coprolites which are composed of nearly pure Typha pollen, which must have been gathered in the spring of the year. Fragments of aquatic tubers are not present in coprolites frim this time-level in the cave. Bulrush seeds are ubiquitous, just as they are in almost all of the coprolites from the cave. However, these seeds tend to be not so abundant in the early coprolites--Elymus perhaps served as the approximate dietary equivalent.

LX coprolites: The upper levels of the LX test area were removed in 1924 by Loud and Harrington. Excavations between rocks C and D by us in 1968 led to recovery of 52 coprolites. These specimens cover a time range from circa A.D. 700 (the approximate equivalent of the INT coprolites) to about A.D. 50. Coprolites LX 1-3 came from the surface debris and are of unknown age. We assume that the LX specimens are temporally coeval to the INT coprolite sample. LX 4-6, found 24 to 36 inches below the existing surface of the test unit (Grid location NS0/W30) probably were deposited in the midden circa A.D. 500-600. Coprolites LX 7-9, found 36 to 48 inches deep, may have an approximate date of A.D. 400-500. Coprolites LX 10-12, recovered from 48 to 60 inches below the surface of the test unit, have been approximately dated by stratigraphy. Coprolite LX 10 gave a date of A.D. 480 ± 90 (I-3963) and coprolite LX-16, from a depth of approximately 56 inches, produced a date of A.D. 350 ± 50 (UCLA-1418). Coprolites LX 13-15, recovered from 58 to 72 inches below the existing surface of the test unit, probably were deposited during the pre-Christian era. Vegetal material from the uppermost part of this level yielded a radiocarbon date of A.D. 50 ± 60 (UCLA-1417). The underlying coprolites are older. However, an empty cache pit found at this depth in the north profile of the LX test unit attests to disturbance of this area in prehistoric times. (The area had not, however, been disturbed during the guano mining or early excavations of the cave.) It is probable that the entire LX test unit is of much more recent date than one would suspect on the basis of depth measurements alone. The Older Guano layer, encountered in the nearby test unit NS0/W35, was not present in the north profile of the LX unit. There had been little or no disturbance, either ancient or recent, in the north profile of NS0/W35, and the radiocarbon dates of vegetal matter from this unit, taken from equivalent depths, are much older. Therefore, we conclude that the deepest LX area coprolites are not as old as the deepest AN or WE coprolites.

The LX coprolites, like the WE series, gave evidence of a gradual transition from use of Elymus in the past to recent use of Scirpus. Fish bones increased through time, and aquatic wildfowl became more popular in relatively recent times.

Aquatic tuber fragments are well-represented in the upper level LX coprolites, and several intact, charred aquatic tuber fragments were found in the midden debris. It is likely that the recent LX coprolites are equivalent in age to the INT coprolite series. Due to the fact that the upper levels of the LX area were removed in 1924 by Harrington, none of the LX coprolites are as recent as the ENT, upper WA, or upper AN specimens.

The constituents suites of the sample ENT, INT, AN, LX, WE, and WA coprolites are given in Tables 6-9. Coprolites from Humboldt Cave (NV-Ch-35) and Pyramid Lake, Nevada caves, are tabulated in Table 10.

Table 3

Location Data on 282 Lovelock Cave Coprolites Processed in 1968-1969 for Identification of Food Remains[a]

| Depth (in.) | Identification Number | Sample Total |
|---|---|---|
| **WA (WEST ALCOVE)** | | |
| 0-12 | 1-5,104-113 | 15 |
| 12-24 | 6-10,114-123 | 15 |
| 24-36 | 11-15,86-103[b] | 23 |
| 48-60 | 31-45 | 15 |
| 72-96 | 46-55,131-135 | 15 |
| 108-120 | 56-65,126-130 | 15 |
| 120-122 | 22-24,66-75,124-125 | 15 |
| 122-144 | 25-30,76-85 | 16 |
| | | (129) |
| **WE (WEST END)** | | |
| 48-54 | 8-12,32-41 | 15 |
| 60-66 | 14,20,24,27,30,13,15, 17,18,19,21,22,23,25, 26,28,31 | 17 |
| 66-72 | 1,3,6,7,29,2,4,5,42-49 | 16 |
| | | (47) |

| WC (WEST CREVICE) | | |
|---|---|---|
| Depth (in.) | Identification Number | Sample Total |
| unknown | 1-20 | 20(c) |
| | | (20) |
| | AN | |
| 0-6 | 1-5 | 5 |
| 48-56 | 6 | 1 |
| 72 | 7-10 | 4 |
| 84 | 11-15 | 5 |
| | | (15) |
| | LX | |
| 0-12 | 1-3,17-28 | 15 |
| 24-36 | 4-6 | 3 |
| 36-48 | 7-9,29-40 | 15 |
| 48-60 | 10-12,41-52 | 15 |
| 58-72 | 13-15 | 3 |
| | | (51) |
| | EE | |
| unknown | 1-10 | (10) |
| | CS | |
| unknown | 1-10 | (10) |

Notes to Table 3

(a) See Table 2 for total of coprolites processed in all types of studies.

(b) Twenty-three coprolites were processed; 8 were examined for parasites, 15 for food remains.

(c) The depth of the West Crevice coprolites is unknown. (See text.)

Table 4

Coprolites from Western Nevada Caves (other than Lovelock) Processed in 1968-1969

| Depth (in.) | Identification Number | Sample Total |
|---|---|---|
| **Humboldt Cave, Nevada[a] (NV-Ch-35)** | | |
| 12-18 | 35-A | 1 |
| 48-54 | 35-B | 1 |
| 60-66 | 35-C,D | 2 |
| 48-88 | 35-E,F,G | 3 |
| 90 | 35-H,I,J | 3 |
| | | (10) |
| **Pyramid Lake, Nevada[b]** | | |
| 26-WA-525[c] | | |
| Burial-2 | 525-A,B | 2 |
| 26-WA-385 | | |
| 6-9 | K10-A | 1 |
| 12-15 | K11-B,J10-C | 2 |
| 36-39 | K11-D | 1 |
| | | (4) |
| 26-WA-275[d] | | |
| surface | M7-40 | 1 |
| -- | M7/L9-3 | 1 |
| Level 5 | M7/L5-13 | 1 |
| -- | M7/L4-20 | 1 |
| Level 1 | J7/K7-111 | 1 |
| | | (5) |
| | | (19) |

Notes for Table 4

(a) Partial sample of coprolites collected in 1937 by R.F. Heizer and A. Krieger (1956). In the intervening 30 years the coprolites from Humboldt Cave (NV-Ch-35) have been lost in the Lowie Museum of Anthropology. (See Roust [1967:49-88].)

(b) Coprolites from caves near Pyramid Lake, Nevada, collected by Don Tuohy in 1966-1967. The excavation data are given as noted on the data sheet of each coprolite. At this writing, only one of these sites (26-WA-525) has been reported upon (see Tuohy 1967:4-5).

(c) Coprolite from the pelvic cavity of a desiccated human body (see Rodovsky, this volume).

(d) Stratigraphic data made available to us by D. Tuohy for these specimens are incomplete.

## Conclusions

Analysis of the food remains found in 300 human coprolites from Lovelock Cave reveals that about 90 per cent of the foods known to have been consumed by the occupants of the cave were obtained from the lacustrine resources of Humboldt Sink. Seeds of aquatic or mesophytic flora, such as bulrush, cattail, waterweeds, and wetlands grasses (*Panicum*, *Elymus*) formed the bulk of the diet of the Lovelock population. Wildfowl, especially ducks and mudhens, were important dietary elements. Fish (*Gila bicolor*) were another very important food item.

It is obvious that the "lacustrine biome" was far more productive of foods useful to man than was the vaunted Pinyon-Juniper zone of the upland or "range" part of the Great Basin (see Steward 1938; 1955). The lack of seeds of the pinyon pine in coprolites and midden samples from several Great Basin Caves suggests that native reliance on pinyon seeds as "*the* primary food" (as some observers have put it), may not be true in some parts of the Great Basin during the proto-Historic period.

One can be sure that there were deficiencies in the Lovelock diet--for example, a probable lack of the vitamins usually obtained by consumption of fresh fruit, and a possible calcium deficiency. In spite of this, the lacustrine resources made possible a relatively stable existence in the vicinity of the Great Basin Lakes.

Communal food preparation is suggested by the homogeneity of the Lovelock coprolite components. Many of the bulrush seeds eaten by the occupants of the cave had not been modified by milling prior to ingestion. This might indicate that these seeds were eaten while the Indians were in residence at the cave (few milling implements having been found in the cave midden), perhaps during times when the lakeshore sites were flooded. It is a matter of interest to find that very few of the seeds found in the Lovelock coprolites exhibit evidence of having been milled by means of a mano and metate. Therefore, one cannot assume, by the absence of these types of milling implements in the artifact assemblages of Great Basin archaeological sites, that seeds were *not* part of the subsistence regime. It is probable that the ordinary method of seed preparation involved reducing them to flour and cooking by stone-boiling in baskets. At Lovelock Cave water for cooking may have been in short supply and required a hike to the lake edge. An alternative method of seed preparation utilized by people who were temporarily visiting in the cave seems to have been to parch the seeds and swallow them whole. In this light, the cave occupants can be seen as travelling light -- "camping out" as it were.

One of the parameters which we hoped to investigate by coprolite analysis was the probable season or seasons during which the cave was occupied. Unfortunately, most (if not all) of the food items found in the coprolites could have been stored for an indefinite time after collection. The majority of the foods represented in the coprolites were most plentiful for harvest during the autumn months, and for this reason it is possible to suggest that Lovelock Cave was occupied in late fall, during the winter months, and in early spring. Foods collected in the fall might have provided a small surplus to aid in survival through the winter months. Wildfowl would have been one of the winter mainstays, and seeds, especially Scirpus, which were collected during the autumn months, helped to provide a reasonably well-balanced dietary during the lean winter months.

The overriding use of lacustrine resources at Lovelock Cave demonstrated by the contents of the human coprolites found in Lovelock Cave is interpreted as a manifestation of a well-developed subsistence pattern or adaptation, for which the name "Lacustrine Subsistence Pattern" has been proposed (Napton 1969: 28-97).

The Lacustrine Subsistence pattern in the western Great Basin may be seen as a long continued and increasingly intensive exploitation of lake, riverine, and wetlands resources. The earliest manifestation of this pattern probably occurred in the vicinity of the post-Lahontan lakes that covered most of Nevada and parts of Oregon and California (Russell 1885; Morrison 1964). As Rozaire (1963) has suggested, the lacustrine pattern might have persisted over a very long period of time. The first native occupants of the Great Basin would have been drawn to the lake and marsh areas by the presence of game and other types of foods. The initial phase of the lacustrine susbistence adaptation probably began with occasional use of wetlands resources. Later, increased use was made of wildfowl, seeds, and fish, as techniques for obtaining these foods gradually became more sophisticated.

The prehistoric subsistence regime which we have outlined here probably obtained elsewhere on the margins of other Great Basin lakes such as Carson Sink, Walker Lake, and Pyramid Lake, though we assume that in these locations there could have been local specializations not present at Humboldt Lake. Outside the Great Basin, as indicated earlier by Jennings and Norbeck (1955:1-11), several areas in southern Oregon and Northern California display an ethnographic manifestation of this regime (Barrett 1910), and the same is true in recent times for the Tulare Lake area (Beals and Hester 1958:211-217), as well as the Clear Lake area in central California (Barrett 1952).

Summary: The human coprolites found in the Lovelock Cave WA, WE, AN, LX, ENT and INT areas (300 processed specimens) represent a well-developed phase of the lacustrine subsistence pattern in western Nevada; see Barrett (1910:230-292), Jennings and Norbeck (1955:1-11); Heizer and Krieger (1956); Beals and Hester (1958:211-217); Rozaire (1963:72-77); Davis (1966:147-165); Napton (1969:28-97). We do not, however, witness in the archaeology or coprology of Lovelock Cave the beginning or initial development of the lacustrine subsistence adaptation in the Great Basin. Instead, the occupation of Lovelock Cave was made possible by the cumulative result of centuries of human adaptation to, and modification of, the circumstances of Great Basin environment. Humboldt Lake is known to have been subject to extremes of flooding and occasional desiccation, and the human population living in the vicinity of the lake made use of lacustrine flora and fauna when these resources were available. In the event of failure of the lacustrine resources, the Indians turned to foods derived from other ecological or economic "niches" in the Humboldt Valley and adjacent areas.

The initial occupation of Lovelock Cave, circa 2000 B.C., might have resulted from rejuvenation of the lake following prolonged water resource failure prior to 3000 B.C. The earliest evidence afforded by the Lovelock Cave coprolites suggests that the first occupants of Lovelock Cave subsisted on foods obtained from lacustrine sources. The roots of this economic orientation will probably prove to lie, when they are finally run to earth, in the post-Lahontan-Bonneville lacustrine or riverine adaptation, such as that hinted at by surface finds of artifacts on the Black Rock Desert, northwestern Nevada (Clewlow 1968b:1-94; Tuohy 1968:6-9).

The single most important fact demonstrated by the Lovelock Coprolite Research and Analysis Project, during 1967-1970 is the intensive, overriding utilization of lacustrine resources, extending (if the coprolite and midden evidence found in Lovelock Cave is any criteria), from as early as 1500 B.C. to as late as A.D. 1805--a scant 24 years prior to the arrival of white men in western Nevada. The longevity and stability of the "Lovelock" dietary can be interpreted as evidence of a very lengthy (if discontinuous) occupation of this site and the surrounding area by a group (or groups) whose culture was very similar to that of the Northern Paiute of the Historic Period--so much so, in fact, that arguments for cultural or linguistic discontinuities in this part of Nevada, based on the presence or absence of certain traits in the Northern Paiute and Lovelock material cultures, would seem to be fallacious, in view of the archaeological and coprological evidence provided by the study of Lovelock Cave and adjacent archaeological sites.

## Sample Size in Coprolite Analyses

Impressive numbers of human coprolites have been analyzed from sites in the Great Basin, Mexico, Kentucky and Peru, and a great amount of detailed information on dietary items has been secured. On the basis of these analyses, certain generalizations on changes of diet over time have been proposed, but the present authors are doubtful whether some of these generalizations are correct. Many of these generalizations are based on analysis of very small numbers of coprolites obtained from sites which have been occupied for very long periods of time. The data given in Table 5 illustrate this point. By dividing the number of coprolites into the time span of occupation, the average coprolites/year ratio ranges from as low as 1/9 to as high as 1/365. While such a calculation is admittedly arbitrary, in default of more precise information as to dating, this means that we have a record of one meal eaten by one person on the average of once each nine years to once each three hundred and sixty five years. While it is generally true that there is a readily discernible pattern in the diet of the occupants of each of the archaeological sites from which coprolites have been collected and examined, it is nevertheless true that there is a good deal of variation in the contents of individual coprolites. It is even possible that in some cases a very small number of coprolites from a single layer could have been left there by a single person or a single family during a brief sojourn. We are not arguing that this is the case, yet the limited number of samples from one layer which was laid down over a fairly considerable period of time (e.g. two coprolites from the Ajalpan phase, Tehuacan Valley, dating 1500 to 900 B.C.; six coprolites from Danger Cave I, Utah, laid down between 9500 and 7000 B.C.) are scarcely sufficient to be taken as anything but a minute sampling of ancient diet.

We are not disputing the fact that precise information can be obtained by analysis of human coprolites; however, when the number of samples is small, broad generalizations about diet or trends of change through time may be in error. We are unable to suggest a universally applicable number which would, in our opinion, constitute an adequate sample of coprolites on which to base tenable general conclusions about ancient diet. We cannot do this because we do not know anything in detail about how the dry cave or shelter sites in Mexico or the Great Basin were used in prehistoric times. Merely because a cave is large and contains a considerable amount of occupation refuse does not mean that it was used by large numbers of people. Lovelock Cave was apparently not permantly lived in on a daily basis, but rather was occupied on a temporary or seasonal basis. Twenty occupants would presumably leave only one-fifth as many coprolites as evidence of a sojourn there as one hundred people would, and because we do not know how many people used the cave we have no way of judging whether the 6000 coprolites which we have collected were left there by only a few or many occupants. It is because of these and other imponderables that it is difficult to make unequivocal statements about the diet of a social group over long periods of time.

Table 5

| No. analyzed | Period and age | No./year |
|---|---|---|
| TEHUACAN VALLEY, MEXICO (1) | | |
| 14 | Venta Salada (700-1500 AD) | 1/57 |
| 59 | Palo Blanco (200 BC-700 AD) | 1/15 |
| 18 | Santa Maria (900-200 BC) | 1/39 |
| 2 | Ajalpan (1500-900 BC) | 1/300 |
| 0 | Purron (2300-1500 BC) | -- |
| 5 | Abejas (3500-2300 BC) | 1/240 |
| 12 | Coxcatlan (5000-3500 BC) | 1/125 |
| 6 | El Riego (pre-5000 BC) | ? |
| 116 | Time span---+7000 years | 1/60 av. |
| DANGER CAVE, UTAH (2) | | |
| 3 | DC V (surface) age? | -- |
| 9 | DC V (2950 BC-20 AD) | 1/330 |
| 8 | DC IV - - - - - - - | -- |
| 8 | DC III (7100-6560 BC) | 1/68 |
| 9 | DC II (7800-7000 BC) | 1/90 |
| 6 | DC I (9500-7000 BC) | 1/416 |
| 43 | Time span---10,000 years | 1/230 av. |
| TAMAULIPAS, MEXICO (3) | | |
| ca. 250 | 6000 BC - 1500 AD | 1/30 |
| HUACA PRIETA, PERU (4) | | |
| 15 | HP-3 (3000 BC-800 BC) | 1/147 |
| 6 | HP-5 (800 BC-500 BC) | 1/50 |
| SALTS CAVE, KENTUCKY (5) | | |
| 3 | Lower SC (1190-770 BC) | 1/210 |
| 11 | Middle SC (400-710 BC) | 1/29 |
| 87 | Upper SC (890-290 BC) | 1/7 |
| 101 | Time span---900 years | 1/9 av. |
| HOGUP CAVE, UTAH (6) | | |
| 2 | Kelton Phase (1350-1850 AD) | 1/250 |
| 5 | Hogup Phase (400-1350 AD) | 1/180 |
| 1 | Elko Phase (1500 BC-400 AD) | 1/1900 |
| 19 | Wendover Complex (8000-1500 BC) | 1/340 |
| 27 | Time span---9850 years | 1/365 |

Table 5 (continued)

| No. analyzed | Period and age | No./year |
|---|---|---|
| LOVELOCK CAVE, NEVADA (NV-Ch-18)(7) | | |
| 300 | 2000 BC-1800 AD | 1/12 |
| BAUMHOFF'S SHELTER, NEVADA (NV-Pe-8) | | |
| 12 | 1 AD-1800 AD (est) | 1/150 |
| HIDDEN CAVE, NEVADA (NV-Ch-16) | | |
| 85 | 1000 BC-1800 AD | 1/33 |
| HUMBOLDT CAVE, NEVADA (NV-Ch-35) | | |
| 10 | 1 AD-1850 AD | 1/185 |

Notes for Table 5

1. Data from Callen (1967:261-289). (See also Callen 1968:641-656.)

2. Danger Cave coprolite data from Fry (1968). Archaeological stratigraphic data from Jennings (1957). Unpublished radiocarbon determinations obtained since 1960 provided by Jennings (personal communications to Heizer and Napton, 1968-9).

3. Data from Callen (1963).

4. Coprolite data from Callen and Cameron (1955:51; 1960:35-37, 39-40). Numerical data from Callen (personal communication to Heizer, 1969).

5. Data from Watson (1969).

6. Coprolite data from Fry (1968).

7. Data from Nevada caves given in this article, Tables 3, 4.

## Explanation of Tables 6-10

Table 6: Coprolite constituents from Lovelock Cave, Nevada, WA and WE areas, expressed graphically as percentages. The full width of each column is equivalent to one hundred per cent. The WA coprolites analyzed are given as aggregate percentages by depth in inches. The contents of small samples of the WA midden (0-12M, 12-24M, 24-26M) are given for comparison. Coprolites from the WE area are given in groups by depth, from 48 to 72 inches. Note the prevalence of *Typha* in the upper level coprolites and the occurrence of *Elymus* in the lower level coprolites from the West Alcove.

Table 7: Coprolites from the AN unit, Lovelock Cave, Nevada. The coprolite constituents are listed by percentage and are arranged in stratigraphic sequence. AN1-5, depth surface to 6 inches; AN-6, 48-56 inches; AN7-10, 72 inches; AN11-15, 84 inches below the existing surface of the test unit. The prevalence of *Typha* in the upper levels and *Elymus* in the lower levels is evident in this sample of coprolites.

Table 8: Coprolites from unit LX, Lovelock Cave, Nevada, NV-Ch-18. LX1,2,3, 17 and 18 depth, 0-12 inches deep; LX4,5,6, 24-36 inches; LX7,8,9, 29, and 30, 36-48 inches; LX10,11,12,41 and 42, 48-60 inches; and LX13,14, and 15 were found 84 inches below the existing surface of the test unit.

Table 9: Sample WA midden constituents and sample ENT and INT coprolite constituents, expressed by frequency of occurrence. Sample constituents are arranged in random sequence in order to emphasize the difference between the constituents of Lovelock Cave, Humboldt Cave, and Pyramid Lake coprolites. Coprolites ENT (E) 10,11,33,38 and INT (I) 5,6,24, and 32 are selected by random numbers. *Typha* is dominant in the ENT coprolites (dated A.D. 1805), and in samples taken from the upper 18 inches of the West Alcove midden.

Table 10: Coprolites from Humboldt Cave, Nevada. (See Table 4 for stratigraphic data.) Compare the data in the first half of Table 9 to data in the second half of the table, pertaining to coprolites from Pyramid Lake, Nevada.

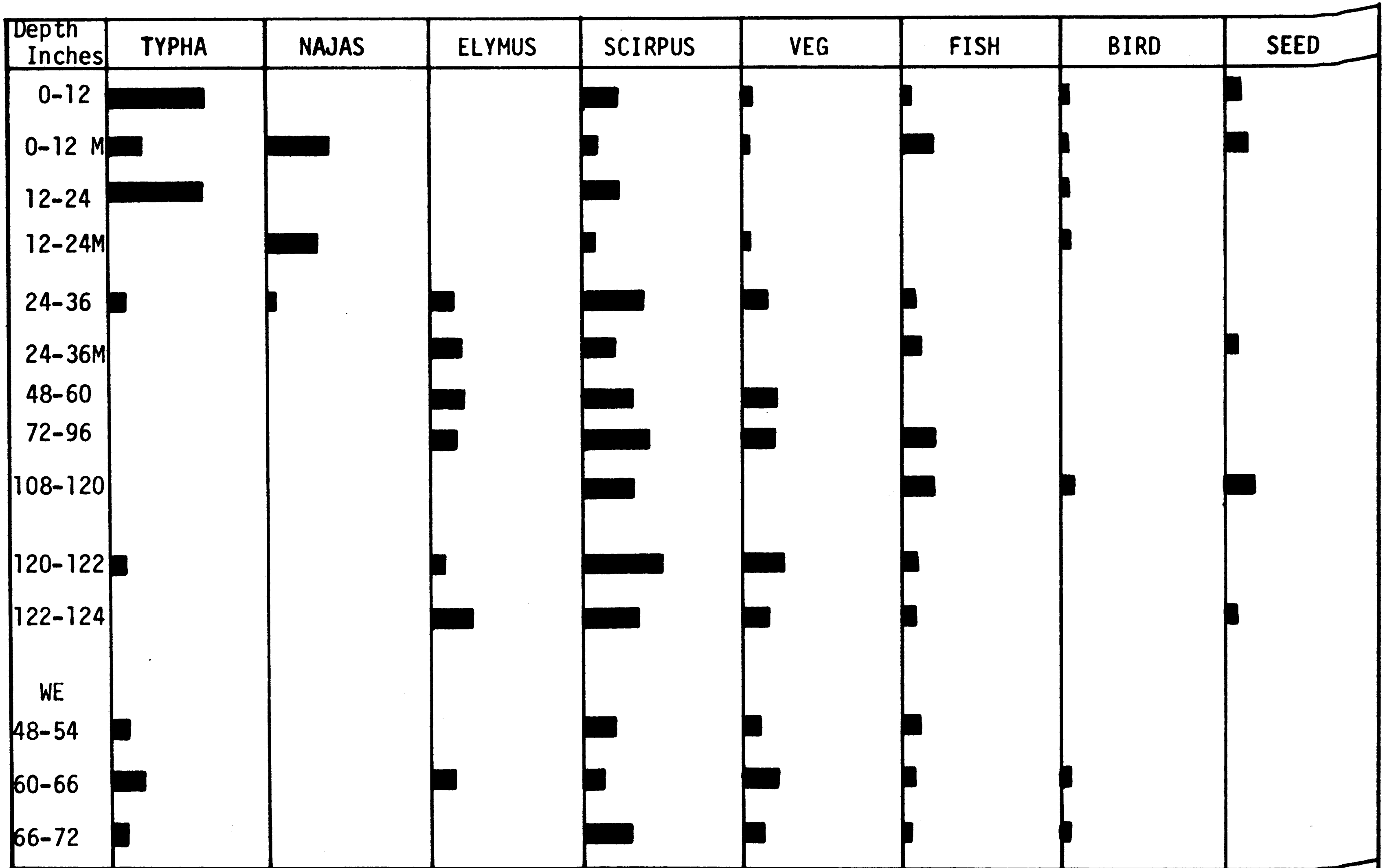


Table 6: Lovelock Cave, Nevada (NV-Ch-18), WA and WE areas, coprolite constituents by percentage. Depth in inches given in right-hand column.

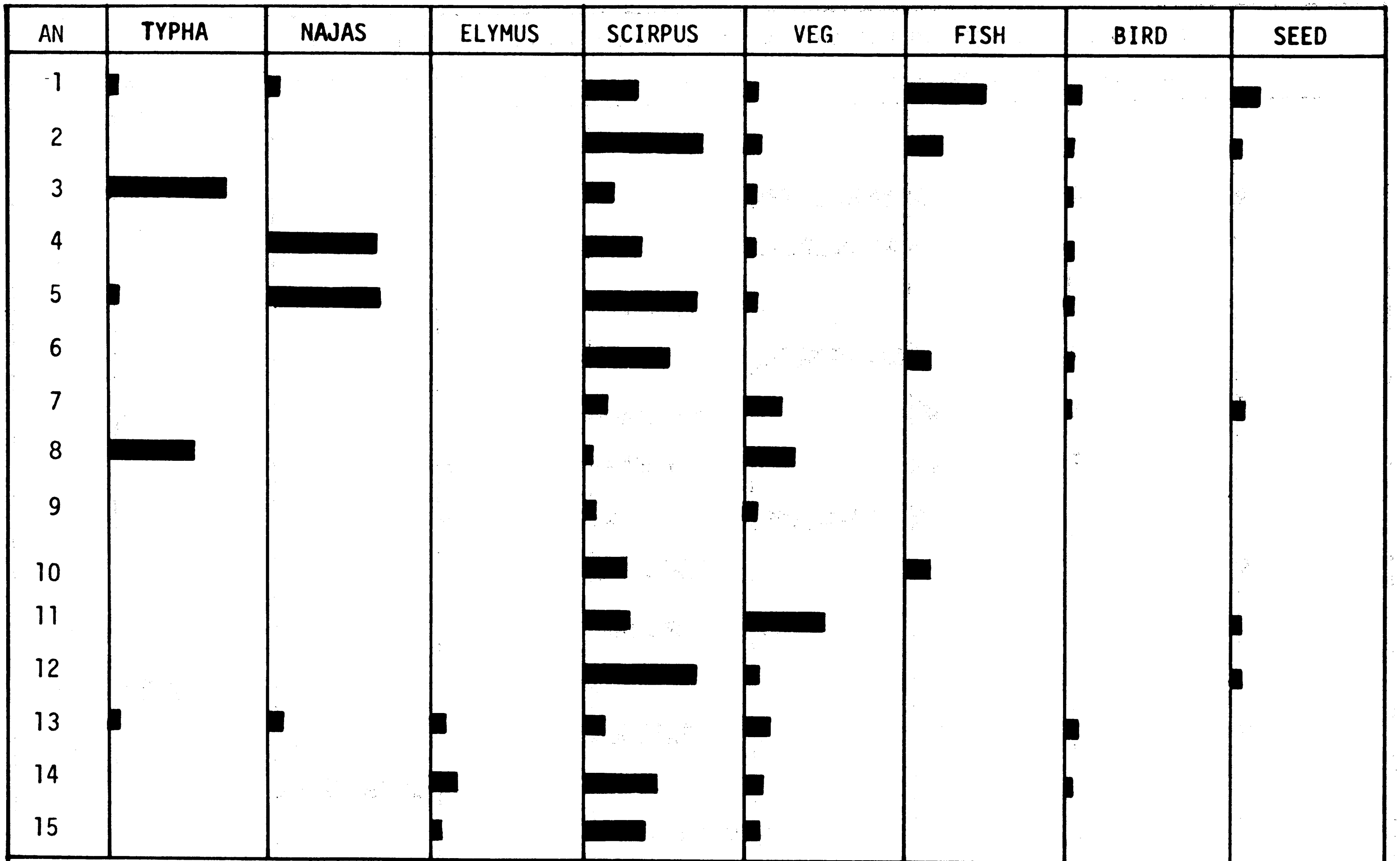


Table 7 Lovelock Cave, Nevada (NV-Ch-18), AN unit, coprolite constituents by percentage. Specimens AN 1-15 are in stratigraphic sequence.

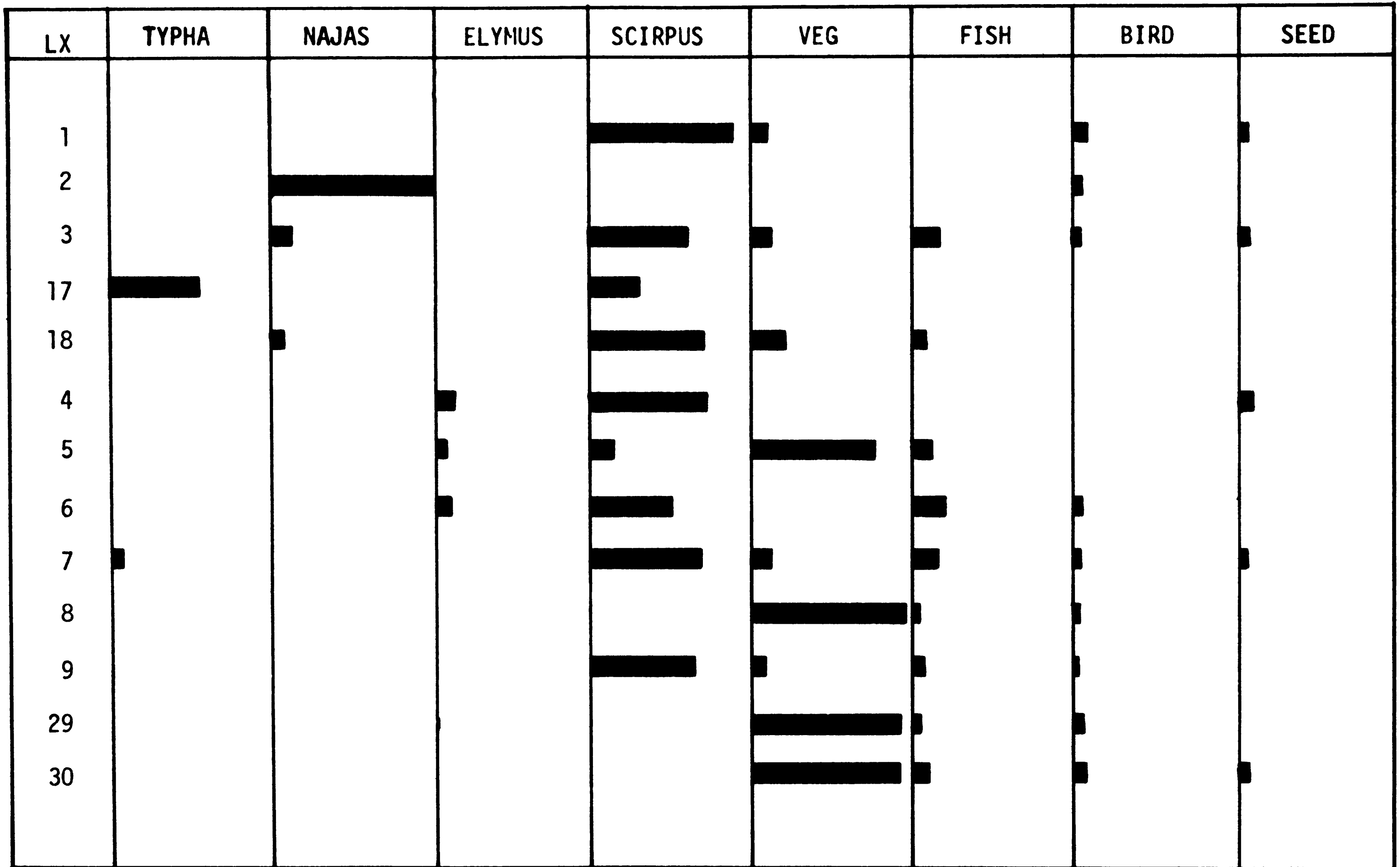


Table 8 Lovelock Cave, Nevada (NV-Ch-18), LX unit, coprolite constituents by percentage, arranged by depth. (See Explanation of Tables 6.14-6.18.)

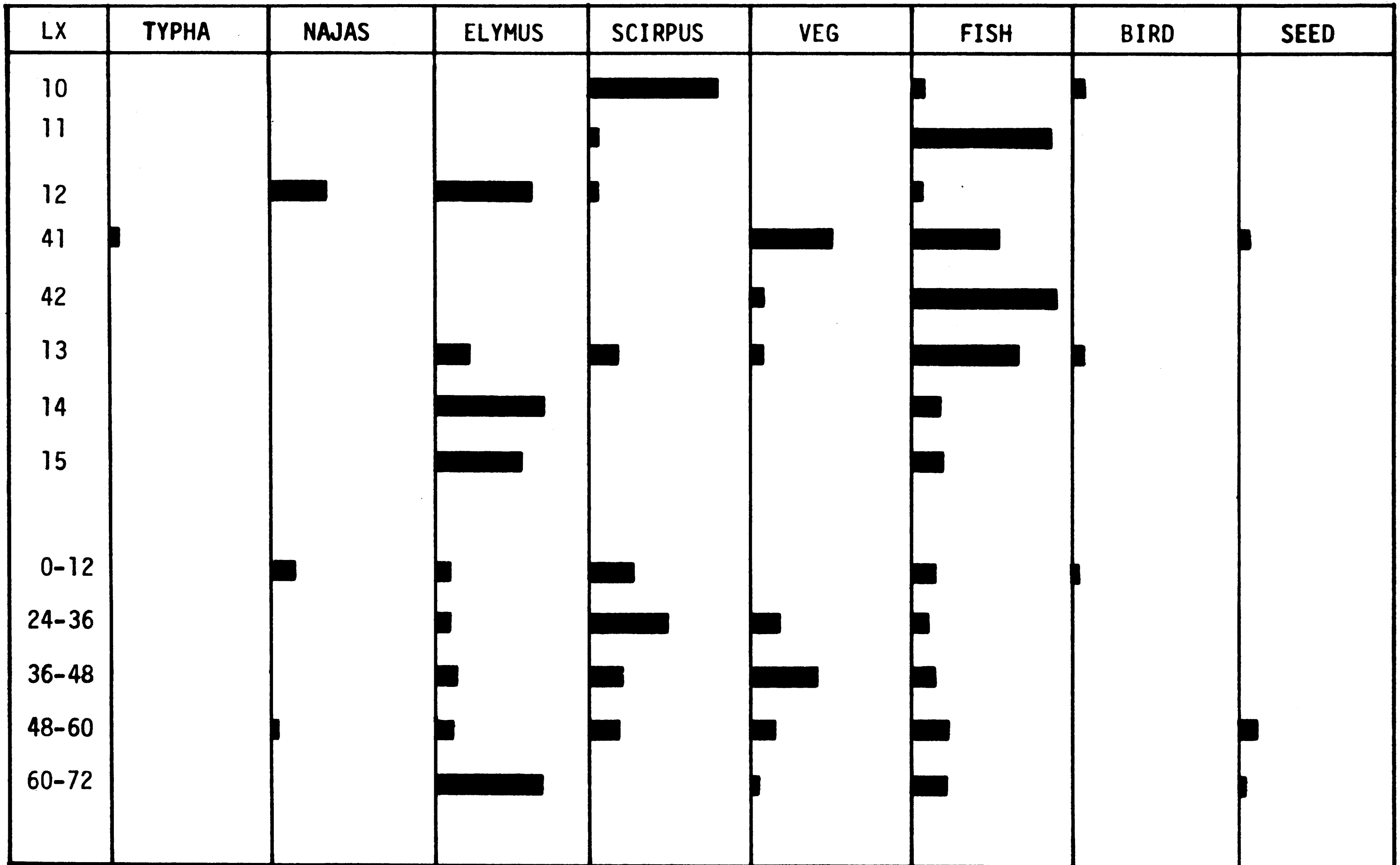


Table 8 (Con't): Lovelock Cave, Nevada (NV-Ch-18), LX unit, coprolite constituents. "Group"totals by depth in inches.

| | Typha | Feathers | Rodent Hair | Bone | Fish bone | Charcoal | Fish Scales | Elymus | Atriplex | Human hair | Scirpus R. | Distichlis | Insect | Spheroids | Vegetal | Oryzopsis | Cricket | Mentzelia | Deer hair | Lizard | Ruppia | Potamogeton | Panicum | Suaeda |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 WA | ■ | | | ■ | | | | | | | ■ | | | | | | | | | | | | | |
| 7 WA | ■ | | | ■ | | | | | ■ | | ■ | | | | | | | | | | | | | |
| 8 WA | ■ | | ■ | ■ | | | | | ■ | | ■ | | | | ■ | | ■ | | | | | | ■ | |
| 11 WA | ■ | | ■ | | | ■ | | | | | ■ | | | | | | | | | | | | ■ | |
| 15 WA | ■ | | ■ | ■ | | ■ | | | ■ | | ■ | | | | ■ | | | | | | | | ■ | |
| E10 | ■ | ■ | | | ■ | ■ | | | | | ■ | ■ | | ■ | ■ | | | | | | | | | ■ |
| E11 | ■ | ■ | | ■ | ■ | | | | | | | ■ | | ■ | ■ | | | | | | | | | ■ |
| E33 | ■ | ■ | | ■ | ■ | | | | | | ■ | | | ■ | ■ | | | | | | | | | |
| E38 | ■ | ■ | | ■ | | | | | | | ■ | ■ | | | | | | | | | | | | |
| I5 | | ■ | | | ■ | | ■ | | | | ■ | | | | ■ | | | | | | | | | ■ |
| I6 | ■ | ■ | | | ■ | | ■ | ■ | ■ | | ■ | | | | | | | | | | | | | |
| I24 | ■ | ■ | | | ■ | | | | ■ | | ■ | | | | ■ | | | | | | | | | |
| I32 | ■ | | | ■ | | | | | ■ | | ■ | ■ | | | | | | ■ | | | | | | |

Table 9 Lovelock Cave, Nevada(NV-Ch-18), ENT and INT constituents and WA midden samples. Five ENT (E) and five INT (I) specimens selected by random numbers.

| NV-Ch 35 | Typha | Feathers | Rodent Hair | Bone | Fish bone | Charcoal | Fish Scales | Elymus | Atriplex | Human hair | Scirpus R. | Distichlis | Insect | Spheroids | Vegetal | Oryzopsis | Cricket | Mentzelia | Deer hair | Lizard | Ruppia | Potamogeton | Panicum | Suaeda |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | | | | | | | | | | | | | | | |
| B | | | | | ■ | | | ■ | ■ | ■ | | | | | | | | | | | | | | |
| C | | | | | | | | | | | | | | | | | | | | | | | | |
| D | ■ | ■ | | | ■ | | | | | | ■ | ■ | ■ | ■ | | | | | | | | | | |
| E | | ■ | | | ■ | | | | | | ■ | ■ | | | ■ | | | | | | | | | |
| F | | | | | | | | | | | ■ | | | | ■ | | | | | | | | | |
| G | ■ | ■ | ■ | ■ | ■ | | ■ | | ■ | | ■ | | | | ■ | | | | | | | | | |
| H | | ■ | | | | | | ■ | | | ■ | | | | ■ | | | | | | | | | |
| I | ■ | | | ■ | ■ | ■ | ■ | | | ■ | | | | ■ | ■ | | | | | | | | | |
| J | | | ■ | | | ■ | | | | | ■ | | | | ■ | | | | | | | | | |
| (ALL) | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | | | | | | | |

Table 10 Humboldt Cave, Nevada (NV-Ch-35), coprolite constituents by occurrence. Sample constituents are selected and grouped at random.

| [site] | Typha | Feathers | Rodent Hair | Bone | Fish bone | Charcoal | Fish Scales | Elymus | Atriplex | Human hair | Scirpus R. | Distichlis | Insect | Spheroids | Vegetal | Oryzopsis | Cricket | Mentzelia | Deer hair | Lizard | Ruppia | Potamogeton | Panicum | Suaeda |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [275] | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | | | | ■ | | | | | | | | | | | ■ | ■ | ■ | | | | | | | |
| 13 | | ■ | | | ■ | ■ | ■ | | | | | | | ■ | ■ | | ■ | ■ | | | | | | |
| 20 | | | | ■ | ■ | | | | | | | | | | ■ | | | ■ | | | | | | |
| 40 | | | | | | | ■ | | ■ | ■ | | | | ■ | ■ | ■ | ■ | ■ | | | | | | |
| 45 | | | | ■ | ■ | ■ | ■ | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | | | | | |
| 111 | | | ■ | | | | | | | | | | | | ■ | | ■ | | | ■ | ■ | | | |
| [385] | | | | | | | | | | | | | | | | | | | | | | | | |
| A | ■ | | | | ■ | ■ | | ■ | ■ | | ■ | | | ■ | ■ | | | | | | | | | |
| B | ■ | ■ | | ■ | | | ■ | | ■ | | ■ | | | | ■ | | | | | | ■ | | | |
| C | ■ | ■ | ■ | ■ | ■ | | | ■ | ■ | | ■ | | | | ■ | ■ | | ■ | ■ | | ■ | | | |
| D | | | | ■ | | | | | | | ■ | | | | ■ | ■ | | | | | ■ | ■ | | |
| [525] | | | | | | | | | | | | | | | | | | | | | | | | |
| A | | ■ | ■ | | | ■ | | | ■ | | | | | | ■ | ■ | | | | | | | | |

Table 10 (Con't): Coprolites from cave sites at Pyramid Lake, Nevada. Sample constituents are selected and grouped at random.

## Notes

1. Vegetal materials from the "Thirty-Two Inch" midden in Hidden Cave (NV-Ch-16) were collected in 1955 by P.C. Orr. According to Orr, these materials date the human occupation of this segment of the cave deposit. The radiocarbon age of the vegetal materials is 1094 B.C. ± 200 (L-289-BB, Broecker and Kulp 1957:1324-1334). Radiocarbon determinations of the age of human coprolites from this midden would be of great interest, in view of the fact that the contents of many of the Hidden Cave coprolites analyzed by Roust (1967:49-88) are remarkably similar to coprolites from Lovelock Cave.

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## Abbreviations Used

| | |
|---|---|
| AA | American Anthropologist |
| AAnt | American Antiquity |
| CFG | California Fish and Game |
| DRI-TRS S-H, | Desert Research Institute Technical Research Series S-H, |
| SSH-P | Social Sciences and Humanities Publications |
| JG | Journal of Geology |
| JSP | Journal of Sedimentary Petrology |
| JWM | Journal of Wildlife Management |
| KAS | Kroeber Anthropological Society |
| -SP | Special Publication |
| NAS-R | Nevada Archaeological Survey Reporter |
| NGM | National Geographic Magazine |
| NSM | Nevada State Museum |
| -AP | Anthropological Papers |
| SAA | Society for American Archaeology |
| -M | Memoir |
| UC | University of California |
| -ARF-C | Contributions of the University of California Archaeological Research Facility |
| -ASR | Archaeological Survey Reports |
| -PAAE | Publications in American Archaeology and Ethnology |
| USGS | U. S. Geological Survey |
| -M | Monograph |
| -PP | Professional Paper |
| UU | University of Utah |
| -AP | Anthropological Papers |


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